# Undergraduate Research Opportunities Program | Proceedings 2017-18



UROP Research

香港科技大學
THE HONG KONG
UNIVERSITY OF SCIENCE
AND TECHNOLOGY

# Table of **Contents**

*\* Abstracts from each School are listed first by alphabetical
order of Department code, and then by alphabetical
order of Advisor's surname.*

# Summary of **UROP Courses**

**UROP 1000** Undergraduate Research Opportunities Program

*0 credit with stipend option, offered in summer session only*

**UROP 1100** Undergraduate Research Opportunities Program Series 1

*1 credit, offered throughout the year*

**UROP 2100** Undergraduate Research Opportunities Program Series 2

*1 credit, offered throughout the year; prerequisite is pass in **UROP1100**, with approval by project advisor*

**UROP 3100** Undergraduate Research Opportunities Program Series 3

*1 credit, offered throughout the year; prerequisite is pass in **UROP2100**, with approval by project advisor*

**UROP 4100** Undergraduate Research Opportunities Program Series 4

*1 credit, offered throughout the year; prerequisite is pass in **UROP3100**, with approval by project advisor*

# | Message from the **President**

As humans, we're all born curious. When we're babies, we explore the world through the five senses – taste, touch, smell, sight, and hearing. As we grow older, curiosity drives us to question, to experiment and to learn.

As American folklorist and writer Zora Neale Hurston once said, "Research is formalized curiosity. It is poking and prying with a purpose." That is why the Undergraduate Research Opportunities Program (UROP) is important to us. It helps students explore their interested areas under the guidance of experienced researchers, leading them to the path of new discoveries.

I'm glad to witness another year of success for the UROP in 2017-18. Hundreds of undergraduate students started their research journey by joining the program. Faculty members also benefited from the program through the interactions with these curious and creative millennials, who often bring in unconventional and unexpected ideas to the research project.

This collection of program proceedings showcases the achievements of many supervisor-student synergies, which help strengthen the research culture within the HKUST community. I hope to see more of this intellectual give-and-take in the years to come.

**Prof Wei Shyy**
*President*
HKUST

# **Sharing** by Students

I first joined UROP when I was in Year 2. Frankly speaking, I joined the programme at that time just because I got one unused credit and would not like to waste it. Yet, I now dare to say I have never regretted participating in UROP. In my opinion, UROP is a platform for you to analyse real-world stuff with first principles. Under professors' supervision, you will be given a chance to apply your textbook knowledge to solve problems, and you will know how useful what you have learnt can be. If you dare to challenge yourself, just join UROP, and it will be a fruitful experience.

**YIP Chun Yin**
*Major in Physics, Year 4*

**GU Qiao**
*Major in Electronic Engineering and Computer Science, Year 3*

UROP has been a great opportunity for me to learn useful skills and apply them in real-world problems, not only about how to use a kind of software, how to conduct a literature review and how to design an experiment, but also about the art of teamwork, like how to achieve balanced workload, and how to coordinate and motivate team members. Moreover, I have got a taste of the nature of research. The curiosity in the exploration and the excitement in the discovery have really inspired me to continuously study deeper into the problem, which I believe is exactly what keeps a researcher enthusiastic.

From walking into the lab as a lost and perplexed student with absolutely no prior experience in conducting research or reviewing literature, to growing personally and academically every moment – UROP has been undoubtedly one of the most treasured journeys of mine at HKUST. The program has allowed me to discover my dormant fascination for research and has helped me develop crucial experimental and critical thinking skills. It has not only helped me decide a path for my future career but has also introduced me to some of the most amazing people without whom life simply would not have been so splendid!

**HASSAN Shaoli**
*Major in Biochemistry and Cell Biology, Year 3*

# UROP Overview
## 2017–18

In the 2017-18 academic year, we are glad to see the Undergraduate Research Opportunities Program (UROP) continued to thrive amongst undergraduate students and faculty members. Over 450 UG students joined the program during 2017-18, a 12% increase from the previous academic year. These students were supervised by 140 faculty members who served as a UROP advisor voluntarily.

Through the UROP Faculty Support Grant, UROP students have a chance to taste how to apply for research funding by submitting a joint application with their supervisors. In 2017-18, more than 90 applications were received and reviewed by the UROP Office and the UROP Advisory Board. In total, over $500,000 were awarded to support the UROP projects.

## 2018
### Mr. Armin and Mrs. Lilian Kitchell Undergraduate Research Award and UROP Faculty Research Award

The **Mr. Armin and Mrs. Lilian Kitchell Undergraduate Research Award** and the UROP Faculty Research Award continued to honor the outstanding achievements by UROP students and their supervisors in 2018. We gladly received 30 nominations from UROP faculty supervisors to recognize their students' research accomplishments through the award. Nine of them made it to the finalists and six of them were named as awardees.

The Award Presentation Ceremony was held on April 19, 2018 at the Cheung On Tak Lecture Theater (LTE) at the HKUST. The UROP Week 2018 during April 16 to 20 exhibited these students' research results and introduced the UROP to more undergraduate students and faculty members in order to encourage their participation in the program.

# Mr. Armin and Mrs. Lillian Kitchell
## Undergraduate Research Award 2018

## List of Awardees

### Champion
**ZHU Lingbang**
*Major/Year:* PHYS-IRE / Year 3
*Supervised by:* **Professor DU Shengwang / PHYS**
*Project Title:* Generating Narrowband Entangled Photon Pairs from a Hot Atomic Vapor Cell

### First Runner-up
**REN Da Wei David**
*Major/Year:* PHYS / Year 4
*Supervised by:* **Professor LI Larry / MAE**
*Project Title:* Confinement Effects on a Planar Dense Wake

### First Runner-up
**YIP Chun Yin**
*Major/Year:* PHYS / Year 4
*Supervised by:* **Professor SZETO Kwok Yip / PHYS**
*Project Title:* Random Walk on Complex Network and Application to Numerical Simulation for Statistical Physics

### Second Runner-up
**GU Qiao**
*Major/Year:* ELEC & COSC / Year 3
*Supervised by:* **Professor QU Huamin / CSE**
*Project Title:* Developing a Visual Analytic System for Traffic and Pollution Patterns

### Second Runner-up
**HASSAN Shaoli**
*Major/Year:* BCB-IRE / Year 3
*Supervised by:* **Professor WEN Zilong / LIFS**
*Project Title:* Unveiling the Role of the Three Csf1ra Ligands in Zebrafish Microglia Development

### Second Runner-up
**WANG Juntao**
*Major/Year:* PHYS / Year 4
*Supervised by:* **Professor WONG Michael K Y / PHYS**
*Project Title:* Dynamics of Housing Prices

### Best Poster Award
**HASSAN Shaoli**
*Major/Year:* BCB-IRE / Year 3
*Supervised by:* **Professor WEN Zilong / LIFS**
*Project Title:* Unveiling the Role of the Three Csf1ra Ligands in Zebrafish Microglia Development

# UROP Sponsorship Recipients

The UROP sponsorship scheme is intended to give UROP students financial support to publish their papers in international journals, to present their posters or papers at academic conferences, or to participate in research-related summer schools or workshops during their undergraduate studies.

Students who have been awarded UROP sponsorships in 2017-18 are listed as follows:

## UROP Research Travel Sponsorship *(by alphabetical order of student's surname)*

*Student:* **CHUENG Long Him**
*Major:* PHYS
*Supervised by:* **Professor SZETO Kwok Yip / PHYS**
*Conference:* The Leading European Event on Bio-Inspired Computation (Evostar 2018)
*Venue:* Parma, Italy
*Duration:* Apr 4 - 6, 2018

*Student:* **GUO Wenshuo**
*Major:* PHYS & COSC
*Supervised by:* **Professor SZETO Kwok Yip / PHYS**
*Conference:* The 6th International Conference on Complex Networks and Their Applications
*Venue:* Lyon, France
*Duration:* Nov 29 - Dec 01, 2017

*Student:* **LAU Albert Wai Kit**
*Major:* PHYS
*Supervised by:* **Professor WONG Michael / PHYS**
*Conference:* International Astronautical Congress
*Venue:* Adelaine, Australia
*Duration:* Sep 25 - 29, 2017

*Student:* **LEE Ting Ting**
*Major:* COMP
*Supervised by:* **Professor HUI Pan / CSE**
*Conference:* The 16th ACM International Conference on Mobile Systems, Applications, and Services (MobiSys 2018)
*Venue:* Munich, Germany
*Duration:* June 10 - 15, 2018

*Student:* **NG Yat Hei**
*Major:* PHYS-IRE
*Supervised by:* **Professor WONG Michael / PHYS**
*Conference:* International Astronautical Congress
*Venue:* Adelaine, Australia
*Duration:* Sep 25 - 29, 2017

*Student:* **REN Da Wei David**
*Major:* PHYS
*Supervised by:* **Professor LI Larry / MAE**
*Conference:* American Physical Society Division of Fluid Dynamics 2017
*Venue:* Denver, Colorado, USA
*Duration:* Nov 19 - 21, 2017

*Student:* **REN Da Wei David**
*Major:* PHYS
*Supervised by:* **Professor LI Larry / MAE**
*Conference:* American Physical Society March Meeting 2018
*Venue:* Los Angeles, California, USA
*Duration:* Mar 5 - 9, 2018

*Student:* **SOBANSKA Sandra Anna**
*Major:* GBUS
*Supervised by:* **Professor CHEN Eva / SOSC**
*Conference:* The 25th Biennial Meeting of the International Society for the Study of Behavioural Development (ISSBD 2018)
*Venue:* Gold Coast, Queensland, Australia
*Duration:* Jul 15 - 19, 2018

*Student:* **YIP Chun Yin**
*Major:* PHYS
*Supervised by:* **Professor SZETO Kwok Yip / PHYS**
*Conference:* Mendel 2018 - 24th International Conference on Soft Computing
*Venue:* Brno, Czech Republic
*Duration:* Jun 26 - 28, 2018

*Student:* **ZHANG Tianpeng**
*Major:* COSC & MATH-PM
*Supervised by:* **Professor SZETO Kwok Yip / PHYS**
*Conference:* IEEE World Congress on Computational Intelligence (IEEE WCCI 2018)
*Venue:* Rio de Janeiro, Brazil
*Duration:* Jul 8 - 13, 2018

## The 5th ASPIRE Undergraduate Research Academy

Our office also sponsored three students to join the 5th Undergraduate Research Academy organized by the Asian Science and Technology Pioneering Institutes of Research and Education (ASPIRE). In 2018, the theme was Smart Cities and students in the program had an opportunity to attend special lectures delivered by expert faculty members and shared their own research findings with peer students from other universities.

Details of the participating students are as follows:

The 5th ASPIRE Undergraduate Research Academy

*Venue:*
Korea Advanced Institute of Science and Technology, Daejeon, South Korea

*Duration:*
Jul 2 - 6, 2018

*Student:*

**LIN Chuan En**, *Major:* COMP
*Supervised by:* **Professor TSUNG Fugee / IEDA**

**SIU Kwong Tai**, *Major:* PHYS
*Supervised by:* **Professor WONG Michael / PHYS**

**TAI Yee Man**, *Major:* PHYS
*Supervised by:* **Professor WONG Michael / PHYS**

Undergraduate Research Opportunities Program

Proceedings
2017-18

SCHOOL OF
SCIENCE

# Department of Chemistry

### Construction and Application of Surface Enhanced Raman Spectrometer in Biomolecules Characterization

Supervisor:      HUANG Jinqing / CHEM
Student:          CHAN Yin Hei Brian / SSCI          Course:          UROP1000, Summer

An attempt to construct a Raman spectrometer to determine the experimental Raman spectrum of different samples. Initially, the Raman spectrum of water and ethanol would be measured experimentally. The theoretical Raman spectrum would also be measured to compare with the experimental spectrum. Further usage of the Raman spectrometer could not be carried out since the spectrometer was found to be inaccurate. After the Raman spectrometer is improved, it can be used for determination of the concentration of ethanol in beer sample and monitor the chemical change of cisplatin and transplatin with DNA. Suggestions and the future prospect will be discussed.

Supervisor:      HUANG Jinqing / CHEM
Student:          LEE Yung Chi / CHEM          Course:          UROP1100, Summer

In the study, we will attempt to construct a Surface-enhanced Raman Spectrometer to characterize biomolecules and propose protocols to improve the application of Surface enhanced Raman Spectroscopy (SERS) in biomolecules detection and monitoring in real life. In the first part of the study, we have constructed a Raman spectrometer and recorded Raman spectra of simple molecules with it. The theoretical Raman spectra of the molecules were calculated using computational chemistry software and were compared with the actual spectra obtained. The methods used for computation of Raman spectra and the design and possible improvements of the spectrometer will be discussed in this progress report.

### Fast evaluation of Sweetness and Sourness of Local Fruits Using Near Infrared Spectroscopy and Data Modeling

Supervisor:      HUANG Jinqing / CHEM
Student:          LEE Yung Chi / CHEM          Course:          UROP1100, Spring

In this study, we attempted to construct a model for non-destructive determination of the quality of oranges using near infrared (NIR) spectrum of orange surfaces. Total sugar content, acidity and density were selected as the quality attributes for comparison with data from NIR spectrum and were measured from 10 sample oranges bought from local supermarkets. Near-infrared spectrum were obtained from the oranges. A combination of Principle Component Analysis (PCA) and Support Vector Machine (SVM) were employed to analyse the spectra. Two other oranges bought from the same supermarket were analysed using the model built to validate and evaluate the model. The model was found to be unreliable and inaccurate. Possible reasons and improvements of the model is discussed.

Supervisor:      HUANG Jinqing / CHEM
Student:          XU Anqi / SSCI          Course:          UROP1000, Summer

This project is aimed to construct a model for testing the quality of blueberries using a non-destructive analytical technique, Near Infrared Spectroscopy (NIRS). The sourness, the density, the condition of the white frost covered, the brands and the freshness were chosen to be the contributes to the quality of blueberries. To analyse the data and set up models for these quality-related properties and the NIR spectra measured, Principle Component Analysis (PCA), Support Vector Machine (SVM) and Python programming based data visualization methods are used in this study. In total, 119

blueberries from 5 different brands are tested for setting up and validating the models. The result is found to be relatively unreliable. Possible reasons and improvement are discussed.


### Modeling Protein-ligand Interactions Using Docking and Other Computational Tools

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| Supervisor: | HUANG Xuhui / CHEM | | |
| Student: | CHAK Man Him / CHEM | Course: | UROP1100, Fall |

Uncoupling proteins are responsible for proton leak in mammals. This is important for thermogenesis and reducing oxidative stress in organisms. Recent studies have shown that the inhibition of UCP2 could lead to a relieve in syndromes of Type 2 diabetes. However, natural purine inhibitors are too non-polar for aqueous cytosol environment while genipin possess the undesirable cross-linking ability which may interfere with other biomolecules. Therefore in this report, the binding pattern of genipin are analysed using Autodock Vina and other computational tools in light to modify and come up with better alternatives of genipin.


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| Supervisor: | HUANG Xuhui / CHEM | | |
| Student: | CHOY Ka Hei / CBME | Course: | UROP1100, Summer |

In the project, we will firstly introduce the concepts of classical mechanics such as formulation of Hamiltonian mechanics, Liouville Theorem and its equations which is crucial for developing the MSMs. Then, I will review basic principle of MSMs describing stochastic dynamics of a biomolecular system aiming to elucidate large scale conformational changes of the system via computational stimulations with high resolution of space and time that is beneficial for understanding the corresponding biological work of the investigated molecule. Finally, we will discuss the applications of MSMs such as transcription process of RNA Polymerase II and colloidal assembly process control.


### Mechanisms of Influenza A virus Replication and Implication to New Drug Discoveries

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| Supervisor: | HUANG Xuhui / CHEM | Co-Supervisor | CHEUNG Pak Hang Peter / CHEM |
| Student: | HAN Jeewon / CHEM | Course: | UROP1100, Fall |

Influenza A virus (IAV) is a notorious pandemic virus that has a high mortality in humans. Viral RNA in IAV is transcribed and replicated by RNA-dependent RNA polymerase (RdRp) in eukaryotes. Although exact pathways of RNA transcription, replication, and spread are still obscure, blocking entry and exit channels of the active site may cause the polymerase stop functioning and thus prevent viral genome from spreading. The aim of this project is to provide an insight on developing antiviral drugs by researching the RNA synthesis to validate ways to inhibit RdRp from transcribing and replicating viral genome. I will first review steps of IAV replication, leading to plans of this project, and show preliminary results.


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| Supervisor: | HUANG Xuhui / CHEM | Co-Supervisor | CHEUNG Pak Hang Peter / CHEM |
| Student: | KEI Hoi Shan / CHEM | Course: | UROP1000, Summer |

Influenza A virus (IAV) is in Orthomyxoviridae family, IAV infect respiratory system of human body and can always cause pandemics, like H1N1 (swine flu), H2N1 (Asian flu). Invention of drugs for inhibiting the virus is important for decreasing number of deaths in the pandemics. In order to design effective drug, we need to have deeper understanding on the structure of influenza A virus and the mechanism that it replicates in human body. This report will introduce the

structure of one of the subunit (PB1) of influenza A virus polymerase and investigating the activity of the polymerase after site-directed mutagenesis and outline implications of the experimental results.

## Chemistry of Aromatic Metallacycles

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| Supervisor: | JIA Guocheng / CHEM | | |
| Student: | NG Tsz Kin / CHEM | Course: | UROP1000, Summer |

Aromatic metallacycle is an important branch of organometallic chemistry, which attracts appreciable amount of interest from the research field in these years to unveil its potential in electronic applications comparing with its organic analogs, which are commonly used nowadays as organic semi-conductors and conducting organic polymers. The simplest example of aromatic metallacycle, the monocyclic metallabenzene, was well investigated by previous studies, while the development of polycyclic aromatic metallacycles was hindered by its thermal instability. Recently Professor Jia's group reported the first example of bicyclic and tricyclic metalla-arynes, which are thermally and kinetically stable for further studies in its chemical or electrical properties. This research focuses on reproducing the result of the osma-anthracyne synthesis to strengthen its reliability.

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| Supervisor: | JIA Guocheng / CHEM | | |
| Student: | WONG Tak Hin / SSCI | Course: | UROP1000, Summer |

The progress report is divided into two parts, one is the reactivity of rhenium carbine complexes with sulphur, and the other one is the design of redox flow battery. For the former one, we studied the reactivity of $[ReI(\equiv CCH_3)(dppm)_2]I$ and $[ReI(\equiv CCH_2Ph)(dppm)_2]I$ with the reaction with sulphur, and the research results was negative. For the latter one, we did the synthesis of anolyte of the battery, we used 4,4'-bipyridine as a viologen and we modified the viologen by different reagent and the product was sent to further investigation by cyclic voltammogram.

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| Supervisor: | JIA Guocheng / CHEM | | |
| Student: | WONG Ting Hei Matthew / SSCI | Course: | UROP1000, Summer |

An attempt to synthesize a new bidentate aryl phosphine ligand ($P(o-C_6H_4Me)_2(o-C_6H_4OH)$) was made. Synthetic methods for similar ligands (e.g. $P(m-C_6H_4Me)_2(o-C_6H_4OH)$) reported in literatures were found to give no reaction in this process, and different coupling reactions were thus tested to produce the oxide form of the ligand. So far, the ligand oxide has been successfully isolated, but its reduction has not yet been achieved, which is hypothesized to be due to the steric hindrance from the methyl group in the ortho position relative to the phosphorus centre. Further investigations are being carried out in attempt to obtain the ligand from its oxide.

## Application of Molecular Orbital Theory to Transition-metal Complexes

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| Supervisor: | LIN Zhenyang / CHEM | | |
| Student: | LEUNG Chung Sum / CHEM | Course: | UROP1100, Fall |

18 and 16-Electron rules are intuitive concepts that are highly useful for us to predict and understand electronic structures of transition metal complexes. In this report, studies on the electronic structures of palladium spiroaromatic complex was carried out to understand the electronic structures and geometric rearrangement of spiro-metalla aromatics, while integrating the concept of electron rules during the interpretation of the electronic structures of the metal complex. Hence, the application of 18 and 16-Electron rules can be explored under the context of metal complexes with strong π interacting ligand.

Supervisor:       LIN Zhenyang / CHEM
Student:          XIA Ruiqin / CHEM               Course:          UROP1100, Spring

Transition-metal-catalysed C-H activation has been received great attention due to their various potential application in the synthesis of heterocyclic compounds. Among them, a novel reported Rh(III)---catalysted direct C-H coupling with methyl trifluoroacrylates shows distinguished advantages but its mechanism is not clear up to now. We proposed 4 possible pathways for the reaction and to examine the correctness of each pathway. For each pathway, the optimized intermediate energy and transition state energy are calculated respectively. With the energy diagram of each pathway, we choose the pathway with the lowest energy as the correctly proposed mechanism for this reaction. Knowing the mechanism, the scope and the utility may be further expanded and suggest new ways to synthesize fluoroolefins and heterocyclic compounds.

### Development of Fluorescent Bioprobes with Aggregation-induced Emission Characteristic

Supervisor:       TANG Benzhong / CHEM          Co Supervisor:    SUNG Hoi Pang / CHEM
Student:          BAE Yeo Jin / CHEM             Course:          UROP1100, Fall
                                                                                 UROP2100, Summer

Monitoring of in situ polymerization is a crucial field to explore as it plays important roles in various aspects. In order to overcome the limitations of conventional research methods, fluorescence-based techniques were applied to investigate the viscosity change on the molecular level. Aggregation-induced emission (AIE) luminogens, tetraphehylethylene (TPE) in particular, were chosen due to its high sensitivity and unique fluorescent property. Here, dithicarbamate based agents marked with TPE were used for reversible addition fragmentation chain transfer (RAFT) polymerizations. Without using any thermal initiators, photochemistry was applied for the control of progress of reaction owing to its spatial-temporal control characteristics. The resulting polymers were then proved to be extremely sensitive towards viscosity, providing a promising method for monitoring the in situ polymerization.

Supervisor:       TANG Benzhong / CHEM          Co Supervisor:    SUNG Hoi Pang / CHEM
Student:          WONG Ting Hei / CHEM          Course:          UROP1100, Summer

In medical perspective, AIEgens can be used as bioprobes, for cell imaging, and even therapy. This project aims to design and synthesize useful AIEgens, so as to explore the potential of AIEgens for biological imaging and in therapeutical uses. In this work, two molecules: TBT and TBE were synthesized. Their photophysical characteristics were studied; their ability for reactive oxygen species (ROS) generation and cell imaging were assessed; so that their potential for performing image-guided photodynamic therapy (PDT) could be evaluated. TBT and TBE were both found to exhibit TICT and AIE properties, which were explained in this report. TBT was found to have both the ROS generation and cell imaging capability, thus making it a potential candidate for image-guided PDT.

### Design and Synthesis of Functional AIE luminogens and Exploration of their Biological Applications

Supervisor:       TANG Benzhong / CHEM          Co Supervisor:    SUNG Hoi Pang / CHEM
Student:          MAK Cheuk Yin / CHEM          Course:          UROP1000, Summer

Bio-imaging is a practical technique to discover and analyze many severe diseases as it can trace the specific substances, which are the indicators of diseases, in the tissue using commercial dyes. However, the fluorescent properties of these dyes cannot perform a traceable and precise imaging for diagnosis. To solve this problem, new fluorescent materials,

aggregation-induced emission luminogens (AIEgens), were suggested to be bio-probes as they present opposite properties to the conventional dyes. In this study, the latest AIEgen, TPE-R, has been synthesized by an elimination reaction with pyridine and its luminescence has been discussed with UV-Vis absorption and photoluminescence intensity.

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| Supervisor: | TANG Benzhong / CHEM | Co Supervisor: | SUNG Hoi Pang / CHEM |
| Student: | NG Wai Pan / CHEM | Course: | UROP1100, Spring |

Organic dyes with aggregation- induced emission (AIE) are superior to conventional organic dyes which may suffer from aggregation caused quenching (ACQ) effect. They also enjoy lower cytotoxicity compared with inorganic quantum dots (QDs) and they are synthetically allowed to have diverse structures for specific purposes. Particularly, AIE dyes are promising candidates for biological imaging because it can be used at relatively high concentration and it will aggregate spontaneously. As a result, it may be suitable for long term imaging due to higher photostability. In this report, two organic dyes with AIE characteristic targeting mitochondria and lipid droplets (LDs) will be discussed. Compound 1 stains mitochondria and probably exhibit dual functions while compound 2 stains LDs but with low resolution. Both of them require optimization before they become promising candidates for purpose of biological imaging.

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| Supervisor: | TANG Benzhong / CHEM | Co Supervisor: | SUNG Hoi Pang / CHEM |
| Student: | PENG Chen / CHEM | Course: | UROP1100, Fall |
| | | | UROP2100, Spring |

A new UV and blue light turn-on luminogen with aggregation-induced emission property is found. This luminogen has a novel emission specifically after UV exposure while this luminogen has higher fluorescence efficiency at aggregated state.

## Catalytic Synthesis of Organic Molecules

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| Supervisor: | TONG Rongbiao / CHEM | | |
| Student: | LEE Seungyeon / CHEM | Course: | UROP1100, Fall |

The protoberberine alkaloids are of a pharmacological importance with regard to isoquinoline natural products in that they are involved in various biological activities with various structures as canadine, berberine, stylopine, corysame, and corydaline in the plant kingdom. In this research, the model study of the total synthesis of the protoberberine alkaloids was conducted to confirm if the synthetic path is valid with acceptable yields and to apply the same route to the total synthesis. The smaller molecule, cycloheptanone was used to synthesize a target molecule with 4 rings.

# Division of Life Science

## Molecular Regulation of Muscle Stem Cell Quiescence by Non-coding RNAs

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| Supervisor: | CHEUNG Tom / LIFS | | |
| Student: | DOROTHEA Mike / BIOT | Course: | UROP1100, Fall |

Skeletal muscle satellite cells are the resident stem cells in adult muscle tissues that have a remarkable regenerative capacity. These cells are normally present in quiescent state, until they are activated to proliferate and regenerate new muscle in response to injury. Upon activation of satellite cells, tight regulations of different transcriptional regulators and cellular mechanisms are required to induce proper development of muscle. Procr, a downstream target of Wnt signalling that is involved in both muscle and mammary gland development, was newly identified to be marking a multipotent population of mammary stem cells, while its function in muscle development is still largely unknown. Therefore, this project aims to investigate where Procr+ cells are located in the Tibialis Anterior (TA) Muscle.

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| Supervisor: | CHEUNG Tom / LIFS | | |
| Student: | ERESTA JAYA Luna / BIOT | Course: | UROP1100, Fall |

This project originally aims to investigate the effects of localized Wnt signaling on the asymmetric cell division of muscle satellite cells. The experimental plan was to immobilize Wnt proteins in nanobeads movable via optical tweezers, so that it could be directed towards one terminus of a satellite cell, thus creating a localized signal. Theories regarding asymmetric cell division, Wnt signaling pathway as well as protein-bead conjugation were learnt, however no experimental involvement regarding the main project had been made due to schedule constraints. Nonetheless, various fundamental laboratory techniques essential for muscle stem cell research were learnt. This report will discuss the two main experiments executed, which are the isolation and immunostaining of single muscle fibers, as well as isolation, cryosection and staining of whole muscle.

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| Supervisor: | CHEUNG Tom / LIFS | | |
| Student: | ZHANG Wenxin / BCB | Course: | UROP1100, Summer |

CPEB4 is one of the important RNA-recognition motifs during the translation. It takes part in regulating the expression of the key protein and so as to regulate the function of cells. Satellite cell is a tiny, mononucleated cell found in muscle fibers which contributes a lot to the muscle regeneration. In this project, we try to figure out the relationship between CPEB and satellite cell activation as well as its mechanism. During this process, various molecular and cell biology techniques need to be performed and the skills of critical thinking and experiment design are required.

## Evolutionary Art at the fast track

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|---|---|---|---|
| Supervisor: | CHOW King Lau / LIFS | | |
| Student: | AQIL Muhammad Alber / MATH | Course: | UROP1100, Spring |
| | | | UROP2100, Summer |
| | FU Brian / BIBU | | UROP1100, Spring |
| | KAN Ying Hei / SSCI | | UROP1100, Summer |

In living organisms such as bacteria, plasmids that carry antibiotic resistances can often be a selective advantage to help these bacteria survive in harsh environments. However, when not necessary to survive, these plasmids simply become a replicative burden for the bacteria. Through multiple generations, these plasmids are expected to be lost since descendants without the plasmid will have a slight advantage in terms of economy over ones with the plasmid. This report seeks to discuss what happens when the motile E.Coli strain AMB1655 is transformed with Chloramphenicol resistance (with GFP marker) and Kanamycin resistance (with RFP marker), and allowed to grow in LB without any selection pressure.

### Genetic Identification of Negative Regulator of Bone Morphogenetic Protein Signaling Pathway Negative Regulator

Supervisor:     CHOW King Lau / LIFS
Student:     CHENG Muyang / SSCI     Course:     UROP1100, Summer

DBL-1/TGF-β is a signaling molecule that is the Caenorhabditis elegans ortholog for mammalian BMP. It is transduced through the Sma/Mab pathway and regulates the organism's body size. As the change in body size at different signaling strength is often insignificant and inconsistent, it is difficult to monitor signal strength merely by the length of the organism. Through Gibson assembly, a GFP reporter construct is created by inserting the promoter sequence of a known DBL-1 responsive gene into a plasmid that drives the expression of GFP. The resulting signal can then be easily recorded and quantified to represent the signal strength of DBL-1.

### Implementation of a Genetic Kill Switch to Control Environmental Release of Genetically Modified Organisms

Supervisor:     CHOW King Lau / LIFS
Student:     CHEUNG Chun Wai / SSCI     Course:     UROP1100, Summer

Genetically modified organisms (GMOs) have important uses in industries and researches. Modified genes may spread when GMOs enter the natural environment, and this could lead to detrimental impacts. To solve this problem, scientists employed different methods to ensure they can only survive in designated conditions and will be automatically killed outside contained environment. This project intends to implement a genetic kill switch with combined features of two reported kill switches, "Deadman" and "Passcode". The circuit preserves much design of 'Deadman' and uses the idea of hybrid transcription factor (TF) in the 'Passcode' circuit to alter the survival environmental signal. Organisms with this switch should only survive under the presence of N-acyl homoserine lactone (AHL), a quorum sensing molecule of common gram-negative bacteria, instead of anhydrotetracycline (ATc) in the original 'Deadman' circuit.

Supervisor:     CHOW King Lau / LIFS
Student:     LAM Ka Chung / SSCI     Course:     UROP1100, Summer

Microbial kill switches have been developed by researchers for bacterial containment purposes. The 'Passcode' kill switch published in 2015 controls cell survival by detecting the presence of a combination of environmental inputs, enabling the generation of many 'passcodes'. To develop the kill switch into a secure system, we introduced the concept of permutation into the kill switch to increase the complexity of the input. In one proposed genetic circuit, two inducers are the inputs to the kill switch. Using inducible transcriptional repression, antitermination, and a toxin/antitoxin system, the circuit demonstrates how the kill switch allows cell survival only when the two inducers are inputted in a particular order.

### Construction of a Signal Transduction Pathway Reporter Indicator for Monitoring Signaling Strength

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| Supervisor: | CHOW King Lau / LIFS | | |
| Student: | ENGINEER Vaspan Darius / BCB | Course: | UROP1100, Spring |

The transforming growth factor beta (TGF-β) related DBL-1 pathway in Caenorhabditis elegans is known to play a significant role towards size and growth regulation. Current methods of measuring the signalling strength of this pathway are limited to worm size measurement, however, these may in some cases be unreliable as size variations tend to be minute. As a result, this project aims at creating a reporter that can indicate the signalling strength of the DBL-1 pathway more efficiently using previously identified partners of the pathway. I attempted to investigate the promoter regions of two genes (ZK1320.3 and D1014.5) in order to observe their viability and effectiveness as reporters. Thus far purified samples of the suspected promoter regions for both genes have been obtained, but the project is still in progress and there is much that needs to be done.

### Analysis of Surface Delivery of Epidermal Growth Factor Receptors

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| Supervisor: | GUO Yusong / LIFS | | |
| Student: | LAM Yat Sum Brisson / BIOT | Course: | UROP1100, Fall |

Protein trafficking is a highly coordinated and complex process that is essential in all living organisms. After being synthesized in the cytoplasm, the protein has to travel through several stops, including the Endoplasmic Reticulum (ER) and the Golgi Apparatus, before proceeding to the plasma membrane. This project will utilize the Retention Using Selective Hooks (RUSH) system, a retentive hook system that controls the release of proteins in ER, to study the mechanisms in the transportation the protein Frizzled 6 (Fzd6), a protein playing a role in Plane Cell Polarity (PCP). We will first generate a mCherry-RUSH-Fzd6 construct, which contains the mCherry florescence protein, RUSH system, and Fzd6 protein. We will then be transfecting the construct into COS7 cells and HeLa cells and use a florescence microscope to analyse its localization.

### Molecular mechanisms that regulate export of a nerve growth factor receptor, p75, out of the trans Golgi network

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| Supervisor: | GUO Yusong / LIFS | | |
| Student: | MALKI Yasine / BCB | Course: | UROP1100, Fall |

Epithelial cells maintain a polarized organization – sorting of cargo protein to apical or basolateral membrane domain for specialized physiological function, this distribution and trans-Golgi trafficking of protein relies upon sorting signals, which tend to be short motifs and post translational modification.  The human neurotrophin transmembrane receptor p75 is a crucial component in neuron survival and functioning, and is known to be dependent on O-glycosylation (particularly in residue site 168-218) for apical membrane transport. Previous studies also establish that the formation of higher-level structures like dimerization and clusters also affect transport directionality. The objective of this experiment was to identify transport characteristics in HeLa cells after deletion of heavily O-glycosylated residue site 193-218 and attempt molecular cloning of p75-GFP for further experimentation.

### Control of Cell Number in the Brain

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| Supervisor: | HERRUP Karl / LIFS | Co-Supervisor: | HUNG Siu Chun / LIFS |
| Student: | CHAN Si Kei / BICH | Course: | UROP1100, Summer |
| | KONG Deyue / BCB | | UROP1100, Summer |

The 3xTg mouse strain was constructed by researchers to serve as a potential model for studying Alzheimer's Disease (AD). However, despite the genetic modification, only mild memory dysfunction and anxiety are shown by 3xTg mice and there is no evidence of significant neurodegeneration. This is insufficient to mimic all of the human AD symptoms. To investigate whether neurodegeneration occurs in 3xTg mice, our team took the quantitative approach of counting the cell number of both the cortex and the hippocampus, and then made comparisons with wild type mice. The results indicated that neurodegeneration occurred, but only in left hippocampus and right cortex.

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| Supervisor: | HERRUP Karl / LIFS | Co-Supervisor: | HUNG Siu Chun / LIFS |
| Student: | WANG Ximeng / BCB | Course: | UROP1100, Fall |
| | | | UROP2100, Spring |
| | ZHANG Yue / BIBU | | UROP1100, Fall |
| | | | UROP2100, Spring |

One of the critical question in neurobiology is whether cell lineage plays a major role in mammalian brain cell number control. It is postulated that, one individual has a certain number of progenitor cells, of which each later will undergo certain times of cell division and differentiate into all types of cells in the brain. This hypothesis can be applied to a particular region in the brain, that is to say, the cerebellum. During the counting of cerebellar cells excluding the Purkinje cells, it was found that clumps were responsible for large variations among different aliquots from the same sample. Therefore, the focus shifted from improving counting techniques, which was the goal of last semester's UROP, to solving the clump issue. There are mainly two ways to deal with clumps. One way is to separate clumps into scattered nuclei, the other is to estimate both the number of nuclei in one clump and the number of clumps in one cell suspension.

## Modeling Mammalian Vesicle Dynamics in Yeast

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| Supervisor: | HERRUP Karl / LIFS | Co-Supervisor: | BANFIELD David Karl / LIFS |
| Student: | CHANG Yau Ming / BICH | Course: | UROP1100, Summer |

ATM and ATR, proteins that are involved in numerous neurodegenerative diseases, were found to have cytoplasmic functions in mammalsi and recent papers revealed their colocalization with endocytic proteins ii .To efficiently dissect its role, we generated yeast mutants deficient in their homologues (TEL1 and MEC1, respectively) and conducted an endocytic FM4-64 dye assay. We discovered that MEC1/TEL1 deficient mutants reached vacuolar staining faster than wild types. In addition, a preliminary mammalian ATM/ATR inhibitor tests was conducted to test for their effectiveness in yeast.

## Biochemical Characterization of Histone Variants and Post-translationally Modified Nucleosomes

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| Supervisor: | ISHIBASHI Toyotaka / LIFS | | |
| Student: | CHEUNG Yat Hin Boris / BIBU | Course: | UROP1100, Fall |
| | | | UROP2100, Spring |

Nucleosome is the fundamental unit of the chromatin structure and is a major component in the process of chromatin condensation and relaxation. The human genome consists of approximately 30 million nucleosomes, however, details for nucleosome-nucleosome interaction remains unclear and defining the interaction will lead to insights to global gene expression patterns. This project focuses on quantifying the inter-nucleosomal interactions among three nucleosomes. We have constructed three identical repeated nucleosomal positioning sequence and successfully loaded tri-nucleosomes. This study helps to quantify the inter-nucleosomal interactions.

## Proteomics Approach to Decipher Gravity Signaling in a Flowering Model Plant

Supervisor:      LI Ning / LIFS
Student:         KO Cheuk Kei / BCB                  Course:        UROP3100, Fall
                                                                    UROP4100, Spring

In this project, we aim to identify genes that are responsible to touch sensing in Arabidopsis thaliana (Col-0). A set of 4 Arabidopsis genes which exhibited signalling potential were selected. Seeds of tDNA insertion lines targeting these 4 genes were bought from ABRC. The first part of the project was to select for homozygous pure line seeds from each tDNA insertional mutagenesis. Pure line plants were obtained from 2 out of 4 mutants. Seeds from these plants were collected and stored. Next semester, it is hoped that force physiological experiments can be done to study the thigmomorphogenetic properties of these mutants.

Supervisor:      LI Ning / LIFS
Student:         LEUNG Yui Him / BIOT                Course:        UROP1100, Spring

It is known that ethylene can serve as a plant hormone which is responsible for the growth and development of plant, such as regulating the process of fruit ripening and germination of seeds. Previous studies showed that when seedlings were put to germinate in the darkness with exogenous ethylene administered, it would alter the phenotype of seedlings. The resulted phenotype was termed as triple response with characteristics of relatively shorter and thicker hypocotyls, larger hooks and shorter roots. In this experiment, the triple response in soybean and Arabidopsis were shown to be confirmed with previous studies as there was a significant difference in the length of hypocotyls under exogenous ethylene treatment and under normal air condition.

Supervisor:      LI Ning / LIFS
Student:         RICE Keira Lee / BIOT               Course:        UROP2100, Fall

Mechanosensory stimuli has been known to trigger a range of responses in plants on both the transcriptional and proteomic level. In nature, these stimuli have pronounced phenotypic consequences that help plants adapt to an ever-changing environment. As touch sensitivity is crucial for the overall survivability of all organisms, the identity of these mechanosensory receptors are intriguing from an evolutionary and pathological perspective. Although more is known about the downstream signalling pathways following touch stimuli, the primary mechanosensitive element of touch has yet to be identified. Touch assays on TDNA insertional mutants of putative touch candidates will help to uncover these receptors. In addition to phenotypic assays, experiments to characterize the genetic identity of mutants using PCR with custom primers are required to verify putative touch mutants. This report is part of an ongoing project to characterize the primary element of touch in A. thaliana, which will hopefully contribute to our current understanding of conserved pathways in other high eukaryotes and humans.

## Mechanisms of Lung Cancer Metastasis

Supervisor:      LIANG Chun / LIFS
Student:         CHEN Zhuojian / BCB                 Course:        UROP1100, Fall

MicroRNA (miRNA) is a type of non-coding RNA which can regulate gene expression in cell. One of function of miRNA is binding messenger RNA and cause them degradation or inhibiting translation. The effect depends on the bases' similarity between miRNA and the target mRNA. MiRNA-370-3p and miRNA-495-3p have been observed that they have negative effect on $MCM_2$, $MCM_6$ and $CDC_6$ expression. $MCM_2$ and $MCM_6$ are the primary control factors of eukaryotes

DNA duplication. CDC6 is an essential regulator of DNA replication and required for loading MCMs proteins onto DNA to start the DNA synthesis. This research aims to find some kinds of miRNA which can inhibit $MCM_2$ and $CDC_6$ expression and produce some medicine that inhibit cancer cell proliferation by use of these miRNA.

### DNA Replication-initiation Proteins in Budding Yeast

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| Supervisor: | LIANG Chun / LIFS | | |
| Student: | KONG Deyue / BCB | Course: | UROP1100, Fall |

Origin Recognition Complex (ORC) critically regulates DNA replication initiation. Examining the mechanisms by which ORC associates and dissociates from chromatin during the cell cycle enables us to enhance our understanding of pre-RC formation and inspires medical advances for cancer treatment. Previous studies have shown that ORC dimerizes and de-dimerizes in a cell cycle dependent way, but the molecular mechanism of this process remains unclear. In this experiment, the phosphorylation status of Orc6p was examined to further our understanding of ORC dimerization and de-dimerization. The chromatin binding pattern of non-phosphorable Orc6p in W3031a wild-type cells was examined throughout the cell cycle.  FACS analysis was used to verify synchrony and cell cycle progression. The results indicate that phosphorylation of Orc6p is required for ORC de-dimerization, while ORC dimerization requires de-phosphorylation.

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| Supervisor: | LIANG Chun / LIFS | | |
| Student: | LAM Ying Yi / BISC | Course: | UROP1000, Summer |

In this study, the capability of traditional Chinese medicine (TCM) on treating insulin resistance (IR) was investigated. The drugs used in the experiments were XKC, QQL, TC, and MDF. To determine the optimal concentration in terms of the effect on cell viability and glucose uptake, these drugs were applied to the Non-IR HepG2 cells first. Afterward, cells were induced to be IR cells model by insulin. After treatment, the glucose uptake and intracellular glucose level were measured through the glucose assay kit. Furthermore, Western blot was used to test the level of GLUT2. The result showed that the optimal concentration of drugs was 0.3 mg/ml. All the drugs showed the ability to reverse insulin resistance and QQL demonstrated the greatest performance.

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| Supervisor: | LIANG Chun / LIFS | | |
| Student: | LEUNG Tsz Wan / BIBU | Course: | UROP1000, Summer |
| | LIAO, Helen Ziqing / SSCI | | UROP1000, Summer |

For this two-month project, few experiments were done to test the hypothesis that pre-replication complex (pre-RC) assembly is impaired by the anti-cancer drug candidate M2 which leads to an abortive S phase followed by apoptosis in cancer cells. Results from flow cytometry of HeLa cells after cell synchronization at G1-phase showed that overall, M2-treated samples result in more dead cells than non M2-treated samples. However, the results from the chromatin binding assay of HeLa and HGC27 cells turned out to be inexplicable and does not support the hypothesis of this project. Such results are contradictive and suggest that more trials and experiments are needed for reliable results that could be used to further study the effect of M2 on MCM protein loading.

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| Supervisor: | LIANG Chun / LIFS | | |
| Student: | LI Qian Xin / SSCI | Course: | UROP1000, Summer |
| | ZHENG Danyi / BIBU | | UROP1000, Summer |

Nucleolar complex associated protein 3 (Noc$_3$p), is essential for DNA replication. To further elucidate the role and function of this protein, we examined the role of nonchromatin bound Noc$_3$p in DNA replication. Noc$_3$p, although continuously bound to the chromatin throughout the cell cycle, has been hypothesized to dimerizes in a cell cycle dependent manner in G1 phase of the cell cycle in the process of pre-replicative complex (pre-RC) formation. In this study, we determined the function of non-chromatin bound Noc$_3$p in DNA replication using the Anchor-Away system. The depletion of non-chromatin bound Noc$_3$p form the nucleus impaired cell growth, although this defect could be rescued with the introduction of ectopically expressed wild-type Noc$_3$p. We further determined that the Anchor-Away system does not deplete chromatin-bound Noc$_3$p. Lastly we calculated the cell density and budding index of circulating FRB-NOC$_3$ cells (depleted/non-depleted) and conclude that cell proliferation defects were evident in cells depleted of non-chromatin bound Noc$_3$p.

### Water Quality Survey for Hong Kong's Marine Fish Farming Zone

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| Supervisor: | LIU Hongbin / LIFS | Co-Supervisor: | LAU Wing Keung / LIFS |
| Student: | CHIU Tze Hin / CIVL | Course: | UROP1100, Spring |

A portion of fish supply in Hong Kong is self supply. This indicates the importance of maintaining good water quality in a way of providing safe fish supply to the consumer, such as Hong Kong citizens. Thus, Agriculture, Fisheries and Conservation Department (AFCD) in order to safeguard the food safety and fish quality, cooperates with HKUST to conduct water quality survey in ,29 in total, local fish cultures zones. The report would only focus on the suspended solid, measured by weighting, chlorophyll concentration, by spectrophotometer, concentration, turbidity and salinity. In additional with tables and figures, the geographical and chronical effect would be illustrated.

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| Supervisor: | LIU Hongbin / LIFS | Co-Supervisor: | LAU Wing Keung / LIFS |
| Student: | CHUNG Shun Lap Benedict / SSCI | Course: | UROP1000, Summer |

Fishery industry of Hong Kong is supported by diversified fishery sources, where some of the common species like grouper, snapper and even oysters that we are familiar with are actually cultured and merchandised locally in various fishing and culturing zones. And aquaculture production was valued at around 147 million last year (AFCD HK, 2018). Thus, in order to ensure the catch/production is up to the legal standard of food safety as well as to sustain the ecological setting for this running business, it would be crucial to maintain the quality of environment that nurturing them. Regular water quality surveying co-conducting by Agriculture, Fisheries and Conservation Department, with HKUST is carried out to monitor water quality determinants and parameters. In this project, figures from analyzing samples and related factors affecting water quality will be presented, to conclude the conditions of the fishing zones.

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| Supervisor: | LIU Hongbin / LIFS | Co-Supervisor: | LAU Wing Keung / LIFS |
| Student: | HUI Chung Man Jessica / BSCI | Course: | UROP1100, Summer |

The quality of aquaculture in Hong Kong is frequently inspected, evaluated and maintained to ensure that fisheries and farms are operating at qualified conditions, providing safe products to markets and people. The Hong Kong Agriculture, Fisheries and Conservation Department works together with the Hong Kong University of Science and Technology (HKUST) to evaluate and monitor the water quality, ensuring safe products and undisturbed seawaters sustaining marine life. This report focuses on the amount of suspended solids, chlorophyll-a concentration and nutrients (nitrogen oxides, ammonia, orthophosphate and silicate) measured by weighing and using spectrophotometer and Skalar San++ Automated Wet Chemistry Analyzer respectively. The findings and interpretation will focus on the above measured contents of four designated sites, Lo Tik Wan, Kau Sai, Tap Mun and O Pui Tong whereas, interpretation is made using spatial and seasonal differences among them.

| Supervisor: | LIU Hongbin / LIFS | Co-Supervisor: | LAU Wing Keung / LIFS |
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| Student: | KONG Jonathan Wai King / BIBU | Course: | UROP1100, Fall |

Water quality has been nagging problem for the fishery industry in Hong Kong. Not only the flotsam and jetsam, pollution could be at a microbiological level, like algal boom. To monitor the water quality in Hong Kong waters, the Agriculture, Fishers and Conservation Department (AFCD) signed a contract with the HKUST Coastal Marine Laboratory for a monthly-basis survey on the water quality. Different parameters were measured in the water and in the laboratory. Level of dissolved Oxygen (O2) and chlorophyll-a would be discussed below. Average levels of dissolved O2, and chlorophyll-a monitored stations in July to late September 2017 were presented in visual aids. A brief discussion on seasonal and regional effect on concentration of nutrient were included.

### Time Series Observation of Microbial Community Dynamics in Port Shelter

| Supervisor: | LIU Hongbin / LIFS | Co-Supervisor: | LAU Wing Keung / LIFS |
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| Student: | WONG Ka Man / BCB | Course: | UROP1100, Fall |

Hong Kong fish supplies rely partly on local fish culture zones, therefore good water quality is essential for rearing fish and providing safe aquaculture products for human consumption. Agriculture, Fisheries and Conservation Department (AFCD) cooperates with HKUST to conduct water quality surveys on 29 fish culture zones in Hong Kong by measuring various kinds of parameters. This report focuses on nutrients, chlorophyll a and suspended solids recorded in 4 fish culture zones situated in different locations of Hong Kong. Nutrient concentrations (Nitrite, Nitrate, Ammonia, Orthophosphate Phosphate, and Silicate) were analyzed by Skalar San++ Automated Wet Chemistry Analyzer, chlorophyll a abundance was measured by spectrophotometer while suspended solids amounts were determined by weighing. Together with tables and figures, regional and seasonal effects on the water near different fish farms will be briefly discussed.

### An Exploration of Nuclear Dynamics in Cells and Syncytia of Developing Zebrafish Embryos

| Supervisor: | MILLER Andrew Leitch / LIFS | Co-Supervisor: | HO Sarah E / LIFS |
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| Student: | SIU Ming Shing / BCB | Course: | UROP1100, Spring |

In zebrafish, two-pore channel type 2 (TPC2) mediates calcium release that is crucial for slow muscle cell differentiation. To understand functional roles played by two pore channels, my study focuses on two-pore channel type 3 (TPC3). Here I report that structures labelled by anti-TPC3 antibodies were scattered along the trunk. Based on literature search, I proposed that the distribution of TPC3 labelling resembled the infiltration pattern of leukocytes in the trunk. I therefore hypothesized that TPC3 was expressed in leukocytes. This hypothesis motivates new experiments that might reveal the functions of TPC3 in zebrafish embryos / larvae.

### Investigation the Role Played by the Scales of the Anadromous Teleost Salmo Trutta in Regulating Blood Plasma Calcium Homeostasis

| Supervisor: | MILLER Andrew Leitch / LIFS | | |
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| Student: | SIU Ming Shing / BCB | Course: | UROP1100, Fall |

Salmo trutta migrates from seawater which is of higher average calcium ion content, to freshwater which is of lower calcium content for spawning. My study aims to measure the plasma calcium levels of the anadromous teleost Salmo trutta under external calcemic challenges. With a calcium ion-selective electrode, I aim to compare the calcium ion concentrations of serum and red blood cells of the fish against the calcium ion contents in water samples collected in

their natural habitats. Elasmoid scales in teleosts can be regenerated upon physical removal. My study also aims to track the temporal changes in morphology of the regenerating scales. With epifluorescence observations of vitally stained zebrafish (Danio rerio) scales, I described the change in calcium hydroxyapatite localization over three weeks of regeneration.

## Role of RNA Helicases in MiRNA Biogenesis

Supervisor:          NGUYEN Tuan Anh / LIFS
Student:             MAN Ka Ho / BIOT                    Course:          UROP1100, Fall

Different types of RNA plays different roles in cellular processes. Students studying in life science usually understand the function of the common RNA like mRNA and tRNA in transcription and translation but there is a type of RNA which does not code for any protein but plays important role in gene regulation—microRNA(miRNA), which is a small non-coding RNA molecule containing about 22 nucleotides. The project will focus on the functions of RNA helicases in miRNA biogenesis and enough amount of human RNA helicases sample is need. Therefore, the first duty for students is to clone, express and purify human RNA helicases from human cells.

## Characterization of Novel Cell Cycle Regulators in Cancer Cells

Supervisor:          POON Randy Yat Choi / LIFS
Student:             LAU Tsz Yin / BCB                    Course:          UROP1000, Summer

Polyploidy is regarded as a hallmark in many human solid tumour types. Polyploid cancer cells help to explain cancer stemness, heterogeneity within a tumour and the possible source for cancer to acquire resistance towards chemo/radiotherapy-induced DNA damage. This study focused on using chemical perturbation to artificially induce polyploidisation in previously established tetraploid Hep3B cell line, as well as characterising the tetraploid cell line. Data revealed tetraploids were equally sensitive to chemical perturbation as diploids, including Nocodazole(Noc)- and thymidine-induced cell cycle arrest and deoxycytidine-induced release. No major difference regarding the unperturbed cell cycle, observed using live cell imaging, was found between diploids and tetraploids. This study provided integral reference for further manipulation and polyploidisation of tetraploids.

## Targeting Mitotic Regulators in Cancer Cells for Potential Treatment

Supervisor:          POON Randy Yat Choi / LIFS
Student:             TAM Man Yee / BCB                    Course:          UROP1100, Summer

The progression of cell cycle is regulated by cyclin-dependent kinases(CDKs) and cyclins. CDK1 and CDK2 are two important CDKs and their functions have not been fully elucidated yet. In this project, the relative ratio of CDK1 and CDK2 in HeLa cells is determined through quantification using Western blotting to examine the functions and relationship between CDK1 and CDK2. On the other hand, this project also aimed to prepare a CDK1 CDK2 double knockout HeLa cell line through CRISPR/Cas9 system to observe its phenotype in the absence of both endogenous CDK1 and CDK2, which may shed light on functional differences between CDK1 and CDK2. It is found that the quantity of CDK2 is larger than that of CDK1, with a 1.44 : 1 ratio, suggesting that functional differences between CDK1 and CDK2 is not due to its endogenous amount.

## Investigation of Novel Mechanisms Underlying Microtubule Organization

Supervisor:       QI Robert Zhong / LIFS
Student:          LUI Sze Wai / BIOT                    Course:          UROP1000, Summer

The microtubule nucleator γ-tubulin forms new microtubules by assembling into γ-tubulin ring complex (γ-TuRC). Previously, it is reported that various lysine residues on γ-tubulin can be ubiquitinated under the action of cullin-RING E3 ligases (CRLs).  Each CRL contains a cullin protein, and there are 7 members in the cullin family (CUL1, CUL2, CUL3, CUL4A, CUL4B, CUL5 and CUL7).  Through CRLs, the ubiquitinated γ-tubulin is subsequently subjected to proteasome-mediated degradation.  This study centers on identifying the specific CRL(s) involving in γ-tubulin ubiquitination. Through protein binding assay between γ tubulin and the cullin proteins, we found that CUL1 and CUL4A demonstrated interactions with γ-tubulin.

## Investigating Microtubule Regulation during Cell Proliferation, Migration and Morphogenesis

Supervisor:       QI Robert Zhong / LIFS
Student:          LUI Sze Wai / BIOT                    Course:          UROP1100, Spring

γ-Tubulin is a crucial component in γ-tubulin ring complex (γ-TuRC) , which is responsible for microtubule nucleation.  It is reported that γ-tubulin can undergo ubiquitination on lysine residues, leading to its destruction by proteasome. Controlling such process in vivo is essential for regulation of microtubule nucleation.  In this study, ubiquitination sites of γ-tubulin are investigated.  Three of the sixteen lysine (K) residues (K48, K113 and K301) in γ-tubulin were mutated to arginine (R) by QuickChange Site-Directed Mutagenesis.  By in vivo ubiquitination assay, three γ-tubulin mutants show ubiquitination at reduced levels, with K48R and K113R demonstrating a greater reduction effect.  Therefore, K48, K113 and K301 could be sites of ubiquitin proteasome-mediated degradation.

Supervisor:       QI Robert Zhong / LIFS
Student:          SULLIVAN Chantelle Dorothy / BCB      Course:          UROP1000, Summer

Microtubule nucleation is mainly activated by γ-Tubulin Ring Complex (γTuRC) at Microtubule Organizing Centres (MTOC) in animal cells. Interestingly, γTuRC binds exclusively to CDK5RAP2 and NEDD1, which are the activating and centrosomal recruitment factors of γTuRC. CDK5RAP2-bound- and NEDD-bound-γTuRCs display different microtubule nucleation activity in vitro. However, it is difficult to study the regulation of the nucleation activity of such γTuRC subpopulations in isolation in cells because of the identical centrosomal localization. Here, the γTuRC-binding domain of CDK5RAP2 was fused with the plasma-membrane-targeting motif of SRC, for recruiting CDK5RAP2-bound-γTuRCs to plasma membrane. Cell imaging revealed that chimeric CDK5RAP2 was found in the cytosol, in addition to the plasma membrane. Therefore, robust cytosolic microtubule nucleation was induced by expressing the plasma-membrane-targeted-CDK5RAP2.

## Computational Study of Long Noncoding RNAs in Cancer

Supervisor:       WANG Jiguang / LIFS
Student:          SHI Hongyu / BCB                      Course:          UROP1100, Fall

Gastric cancer (GC) is one of the leading causes of cancer-related deaths. Previous research devoted great efforts in revealing genetic variations that may contribute to gastric cancer progression, however, most of them focused on coding genes. Though many long non-coding RNAs (lncRNA) have been proved to possess diverse regulatory functions in different biological processes, the role of lncRNAs in GC have not been fully elucidated and it is likely to discovery new drug targets and biomarkers for GC in lncRNAs. In this UROP project, we aimed to establish a new computational

strategy to detect important lncRNAs related to GC by combining RNA sequencing data, mutation and clinical information from GC patients. The preliminary results showed that lncRNA profile was drastically changed in gastric cancer comparing with normal tissues.

## Study of Blood Cell Development Using Zebrafish Model

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| Supervisor: | WEN Zilong / LIFS | | |
| Student: | SUN Dajun / SSCI | Course: | UROP1100, Summer |

T lymphocytes are key components of the adaptive immune system and play a central role in cell-mediated immunity. Although many subsets of T lymphocytes have been identified and their functions have been characterized, whether the early embryonic development and fate determination of T lymphocytes shares the same mechanism with adults remains unclear. Based on the fact that zebrafish and vertebrate immunity have many aspects in common (Renshaw and Trede, 2011), we choose zebrafish as an experimental model to study the early development of T lymphocytes. As indicated previously, the first wave of T cells are all CD4+ cells(Tian et al., 2017), we are eager to know why CD8+ T cells cannot be generated in the first wave and whether there exists differences in CD4/8 T cells fate choices between fetal and adult T cell in zebrafish.

## Enhancement of Animal Growth Employing Feed Supplemented with Recombinant Growth Hormone

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| Supervisor: | WONG Wan Keung / LIFS | | |
| Student: | HO Man Wai / BCB | Course: | UROP1100, Spring |

With the foreseeable commercial potential of relaxin, it would worth to explore a more efficient way to produce and purify the proteins in order to accommodate the future market need. In this project, an intein approach is employed to achieve our target, in which plasmid constructs (i.e. pGEX2T-GyrA-A and pGEX2T-GyrA-B) were used to transform the E. coli for the expression of recombinant proteins (i.e. GST-GyrA-A and GST-GyrA-B). Protein expression was induced by IPTG and the products were undergone GST chromatography for purification. The purified fusion proteins were incubated under different conditions to see the effectiveness of the cleavage of the A chain and B chain from the intein.

## G Proteins and Their Regulators in Cancer Biology

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| Supervisor: | WONG Yung Hou / LIFS | | |
| Student: | SHIN June Yeol / SSCI | Course: | UROP1100, Summer |

Metastasis is the process in which primary tumours disperse to other unaffected organs. It is estimated that nearly 90% of cancer deaths result from metastasis (Seyfried & Huysentruyt, 2013 ). With such high lethality linked to the process of metastasis, it would be highly beneficial if we can discover substances that will inhibit the primary tumours from dispersing into the circulatory system. It is known that metastasis is regulated by the balance between both metastasis-promoting and metastasis-suppressing genes. (Yan, Yang & Huang 2013) As a result, we tried to observe if an introduction of specific ligands into cancer cells could possibly result in an up-regulation of the metastasis-suppressor genes to prevent metastasis.

## Making a Microfluidic Device for Cryo-EM

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| Supervisor: | WU Angela Ruohao / LIFS | | |
| Student: | CHAN Shek Nga / CBME | Course: | UROP1100, Summer |

To enhance the quality and ease of Cryogenic Electron Microscopy (Cryo-EM) research at HKUST, a microfluidic sprayer device, its design stipulated in Feng et al., 2017, was fabricated using polydimethylsiloxane (PDMS) to apply samples evenly and thinly in a reproducible manner. The device is also helpful in circumventing protein aggregation and sample wastage typically incurred during sample preparation for Cryo-EM. The sprayer was tested by means of spray pattern visualization to gauge preliminarily its ability to produce symmetric spray shape. The resultant pattern was circular and symmetric about the centre of nozzle. Further examination of device performance includes quantitative characterization of droplet size and distribution and spray diameter.

### Big Data: Bioinformatic Analysis of Single-cell Genomic Data

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| Supervisor: | WU Angela Ruohao / LIFS | | |
| Student: | SHIN Wai Ching Martin / CPEG | Course: | UROP1100, Fall |

The project will focus on bioinformatics and statistical analysis of state-of-the-art single cell RNA-sequencing data from human or non-human cells. The project aims to understand what are the differences in gene expression between individual cells, and how external conditions such as stress, physical perturbation, drug treatment, or physical properties like cell size, can contribute to heterogeneity within a population.

### Human Complex Disease Genomics and Bioinformatics

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| Supervisor: | XUE Hong / LIFS | Co-Supervisor: | LIANG Chun / LIFS |
| Student: | CHAN Ho Yung / BIBU | Course: | UROP1100, Spring |

Utilizing forefront genomic and bioinformatics advancements, the undertaking means to decode the hereditary reasons for human complex infections, including malignancies and mental issue. In the project, I will take part in giving help to postgraduate colleagues in general laboratory assistant. After appropriate nearby training weeks, I am allocated to do seat work with test systems, for example, PCR and sequencing. Through partaking in the undertaking, I can increase direct involvement with and coordinate understanding into the quickly developing field of human complex infection genomics and bioinformatics. Through taking an interest in this task, I have increased direct involvement and coordinate knowledge into the quickly developing field of human complex illness genomics and the bioinformatics. They offer me a solid base to proceed with my quest for scholarly and look into greatness, and in addition to begin a profession in this career field. And this report would be a journal of what I have learnt in this semester.

### Receptor based Drug Development from Chinese Herbal Medicine

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| Supervisor: | XUE Hong / LIFS | | |
| Student: | LEE Lok Yi / SSCI | Course: | UROP1100, Fall |

$GABA_A$ receptor, exclusively the $\beta_2$ subunit (GABRB2) has been found in relation to susceptibility of schizophrenia in previous studies. Co-relationship between Gabrb2 and neuroinflammation as well as with schizophrenia will be investigated in this study. Biochemical assays, which includes MDA test and ELIZA, immunostaining analysis and gene expression are studied in wildtype, heterozygous and Gabrb2 knockout mice. Neuroinflammation is verified in Gabrb2 knockout mice which may lead to neurodegeneration, showing some schizophrenia related symptoms. This study may be useful for further investigation on association of GABRB2 and schizophrenia in addition to its underlying pathology and development in later field of study.

| Supervisor: | XUE Hong / LIFS | | |
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| Student: | LI Ping Yin / SSCI | Course: | UROP1100, Summer |
| | LI Yixuan / SSCI | | UROP1100, Summer |

DNA library construction is one of the main procedures for the preparation of drug experiment. By doing the DNA library, we can identify and locate specific gene and, more importantly, by comparing the sequence of isolated gene sample and the sequence of normal gene, we can find out the organism with interested mutation, which can be used in experiment and drug test. In order to obtain the targeted DNA fragment with specific indexes from a complete DNA sample, we have done a series of procedures, including fragmentation, end repairing, adenylation, ligation and adding indexes on different fragments and sending them to another institute for further analysis. After all these, 4 DNA libraries with concentration between 16.5 to 27.7 ng/µl are obtained from 6 samples.

| Supervisor: | XUE Hong / LIFS | | |
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| Student: | PARK Harry / BIOT | Course: | UROP1100, Spring |

In the past, mental disorders were considered to be patients' weakness that should be hidden and to be shamed of. Now, it is widely accepted that it is similar to other disorders, curable with appropriate measures. With the improvement of awareness, many discoveries and treatments have been developed. Calmlin is one of those recent drugs, targeting anxiety disorder such as panic disorder and post-traumatic stress disorder. Calmlin is composed of four herbal formulas: Radix Bupleuri, Rhizoma Corydalis, Flos Albiziae, and Caulis Polygoni Multiflori. Several experiments on mice were conducted to investigate the effect of Calmlin. Data analysis proved that Calmlin has no significant influence on mice's behaviors, but further experiments should be conducted to determine its efficacy.

| Supervisor: | XUE Hong / LIFS | | |
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| Student: | TO Yuen Ching / BIOT | Course: | UROP1100, Fall |

Gamma-aminobutyric acid type A (GABAA) receptor is one of the receptor of a major inhibitory neurotransmitter called GABA in the mammalian central nervous system and is localized in many regions of the brain. To improve the understanding between the relationship between the GABAA receptor and neuroinflammation, Gabrb2 transgenic mice was used for investigation. Molecular analyses were carried out to scrutinize the difference on phenotypic and biochemical alternations.

| Supervisor: | XUE Hong / LIFS | | |
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| Student: | XIE Jia / SSCI | Course: | UROP1100, Summer |

Due to the change of extracellular microenvironment, the external stress acts on internal biochemical signalling pathways and inherent these processes, for example, mitosis. The stress is suspected to alter normal mitosis cell division through chemical means by suppressing spindle assembly checkpoint. Aneuploidy is the result of suppression of spindle assembly checkpoint, and is a common phenomenon of cancer cells. In this study, we used human cervical carcinoma (HeLa) and the human liver carcinoma (HepG2). We studied the effect of acidic extracellular microenvironment on aneuploid response in mitosis, and neutral treatment was given to mimic normal physiological microenvironment as a control. We observed that tri-daughter cells formation/occurrence was enhanced with increased cell division time. Providing sufficient support for study cancer cell development.

# Department of Mathematics

### Low-Rank and Sparsity Reconstruction in Data Science

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| Supervisor: | CAI Jianfeng / MATH | Co-Supervisor: | YE Guibo / MATH |
| Student: | JIANG Bo / MATH-SFM | Course: | UROP1100, Fall |
| | ZHOU Weixuan / ECOF | | UROP1100, Fall |

This paper tends to provide a brief analysis and some implementations of a popular algorithm in object detection, namely, max-margin object detection (MMOD). To introduce this algorithm, a quick review of Platt's fast training of support vector machines (SVM) using sequential minimal optimization (SMO) will be provided. Some background knowledge in Histograms of Oriented Gradients (HOG) and Convolutional Neural Network (CNN) will also be discussed. Then this paper will analyze the main algorithms of MMOD and, using the publicly available library, implement the algorithms and display the main results visually. Our results show that MMOD generally works well in avoiding false-alarm, while there is still room for improvement in missed detections.

### Combinatorial Studies of Gauss-Bonnet and Hopf Theorems

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| Supervisor: | CHEN Beifang / MATH | | |
| Student: | WAN Jingbo / MATH-IRE | Course: | UROP1100, Spring |

This report focus on the classical Poincare-hopf theorem for vector field on 2-dim manifold and its generalization on directed graph. The classical Poincare-hopf theorem is a theorem concerning the relation between isolated zeros of smooth vector field and the topology of the smooth 2-manifold. Is is very surprise that the sum of index of any vector field is a topological invariance. More precisely,

$$\sum_i \mathrm{index}_{x_i}(v) = \chi(M),$$

for any smooth vector field v on M. The significance of this poincare-hopf theorem is that $\chi(M)$ is a purely topology quantity of the manifold, where the index of vector field is an analytic concept of a manifold, and this means poincare-hopf theorem gives a relation between the topology or geometry and the analytic information of the manifold.

### Statistical Analysis in Portfolio Construction

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| Supervisor: | CHEN Kani / MATH | | |
| Student: | ZHANG Kao / MATH | Course: | UROP2100, Fall |

In this report, we first try to look at the drawback of classic portfolio construction methods such Markowitz's risk-return. Then we provide a self-contained 4-step routine to formulate an automated and general portfolio selection process, taking the advantage of deep learning structure. Afterwards, we try to verify and demonstrate our theory in an example of IBB Index. And finally, we conclude and would like to put down a few ideas of potential improvement.

### Statistical Analysis in Competition Data

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| Supervisor: | CHEN Kani / MATH | | |
| Student: | ZHANG Yi / COMP | Course: | UROP1100, Summer |

The title of this UROP project is "Statistical Analysis of Competition Data". In this UROP project, we collect millions of posts from Twitter and combine them with the corresponding odds data, to analyze and predict the outcomes of World Cup football matches. First of all, we wrote programs to crawl data from the bookmaker website and twitter each time there exists a world cup soccer match. After collecting all the data we need, we clean and integrate large amount of data and do some simple analysis. Finally, we use statistical software to analyze these data. During this UROP project, I learnt more about statistical modeling and how to deal with large amounts of data.

## Geometric Flows

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| Supervisor: | FONG Tsz Ho / MATH |
| Student: | CHEN Xinyi / SSCI | Course: | UROP1100, Summer |

$$\frac{\partial F}{\partial t} = -kN.$$

The paper written b yM.GAGE & R.S. HAMILTON and my report are all playing around with this main equation. We consider a initially convex curve and shrink it under the heat equation mentioned above. We study the curve when the evolution is undergoing and prove it would goes to a circular point after a finite time T. Moreover, after scaling the curve, we can see clearer that it goes to a circle. This report is mainly a summary and supplementary of the original paper, which completes the proofs that were omitted by Hamiltion.

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| Supervisor: | FONG Tsz Ho / MATH |
| Student: | GUTIERREZ Mauricio Antonio RODRIGUEZ / SSCI | Course: | UROP1000, Summer |

This report will summarize the paper by Gage and Hamilton while also going more in detail into the explanations. The numbering and structure will follow that of our main reference. The first section will give the basic context of the problem, while proving that simple curves remain so during evolution. On the same chapter is a proof of a weaker isoperimetric inequality without the equality case. The next chapter will restate the problem into a parabolic partial differential equation and expose bounds on the curvature and its derivatives to prove the long term existence. The last chapter will prove the ratio of the maximum and minimum curvatures to approach, and finally prove the higher derivatives uniformly converge to 0 through computations.

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| Supervisor: | FONG Tsz Ho / MATH |
| Student: | HUNG Yui Chi / SSCI | Course: | UROP1000, Summer |

In the paper The Heat Equation Shrinking Convex Plane Curves by M. Gage and R. S. Hamilton, it proves that the heat equation $\frac{\partial F}{\partial t} = \Delta F = kN$ (note: F is the parametrization, k is the curvature and N is the unit normal vector) will shrink a convex plane curve into a point with several characteristics. Nevertheless, the authors have omitted several details and have left them as exercises for the readers. This report mainly highlights the main steps leading to the main theorem and "fills" the details that have been omitted by the authors. In this report, section 2 mainly outlines the structure of the paper, while section 3 constitutes some details of the parts that the authors have omitted.

| Supervisor: | FONG Tsz Ho / MATH | | |
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| Student: | LIANG Shu / PHYS | Course: | UROP1100, Summer |

In this report, I'll discuss the paper Geometric Flow written by Hamilton and Gage. The main purpose of this report is to fulfil some missing parts in the proofs of the paper. Since chapter 1 and 2 are not very relevant to the proof of the result of the paper, I'll discuss the details of chapter3 and 4. Chapter3 derives some useful evolution equations of the curve, and chapter 4 shows that the curve will evolve until it shrinks to a point. Some techniques used in the proof such as maximum principle, doing estimation using geometric properties are very useful in the analysis of geometric flow problems.

| Supervisor: | FONG Tsz Ho / MATH | | |
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| Student: | LONG Zhong / MATH-PMA | Course: | UROP1100, Fall |
| | | | UROP2100, Summer |

This report focus on Chapter 3,4,5,9 of the the paper Three-Manifolds with Positive Ricci Curvatureby Richard S. Hamilton. By filling the details of the computation which lead to important result, we try to get a point of view on how to connect the Ricci curvature with the constant curvature of a compact 3-manifold.

| Supervisor: | FONG Tsz Ho / MATH | | |
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| Student: | TANG Tianchen / MATH-IRE | Course: | UROP1100, Fall |

In the paper The Heat Equationn Shrinking Convex Curves by M.Gage and R.S.Hamilton, they consider the case of a plane curve shrinking when acting on a quasi-heat equation.By using geometric analysis methods, they first derived the time evolution equations of the length of the curve,the curvature of the curve and the area it encloses. With these equations one can show that a curve remains embedded in finite time. After gaining these results they turned to the more specific case of convex curves and showed the long time existance of the solution to evolution equation. Quite a lot of technical calculation is involved in the process and the authors of that paper omitted some unimportant details. In this report, I will try to go through the important calculations in that paper and summarize the main idea.

| Supervisor: | FONG Tsz Ho / MATH | | |
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| Student: | WAN Jingbo / MATH-IRE | Course: | UROP2100, Fall |
| | | | UROP3100, Summer |

The Harnack type estimate is very important in geometric analysis. This report aims at introducing some results about gradient estimate and Harnack inequalities and their applications which I have read in this summer time. I will mainly focus on the Harnack estimates of Laplacian equation which is elliptic and heat equation which is parabolic. Moreover, I will also cover their applications on eigenvalue estimate and heat kernel estimate. In the end, further results for different geometric flows will be mentioned.

| Supervisor: | FONG Tsz Ho / MATH | | |
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| Student: | WONG Sing Lam / MATH-PMA | Course: | UROP1100, Fall |

In this project, we mainly concern the paper titled "Curvature Bound for Curve Shortening Flow via Distance Comparison And A Direct Prof of Grayson's Theorem" by Ben Andrews and Paul Bryant. In this report, I would try to fill in some non-trivial details in the paper. The main objective of this paper is the same as the paper that I have read in previous project

i.e. proving the Grayson's theorem by proving a new isometric bound. This paper uses a different approach by considering firstly normalised the curve to 2π and then get an estimate lower bound for the chord length in terms of arc length Applying the estimate the authors get, the maximum curvature of the curve would be decay exponentially to 1 which eventually leads to the same result in the papers of Grayson. This method avoid the use of monotonicity formula or the classification of singularities thus simplify the analysis.

Supervisor:          FONG Tsz Ho / MATH
Student:             XIE Meng / MAEC                    Course:          UROP1000, Summer

This report focuses on the paper, The Heat Equation Shrinking Convex Plane Curves, outlining its structure of proof with some explanations and alternative proofs omitted in the paper from the beginning to corollary 5.5, with an emphasis on the second part of chapter 4 where proofs of many lemmas are omitted. It will also focus on the geometric proof used in chapter 5, providing a more detailed illustration of the two graphs. However, some parts of the paper which are already complete with few things omitted will not be discussed in detail in this report. In particular, the details of the three estimates used to prove the boundness of k will not appear in this report.

Supervisor:          FONG Tsz Ho / MATH
Student:             YE Jeff York / SSCI                  Course:          UROP1000, Summer

The mean curvature flow according to the heat equation has been a recent topic of interest in differential geometry. It has been shown by Gage and Hamilton that convex plane curves converge smoothly to a circle under this flow. Another geometric flow of interest is the inverse mean curvature flow, which is used in the proof of the Riemannian Penrose inequality. In this paper we imitate the method by Gage and Hamilton, to study the inverse curvature flow on convex plane curves. We will prove the long term existence of the solution, then show that the isoperimetric ratio converges to 4π and the curve converges to a circle smoothly.

Supervisor:          FONG Tsz Ho / MATH
Student:             YUAN Tong / MATH-IRE                 Course:          UROP1100, Fall

In the paper The Heat Equation Shrinking Convex Plane Curves, M.Gage and R. S. Hamilton considered the evolution of a plane curve under the heat equation, and derived some nice results on the existence and properties of the evolution equation. This report mainly focuses on section 3 and 4 of the original paper, concerning the heat equation acting on embedded and especially convex plane curves. Some ideas in the original paper will be discussed, and some steps of argument and calculation omitted in the original paper will be completed. Parts that are already covered in detail in the original paper will be briefly described of interest in differential geometry. It has been shown by Gage and Hamilton that convex plane curves converge smoothly to acircle under this flow. Another geometric flow of interest is the inverse mean curvature flow, which is used in the proof of the Riemannian Penrose inequality. In this paper we imitate the method by Gage andHamilton, to study the inverse curvature flow on convex plane curves. We will prove the long term existence of the solution, then show that the isoperimetric ratio converges to 4π and the curve converges to a circle smoothly.

## Weather Prediction and Air Quality

Supervisor:          FUNG Jimmy Chi Hung / MATH          Co-Supervisor:     LU Xingcheng / ENVR
Student:             CHAN Siu Chung / MAEC               Course:            UROP1000, Summer

Below-cloud washout (BCW) is one of the most efficient removal mechanisms for $PM_{2.5}$. This study investigates the correlation between the BCW coefficients of PM2.5 species ($NO3^-$, $SO4^{2-}$ and $NH4^+$) as well as $PM_{2.5}$ and rain intensity in heavy rainfall events, using the power regression model ($\lambda=aP^b$). Hourly data on ambient PM2.5 and meteorological factors were collected in HKUST super-site, a clean rural area, from 2011 to 2017. This study is presented on the basis of 39 selected precipitation cases for $PM_{2.5}$ species and 47 selected precipitation cases for $PM_{2.5}$. The collected results can be applied in 3-D air quality model to improve the $PM_{2.5}$ simulation during the rainy season.

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| Supervisor: | FUNG Jimmy Chi Hung / MATH | Co-Supervisor: | LU Xingcheng / ENVR |
| Student: | JEONG Eall Hyuk / SSCI | Course: | UROP1000, Summer |

Due to the possible hazardous effects of $PM_{2.5}$, it is crucial to monitor the deposition of $PM_{2.5}$ by precipitation. Through analyzing the 2011-2012 observation data (Na, K, Mg, and Ca composition data), the Below-cloud washout (BCW) coefficients of Na, K, Mg, and Ca are calculated. Further, the uncertainty assessment of scavenging coefficient is recognized. Na, K, Mg, and Ca are not fully studied in the current period; hence, the calculated BCW coefficients of Na, K, Mg, and Ca could further assist in understanding about the BCW of aerosol particles by precipitation in Hong Kong.

### Retrieval of Aerosol Optical Depth Using Machine Learning Algorithm

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| Supervisor: | FUNG Jimmy Chi Hung / MATH | Co-Supervisor: | LU Xingcheng / ENVR |
| Student: | GUPTA Abhishek / SENG | Course: | UROP1000, Summer |

Atmospheric Aerosol Optical Depth is a major factor that causes random variation of solar radiation intensity and affects atmospheric pollution. Most of the methods of obtaining AOD suffer from resolution or scarce observation points. By observing the various correlations between AOD and PM concentrations, Surface Temperature, Relative Humidity and Boundary Layer Height, an estimation model using the above physical quantities is proposed to obtain AOD conveniently and accurately. A multi-layered back-propagated neural network is used to map the non-linear relationships between the variables and predict AOD values. On testing with unbiased data, the network shows a high accuracy, leading to the conclusion that such a model can effectively predict the Aerosol Optical Depth.

### Use Kolmogorov–Zurbenko Filter to Detrend the Air Quality Data

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| Supervisor: | FUNG Jimmy Chi Hung / MATH | Co-Supervisor: | LU Xingcheng / ENVR |
| Student: | HU Mingyun / MATH-AM | Course: | UROP1000, Summer |

Ozone ($O^3$) pollution has become one of the most severe environmental issues in Hong Kong. To investigate the long-term trend of surface $O^3$ and correlations between $O^3$ and meteorological variables, $O^3$ data is detrended into various spectral components based on the Kolmogorov–Zurbenko filter (KZ filter), using measurement data at four meteorological sites (Central, Tsuen Wan, Tung Chung, Yuen Long) for the period of 2003-2017. In general, the long-term components of $O^3$ have undergone a fluctuating increase during the period, while temperature plays a leading role in the formation of $O^3$ among the meteorological variables. The seasonal components of $O^3$ have moderate correlations with meteorological variables in Hong Kong.

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| Supervisor: | FUNG Jimmy Chi Hung / MATH | Co-Supervisor: | LU Xingcheng / ENVR |
| Student: | HWANG Min Ho / MAEC | Course: | UROP1000, Summer |

Potential effects of meteorological change, transport of pollutants, or primary pollutants on $PM_{2.5}$ concentrations on $PM_{2.5}$ levels in Hong Kong are investigated based on the Kolmogorov-Zurbenko filter (KZ filter). Meteorological impacts on $PM_{2.5}$ was studied using a joint analysis of KZ filter and linear regression model. Influences of meteorological variables on $PM_{2.5}$ are high except in Central. The short-term variations of $PM_{2.5}$ were studied with wind direction. It reveals that $PM_{2.5}$ showed strong increasing tendency with northern or northwestern wind direction. The long-term variations were explored with normalized long-term trend of $NO_2$, $SO_2$ and CO. $PM_{2.5}$ generally shows similar pattern with primary pollutants. This paper will be useful for Hong Kong Government regarding $PM_{2.5}$ policies.

### Integro-differential Equations: Theory and Applications

Supervisor:     JIN Tianling / MATH
Student:        HUNG Chun Kit / MATH            Course:            UROP1100, Summer

In this report, we first study the fractional Sobolev Space $W^{s,p}(\Omega)$, in particular, $W^{s,2}(\Omega)$ for any $s \in (0,1)$, which is a Banach space tightly related to the fraction Laplacian $(-\Delta)^s$. Two equivalent definitions of it will be introduced, one is through the Fourier multiplier, the other is through a singular integral. Afterward, we investigate the spectral properties of it and turns out to be similar to classical symmetric elliptic operators. Finally, we prove that if $s = 1/k$ for some $k \in N$, then the first eigenfunction is superharmonic.

Supervisor:     JIN Tianling / MATH
Student:        TAM Tsz Yan / PHYS              Course:            UROP1100, Summer

The report mainly studies the results from the paper "On the superhar monicity of the first eigenfunction of the fractional Laplacian for certain exponents", and discussed some technical details supporting the original proof. Properties of the eigenvalues and first eigenfunction of the fractional Laplacian were studied, followed by discussing the main theorem of the selected paper. It is shown that eigenvalues of fractional Laplacian are real and the limit diverges, and their corresponding eigenfunctions forms an orthonormal basis of $L^2(\Omega)$. Several properties of the first eigenfunction of the fractional Laplacian were also studied. With these results, the main theorem on the selected paper were discussed.

Supervisor:     JIN Tianling / MATH
Student:        YIP Chi Hoi / MATH-PMA          Course:            UROP1100, Fall

We mainly study the existence, regularity of weak solution of boundary value problem. For the existence, we first introduce Lax-Milgram Theorem and energy estimate, and then use them to get the existence theorem. For the regularity, we consider various kinds of space embeddings, and we should divide them into 3 subclasses to study. We first introduce Gagliado-Nirenberg-Sobolev inequality and Morrey inequality, which deal with the embedding of $W^{1,p}(\Omega)$, and then we introduce General Sobolev inequality, which is a generalization to the embedding to $W^{k,p}(\Omega)$. Finally, we study the interior regularity. The amazing conclusion is that weak solutions are in fact smooth.

### Efficient Algorithms for Visualizing Dynamical Systems

Supervisor:     LEUNG Shing Yu / MATH
Student:        LEUNG Kai Lok / MAE             Course:            UROP1100, Summer

Lagrangian coherent structure (LCS) is a useful concept to understand element transport in a fluid flow. Having the velocity-field data, the LCS approach can be used to predict the future movement of the particles in a flow and forecast the shape of the adverted particle. This technique can be used to estimate the contaminated area in an oil spill in ocean or in volcano ash in the air. To obtain such a LCS, a mathematical tool so called the finite-time Lyapunov exponent (FTLE) is used. This report aims to study the concepts used in these mathematical tools and replicate a commonly used double gyre example to illustrate their application. Moreover, the multiscale method is also studied in this report. Some of its advantages and applications are also discussed in this report.

## Prediction of Utility Value for Joint Health States

Supervisor:     WONG Man Yu / MATH
Student:        ZHANG Tina Danting / MATH                Course:           UROP1100, Fall

The topic of suicide has been well discussed in phycology and sociology since Durkheim's keystone theory of suicide (1897), where it's seen as mental abnormalities or result of social integration and regulation. Only after a century, economists started looking at suicide formally with Hamermesh's Economic Theory of Suicide. Studies that look at suicide from decision making angle, in comparison to those from social angle, is inadequate. This report discusses three explanatory factors for suicide in China: income, financial crisis, and availability of method of suicide. For each, along with some literature review, I present why this factor is important, how we might capture its effect on suicide rate, and what problems/difficulties are seeking for solutions.

## Department of Physics

### No-collapse Quantum Mechanics

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| Supervisor: | CHEN Tian Wen / PHYS | | |
| Student: | FONG Kai Yuan / PHYS | Course: | UROP1100, Summer |

Since its inception in the early 20th century, Quantum Mechanics has been a successful theory in giving accurate and consistent predictions to the behavior of particles at the atomic scale. However, there are two main questions that still have not been answered: why do wavefunctions collapse in a non-unitary fashion and why the probability of measured value is the square of the amplitude, viz., the Born rule? In this research, we studied two proposed solutions to these two problems: decoherence and Many World Interpretation. We investigated the weaknesses of each solution. The topic of subjective probability used to derive Born rule in the Many Worlds Interpretation was also discussed briefly.

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| Supervisor: | CHEN Tian Wen / PHYS | | |
| Student: | FUNG Sze Ching / PHYS | Course: | UROP1100, Fall |

The probabilistic nature of quantum mechanics has been a longstanding problem. It was proposed by Everett that the probabilistic feature of quantum mechanics is indeed due to the ignorance of observers, and in a more global view, the wavefunciton, together with the observer, branching into all possible outcomes. As a result, the wavefunction looks probabilistic to an observer in a particular branch of the wavefunction. In this interpretation, the probability is interpreted as the "Self-locating Uncertainty" of an observer, but at the same time reducing to Born's Rule when an observer in a particular branch tries to measure such a probability.

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| Supervisor: | CHEN Tian Wen / PHYS | | |
| Student: | MA Junwei / PHYS-IRE | Course: | UROP1100, Summer |

In this report, we'll first examine two proofs of Born rule in Many Worlds Interpretation of quantum mechanics (MWI): Decision theoretic approach by Deutsch and Wallace, and Envariance approach by Zurek. Then we will further contemplate on the Hilbert space framework, which will lead to an interpretation of Gleason's theorem. Then, doubts on the validity of Hilbert space itself will further take us to the investigation of quantum logic, where the origin of quantum probability is likely located. The final part is the author's own opinion about the interpretation of quantum probability, that we'd better treat it as a part of quantum logic instead of postulating various interpretations on it.

### Optical Microscopy

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| Supervisor: | DU Shengwang / PHYS | Co-Supervisor: | CHEN Sherry / MAE |
| Student: | CHIU Hoi Chun / PHYS-IRE | Course: | UROP1100, Fall |
| | | | UROP2100, Spring |
| | | | UROP3100, Summer |

In this UROP project series, we would like to build a differential interference contrast microscope (DIC) to quantitatively reconstruct alloy surfaces and study phase transformation. Following the concept and design of the system proposed previously in UROP 1100 and UROP 2100, we now work on the software to control various hardware and make sure the data from the camera flow to the computer properly. In the following, the structure of the software and the data flow will be discussed.

## Quantum Optics and Atomic Physics

Supervisor: DU Shengwang / PHYS
Student: LI Bohan / PHYS-IRE          Course:          UROP2100, Fall
                                                       UROP3100, Spring

In this report, we use the rubidium spectrum to illustrate how the external cavity laser is able to lock its frequency at an absorption peak in the rubidium hyper-fine transition spectrum. We would first introduce the mechanism of the hyper-fine structure and explain the rubidium transition spectrum. The design of the external cavity diode laser and the locking technique would also be described.

Supervisor: DU Shengwang / PHYS
Student: ZHU Lingbang / PHYS-IRE          Course:          UROP3100, Fall
                                                           UROP4100, Spring

Entangled photon pair generation has been demonstrated in various systems for quantum optics experiments in the last decade. A simple and economical way is using atomic vapor cell for four wave mixing scheme. Here we report our preliminary tests on the performance of biphoton generation from a Rubidium vapor cell with a small phase-mismatching angle. Good quality electro-magnetically induced transparency could be obtained by adopting a 0-degree coupling scheme. Two-photon coincidence measurement is carried out and compared with previous results, which indicates a slightly longer coherence time.

## Fabrication of Novel Granular and Colloid Particles

Supervisor: HAN Yilong / PHYS
Student: CHEUNG Chak Lun / PHYS          Course:          UROP1100, Fall

The project has two main goals: to fabricate thousands to cm-sized soft and hard particles, to design the compression system for the crystal-to-glass transition experiment. The particles can mimic atoms in crystal-to-glass transitions and reveal the interesting structure changes at the single particle level. After the setup is prepared, we will track the position of particles by image processing and obtain several useful parameters, such as susceptibility of orientational order and density functions, for  the quantitative understanding of the structure transition.

## Development of Intensity Stabilization System for Optical Cooling of Quantum Gases

Supervisor: JO Gyu Boong / PHYS
Student: CAI Qianhang / PHYS-IRE          Course:          UROP1100, Fall
                                                           UROP2100, Spring

In quantum optics experiments, it is meaningful to perform exquisite light modulation in the scale of atoms, which requires a through but fine manipulation over beam profiles including both its phase and intensity. In this report, a method to achieve this purpose with the adoption of DMD and hologram generation is briefly introduced, as well as some of my current progress in terms of realization.

## Building an Apparatus Cooling and Trapping Erbium Quantum Gas

Supervisor: JO Gyu Boong / PHYS
Student: TSO Yee Ming / PHYS-IRE          Course:          UROP2100, Fall

In this paper we presented a customized and effective design for cooling erbium atoms, which consist of a control system, main machine and a laser system. Development for the setup of each component and the current progress of the implementation of design is presented as well. We also report the spectroscopy result on Erbium atoms, which provides the evidence of our laser interacting with Erbium gas. Furthermore, we will present the possible future research topics on dipolar Erbium quantum gases.

## Organic Molecular Beam Deposition in Ultra-high Vacuum

Supervisor: LIN Nian / PHYS
Student: LEUNG Ho Yin / CIVL          Course:          UROP1100, Spring

The main purpose of this experiment is to study surface property of graphite at ultra high vacuum. Two techniques are used. Low energy electron diffraction (LEED) is used to investigate the atomic structure of graphite by the pattern of electron diffracted out from a graphite sample. Auger electron spectroscopy (AES) is used to investigate the chemical composition of graphite sample by the auger electron emitted out from the sample when collided with high energy electron. We also learn the properties of ultrahigh vacuum and the methods to obtain ultra-high vacuum.

## Atomistic Simulations of Dynamic Properties of Water

Supervisor: PAN Ding / PHYS
Student: CHENG Man Hin / PHYS-IRE          Course:          UROP1100, Fall

The Shear viscosity of water is an important property that affect the use of it. Under extreme condition such as temperature higher than the critical temperature and pressure higher than the critical pressure, it is difficult to measure it experimentally. This project focus on finding an efficient method to predict the shear viscosity using computational simulation. Two different method, Green-Kubo relation and Einstein relation is presented in this context and compare the efficiency and accuracy.

## Random Walk on Complex Network and Application to Numerical Simulation for Statistical Physics

Supervisor: SZETO Kwok Yip / PHYS
Student: CHEN Huijin / PHYS          Course:          UROP1000, Summer

As my UROP project titled "Random Walk on Complex Network and Application to Numerical Simulation for Statistical Physics", my first task is to self learning linear algebra and being able to find the eigenvalue and eigenvector, at the same time, diagonalise a 3 by 3 matrix. Since python is very important and much more convenient in terms of coding for complex networks, another task is learning python programming language and writing the codes to diagonalise the matrices. In the past one and a half months, I spent most of my time on reading the textbook of linear algebra and during the process, I not only learnt basic ideas of matrix computation and diagonalization, but also some interesting properties of simple networks and some knowledge about Markov process, which is the foundation of Markov chain in information engine. In the report, I will illustrate some mathematical concepts that I have learnt relating to the eigenvalue and eigenvector, and also some presentation of simple networks and Markov process.

| Supervisor: | SZETO Kwok Yip / PHYS | | |
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| Student: | FENG Zhijie / PHYS-IRE | Course: | UROP1100, Fall |
| | | | UROP2100, Spring |
| | | | UROP3100, Summer |

We investigate the stochastic resonance phenomenon and the importance of time scale in opinion formation dynamics by building an agent-based binary voting model consisting of one-spin-flip damage spreading, random walk searching, and a well-defined deadline for vote counting. The social network of each party is a Watts-Strogatz (WS) network with interaction between voters modeled by nearest-interacting Ising model. We model the structure of a strictly fair voting population by connecting two identical WS networks of opposite spin configurations. The earlier a party introduce the local disturbance in the enemy's camp, the higher probability of its winning due to advantage in time. On the other hand, the party (the latecomer) that introduces the local disturbance later has the advantage in searching for the best place to inflict the damage, such as the information of node degree gathered from preliminary random walk searching. The competition between advantage in time and advantage in information reveals the existence of an optimum searching time for the latecomer to win. The winning probability of the party are measured at the deadline after we allow the introduction of two counterbalancing local disturbances, by sudden flipping of opinion configuration, at two different times during the interaction. In this work, we show the significance of node's degree, and study how the parameters, including (1) deadline, (2) network randomness, (3) winning threshold, and (4) temperature, affect the dependence of winning on time by numerical simulation. For the effect of temperature, we notice an optimum temperature that induce longest range of winning time for the latecomer, and propose a comparative study with prototype stochastic resonance for the phenomenon in our model.

| Supervisor: | SZETO Kwok Yip / PHYS | | |
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| Student: | GUO Wenshuo / PHYS | Course: | UROP1100, Spring |

This report serves as a progress report for UROP1100: Random Walk on Complex Network and Application to Numerical Simulation for statistical physics. In this semester, Guo did various explorations on random walk topic. This report contains mainly three parts: In the first part, an interesting model on Random Walk for Opinion Formation in Complex Networks is presented. This part of work is an outcome collaborated with Sarah during the semester. Guo purposed the model, Sarah performed the numerical simulations and Guo helped check and fix the program. In the second part, we provide a summary of the study progress on complex network and random walk. In the last section, Guo included her learning on statistical inference during this semester.

| Supervisor: | SZETO Kwok Yip / PHYS | | |
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| Student: | YIP Chun Yin / PHYS | Course: | UROP4100, Spring |

In the present report, the topological charge of a node in a network is defined as the difference between its degree and the average degree. In particular, the report focused on the WS network model, which is often used to describe a social network. The report then devised various types of topological-charge-biased random walkers, who preferred to go to a neighbouring node with either a like or an opposite charge. The walkers' cover time and cover speed on WS networks were studied. It was observed that the performance of likecharge-biased walkers were slightly different from that of opposite-charge-biased walkers. The reason for this phenomenon is yet to be answered.

### Maxwell Demon and Information Thermodynamics

Supervisor:     SZETO Kwok Yip / PHYS
Student:       CHEUNG Long Him / PHYS-IRE     Course:     UROP3100, Fall

The dynamics of opinion formation process in a social network is of great interest for many non-equilibrium systems, such as election, competition of market share in advertising etc. By introducing local disturbance in the social network, such as the implantation of an agent, we can use numerical simulation to measure the effect of this agent on the result of the election, which has a deadline. By extending the statistical physics of damage spreading in spin models on lattice to social network, we investigate the effect of one agent on a two-party election on the time to dominance as a function of the given time to the deadline of the election. We find that certain rewiring mechanism of the social network will enhance the speed to dominance by the party that implant the agent. Using genetic algorithm, we also find good method of rewiring that can greatly increase the efficiency of the agent. Our model used is the Ising model and the network used is Watts-Strogatz network. We perform Monte Carlo simulation on the effect of interaction and use a genetic algorithm with a mutation matrix to find the best way of rewiring to amplify the effect of the agent in influencing the result of the election. We also discuss the general topological feature of an optimal rewiring condition in maximizing the effect of the local disturbance in opinion formation.

Supervisor:     SZETO Kwok Yip / PHYS
Student:       WANG Ziqi / PHYS     Course:     UROP1100, Spring

In this paper we will basic on the 2 model of networks: random graph networks and Watts-Strogatz (WS) model, study the construction of them and the network property like its clustering coefficient. Then we develop an extended definition of clustering coefficient to polygon expression, and explore how the parameter which construct the network affect the clustering coefficient of nodes within the origin and extended clustering coefficient. Applying the node-individual difference of clustering coefficient, we hope to find a strategy related to the clustering coefficient to spread information, simulated by a bias random walker move on the 2 types of networks.

### Damage Spreading in Networks

Supervisor:     SZETO Kwok Yip / PHYS
Student:       CHOW Chun Yu / PHYS-IRE     Course:     UROP1100, Fall

The first part of the paper discusses the Ising model for ferromagnetism and shows the results of an implementation. The graphs of mean energy, mean magnetization are plotted as functions of temperature. Addition of spy in the Ising model lattice has influence on the relations above, and the dominating time is investigated. The second part focuses on using the genetic algorithm (GA) to solve an optimization problem, the result of traditional GA is compared with the mutation only genetic algorithm (MOGA) approach.

### Evolutionary Computation for Optimization

Supervisor:     SZETO Kwok Yip / PHYS
Student:       LAU Ka Ki / PHYS     Course:     UROP1100, Spring

This research mainly focuses on the problem of scheduling workers in different daily shifts for a company operating 24 hours per day and 7 days per week. By the preference of the workers, different time slots available will be assigned a "satisfactory rating", indicating the degree of satisfaction of that worker if he is scheduled to work on that shift. This research simulates the arrangement of one week. The goal is to maximize the total satisfactory rating of the workers,

and to minimize the variance of the rating, i.e. maintain the fairness between different workers. For the simple version of the problem, which the different players have the same preferences and different days of a week have the same preferences by the players, it is found that there are 29064960 optimal results, using exhaustive search. For the more realistic version of the problem, genetic algorithm within 5000 generations is used, with compensation calculated in the fitness if constraints of scheduling are violated. It is found that mutation method is better than crossover in this problem.

| Supervisor: | SZETO Kwok Yip / PHYS | | |
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| Student: | WANG Ziqi / PHYS | Course: | UROP1100, Summer |

In this paper we will discuss a network model of a financial system problem, study the construction of the 3 classical types of network: Erdo´s–R´enyi(ER) model, Watts-Strogatz (WS) model and Baraba´si–Albert (BA) model and focus on the relation between structure and the model stability of the networks in the financial problem. Then, we will apply the genetic algorithm on the problem and figure out the factor that affects the stability of the system. The cascade failure phenomenon is also a potential risk we need to be studied and avoided in the models. We aim to find the efficient rewiring strategy to reduce the cascade failure through programming, such as genetic algorithm and enumeration.

| Supervisor: | SZETO Kwok Yip / PHYS | | |
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| Student: | WONG King Chun / PHYS | Course: | UROP1100, Spring |
| | | | UROP2100, Summer |

Opinion formations in a social networks, such as elections, are highly non-equilibrium processes that exhibit rich dynamics and many interesting features. Borrowing the ideas and techniques of the Ising model from statistical mechanics, a model was built to study the voting dynamics between two competing parties. Based on this model, we had studied the effect when one of the agents in the network is fixed to belong to a certain party immutably, that is, the effect of the implantation of a "spy". A party-specific centrality measure was introduced to analyze the effect of different implantation sites and the affected dynamics. We ended this report with a note of possible future developments of the project.

| Supervisor: | SZETO Kwok Yip / PHYS | | |
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| Student: | XIA Yusen / SSCI | Course: | UROP1000, Summer |

This report is a summary of the work done in UROP 1000 course, summer 2018. We preliminarily study the Evolutionary Genetic Algorithms. We study the conventional GA which based on mutation and crossover, and the adaptive Mutation Only GA introduced by Prof Szeto Kwok Yip. In both methods, we establish a set of chromosomes to represent the solutions and try to keep enough information of the fittest as well as introduce new information to the population by mutation. A probability matrix is introduced in the latter method and it is parameter free and evolving with time. We apply the conventional method to a function optimization problem and both the conventional and Prof. Szeto's methods to Travelling Salesman Problem. Different improvements of efficiency are discussed in the TSP experiments.

| Supervisor: | SZETO Kwok Yip / PHYS | | |
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| Student: | ZHANG Tianpeng /  COSC | Course: | UROP3100, Fall |
| | | | UROP4100, Summer |

The contention resolution problems deal with sharing limited resources among multiple parties. Some cases can be solved using centralized methods, or using communication between parties, but there are problems that are inherently

decentralized and there is no efficient communication mechanism between different parties. For example to passengers deciding among themselves who to take the only empty seat on the subway, or web clients attempting for the access to the database. A common solution is to let every party follows the same randomized protocol, which is to toss a coin to decide whether to acquire or yield the resource. The problem is resolved when only one party decides to acquire and all others yield. The randomized protocol is extremely efficient when the size of contention, i.e. number of parties attempting the same resource, is known. However, it is often the case that the contention size is hardly known by individual parties, as in the contention of web clients, and in this work we try to tackle this issue. We will first review the contention resolution problem, analyze the traditional randomized protocol, then introduce new two protocols which has good efficiency without the knowledge of contention size. The idea is to adapt the probability of acquiring the resource and the contention size through iterations, so that they match each other.

### Time Dependent Mean Variance Analysis in Econophysics

Supervisor:     SZETO Kwok Yip / PHYS
Student:        WANG Juntao / PHYS          Course:          UROP1100, Spring

The portfolio management problem is a hot and complex topic in asset management and investment. In this paper, we introduce a dynamic set of portfolio strategy for two stocks and cash using Genetic Algorithm. The two stocks are selected from Hang Seng Index constituents, which satisfy two conditions: they are highly anti correlated during some periods of time, and there are enough daily close prices data to be studied. The strategy comprises of three parts: conditions, fraction, and action. The genetic algorithm is applied to search for optimal strategies, by which one can achieve the largest Sharpe ratio. By employing this dynamic set of strategies, we show that the return rate of investments is increased, compared to using random strategies.

### Chaotic Dynamics in a Complex Network

Supervisor:     SZETO Kwok Yip / PHYS
Student:        WONG King Chun / PHYS          Course:          UROP4100, Fall

A model of analyzing quasi-periodic time series was constructed based on Parrondo's paradox. The model consists of two independent predictors, a fair guesser A and a history-dependent B. The goal of the model is to investigate the possibility of Parrondo Effect in time series prediction, in which two losing prediction strategies can be combined to a winning one, and to utilize the phenomenon to search for a optimal prediction scheme given a limitedly accessible history. Simulations and analysis of the model had been performed by inputting artificial sinusoidal time series, and an optimal mixture of the two predictor, A and B, had been attempted to construct both stochastically and deterministically.

### Negative Refractive Index Meta-materials

Supervisor:     TAM Wing Yim / PHYS
Student:        BRACKE Vincenz / PHYS          Course:          UROP2100, Fall
                                                                UROP3100, Spring
                                                                UROP4100, Summer

In this progress report, I will briefly introduce the project I have worked on during this summer semester. I will introduce the aim of the project and outline how what to achieve this. Then I will summarize the progress made this summer in manufacturing a larger and thicker sample of a negative refractive index material using the combined focused ion beam and scanning electron microscope system and detail the results gathered so far. Using pictures taken during the

manufacturing process as well as from the transmittance and reflectance analyses I will illustrate the current state of the project, compare the results to last semester's and suggest further steps to be taken to achieve better results.

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| Supervisor: | TAM Wing Yim / PHYS | | |
| Student: | CHAN Yi / PHYS | Course: | UROP1000, Summer |
| | LI Wing Shun / PHYS-IRE | | UROP2100, Fall |
| | | | UROP3100, Summer |

This project aims to find out the change in optical activities in laser dye in its ground state and excited state. A cylindrical cell was used to store the dye and trap an air bubble for interferometry analysis. Several factors affecting the thickness of gap, which is an important parameter in interferometry, were studied. Tests regarding the volume of bubbles and the leakage of the cell were carried out. Lastly, a laser pumping test was tried however the data analyzed cannot draw a conclusion.

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| Supervisor: | TAM Wing Yim / PHYS | | |
| Student: | NGAI Tsz Ue / PHYS | Course: | UROP1100, Fall |
| | | | UROP2100, Sping |

Phase change on reflection is important optical property to be considered for designing metamaterial surface. Following Yung's et al. idea of using continuum source for phase measurement, this project aims to measure the reflection phase change using supercontinuum laser and FP interferometer mounted on a rotation table. This setup is able to measure the dependence of phase change on the incidence angle within beam diameter of 2 mm. A glass-air-100 nm Au etalon was tested with clear interference pattern emerged. The constructive interference peaks were analyzed by the two-beam model and the air-gap spacing and the reflection phase of the etalon. This setup is also able to measure the transmission phase change for transparent materials.

### Controlling Confinement Effect of Polymer Dynamics

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| Supervisor: | TSUI Ophelia K. C. / PHYS | | |
| Student: | CHOW Man To / PHYS-IRE | Course: | UROP1100, Fall |
| | | | UROP2100, Sping |

The glass transition temperatures, $T_g$, of random copolymer thin films containing poly(4-tert-butylstyrene) (P4TBS) and poly(4-acetoxystyrene) (P4AS), with two compositions, 65.6 mol% P4TBS (P4TBS-66%) and 47.5 mol% P4TBS (P4TBS-48%), were investigated against those of pure P4TBS and P4AS thin films. The $T_g$ of P4TBS decreases with decreasing film thickness while that of P4AS increases with decreasing film thickness. We thus expect that the $T_g$ vs film thickness, h, curves ($T_g$ curves) to follow the order of pure P4AS, P4TBS-48%, P4TBS-66% and pure P4TBS from highest to lowest $T_g$ values for thin enough films. However, no discernible difference could be found between the $T_g$ curves of P4TBS-66% and pure P4TBS. Separately, we observed that the breadth of the glass transition of both copolymer films decreases with decreasing film thickness, suggesting that P4TBS may dominate the dynamics of the $T_g$ of the P4TBS-co-P4AS copolymer films.

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| Supervisor: | TSUI Ophelia K. C. / PHYS | | |
| Student: | WANG Tong / PHYS-IRE | Course: | UROP1000, Summer |

We used ellipsometry to examine the thickness-temperature (h-T) relationship of two sets of pure polymer thin films, P4TBS (poly(4-tert-butylstyrene)) and P4AS (poly(4-acetoxystyrene)) and three sets of their copolymers whose compositions are 65.6%PTBS, 47.5%PTBS and 31.7%PTBS. From the h-T curve, the glass transition temperature Tg, the starting and the ending temperature of glass transition T- and T+, the breadth of the transition ΔTg and the thickness of the surface liquid-like layer can be estimated. We investigated how the different compositions and total film thickness influence the behavior of Tg, T-, T+, ΔTg and the surface liquid-like layer to reveal the confinement effects of the substrate on copolymer films.

## Fuzzy Dark Matter

Supervisor:    TYE Henry / PHYS
Student:       HO Sui Lun / PHYS                 Course:        UROP1100, Spring

The standard Cold Dark Matter model (CDM) interpretation of dark matter is successful in explaining large-scale structure of our universe. Nevertheless, four major problems emerge in such model in the description of small-scale structures. Fuzzy Dark Matter (FDM) model suggests an ultralight (m ~ $10^{-22}$ eV) scalar field to explain dark matter composition. The quantum effects in astronomical scale shown FDM model successfully preclude the problems faced by CDM model. Observation shows a supermassive blackhole is a crucial central component of galaxies, leads to questions on the effect of FDM model in the scenario of supermassive blackhole(SMBH) formation. The paper suggested a careful study on the correlation between SMBH formation and FDM results in a mass constraint that disfavour FDM model. This demonstrates that FDM model neither correlate nor contradict with SMBH formation. In addition, recent studies shed light on possibility of dark matter not couple to baryonic matter in galactic scale, by discovering a galaxy lacking dark matter. The paper suggest an upper bound for initial misalignment angle for the quantum fluctuation patch corresponding to the dark-matter-lacking galaxy, through a spherical symmetric toy model with structure formation scenario considered in expanding universe.

Supervisor:    TYE Henry / PHYS
Student:       LI Shing Yan / SSCI              Course:        UROP1100, Summer

We present a possible string theory explanation to an exponentially small cosmological constant. Through flux compactification in Type IIB string theory, we obtain the Kähler uplift racetrack model. It shows that there is a statistical preference of such cosmological constant within the string landscape, without much fine tuning. We emphasize the difference between simple racetrack and multiple racetrack models. We also investigate the statistical distribution of associated mass scales of the models from different mechanisms. The mass scales are as small as the cosmological constant, and may correspond to ultra-light axions (ULAs), which are a candidate of dark matter in the model of fuzzy dark matter.

## Quantum Oscillations in Low Dimensional System

Supervisor:    WANG Ning / PHYS
Student:       KONG Kangyi / PHYS              Course:        UROP1100, Summer

This is a report exclusively for the UROP 1100 program "Quantum Oscillations in Low Dimensional System". The aim of this report is to summarize the studying progress of understanding the quantum statistical mechanics and solid state physics in a progressive manner as a reference for future further studies and review. It will start with basic assumptions in classical statistical mechanics. And then the thermodynamic properties of an ideal gas will be recovered. Combined

with the methods in quantum statistical mechanics, the thermodynamic functions of fermi gas will be also deduced. Last but not least, we will discuss the magnetization properties of the Fermi system.

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| Supervisor: | WANG Ning / PHYS | | |
| Student: | WAN Chun Yu / PHYS | Course: | UROP1000, Summer |

This report covers the fundamental concepts behind the theory of magnetic oscillations, such as Landau levels, Fermi gas and quantum statistical mechanics. The focus is on using the free electron model to derive two kinds of magnetic susceptibility of metals. Pauli paramagnetism which originates from the spin magnetic moment of the electrons and Landau diamagnetism which originates from the motion of electrons in a magnetic field. The degenerate limits and the non-degenerate limits are derived with discussion on the accuracy and the neglected effects. Finally, the de Haas-van Alphen effect in a two-dimensional system is briefly introduced as the degenerate limit of Landau diamagnetism which exhibit oscillation in the magnetic susceptibility.

### Charge Generation and Carrier Diffusion in Organic Solar Cells

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| Supervisor: | WONG Kam Sing / PHYS | | |
| Student: | CHEUNG Hon Ning / CHEM | Course: | UROP1000, Summer |

Organic solar cells are one of the next generation photovoltaics due to its high mechanical flexibility, light weight and low cost1. To meet the requirement before OPV being commercially available, challenges need to be overcome which includes: unsatisfactory efficiency, short charge carrier lifetime and low stability due to unavoidable charge recombination. In recent years, significant investigations have been conducted to overcome the technological and material limitations while developing new organic photovoltaics devices with higher efficiency and commercial viability collectively1-2. In this project, we focus on the study of charge recombination through. Transient photovoltage measurements are conducted to evaluate the device performance through measuring the voltage decay lifetime (which determines charge-carrier lifetime) and open-circuit voltage while varying background light intensity.

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| Supervisor: | WONG Kam Sing / PHYS | | |
| Student: | LI Veronica Qin Ting / PHYS | Course: | UROP1100, Fall |
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| | | | UROP3100, Summer |

This report documents the first observations in this research project of strong photo-CELIV peaks in organic solar cells (OSCs) fabricated at HKUST. Specifically, devices with thicker electron transport layers (ETLs) appeared likelier to display photo-CELIV curves that are considerably greater in amplitude than the corresponding dark CELIV curves. However, such devices were still RC time limited, as the decay time of transient photocurrent continues to change with shunt resistance. More trials will need to be conducted on samples with active layers other than P3HT:PC61BM for a generalized understanding of OSC properties during photo-CELIV measurements.

### Dynamics of Housing Prices

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| Supervisor: | WONG Michael Kwok Yee / PHYS | | |
| Student: | FONG Kin Long / PHYS-IRE | Course: | UROP2100, Fall |
| | | | UROP3100, Spring |

Housing prices in Hong Kong are worth studying as they are closely related to the well-being of the society. Efforts have been made previously on analysing the characteristics of the housing market and predicting the housing prices so as to identify potential bubbles and issue warnings. In this project, analysis of the periodicity of the housing market from 1996 to 2010 and its driving force using cross correlation is conducted. In our previous work, it was shown that there is a 30 month periodicity in the housing price of Hong Kong. The work on the periodicity is continued and the reason for the periodicity is investigated. There are evidences showing that the interest rates of Hong Kong are closely correlated to housing prices and therefore interest rates could probably be the driving force of the periodicity of housing prices.

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| Supervisor: | WONG Michael Kwok Yee / PHYS | | |
| Student: | MA Ka Long / PHYS-IRE | Course: | UROP1100, Fall |

At the very beginning of this project, predicting housing prices and looking for precursors to bursts of bubbles from existing price data have always been one of the main goals. After housing price data for all 18 districts in Hong Kong were collected, attempts at predicting housing prices, with different methods and techniques, of some or all districts were made recently. Results with satisfactory performance (in both interpolation and extrapolation within a short time interval) were obtained by applying the Gaussian process with a suitable kernel. In this report, some of the major work and findings, including those by applying the Gaussian process (GP), will be discussed.

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| Supervisor: | WONG Michael Kwok Yee / PHYS | | |
| Student: | WANG Juntao / PHYS | Course: | UROP2100, Fall |

Housing markets not only have close relations to residence livelihood but could affect the overall economy of a whole country, so researchers invented several methods to predict the housing price of different countries. Many scientists are seeking the non-stationary behavior in housing price time series to detect the rapid growth, which is considered as asset price bubbles. Thus, statistical techniques are used to confirm the existence of explosive behaviors, such as root test, augmented Dickey Fuller test and PSY method. However, though these methods are plausible in some special case, they are still far from practical, since they lack predictive power. Thus, in this paper, we would apply Gaussian Process (GP) with appropriate kernels to predict the changes of Hong Kong housing price.

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| Supervisor: | WONG Michael Kwok Yee / PHYS | | |
| Student: | YAM Wun Kwan / PHYS-IRE | Course: | UROP2100, Fall |
| | | | UROP3100, Spring |
| | | | UROP4100, Summer |

In this report, we attempt to find a model for Hong Kong housing price and try to find the cause of periodicity in the Hong Kong housing market. In the first part of the report, we analyze the correlation between price and interest rate in the Hong Kong housing market. Periodicity is found in price change and interest change, and it seems that price is correlated with changing interest. In the second part of the report, we use information from Fourier components to construct a model for housing price. The calculated model somewhat matches real values and suggests that the Hong Kong housing market resembles an oscillating system.

## Dynamics of Traffic Congestions

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| Supervisor: | WONG Michael Kwok Yee / PHYS | | |
| Student: | KWOK Tsz Hong / SSCI | Course: | UROP1100, Summer |

Traffic congestion is caused by many factors, such as the road capacity and the traffic density. Besides the internal factors, congestion may also be caused by external factors, such as different days of the week, different hours of the day, and the weather conditions (e.g. the temperature, precipitation, wind speed, visibility). In this study, we collect the data from Taiwan highway system and The Central Weather Bureau Observation Data Inquire System to investigate the impact caused by rainfall on the traffic. Among all the weather conditions, we believe that rainfall will cause the greatest effect on highway traffic. To find out the impact, we will look at how road capacity, traffic density and traffic latency are influenced by the rainfall.

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| Supervisor: | WONG Michael Kwok Yee / PHYS | | |
| Student: | SIU Kwong Tai / PHYS | Course: | UROP1100, Spring |
| | | | UROP2100, Summer |

Hypercongestion is a controversial traffic state in recent studies of congestions. By analyzing the real traffic data from the Taiwan highway system, we find that hyper congestion exists on some road segments of the Taiwan National Freeway. In the study, we focus on the speed-flux distribution of highway segments, and some of the features are consistent with theoretical predictions of the hypercongestion state. In addition, we discuss briefly some possible reasons that will probably determine the occurrence of hyper-congestion based on some preliminary observations.

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| Supervisor: | WONG Michael Kwok Yee / PHYS | | |
| Student: | TAI Yee Man / PHYS | Course: | UROP1100, Spring |
| | | | UROP2100, Summer |

Kerner's Three-phase Traffic Theory summarizes traffic states into three phases, namely "free flow", "synchronized flow" and "wide moving jams". The theory shows contradictory findings to the earlier fundamental diagram approaches to traffic studies, in which "synchronized flow" traffic does not lie on the curve of the fundamental relation of traffic flow in the flow-density plane, but occupies a separate two-dimensional region. To investigate the theory, we attempted to verify Kerner's findings using Taiwan real data. Flux-versus-density graphs and space-time diagrams are plotted to make comparison between real data and the theory, and disagreements are detected. The reasons for the inconsistencies and limitations of Kerner's theory are discussed.

### Space Orbit Design

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| Supervisor: | WONG Michael Kwok Yee / PHYS | | |
| Student: | LAU Albert Wai Kit / PHYS | Course: | UROP4100, Fall |

During the design of space trajectories, it is crucial to know where the spaceship can go for a given amount of fuel and within a time constraint, and this is known as the reachability problem. In ballistic trajectories, the analytical solution of reachable region exists as function of the initial states. For low-thrust trajectories, the problem of computing the accurate reachable region in a reasonable time remains unsolved. The low-thrust reachability problem is of interest to the planning of future missions as many low-thrust missions have been launched in the past two decades and more are expected in the near future. Previously, a superposition method for estimating the low thrust reachable region is developed by our team with a greedy optimization method to choose the boundary solutions. The result has been published in International Astronautic Congress 2017, Adelaide. In this report, a brief summary of the published method is stated, and some possible enhancements including the polar form superposition algorithm is discussed.

## Neural Dynamics

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| Supervisor: | WONG Michael Kwok Yee / PHYS |
| Student: | TAI Wai Ting / PHYS-IRE |

Course: UROP2100, Fall

Neural network is most commonly used for the classification of discrete data, but its behavior for continuous data has also been a subject of wide interest, as it can shed light on the mental representation of continuous data. This project aims to study the ability of a neural network to handle images in different orientations. A neural network is trained with images of rotating chairs and is able to learn a continuous distribution of the image based on its orientation. Afterwards, networks are trained with images of rotating sofas in different colors, and the results suggested that the network is able to generalize to some extent to different colors, showing that the distribution is also applicable to images of different colors.

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| Supervisor: | WONG Michael Kwok Yee / PHYS |
| Student: | YUAN Weijun / PHYS |

Course: UROP2100, Fall

Understanding how the brain works is one of the most challenging issues in modern scientific research, but many questions remain unanswered. One possible approach to address this problem is to utilize the tools of deep learning to simulate the functions of the brain. The purpose of this study is to realize the mechanism of rotational motion recognition in human brain using the artificial neural network. It is shown from deep visualization that the deep neural network can extract the features of an image with hierarchical structure, which is very similar to the visual system. The VGGNet trained with Imagenet data is used to mimic the visual system and a feed-forward neural network is designed to simulate the function of rotational-motion recognition.

# SCHOOL OF ENGINEERING

# Department of Chemical & Biomolecular Engineering

## Drug Delivery Approaches for Pharmaceutical Intervention to Control Myopia

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| Supervisor: | CHAU Ying / CBE | | |
| Student: | CHEN Longfei / CBME | Course: | UROP1100, Summer |
| | LI He / SENG | | UROP1000, Summer |

Myopia, also known as short-sightedness, is an optical focusing anomaly. One kind of myopia is produced by exceeding eyeball elongation called myopic growth. Study [1], [2] and [3] revealed that a native protein called Apolipoprotein A1 (ApoA1) have the potential to inhibit the myopic growth through photoreceptor cells uptake. Photoreceptor cells are located in retina, which is a posterior segment of eye structure. Study [4] provided varies approaches for drug delivery systems (DDS) to access to posterior segments, including topical pathway, intravitreal injection pathway as well as transscleral pathway. In this study, we mainly focus on topical delivery pathway of ApoA1 towards retina.

## Nanoparticles for Delivering Nucleic Acids to the Retina

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| Supervisor: | CHAU Ying / CBE | | |
| Student: | HOQUE Ayman/ SENG | Course: | UROP1100, Summer |

The retina has a multitude of gene targets for specific disease including glaucoma, age related macular degeneration (AMD) and diabetic retinopathy. These diseases affecting the posterior segment of the eye are the common reasons for retinal degeneration among citizens, especially aged people. Although for diseases like glaucoma, typical treatment largely relies on physical surgery, in recent years many new drugs are being approved, including nucleotides.
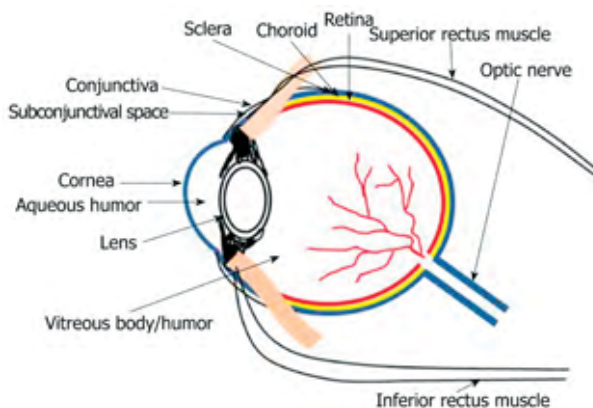


Structure of the eye

The project aims to understand how the parameters of nanoparticles influence their distribution after intravitreal injection. These parameters include size, charge and surface ligands. The objective is to examine the RNAi silencing efficiency of retinal targeting nanoparticles by varying the composition of liposomes.

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| Supervisor: | CHAU Ying / CBE | | |
| Student: | SABRINA Jacqueline Cheryl / CHEM | Course: | UROP1100, Spring |
| | | | UROP2100, Summer |

Nanoparticle polymer (PEG-PCL) was used and modified using different peptide ligands – COG, TGN, RXR. The nanoparticles were modified to enable crossing of BBB and specifically target cerebellum. The nanoparticles were prepared using double emulsion method, then the particle size and potential were characterized. The cellular uptake of PC12 cells was determined using flow cytometry, and the permeability of bEnd.3 cells was determined using transendothelial electrical resistance (TEER) measurement. The particle sizes vary depending on the ligands attached. Ligand-modified nanoparticles show positive surface charges, indicating that the ligands are exposed on the surface. Transendothelial electrical resistance indicates that tight junction was not formed by bEnd.3 cells.

### Towards Zero-waste Pharmaceutical Processes: Mapping Complex Process Behavior of a Novel Membrane-assisted Crystallization Process

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| Supervisor: | LAKERVELD Richard / CBE | | |
| Student: | MADEJ Dominik / CENG | Course: | UROP2100, Fall |
| | | | UROP3100, Spring |

Solvent selection and process optimization are key challenges in pharmaceutical manufacturing. Simultaneous optimization of solvent type and process conditions using PC-SAFT with mixed-integer nonlinear programming method was conducted for continuous antisolvent crystallization of paracetamol with and without solvent recycling. Moreover, the performance of MINLP and brute force optimization methods were compared. In all cases (with and without solvent recycling, MINLP vs. NLP brute force method), selection of the optimal solvent pair was consistent. A system with solvent recycling could produce a higher yield (0.230) than a system without recycling. For all cases investigated, CPU time needed for evaluation of MINLP problems was 3 orders of magnitude shorter than the CPU time of a combination of NLP problems and brute evaluation. The developed approach can support process design for pharmaceutical industry to shorten time-to-market and minimize waste generation from solvents.

### Biofuels and Derived Products from Spent Coffee and Tea Ground

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| Supervisor: | LAM Leung Yuk Frank / CBE | Co Supervisor: | HU Xijun / CBE |
| Student: | HUI Yiting / EVMT | Course: | UROP1100, Spring |

The advantages of generating biofuels from biomass have been self-explanatory for decades and there is continuous research on maximizing biofuel generation potential by altering raw materials and pretreatment parameters. With the discovery of graphene, a one-atom-thick layer of carbon atoms arranged in a hexagonal lattice, the astonishing properties of graphene and its compounds (such as graphene oxide as photocatalyst) have come into light. Since there is a huge amount of spent tea waste in China, it is meaningful to explore the graphene generation potential of different types of spent tea and figure out the optimal experimental conditions. Factors like intrinsic properties, various pretreatment parameters, and particle size of could be vital to final outcome, and should be deeply investigated.

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| Supervisor: | LAM Leung Yuk Frank / CBE | Co Supervisor: | HU Xijun / CBE |
| Student: | YEUNG Chun Chung / ENVS | Course: | UROP1100, Spring |

Nowadays, the popular coffee shop culture has generated a huge amount of by-products i.e. spent coffee grounds. In other to handle this waste stream in a sustainable manner, people have been developing different ways to valorize it. One sustainable valorization route would in theory consist of different processes integrated together to separate and utilize the different portion of spent coffee ground because it has a wide spectrum of chemical composition. For instance, coffee grounds can be extracted for lipids and be turned into biodiesel and the subsequent residue can be used to produce biochar from pyrolysis. In the present study, we focus on the latter part of such valorization chain i.e. the

production biochar with beneficial properties. We aim to evaluate how different production factors i.e. pyrolysis holding temperature and acid and base pretreatment influence biochar properties derived from the pyrolysis of defatted spent coffee grounds.

### Metal Extraction from E-Waste

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| Supervisor: | LAM Leung Yuk Frank / CBE | | |
| Student: | KIM Haeyoung / CBME | Course: | UROP1000, Summer |

Lithium-ion batteries have become one of the most common type of rechargeable batteries after its inception in the late 20th century. In contrary to the fast growth of the Li-ion battery industry, the recycling industry has yet to be developed. In China, out of 570 kilotons of all types of batteries being disposed, 35% consisted of secondary Li-ion batteries, in 2013. Moreover, approximately 95% of spent Li-ion batteries worldwide are known to be landfilled instead of being landfilled. A commercially viable recycling process is needed not only due to environmental concerns, but also to extract valuable metals contained in Li-ion batteries. For instance, NMC batteries contain lithium, nickel, manganese and cobalt, which are the active materials. Currently, the cost of mining is lower than that of recycling due to the lack of a commercialized process, but the recycling industry is expected to rise as cost of cobalt and nickel has been increasing continually. In early 2017, the cost of cobalt was USD35/kg, whereas the price increased to USD75/kg at the end of the year. This report will focus on the review of the structure of different types of Li-ion batteries and a brief process of disassembly mechanism to further develop an automated process that is safe and efficient. The batteries concerned are Lithium Nickel Manganese Cobalt Oxide (NMC), Lithium Cobalt Oxide (LCO) and Lithium Nickel Cobalt Aluminium Oxide (NCA).

### Design and Synthesis of Novel Cathode Material for Lithium Sulfur Batteries (LSB)

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| Supervisor: | LUO Zhengtang / CBE | | |
| Student: | CHAN Chak Ming / SENG | Course: | UROP1100, Summer |

This project is to demonstrate possibilities for recycled lithium ion batteries by using it as a power source for mini transportation vehicles such as kick scooters. The idea is to design and construct a scooter that will be powered by recycled lithium ion batteries. The prototype is not yet finished by the time of report writing and our battery pack design is expected to deliver 24v and ah to a 24v 500w motor. The expected maximum speed would be 35 to 40 kph with a driving distance of around 30 km. It is believed that the scooter can be a transport alternative for regions with less convenient public transport facilities.

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| Supervisor: | LUO Zhengtang / CBE | | |
| Student: | LEE Hwanbin / CENG | Course: | UROP1000, Summer |

Sulfur nanoparticle with Nitrogen and phosphorous doped reduced graphene oxide (SNP@N,P rGO) composites were prepared by synthesizing the hollow-sphere structured Polyvinyl Pyrrolidone and mixing with N,P rGO. The expected impacts of adding N, P rGO were improvement in electrochemical performance and well spread SNP on nanosheets of N,P rGO. The effects of N,P rGO on microstructure of active cathode materials and electrochemical performance of coin cell were investigated in this report. The improved results of SNP@N,P rGO are shown as specific capacity, cycling performance and coulombic efficiency which are significantly related to the microstructure of active cathode materials and sulfur loading. The sulfur composition of SNP was about 95%. The specific capacity of SNP is 240 mAhg-1 at rate of 0.2 C while the specific capacity of SNP@N,P rGO is about 540 at rate of 0.2 C. The improved specific capacity emphasized addition of N,P rGO is critical to show the potential of commercialization of Lithium sulfur battery.

Supervisor:     LUO Zhengtang / CBE
Student:        POYYAMOZHI Sricharan / SENG          Course:          UROP1000, Summer

This paper presents an innovative way to reuse lithium-ion car batteries at the end of their life-spans to power motorized bicycles, which would benefit rural communities by upgrading their current bicycle and limiting the need to recharge owing to the batteries large capacity. Looking at this plans' market viability shows that a good marketplace is China as it would outstrip its closest competitor electric bikes, in terms of functionality and pricing but lack in peak performance level. Presenting a base design and prototype confirms this device as functional but there is room for improvement to make it market-ready while the key component, degraded car batteries will not be readily available for a few years making this a long-term sustainability project.

## Blood Purification Devices

Supervisor:     LUO Zhengtang / CBE
Student:        CHOI Eun Seo / CBME                  Course:          UROP1000, Summer
                OKTAVIUS, Andreas Kenney / CBME                       UROP1000, Summer

We constructed a blood purification system with a column packed with graphene oxide (GO) – cellulose acetate (CA) beads as the main component. Compared to most hydrophobic carbon based macrostructures, GO-CA beads with a core/shell structure are particularly promising for adsorption of various substances due to their amphipathic nature. To ensure acceptable hemocompatibility and adsorption kinetics, we prepared neutral GO dispersion manually via a modified Hummers method, extruded the beads individually with extra care in their porosity, and designed and fabricated the column via a 3D Printer. To test for adsorption capacity of the GO-CA beads directly, we pumped a solution of methyl blue and water through the column and analysed the effluent using ultraviolet-visible spectroscopy. Then, to compare the advantages of GO-CA beads to other adsorbents, we repeated the experiment with activated carbon (AC) as an adsorptive material.

## The Effect of Particle Size on Solids Suspension in a Stirred Tank Reactor

Supervisor:     MAK Andrew Tsz Chung / CBE
Student:        YOO Seungbin / CEGBM                 Course:          UROP1000, Summer

This report attempts to summarize the latest studies and findings on the effect of solid particles on solid suspension speed in a stirred tank. The purpose is to improve the Zwietering Correlation (1958) on the effect of particle size which was established through dimensional analysis. This has been the most popular design equation for solid suspension while the variation on the predicted particle size exponent of particle size is relatively large (Kresta, 2016). This analysis compares the past literature comparison qualitatively and found that the relationship between the ratio of particle size to impeller size, $d_p/D$ and the exponent of particle size has correlation with less deviation from Zwietering Correlation.

## Fuel Production from Carbon Dioxide

Supervisor:     SHAO Minhua / CBE
Student:        POON Lok Nga / CHEM                  Course:          UROP1100, Fall

Electrochemical reduction of carbon dioxide, while being a promising way of controlling atmospheric CO2 content and producing fuel, remained challenging due to low selectivity, high kinetic barrier and low stability of catalysts. Metal nanoparticles with controlled morphologies are desired to solve the problem. Herein, we describe the synthesis of Pd and Pd-Au alloy nanowires by template free methods and evaluate the catalysts performance against commercial Pd/C

catalyst. Results show that the nanowires have better performance than commercial catalyst in terms of selectivity, especially at low voltage.

### Anode Materials for Lithium Ion Batteries

Supervisor:          SHAO Minhua / CBE
Student:              WOO Nam Jae / CENG                    Course:              UROP1100, Fall

Usefulness of Lithium-ion batteries (LIBs) has been widely recognized and they have been researched on even further improvement in their efficiency and battery life. There are a few drawbacks addressed to be fixed for development of LIB; in this research, instead of conventional electrode composition, that of only Si as active material and polymer was assembled into a coin cell and tested. Data from testing result of assembled coin cell was then used to analyze its characteristics; plotted graph of its measured capacity, current, voltage at different cycle numbers provided with an information that explains how superior Si-polymer composition is in terms of different aspects such as capacity and stableness at different current density.

### Reusable Protein-based Materials for Uranium Extraction from the Ocean

Supervisor:          SUN Fei / CBE
Student:              PARK Ye Eun / CBGBM                    Course:              UROP1100, Spring

Protein-based hydrogels consist of enriched or isolated proteins from natural extracellular matrix. Hydrogels are promising candidates for material research and drug delivery due to their high water content, biocompatibility and tuneable viscoelasticity. The following report is based on two different projects.  In the training session, DNA cloning was performed for proinsulin that would be used in research on drug delivery of insulin using hydrogels. Thus, experiment techniques such PCR, gel electrophoresis, DNA purification, gel purification, etc. were learnt in lab. The cloned DNA were sent to the DNA analysing company for sequencing and the obtained sequence was compared with the actual proinsulin sequence using an online tool called Clustal Omega. Among the four samples, one sample matched the proinsulin sequence and could be used for the next step of the insulin research project. For the individual project, three constructs of Truncated Mussel Food Protein (TMfp)—TMfp3, TMfp5-1 and TMfp5-2— were extracted by transformation, seed culture, protein purification, dialysis and lyophilization. This project's goal is to evaluate the effect of THPC and lysine on the stiffness of the hydrogel by varying only the THPC concentration and then varying only the number of lysine by using TMfp3, TMfp5-1 and TMfp5-2, which has 3, 6 and 9 lysine respectively. The last step of the project would have been to performrheology of the protein-based hydrogel to measure the stiffness. However, due to procedural issues, the experiment had to be repeated and could not reach the last step. Thus, qualitative data could not be obtained for this progress report.

Supervisor:          SUN Fei / CBE
Student:              WEN Evan Yu-an / CHEM                    Course:              UROP1000, Summer

Owing to their great functional tunability and biocompatibility, protein-based hydrogels currently have a lot of potential applications in the biomedical sciences.  Many different cross linking methods have been investigated in making these hydrogels. Also, there is an increasing demand for more functionalized hydrogels. This project aims to create a unique type of hydrogel that can be easily functionalized. Lysine residues found on SpyTag can be cross linked with THPC to form a hydrogel. Genetically encoded SpyTag-SpyCatcher chemistry can then be utilized to further decorate and give different functions to the gel's surface. The resulting hydrogels were shown to have high elasticity and viable cytocompatibility.

# Department of Civil & Environmental Engineering

## Development of a Red Tide Early Warning System for Fisheries Management

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| Supervisor: | CHAN Shu Ning / CIVL | Co-Supervisor: | LEE Joseph Hun-wei / CIVL |
| Student: | KAM Chun Hao / EVMT | Course: | UROP1100, Spring |

A red tide warning system benefits local fisheries by allowing early preparatory management to minimize fish loss. To facilitate forming predictions for red tides, this research project studied the real time measurements from a continuous monitoring site at Yung Shue Au. The measurement data include water temperature, salinity, dissolved oxygen and chlorophyll concentration. It was found that red tides generally occur at moderate to high water temperature (15 °C ~ 30 °C) and high salinity (30 ppt). Dissolved oxygen depletes as red tides develop. However, the real time data could not serve as a predictive guide for red tides due to the frequent data gaps and suspected measurement errors. Improvements in the robustness of real time data sensors should be made before developing prediction models for red tides.

## Image-based Structural Analysis Using Deep Convolutional Neural Network

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| Supervisor: | CHANG Chih-chen / CIVL | | |
| Student: | LEUNG Ho Ming / CIVL | Course: | UROP1100, Summer |

Hand-drawn structural diagrams are the common and direct tool for civil engineers to express the blueprint of their design. Notwithstanding the high demand, a convenient software that can perform structural analysis by hand-drawn diagrams is yet to be developed. The conventional way of performing structural analysis by using the hand calculation is timeconsuming. Using finite element software to solve the structural system could be a possible way but learning those complicated software could be difficult to the students and new engineers. Hence, this project proposes Image-based Structural Analysis (ISA), which can directly generate the structural response by recognizing the hand-drawn structural images. Up to now, selective search and deep Convolutional Neural Network (CNN) have been designed for object detection. Extending the works from previous UROP and FYP, this paper extends the preparation of 2-D frame structure. The details of preparation of the 2-D frame structure problem and the image labelling work are discussed.

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| Supervisor: | CHANG Chih-chen / CIVL | | |
| Student: | NG Zhi Yong Ignavier / COSC | Course: | UROP2100, Fall |

Hand-drawn schematic drawings of a structural system are often adopted by civil engineers and engineers-to-be to study the response of the structure under a set of external loading. Modern finite Element Model (FEM) softwares allow users to analyze the response of the system quickly. However, it is often difficult to use FEM software due to having to learn new methods, which may require even more effort to input data. The aim for the UROP project is then to create a system to have the best of both worlds, which would be to directly extract information from hand-drawn diagrams and automatically reconstruct the model in the FEM software. With the recent advances of machine learning, this study proposes a novel deep Convolutional Neural Networks (CNNs) for image recognition of the structural components in the diagram. The study first reviews the work done by previous UROP students, followed by pipelining of software engineering practices like code refactoring and fine-tuning of machine learning system like multiple predictors model.

| Supervisor: | CHANG Chih-chen / CIVL | | |
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| Student: | SAN JUAN Justin David Quitalig / CIGBM | Course: | UROP2100, Fall |
| | | | UROP3100, Spring |

Hand-drawn-schematic-structural diagrams are always adopted to analyze the response of civil structures for further design purposes. Analysis of such structures is often complex and better completed by a computer, while learning specialized software is often out of reach for students due to time and cost. To address this issue, this study develops a method to analyze the structures directly from the hand-drawn diagrams, namely Image-based Structural Analysis (ISA). Selective search and a deep Convolutional Neural Network (CNN) are designed to detect objects in the images. Based on the bounding boxes and class information of the objects, a finite element model is constructed for determining the response of the structure. To this end, results show that the proposed system is capable of reconstructing the structural system with reasonable accuracy and it is suitable for mobile deployability. The code is now available at: https://github.com/JSANJ/isa_python.

### Personalized Learning for Civil Engineering Using Recurrent Neural Network

| Supervisor: | CHANG Chih-chen / CIVL | | |
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| Student: | TAN Ke Yi / COMP | Course: | UROP2100, Fall |
| | | | UROP3100, Spring |

Knowledge tracing, the technique used to model learners' masteries of knowledge being tutored and understand their learning process, is fundamental in the domain of intelligent tutoring system. Bayesian Knowledge Tracing and Deep Knowledge Tracing are two popular implementations of knowledge tracing. In this paper, we investigate the feasibility of modelling students' learning behavior with recurrent neural network within a traditional classroom. Students' interactions with coursework of structural analysis are transformed into concept vectors. The learning dynamics of students are then constructed with recurrent neural network. This learning dynamics system is intended to help instructors with evaluating students' learning states. With this framework, instructors can trace students' performance and arrange the teaching sequence for more effective learning of students.

### UROP Research on the Assessment of Population Exposure to Air Pollution

| Supervisor: | LAU Alexis Kai Hon / CIVL | | |
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| Student: | FAN Huiying / EVMT | Course: | UROP1100, Fall |
| | YAU Hoi Ying /EVMT | | UROP1100, Fall |

With the increasing demand for understanding the population exposure of air pollution in Hong Kong, a huge amount of air quality data were collected from various monitor stations. To ensure the collected data reflects the air quality the public were exposed to with high reliability, there is a need for data cleaning before the analysing stage. By conducting data tests including physical range and extreme value check, Signal's gradient test, calibration drift adjustment and data frequency conversion with reference to the expected range of data, our group has developed a data cleaning tool in Python to correct faulty data through smoothening the gradients and adjusting for calibration drifts.

### Field Measurements of Pressure Surges in Water Supply Pipeline Systems for Leakage Detection

| Supervisor: | LEE Joseph Hun-wei / CIVL | Co-Supervisor: | CHAN Shu Ning / CIVL |
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| Student: | WONG Leong Sang / CIVL | Course: | UROP1100, Fall |
| | | | UROP2100, Spring |

Geysers are explosive eruptions of air-water mixtures from manholes or drop shaft of underground drainage system. During rainstorm, the capacity of drainage systems may be exceeded with a vast amount of storm water inflow. With rapid continuous intake of rainwater and large fluctuation on water level, air can be easily trapped in the enclosed drainage system and move along the pipe until releasing through another manhole. Geysers are therefore formed due to the rapid release of air, pushing water up to the surface drastically to bring perilous bursting effects. This physical phenomenon of air-water interaction is the main topic for discussion, observation and analysis. To simulate this situation, an idealized urban drainage system is scaled down to a simple model made of valves, horizontal pipes, vertical risers and pressure transducer. The formation of geyser is observed by filling the system originally with water, and release an air pocket into the horizontal pipe. The trajectories of the air pockets in horizontal pipe and vertical riser are measured by a high speed camera, while pressure is measured at four specific locations of the vertical risers by pressure transducers.

**A Big Data Landslide Early Warning System with Apache Spark and Scala**

Supervisor:     WANG Yu-Hsing / CIVL
Student:        CHANG Bing An / MATH-CS           Course:        UROP2100, Fall
                WONG Wen Yan/ COMP                               UROP2100, Fall

This report attempts to improve existing monitoring system and enable predictive maintenance by classifying unlabelled audio data. To achieve this, we propose an unconventional approach which involves developing autoencoders and applying transfer learning. This report provides a description of the transfer learning architecture that was chosen, as well as the implementation and proposed evaluation methods. Furthermore, this report compares the performances and bottlenecks of various open-source data bases based on research done by other groups in the past. The volume and structure of data involved, as well as the querying algorithms used by the research to evaluate database performance, is in accordance with the Social Network Benchmark developed by the Linked Data Benchmark Council. Therefore, the results are reproducible and consistent, so we would use them directly in our analysis. But first, we want to reproduce their results to ensure correctness. Besides that, this report also aims to provide suggestions for extending existing querying languages to perform complex queries quickly, easily and intuitively. Finally, we discuss lessons learned along the way and potential future developments.

Supervisor:     WANG Yu-Hsing / CIVL
Student:        LIU Chengzhong / RMBI             Course:        UROP1000, Summer

This report introduces two ways in setting up local Spark with Zeppelin and Jupyter notebook on two systems: Windows and Ubuntu. Apart from this, the report also examines failed attempts in setting up local Spark to provide some insights for the future students in this UROP topic. A mini project in implementing a machine learning model with Spark MLlib will be introduced in accordance with Jupyter notebook on Windows. I do hope this project can be helpful to future students in this UROP project. The project is available on GitHub at here. You can find more detailed instructions and more references in this repository, in case I missed out any importance. Also, due to the limitation inSpace and format, my report is only are presentation of my work, and more information is store in this GitHub repository.

Supervisor:     WANG Yu-Hsing / CIVL
Student:        SUN Ji / CIVL                     Course:        UROP2100, Fall

We have entered an age of images and videos because of the explosion of Internet which is a carrier of data as well as sensors. In order to process and analyze these data intelligently, technicians try to teach the machines to see things just

like human beings. This report provides an overview about 1. An introduction to the machine learning 2. How to implement sensor and transmit data on site.

## Advanced Landslide Identifications, Classifications, and Prevention in Hong Kong Using Deep Learning

Supervisor:     WANG Yu-Hsing / CIVL
Student:        CHAUDHRY Mukund / PHYS          Course:          UROP2100, Fall

With the rise of services like Google Street View, which allows the user to view images of streets from around the world, privacy becomes an important issue. Two major sources of concern for privacy are faces of pedestrians and car number plates. This study attempts to automate the process of blurring pedestrian faces and vehicle number plates. The problem is treated as a computer vision problem. The image is processed by two modules, the first one being a deep neural network trained for semantic segmentation, and the second being a combination of several computationally lightweight computer vision techniques.

Supervisor:     WANG Yu-Hsing / CIVL
Student:        CHENG Log G / COGBM              Course:          UROP1100, Summer

In this UROP 1100 project, I am responsible for creating a Raspberry Pi based Real-time, Lidar Odometry and Mapping (LOAM) device to be use in the future for creating a 3d mapping landscape in Hong Kong. Using a Velodyne's new PUCK™ (VLP-16) sensor connecting with a raspberry pi 3+ that was installed with ROS and existing Simultaneous localization and mapping (SLAM) algorithms, we created point cloud of the scanned area by moving the device around.

Supervisor:     WANG Yu-Hsing / CIVL
Student:        YIU Ka Yan / CIVL                Course:          UROP1100, Fall

I have taken this Civil Engineering based UROP project which focuses on technology development in light of increased adaptation of such advanced technologies into all professions, Civil Engineering being one of the major industries to be heavily affected and possibly revolutionized. Having learnt the basics of Python programming has enabled me to understand the technology that is being used in the lab more. Whilst I am beginning to learn the hardware aspect of the project, for example learning the components used in the project and using Printed Circuit Board drawing software such as Eagle and Altium Designer to design the PCB boards, I have learnt most about the practical applications of such technology in the real world.

## Designing Reliable, Scalable Software Systems for Internet of Things (IoT)

Supervisor:     WANG Yu-Hsing / CIVL
Student:        TAN Tun Jian / CPEG              Course:          UROP2100, Fall

This work is a continuing from the work from last summer and including an additional task which is also related to deep learning. In this work, I am recapping and polishing my knowledge on deep learning concepts to find better solutions in classify the aerial photograph. Apart from that, I helped in labelling the images to create datasets for training a deep learning model which is able to identify the pedestrian and number plate of the car such as image blurring. Nowadays, in the applications such as Google Map, users are allowed to view the photo of the streets which had been taken. Before publishing them to the public, private information has to be removed.

## DESR (Data-Enabled Scalable Research) Lab – Incubator of Creative Learners and Hub of Transformation

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| Supervisor: | WANG Yu-Hsing / CIVL | | |
| Student: | WEI Huan-ting / SENG | Course: | UROP1100, Summer |

PyTorch is a powerful and popular deep learning tool based on one of the most popular language for machine learning, Python. It is thoroughly introduced and taught in Professor Sung Kim's online tutorial, which is the very beginning of my learning of deep learning. In first part of this report I will focus on the basic concepts of deep learning including the gradient descent, back propagation, and my own understanding toward it. I will also demonstrate building a simple model with PyTorch by using linear layer, activation function, compute the loss with various loss functions, and optimize the model with optimizers. Lastly, I will discuss about the idea and the structure of RNN (Recurrent Neural Network), and one of its variations, the LSTM (Long Short Term Memory), of its approach to create a more accurate model. Deep learning has taken us closer to the realization of artificial intelligence, and I would definitely like to learn more about it.

## Improving Public Private Partnerships in Infrastructure Development

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| Supervisor: | ZHANG Xueqing / CIVL | | |
| Student: | DWIVEDY Sampriti / CIGBM | Course: | UROP1000, Summer |

This UROP research report, follows research studies conducted by HKUST graduates in 2018 titled "Comparative Analysis of International Practices of Public-Private Partnerships in Infrastructure Development and Management" for the United States, Australia and United Kingdom. The objective of this report is to identify patterns in the development of PPP legislations by comparing the historical development of PPP legislations in United States, Australia and United Kingdom. The identified patterns can be learnt from and implemented in developing countries that are looking to adopt PPP legislations.

## An Analytical and Numerical Investigation of Debris Flow and Its Impact to Hong Kong

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| Supervisor: | ZHAO Jidong / CIVL | | |
| Student: | CHOI Chung Yin / CIVL | Course: | UROP1100, Spring |
| | CHOW Tsz Yin / CIVL | | UROP1100, Spring |

The particle size distribution is one of the main parameters that we need to focus on in our debris flow model design. Different size distributions of particles can have different properties and effects in the debris flow. Since a lot of models which are used to describe the debris flow assume that the particle size is the same for simplifying the calculation. However, there are a range of size distributions in the actual situation. Therefore, we need to consider the particle size distribution for the more accurate measurement and prediction for the real-life situation. Numerical simulation with CFD-DEM provides aid for the further discussion and analysis.

## Computer Visualisation of Sand Grains

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| Supervisor: | ZHAO Jidong / CIVL | | |
| Student: | LEUNG Ho Yin / CIVL | Course: | UROP1000, Summer |

Soil mechanics is an important aspect in civil engineering. In the past, researcher usually do experiment with soil to study its macroscopic properties. However, it was difficult for researchers to investigate the microscopic behavior of sand grains. Nowadays, computer become more powerful than before. With the aids of computer, we can do massive

calculation, even the interaction done by over ten thousand of particle. In this way we can study the microscopic behavior of sand grains.

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# Department of Computer Science & Engineering

## Congestion Control for Data Center Networks

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| Supervisor: | BENSAOU BRAHIM / CSE | | |
| Student: | AGGARWAL Ashish Kumar / COMP | Course: | UROP1100, Spring |

This is a project done as a part of Undergraduate Research Opportunities Program 1100 under the supervision of Professor Brahim Bensaou on the topic of Datacenter Networking. The project focused on mitigating congestion in datacenter networks especially incast congestion generated due to small, bursty datacenter traffic. After reading various research papers and tools to understand the current techniques used and proposed by other researchers to mitigate datacenter congestion, I gained an understanding of the current state of art solutions as well as the causes of latency in datacenter network. Then I worked to implement a simple solution to using DPDK library to reduce virtualization latency. The project will be continued in the summer 2017-18.

## AI meets Big Data: User Analytics and Personalized Recommendation Based on Location Data

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| Supervisor: | CHAN Gary Shueng Han / CSE | | |
| Student: | CHAO Wen-shuo / SENG | Course: | UROP1100, Summer |

There are plenty of parking lots face the issue of inefficient entrance methods, which use the parking ticket. In order to solve this problem, we propose the idea of auto-payment through image recognition. With license Plate recognition, people could easily pay the fee without complicated procedure. Moreover, it helps the user to locate their car more conveniently. To achieve the target, we try to use the machine learning method. Not only does it provide accurate results, it is able work efficiently. We have tried Haar cascade training and analyzed the performance. Although there are still lots of things could improve, we have gained the basic structure already.

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| Supervisor: | CHAN Gary Shueng Han / CSE | | |
| Student: | ZHOU Yeju / COMP | Course: | UROP1100, Summer |

The objective of the project is to detect multiple HK license plates at a time from a video frame and recognize the license number on the plates. The operation contains mainly two procedures: First, detect the license plates and allocate the coordinates of the plates in the given image; Second, extract the license plates (and segment the texts if necessary) and recognize the texts. Two methods both based on OpenCV library did I try to implement the first procedure: One is to operate pre-processing, color extracting, morphological changes and edge detection on the given image, which is considered as the "traditional method"; the other is to use Cascade Classifier to train a classifier by means of AdaBoost (a means of machine learning). This report will only discuss about the first procedure and the results and challenges of the two methods respectively.

## AI meets Big Data: Analytics and Recommendation for User Location Data

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| Supervisor: | CHAN Gary Shueng Han / CSE | | |
| Student: | BAE Juyoung / COMP | Course: | UROP1100, Fall |

GPS has been used in wide range of application in outdoor localization since it was first introduced. In the same context, localization in indoor environments has attracted growing interest in the past decades due to its promising application

potentials. This report focuses on indoor tracking technique that solely depends on data from user's smartphone for the entire course of map construction and user tracking. These data include Wi-Fi fingerprints as well as data from built-in physical sensors in the smartphone. Accompanying a smartphone app that collects and sends the data behind the user's back at-the-spot, our project aims an efficient and accurate map construction via crowdsourcing. With the complete floor plan set as a reliable constraint, the next step for our project would be to utilize Conditional Random Field model to provide reliable, real-time location information.

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| Supervisor: | CHAN Gary Shueng Han / CSE | | |
| Student: | HUANG Zijian / COSC | Course: | UROP1100, Spring |
| | ZHANG Lin / COSC | | UROP1100, Spring |

Indoor localization has been a hot topic in recent years, leading many researchers to develop different kinds of localization methods using different sensors. This report will mainly discuss our implement of indoor localization using beacons and Android devices. We will illustrate how we choose our hardware devices and software platforms, and the structure of our system, as well as our mathematical foundations. The system we implemented is not so complex, we only implemented the skeleton structure of the system, but the function is completed and can be used for further developing. The structure basically is a server-client system structure and will track the users and save the users' location into our database. Further improvement will include using more advanced localization algorithm, adding more functions to our front-end page, etc.

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| Supervisor: | CHAN Gary Shueng Han / CSE | | |
| Student: | MENG Zihan / COMP | Course: | UROP1100, Fall |

Smartphones have numerous sensors implemented and are now ubiquitously used. These sensors will have the capability to provide more information about the user with proper use. Especially for step counting use, if combined with indoor location technology, we will be able to improve the accuracy of the outcomes. We have studied some algorithms for step counting taking advantage of the accelerometers in modern smartphones. For most of the papers currently available about step counting methods, they evaluate step counting algorithms using independent sensors and have these sensors fixed to only some body part. Our experiment will use a common smartphone to test the algorithm, this algorithm will be implemented as a mobile application and installed on a smartphone. Also, the smartphone will be used naturally instead of being attached to some body part.

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| Supervisor: | CHAN Gary Shueng Han / CSE | | |
| Student: | MU Yifan / COMP | Course: | UROP1100, Fall |
| | | | UROP2100, Spring |

With the development of mobile devices and other location-based services, there are a large number of datasets of individual location information is available nowadays, which provides us an opportunity to infer people's social ties through analysis on these datasets. Several models or algorithms to infer social strength by analyzing co-occurrence information and trajectory similarity have already been introduced in some pervious papers. In this project, we are trying to improve current algorithms to measure trajectory similarity and then figure out social ties according to trajectory similarity first, and combine co-occurrence information with our algorithm.

Supervisor:     CHAN Gary Shueng Han / CSE
Student:        PAN Linfei / COMP                    Course:        UROP1100, Spring

Recently, the social network analysing has been a popular field for researchers because of its massive potential in applications. While the social network online has been studied thoroughly, the social network off-lined has not been well explored. Noticing the strong correlation between the social connection and showing up simultaneously, we use data mining method to analyze the location information of users generated by the off-line location accumulation facility. This project puts its main focus on the data generated in a particular mall, and have done some work on building a model and carrying some experiments.

Supervisor:     CHAN Gary Shueng Han / CSE
Student:        YAP Alistair Yun Hee / CPEG          Course:        UROP1100, Fall
                                                                    UROP2100, Spring

Previous studies on information propagation in location-based social networks (LBSN) such as Yelp and Foursquare make the simplistic but unrealistic assumption that information propagates exclusively through users 'actively' checking-in at points of interest (POI). This paper introduces a propagation model that accounts for other 'passive' means for information to spread, such as sharing the check-ins of peers via retweets on Twitter or otherwise. The problem of modelling user-to-user propagation probabilities in LBSN's is formulated as a classification problem, and initial results from a variety of classifier models are discussed.

Supervisor:     CHAN Gary Shueng Han / CSE
Student:        ZHANG Xinyu / COMP                   Course:        UROP1100, Fall
                                                                    UROP2100, Spring

While there are several categories under recommendation model, so far, only content-based and collaborative-filtering recommender model have been explored, where the former relies on the entity feature information, and the latter relied exclusively on affinity data (e.g. rating). Collaborative filtering can be further categorized as Memory-Based System and Model-Based system. Considering the scalability, we will focus more on the Model-Based system in later content.

Supervisor:     CHAN Gary Shueng Han / CSE
Student:        WENG Jiaqi / COGBM                   Course:        UROP1100, Fall
                                                                    UROP2100, Spring

As I further studied in handling and analytical methods, the collecting process has been refined. The second step after collecting and reconstructing data in the database is to draft the floor plan. Data collected cannot be used directly without analyzing and reducing errors. The PDR algorithm is implied to combine all available information and reduce errors to construct path coordinates. Splitting and merging are applied to the constructed paths to further reduce the errors. This report will discuss the modifications made on the server to make the receiving process more efficient and the process applied to the collected data to construct the path and reduce errors. Finally display the analytical results.

## Indoor Localization and Mobile Computing

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| Supervisor: | CHAN Gary Shueng Han / CSE | | |
| Student: | LEE Wai Lam / COMP | Course: | UROP1000, Summer |
| | ZHANG Yichen / CPGBM | | UROP1100, Summer |

With the ability to localize the position of a mobile phone user, a wider range of service can be provided by computer technology. For example, it can track the path of the user and navigate the user to the destination. Due to the success of the development of GPS, the localization of outdoor mobile phones is fairly precise. However, it is difficult for the GPS satellite to access indoor mobile phones, so GPS cannot localize indoor mobile phones accurately. Mobile phones are used not only in outdoor environment but also indoor situation. Thus, there is a need to develop a system to localize indoor cellular device.

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| Supervisor: | CHAN Gary Shueng Han / CSE | | |
| Student: | OH Minseok / SENG | Course: | UROP1000, Summer |

Over the last few decades, Global Navigation Satellite System has enjoyed a tremendous success in multiple technological domains, mainly revolving outdoor localization. However, due to proliferation of 'urban canyon environment' and relative power inefficiency of GPS scanning, such method is not ideal for indoor localization situations. This project aims to address this problem, using Wi-Fi positioning system, a more energy efficient and accurate methodology. The application developed for the project, manually records currently available Access Points' BSSID and RSSI, which accumulates and is sorted according to pre-specified criteria. Based on this, geolocational coordinates are approximated using weighted non-linear least squares optimization algorithm, which provide base dataset to ultimately locate users solely with their Wi-Fi AP list.

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| Supervisor: | CHAN Gary Shueng Han / CSE | | |
| Student: | OU Jiefu / SENG | Course: | UROP1000, Summer |

To match the time differences between two speech audio streams (WAV format) - same source but one recorded by users' mobile phone, with noise and random time delay than the other. First, I learned and utilized the Mel-frequency cepstral coefficients (MFCCs) to extract a 13-dimensional vector for each frame, to characterize the speaker's voice feature (C++). Second, I came up with a linear comparison algorithm to find the position in the default stream at which the first 1/10 of the record stream reached its highest similarity compare with the default stream (C++). Finally, I utilized NDK and JNI in android to combined programs above together as a record-detect delay application.

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| Supervisor: | CHAN Gary Shueng Han / CSE | | |
| Student: | PANG Hong Wing/ COMP | Course: | UROP1100, Fall |

This project trys to implement a stepcounting algorithm using HMM (Hidden Markov Model), that counts the no. of steps a person has taken while holding a phone. The no. of steps is used to estimate the distance the phone user has traveled, which is to ultmately used in an indoor localization app. The algorithm only takes in the accleration of the phone, in particular the up-down oscillation as the user walks, into account, and is able to identify if the user is actually walking or unknowingly shaking his/her phone, which could be mistaken as walking. This report covers the HMM model behind the algorithm, other steps required for the calculation of probabilities and related experimentation conducted.

Supervisor:       CHAN Gary Shueng Han / CSE
Student:          WONG Tsz Nok / SENG                    Course:          UROP1100, Summer

Indoor localisation service has been using different signals to overcome low precision locating by the Global Positioning System. Wherami is a project targeting at providing dependable techniques for mobile localisation. This UROP research project is to assist the iOS development with the Research & Development team. The major tasks of it are to create a map view framework for the project and to debug iOS existing applications. Influencing technical and personal development, valuable learnings and skills are earned from both tasks. It is concluded that this UROP project is a precious opportunity to participate in a technology-based project and gain incisive viewpoints.

Supervisor:       CHAN Gary Shueng Han / CSE
Student:          ZHANG Luoshu / COMP                    Course:          UROP1000, Summer

Indoor localization is a technology where numerous sensors and communication technology is utilized to detect the locations of targets in indoor environment, which is widely applied in various aspects of our daily life, such as logistic tracking, shopping mall map design, etc. However, the prevailing localization method using GPS cannot be accessed effectively in the indoor environment. To remedy the situation, tracking the user's location from the wireless signal is utilized. In this research project, the data from the Wi-Fi signal shall be exploited to detect the user's location. To be more specific, a convenient and responsive method that extracts data from a set of routers and compute the location through a delicate algorithm is proposed to improve the situation.

Supervisor:       CHAN Gary Shueng Han / CSE
Student:          ZHAO Ziqi / COSC                       Course:          UROP2100, Summer

Indoor crowdsourcing-based localization solutions have been under development for a few years, but most of them use the prior knowledge of the building (e.g. floor plan or Wi-Fi AP locations) to build the map. Therefore, we propose a new way to construct without knowing building information. This method is based on IMU (Inertial measurement unit) sensors and Wi-Fi scanning on the smartphone. The phone first collects accelerometer, gyroscope, gravity, magnetometer and Wi-Fi signals, and send them back to the server. Then backend program will recover the path based on sensors, segment path using turnings, and use signal similarity to concatenate different segments. Results shows that this method could generate a satisfying pathway map, but related work is still needed to reduce the complexity and improve adaptability.

Supervisor:       CHAN Gary Shueng Han / CSE
Student:          ZHU Xinyu / COSC                       Course:          UROP4100, Fall

In this semester, I worked on the mobile sensor-based tracking system (Mosent) with two Ph.D. students and I contributed to this project by doing literature survey, implementing some localization algorithms with Python, conducting experiments and writing the paper. Mosent is a novel and potent tracking system based a series of advanced algorithms such as Forward Dependent Particle Filter (FDPF) and Propagation Loss Matrix Learning (SCAL). It can track multiple mobile targets in a large area with only a few of sensors and can handle the environmental influence on signal propagation and influence from sensor location error. Our experimental results show that the Mosent can achieve high accuracy with fewer sensors compared with the state-of-the-art.

## Video Analytics and RF People Sensing for Smart City and New Retail

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| Supervisor: | CHAN Gary Shueng Han / CSE | | |
| Student: | LI Xiang / CPEG | Course: | UROP1100, Summer |

Indoor localization is a technology where numerous sensors and communication technology is utilized to detect the locations of targets in indoor environment. It is widely applied in variousaspects of our daily life, such as logistic tracking, shopping mall map design, etc. Nowadays, various indoor localization technologies have been well-developed using laser, ultrasound, Bluetooth and so on. In this project, we are going to propose a convenient and responsive method that extracts data from a set of routers and compute the location through a delicate algorithm.

## Approximation Algorithm for Fair Allocation

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| Supervisor: | CHENG Siu Wing / CSE | | |
| Student: | FENG Xuming / MAEC | Course: | UROP1100, Summer |

The problem of restricted max-min fair allocation focuses on obtaining a resource allocation so that the minimum value of resources assigned to any player will be maximized. The essay presented an algorithm that has improved the optimum approximate ratio to a factor $6 + \delta$ for any constant $\delta > 0$. The algorithm can achieve a polynomial running time which is determined by the input size for any constant $\delta$ selected. In the past 2 months, I have self-studied basic concepts of combinatorial algorithm, basis of restricted max-min fair allocation and the detailed implementation of the new algorithm. This report mainly contains my progress in self-learning in this summer and my understanding of the algorithm as well as the restricted max-min fair allocation problem.

## Spreadsheet Error Detection

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| Supervisor: | CHEUNG Shing Chi / CSE | | |
| Student: | CHAN Hiu Chun / QFIN | Course: | UROP1000, Summer |
| | WONG Chi Ho / QFIN | | UROP1000, Summer |

This report aimed to analyze how Insights, a new OLAP (Online analytical processing) tool in Excel provided by Microsoft, process data in Excel. We explored Insights' characteristics and limitations by analyzing example spreadsheets with Insights. We also came up with an algorithm to manipulate existing spreadsheets and improves their format so that those spreadsheets could be better analyzed by Insights and yield more meaningful results. This report also included progress on migrating existing spreadsheet error detection tools (CUSTODES) from Excel to Google Sheet.

## Analyzing Evolving Collaboration Networks

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| Supervisor: | GOLIN Mordecai Jay / CSE | | |
| Student: | GUO Wenshuo / PHYS | Course: | UROP1100, Fall |

The collaboration graph models social networks, where the act of collaborating in a research study usually requires personal acquaintance among the coworkers. In this report, the local collaboration graph of researchers associated with Hong Kong University of Science and Technology are constructed and analyzed based on the HKUST scholar and publication database. In the co-authorship graph, the vertices represent individuals and links denote relationships between individuals. Two authors are related if they are coauthors of a paper. The literature on collaboration network are studied, and network structures of the co-authorship graph are analyzed. Besides, subgraphs with different

constrains on the vertices are also constructed and analyzed. Moreover, discussions on possible further extensions and research ideas are also proposed

## Machine Learning on Wearable Devices

Supervisor:      HUI Pan / CSE
Student:         CHO Hyun Dong / COGBM              Course:           UROP1100, Spring

With the advances in sensors, electronic devices have enjoyed the luxury of carrying more sensors at a fraction of their previous costs. An abundance of sensors enable a comprehensive collection of data regarding the surroundings of the device, and this has been most evidently perceivable in our smartphones. One of the most useful information that could possibly be deduced from such data is the emotional state of the user of the wearable device, as emotional information has implications for mental health, accurate recommendation systems, etc. Understanding the importance of such information, this research seeks to mimic previous work in taking advantage of data collected through mobile phones in realistic, non-intrusive settings, and discover areas for improvement during that process.

Supervisor:      HUI Pan / CSE
Student:         HU Zeou / COSC                      Course:           UROP1100, Fall

Machine learning technology is widely used in computer vision nowadays to solve many real-life classification problems. In this project, we will try to use Android phone (as a replacement for wearable devices) to capture images of human facial expressions and try to use machine learning techniques to predict the correct emotion. We will use some free well-known facial expression datasets as our foundation of work, mainly FER2013 and CK+ dataset. In order to get good classification result, this project will try to use Convolutional Neural Network (CNN) to train and predict outcomes, with utilization of some deep learning frameworks (mainly Tensorflow), and also use transfer learning to ease the training process of deep CNN networks.

Supervisor:      HUI Pan / CSE
Student:         LIU Heshan / COMP                   Course:           UROP1100, Fall

The research aims to find a best algorithm to complete the real-time emotion recognition task on the wearable devices such as mobile phone and google glasses. In this research, we first design several machine learning emotion recognition algorithms based on some existing facial recognition algorithm and test them on some famous emotion dataset such as CK+ and Yale dataset to find the best algorithm. Then we try to implement it in android system to see whether it also works well in real-time recognition.

Supervisor:      HUI Pan / CSE
Student:         SUN Yusen / PHYS                    Course:           UROP1100, Summer

Nowadays, photos of food are ubiquitous. People are used to upload photos of their food to the social networking website or Apps such as Facebook and Instagram before eating. Besides, most restaurants also upload their food photos online as an advertisement to attractive customers. However, while some of the food images look attractive, some do not. Some features of a photo determine its attractiveness. In this project, we analyzed the attractiveness of the food photos by extracting and analyzing different handcraft features such as colors and texture. By utilizing features from these two main categories, the accuracy to test whether a food is attractive or not solely from its photo has successfully reached 80.74%.

## Blockchain Applications

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| Supervisor: | HUI Pan / CSE |
| Student: | LEE Chak Chiu / COMP | Course: | UROP1100, Fall |

With cryptocurrency being popularized and blockchain technology being tested and used in various business sectors, the security of blockchain technology is increasingly being concerned and reviewed. Various flaws had been exploited in different cryptocurrency system, and countermeasures were proposed to handle possible adversaries. This report discusses various system flaws and attacks on blockchain systems, including double spending problem, Sybil attack, 51% attack and Tragedy of Commons. It evaluates different Proof-of-X scheme used in blockchain consensus system for addressing the aforementioned issues and compared them using various aspects, including voting power, the difficulty of forging block content and difficulty of mining, based on the current implementation in various cryptocurrency system.

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| Supervisor: | HUI Pan / CSE |
| Student: | HU Yao-chieh / COMP | Course: | UROP2100, Fall |
| | | | UROP3100, Spring |

In spite of the fact that the major contribution of decentralized ledgers, especially in the applications to blockchain and cryptocurrencies, is to retain states and data which is pertain to the interactions and associations between users to build the trust between parties that are not in trustful relationship, their potentials encourage them to provide much more complicated features and characteristics. Smart contracts are rules that are decentralized and stored on chain of blocks, which can be executed on demand. Moreover, message exchange enables smart contract to talk to each other so as to access data that are used to save on themselves as well as to trigger each other's functions. In the scope of this research, we address a multi-level hierarchical framework that includes two categories of smart contracts: Custodian contract and Client contract. A custodian contract has the ability to deploy on-demand client contracts, retrieve their data and trigger their functions to execute particular updates. Additionally, we propose an architecture to enable client contracts to share common states within the group, in a whole and partially, which might be restricted to mutation only from their creator, namely custodian contracts. We measure the effectiveness of our solution by creating the addressed structure and contracts, and deploying them on three different Ethereum testnets: Rinkeby, Kovan, Ropsten.

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| Supervisor: | HUI Pan / CSE |
| Student: | JADOON Asfandyar Khan / CPEG | Course: | UROP1000, Summer |

The process of Peer review has long been used as a means of evaluating the merit of academic works and has not changed much throughout history. Reviewers and authors are kept in the dark about each other's identities and reviews are kept unpublished, all to allow the reviewer to judge submissions freely and without bias. However, without being open to judgement, reviewers may not feel compelled to produce wok of the highest quality. This paper describes an open academic publishing and peer reviewing platform that identifies high quality reviews through a trust-less voting mechanism and creates an audit trail for academic activity to make reviewers accountable for their work. This is done using blockchain technology and cryptographic signatures.

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| Supervisor: | HUI Pan / CSE |
| Student: | LEE Ting-ting / COMP | Course: | UROP2100, Fall |
| | | | UROP3100, Spring |
| | | | UROP4100, Summer |

In the last series of this UROP research, we proposed a multi-level hierarchical framework that involves two roles of smart contracts: Custodian and Client. Custodian contract has the ability to deploy on-demand Client contracts, retrieve their data, and perform updates on Client contracts. On top of this, common states can be shared between Custodian and Client contracts. However, as the types of interactions discussed previously were not as comprehensive as the development of smart contracts become more rapid, this research serves as the extension of the hierarchical structure proposed before, which put the main focus on comparing and contrasting all types of smart contract interactions, and how they can be differentiated with our proposed framework. In this work, we hope to give more comprehensive insights by introducing the interactions in a more thorough perspective.

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| Supervisor: | HUI Pan / CSE | | |
| Student: | WUU Cheng-hsin / COGBM | Course: | UROP1100, Spring |

Smart contract has been widely used in different decentralized application. To execute a smart contract, user needs to pay corresponding gas, which is proportional to the computational resources, to the miner. If all gas is consumed during the execution, then the smart contract will fail and create the loss of gas as it will not be refunded. Thus, to avoid such situation, one possible way is optimizing the gas cost of the smart contract. The optimization of gas cost comes from 3 different perspectives, operation-related cost, function-related cost, and code related cost. In this paper, Solidity is used for conducting the research and analysis the factor of gas cost.

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| Supervisor: | HUI Pan / CSE | | |
| Student: | UY Mark Christopher Siy / MAEC | Course: | UROP1100, Summer |

A smart contract is a blockchain-based technology that utilizes the decentralized, distributed, and immutable nature of a blockchain in order to automate different transactions. The contract follows a set of 'rules', which is used to determine the validity of a transaction. The contract itself is stored on the blockchain and can be 'called' on demand by individuals or other contracts by accessing the said contract's public methods and global variables. Now, while there have been many promising developments that have arisen due to the advent smart-contracts, such as blockchain-enabled decentralized applications. Smart contracts are far from perfect. This paper looks at a particular flaw regarding Ethereum based smart contracts, with an emphasis on the cost of executing smart contract based transactions. This paper implements a simple smart contract and presents a potentially large flaw in the way Ethereum charges gas for the execution of transaction-operations, and correspondingly presents a solution to the said flaw. The solution, while specific to the smart contract implemented, can serve as a framework for dealing with similar, but different cases. The framework helps solve the problem of varying transactional costs due to variable or object initialization from a "zero" value. All contracts are implemented using the Remix Web IDE and are deployed onto the Rinkeby and Ropsten test nets using the Metamask browser extension.

## Algorithms and Games in Android Devices

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| Supervisor: | HUI Pan / CSE | | |
| Student: | HUANG Yi-feng / SENG | Course: | UROP1100, Summer |

The target of this project is to implemente a real time online database system that supports query and synchronization of data for auction game in android device. The system incorporates relational database system (SQLite) for querying and non-relational database system (Firebase Firestore) for online synchronization. The data is updated and stored in Firestore in the cloud. And data is fetched to the local SQLite database for processing when executing query. Meanwhile, a connection for keeping data updated is made to keep data in real-time. This structure may be extended to be used in other projects that involves real-time extendable database.

Supervisor:       HUI Pan / CSE
Student:          KUO Tzu-yang / COSC          Course:         UROP1100, Spring

In this research, several documents of java library and GitHub source codes had been investigated and specific functionalities were implemented on an Android application. This application is competent to explore other Android devices, attempt to establish the connection with other Android devices, and transferring data between devices. By the request transmitted among Android devices, the manipulation of database and query for certain data is enabled. Working principles of exploration and connection to other Android devices and the exact implementation by code are studied in this research.

Supervisor:       HUI Pan / CSE
Student:          REN Xuanchi / SENG         Course:         UROP1100, Summer

I do this research program to learn Android programming and java language. The target of this project is to introduce the basic concepts of Algorithmic Game Theory and implement a set of agents in the mobile devices. I gained knowledge including Android widgets, java class and SQLite database from the Internet and books. Finally, I make an app with multi-function using what I learn in the project with the help of my supervisor. For the future actions, I will implement an Android Service that supports Game Theoretic functionalities. For the method that I used in the project, I run the app every time I create a new function and I need to test it and debug.

Supervisor:       HUI Pan / CSE
Student:          ZHANG Yi / COMP          Course:         UROP1100, Spring

The title of my UROP project is "Algorithms and Games in Android Devices". During this UROP project, I have learned a lot about Android programming and Algorithmic Game Theory Concepts. After gaining the basic knowledge about how to program on Android Studio, I created a small application which connects two phones over peer to peer WIFI connection. Besides, I have read some materials and learnt the basic concepts of algorithmic game theory and applied them to implement a simple prisoner's dilemma application. Finally, I adjusted the code and made the application support some other functionalities. The final objective of this UROP project is to be familiar with the concepts of game theory and understand the algorithmic issues of this area.

### Dissecting WhatsApp Messages and Calls

Supervisor:       HUI Pan / CSE
Student:          LI Haoran / COSC           Course:         UROP2100, Fall
                                                 UROP3100, Spring
                                                 UROP4100, Summer

This report aims on the traffic analysis of WeChat which is a Chinese multi-purpose social media mobile application software developed by Tencent. In addition, we also perform static code analysis and exploit the property of database file with the help of rooted android phone. We start from packets of Webank transaction records via HTTPS protocol, and would like to see how they make use of their packets to support huge amount of active users and maintain stableness. Then we move on to WeChat message packets, which WeChat team write their own socket programming based on TCP protocol. The failure to decrypt the corresponding packets proves the security of socket programming technique combined with cryptography. Finally, we perform static code analysis technique on specific database related packages and successfully decrypt the database file with a rooted android phone provided. And show the security of WeChat traffic.

## Can We Build a Cloud from the Crowd? Cloud Computing on Smartphones

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| Supervisor: | HUI Pan / CSE | | |
| Student: | LI Xiang / COMP | Course: | UROP1100, Fall |

The title of my UROP project is "Can We Build a Cloud from the Crowd? Cloud Computing on Smartphones". During this UROP, I have learned a lot about Android programming, computer network and specifically the WIFI P2P communication network among android phones. After learning about an open source WIFI P2P API Salut, I have created an instant messaging APP that sends messages between two phones over peer to peer WIFI connection. Also, I have carried out extensive experiments to calculate the speed of data transfer and detecting hosts using Salut. Finally, an APP is implemented that applies Salut to synchronize two databases on different devices. My UROP study will continue and our final objective is to understand and contribute to an open source middleware OPENRP.

## Security on Internet of Things (IoT) Devices and Network Protocols

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| Supervisor: | HUI Pan / CSE | | |
| Student: | SONG Renhe / COMP | Course: | UROP1100, Summer |

New technology advances such as wearables, computer vision can also lead to new shopping experiences and analytics. However, many current approaches lack of precision (e.g., wireless) or threats customer's privacy (e.g., face recognition, smartphone tracking). In this report, we propose an innovative system to track shopper's gaze and provide better insights about customers' behavior in physical stores. EyeShopper is a gaze estimator ubiquitous system which includes privacy awareness (i.e., face recognition) and works on video surveillance footage. We believe that the fine-grained information collected by our system can be the key to success for retail stores. We define customer's gaze as a two-parameter function based on head pose: yaw, and pitch. In this report we will focus on back head detection algorithms so the system will be able to not only estimate clients' gazes but track them. So this gaze estimations can be provided to retailers as another level of granularity (i.e., what customers look at and for how long) to enhance their store analytics with augmented features such as most viewed products.

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| Supervisor: | HUI Pan / CSE | | |
| Student: | VERMA Kshitij / COMP | Course: | UROP1100, Spring |

Currently, most cryptocurrencies are based on the blockchain architecture, which has limitations on the frequency at which transactions can be added to the network. Additionally, having separate miners maintain correctness of the ledger imposes transaction fees and consumes a lot of computing power. This stemmed the creation of DAG based cryptocurrencies, in which the ledger is maintained in the form of a directed acyclic graph of transactions or blocks of transactions by the users themselves. This architecture allows for faster verification of transactions. This report explores the working, advantages and disadvantages of various DAG based ledgers. It also explains in depth possible security flaws in IOTA, a cryptocurrency which maintains a DAG of transactions as a ledger.

## A Data-Mining-based System for Trip Planning

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| Supervisor: | HUI Pan / CSE | | |
| Student: | YANG Hsuan-ru / COMP | Course: | UROP1100, Fall |

The project applies data-mining techniques on over 33, 000 user records, 15,000 question records, and 100,000 answer records and have discovered frequent patterns in the relationship between users, questions, and answers on the knowledge sharing platform Quora.com. The length of answer text has a negative impact on the number of votes and

views of the answer; Users are most interested in topics about the country they reside in and topics their alma mater are well-known for; Answerers of a certain topic are also interested in topics with similar concepts; Accuracy and the number of association rules among topics both decreases as the minimum support in the FP-growth algorithm increases.

## Augmented Reality on Wearable Devices

Supervisor:          HUI Pan / CSE
Student:             YEUNG Ngo Yan / COGBM          Course:          UROP1100, Summer

This report investigates on the possibility of a pressure-based text input system derived from traditional text on 9 keys (T9) predictive text keyboard. First, the report briefly introduces the constraints of migrating existing keyboards into devices with a limited key factor, such as smartwatches plus a brief introduction to some of the force-assisted input method so far. Next, the report will include the implementation of the keyboard, including two preliminary test designs set up to determine the sensibility of users towards exerting different numbers of levels of pressure. The keyboard also comes with a haptic feedback mechanics to provide feedback referring to the level of pressure exerted. The keyboard can potentially be used in devices with limited form factors or incorporated with smart glasses or other display devices to provide an eyes-off text entry system. The system is implemented on an iPhone 6s with force touch functionality and Apple Taptic engine as a prior study. Finally, possible future improvements to the keyboard will also be discussed at the end of the report.

Supervisor:          HUI Pan / CSE
Student:             YU Jiuzhi / COMP          Course:          UROP1100, Spring

The main feature of augmented reality is to mix the digital information with the concrete objects in real life, in order to provide the user with an immersive experience. With the help of the advanced computer vision techniques (object recognition, etc.), it is far easier to detect the objects and information needed by the user. The next step is to collect the correct data about the scene and display them accurately and succinctly. The primary focus of this UROP project is about finding a feasible solution for providing a stable information service for augmented reality applications, providing the information from the scene is correctly detected.

## Augmented Reality Technology for Visually Impaired

Supervisor:          HUI Pan / CSE
Student:             ZHANG Daofu / SENG          Course:          UROP1100, Summer

New technology advances such as wearables, computer vision can also lead to new shopping experiences and analytics. However, many current approaches lack of precision (e.g., wireless) or threats customer's privacy (e.g., face recognition, smartphone tracking). In this report, we propose an innovative system to track shopper's gaze and provide better insights about customers' behavior in physical stores. EyeShopper is a gaze estimator ubiquitous system which includes privacy awareness (i.e., face recognition) and works on video surveillance footage. We believe that the fine-grained information collected by our system can be the key to success for retail stores. We define customer's gaze as a two-parameter function based on head pose: yaw, and pitch. In this report we will focus on back head detection algorithms so the system will be able to not only estimate clients' gazes but track them. So this gaze estimations can be provided to retailers as another level of granularity (i.e., what customers look at and for how long) to enhance their store analytics with augmented features such as most viewed products.

## Photo and Document Digital Forensics

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| Supervisor: | IEONG Sze Chung Ricci / CSE | | |
| Student: | ANANNA Shekh Shermin Jahan / COGBM | Course: | UROP1100, Spring |

In an era when image manipulation is becoming more and more common, methods to identify falsified images have become a major topic of interest. Error Level Analysis is one such tool that can identify differences in compression level within a single image. In my research, I looked at how Error Level Analysis is implemented and used it on modified images to understand the extent to which this tool can identify edits in images. Changes such as blurring, sharpening, cloning and splicing are easily detectable but changes in color, saturation, brightness and contrast are not detectable.

## Deep Coding: Generating Source Code Using Deep Learning Techniques

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| Supervisor: | KIM Sung Hun / CSE | | |
| Student: | CHEN Ziqi / CPEG | Course: | UROP1100, Fall |

Source code generation has been a hot topic as it helps people to achieve repetitive and heavy programming tasks and enhance work efficiency. In this project, I studied state-of-the-art deep learning models for source code generation, and implemented a neural encoder-decoder model with attention mechanism to generate general-purpose code from natural language inputs, proposed in a paper [1]. More specifically, the model encodes natural language inputs using bi-directional LSTM, and decodes into source code by spanning an abstract syntax tree and generating tokens at tree terminals. I implemented the model using Tensor flow framework, experimented it on two datasets and obtained similar results as in the literature.

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| Supervisor: | KIM Sung Hun / CSE | | |
| Student: | CHUNG Jihoon / COMP | Course: | UROP1100, Fall |

Voice conversion is a technique to aim to modify a speaker's voice characteristics in order to sound like someone else. In this project, we focuses on extracting data from wave files, processing the data and, finally finding the spectral mapping component of voice conversion. We tried to achieve some of the current state of the art result which is implemented by a deep bidirectional long short term memory recurrent neural network based voice conversion system, and also tries to apply sequence to sequence model with attention. We were not able to make the attention layer to have meaningful result to the total model. We believe we can improve our model with regularization.

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| Supervisor: | KIM Sung Hun / CSE | | |
| Student: | DEL MUNDO Gian Miguel Sero / COMP | Course: | UROP1100, Fall |

Autonomous driving has recently become a hot topic in computer science, but state-of-the-art approaches have not been able to account for non-deterministic scenarios, semantic information, interactions with other agents such as pedestrians, or long-term possibilities. The project explores a proposal by Lee et al. [1] called the Deep Stochastic IOC RNN Encoder decoder network (DESIRE) to overcome the aforementioned limitations. It consists of two modules, namely the Sample Generation Module (SGM) and the Ranking & Refinement Module (RRM). The SGM produces a diverse set of future trajectory predictions based on the past trajectory of the car, and the RRM scores these predictions based on semantic information retrieved by a convolution neural network (CNN) as well as interactions with other agents.

Supervisor:      KIM Sung Hun / CSE
Student:          GAO Tong / COMP                Course:         UROP1100, Fall
                      Fang Haoyang / MATH-PMA                         UROP1100, Fall

Neural dialog system has been an active area of research, as a dialog system makes it possible for human to interact with computer using everyday language, lowering the threshold to fully utilize devices' functionalities. One basic dialog model is called sequence-to-sequence, which encodes the question into a context vector, and use a decoder to reconstruct the corresponding answer given that context vector. However, this model does not consider the topic clusters of answers thus producing monotonous responses. In our project, we present a modified version of sequence to sequence model, aiming at improving the quality of replying questions with certain latent topics. This model is combined from ideas of VAE and our supervisor. We implemented two improved models to answer questions with specific latent topics. In this report, we first introduce the intuition and mathematic theory behind two models, then present our idea with important code snippets. Finally, we propose some possible ways for further improvement on this model.

Supervisor:      KIM Sung Hun / CSE
Student:          KIM Dohoon / ELEC                Course:         UROP1100, Fall

The following report is a paper study of Unsupervised Neural Machine Translation, a novel method of NMT only using monolingual corpuses of both languages. This is achieved by creating a cross-lingual embedding using the unsupervised bilingual encoding method. The architecture of the RNN uses a shared encoder, with two separate decoders for the translation of each language. In order to train the model unsupervised, new techniques such as denoising and back translation is proposed to create pseudo parallel corpus for the RNN to learn on. The implementation of this method was done using Tensor flow, up to the part of denoising of the cross-lingual embedded inputs.

Supervisor:      KIM Sung Hun / CSE
Student:          KOO Tin Lok / ELEC               Course:         UROP1100, Fall

The project topic I have chosen to study is "End-to-end representation learning for Correlation Filter based tracking"[1]. It uses Correlation Filter to discriminate an image object from the surrounding images, thus allowing object tracking. One key point in this project is to deep integrate Correlation Filter (CN) and Convolution Neutral Network (CNN), thus deep features can be learnt.

Supervisor:      KIM Sung Hun / CSE
Student:          NG Chung Ki / ELEC               Course:         UROP1100, Fall

With the significant improvement of the computation power, it open up a lot of possibility of using computer to solve problems in our lives. Nowadays conventional programs in the world, they are built with clear logical path for specific task, and in order to build a sophisticated program, a thorough study of a problem is needed to develop a suitable model for such task. As the amount of data in the world is growing, it is increasingly difficult for human to discover pattern and creating the model. Deep-learning has offer a more sophisticated machine learning capability that could be more efficient to learn about what the data representation. This report will briefly discuss about various concept of deep learning.

| Supervisor: | KIM Sung Hun / CSE | | |
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| Student: | PARK Chun Ho / MATH-CS | Course: | UROP1100, Fall |

Neural machine translation is regarded as a promising method of machine translation that could replace traditional statistical machine translation models. It usually utilizes RNNs because of the sequential nature of processed data, and the encoder-decoder architecture with LSTM cells has led to good results. This report takes a look at the attention mechanism that is added on top of the encoder-decoder structure by analyzing the paper "Neural Machine Translation" By Jointly Learning To Align And Translate. It demonstrates the mathematical methods used to align the output word to the input sentence, giving attention to parts of input that are most relevant to the current output word, and describes the results of an experiment that proves the effectiveness of this model.

| Supervisor: | KIM Sung Hun / CSE | | |
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| Student: | XIA Zihan / COMP | Course: | UROP1100, Fall |

This is an analysis and comprehension about DEEP CODER: LEARNING TO WRITE PROGRAMS, which is a paper written by Alexander L. Gaunt, Marc Brockschmidt, Sebastian Nowozin and Daniel Tarlow. Their work is about solving simple competition problems by analyzing input-output examples using deep learning techniques. And my task is to implement this work using codes, and is still in process. The first thing to do is to find all functions defined in the DSL or write them by myself, and the second thing to do is to finish the model building by using Tensorflow via Python.

## Machine Learning and Chatbot

| Supervisor: | KWOK James Tin Yau / CSE | | |
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| Student: | FAN Ziqian / COMP | Course: | UROP1100, Spring |
| | Yang Hsuan Ru / CS | | UROP1100, Spring |

With time pass by, the world is coming closer and closer to the best of machine learning and natural language processing technology. From dictation input method to intelligent helper, those technologies have come a long way and help us in several aspects of our life. The purpose of this research was to have a basic understand of such technologies and develop a chatbot that can help people with their work or daily life. A price searcher bot and a chit-chatting bot are developed in this project. Those price searcher bot allows users to ask price of stock or digital currency and exchange rate, and the chit-chatting bot receives user input with speech recognition techniques and generates responses with natural language generation algorithms.

## Deep Learning and Fintech

| Supervisor: | KWOK James Tin Yau / CSE | | |
|---|---|---|---|
| Student: | KIM Zi Won / COMP | Course: | UROP1100, Spring |
| | MA, Qiurui / COGBM | | UROP1100, Spring |
| | SU, Heng / COMP | | UROP1100, Spring |
| | YANG Yifeng / MATH-SFM | | UROP1100, Spring |

In recent years, deep learning has proven itself as a powerful technique for various applications. These applications range from object classification from images to forecasting events to natural language processing. In this research project, we try to apply machine learning and deep learning techniques for predicting stock prices from historical data only. Specifically, we utilize deep Q networks, a form of reinforcement learning, long short-term memory recurrent neural networks, a combined approach with both LSTM and RNNs, and convolutional neural networks to tackle the

problem of predicting stock prices. Without any professional experience, amateur investors and analysts may potentially use this information to make decisions when performing trades.

### Machine Learning and Anti-money Laundering

Supervisor:        KWOK James Tin Yau / CSE
Student:           WONG Ngo Yin / COMP                    Course:           UROP1100, Spring

In this project, we used two different machine learning algorithms, support vector machine (SVM) and decision tree, to classify which customers using the banking service are potentially laundering money. We compared the difference of these two approaches in terms of their performance. The dataset used in this project is provided by an online bank in China, with basic information of the customers and transaction records of their accounts. We first preprocessed the data and designed features before applying our models.

### Software AI agents

Supervisor:        LIN Fangzhen / CSE
Student:           ZENG Kuang / COMP                      Course:           UROP1100, Spring

After AlphaGo defeated a series of best Go players, Artificial Intelligence has become the one of the hottest topics. Similar with Go, Five-in-a-row is also an abstract strategy board game for two players, in which the aim is to put five same pieces in a row more quickly than opponent. Compared to Go game, Five-in-a-row game has lower complexity and simpler rule so the project study human-computer game reasoning based on Five-in-a-row game. Some search methods, decision-making planning algorithm and game analysis will be discussed, varying from basic game tree to complex machine learning and optimization methods. An intelligent Five-in-a-row agent is implemented according to mentioned algorithms.

### Multimodal Interaction with Sensor Fusion in VR/AR

Supervisor:        MA Xiaojuan / CSE
Student:           CHEN Yuan / COMP                       Course:           UROP2100, Fall
                   LIANG Zhibo/ CPEG                                        UROP2100, Fall

The ultrasonic sensor Welle outputs 2D x-y coordinate points when a person's hands are approaching it. However, these points could be easily polluted by the environment and needed to be mapped to gestures. Besides, in UROP 1100, the VR system we proposed was lack of entertainment. To address these two issues, we propose the new VR system "WellVR2", which consisted of two parts, namely the server system and the VR mobile system. In this note, we will introduce how we design and analyze the gesture-mapping and test gesture-mapping control, how to reduce the noise and implement the system architecture. In the end, we will present an informal evaluation on the robustness of this approach.

### Air Quality Data Analysis and Prediction Using Machine Learning Approach

Supervisor:        NG Wilfred Siu Hung / CSE
Student:           CHA Seunghwan / CPEG                   Course:           UROP1000, Summer
                   ROHATGI Tanay / COGBM                                    UROP1000, Summer

This report describes the progress of our UROP - "Air Quality Data Analysis and Prediction Using Machine Learning Approach." In this paper we provide methods to improve the efficiency and the feasibility of predicting the rainfall at the region for the next 1-2 hours based on the radar images. Our solution uses a two phase structure to predict the precipitation index. Firstly, using feature engineering on the dataset to get better understanding of the global cloud pattern, the temporal and the spatial structures and in the second stage, we feed the vectors into the Neural Network along with the pinpoint local radar images to get the results.

### A Study on the Principles and Implementations of Array Databases

Supervisor:     NG Wilfred Siu Hung / CSE
Student:        HYUN Jeongseok / CPEG             Course:        UROP1000, Summer

During the past few decades, there was a paradigm shift in the scientific research from experimental approach to data analytic approach. The conventional DBMSs, such as Relational DBMS, is inefficient to store and process scientific data. In order to manage the scientific data more effectively, the new concept of database come up with that selects array as a first-class citizen. Array Database Management Systems (ADBMSs) improve the performance and functionalities from the conventional DBMSs.This research explores the principles of array databases and conducts the experiment to compare the performance of Array Database and relational database. The experiment was done with the datasets of vessel traffic data, or Automatic Identification System (AIS) data collected by U.S. Coast Guard which is used for a variety of coastal planning purposes. The process of experiment is started by pre-processing the raw data to remove the header of csv file and remove the data of duplicated coordinates. The coordinates are consisted of lattitude, longitude and base Date Time, thus, it is a 3-D array data. After that, the time spent for loading each csv file is recorded. Even though the experiment origianlly purposed to compare the time spent for loading in MySQL, a famous relational DBMS, due to the time constraint, this research is done with only tileDB, a new array database library.

### Message Labelling Project for Using Machine Learning in Spammer Detection on Real-life Data

Supervisor:     NG Wilfred Siu Hung / CSE
Student:        CHENG Chi Fung / COMP             Course:        UROP1000, Summer
                TANG Yubo / SENG                                UROP1000, Summer

This UROP is running spammer detection on a commercial dataset from Mama Helper, which is developed for employers and HK domestic helpers' communications. First, we contact with the Mama helpers organization and intend to help them build a spammer detecting device. The general procedures are as follows: preprocessing, labeling, machine-learning, detecting and what we are supposed to do is the first two part as for this UROP. First, we spent some time learning python and relevant knowledge about machine learning and spammer detection. Then we started to write our own code for preprocessing and labeling. The process was hard and repetitive, due to unexpected fatal error in code and consequently rewriting the whole code. But the progress was done at the final stage. After refining the code time after time, we got a well-functioning version and we used it to label near 10000 messages manually.

### Visual Analysis of Big Data

Supervisor:     QU Huamin / CSE
Student:        CHIU Ka Ho / SENG                 Course:        UROP1000, Summer

Data visualization has been prevalent around the world for years. It is extremely useful in the field of analyzing specific objects' changes over a period of time. In data visualization, we typically adapt tables and graphics to make data accessible and easy to be compared. And we also gather statistics in an interval and process it to see how its

corresponding object changes during this interval. HKUST is a technological university accommodating over 10000 students and staff who busily cross through various zones. Therefore, as for our project, we choose people in HKUST to see how they move around in the university every day. How people's locations vary with time and which approach they select interest us a lot. After studying it, we develop a visual web page to demonstrate these contents and draw some conclusions about people's daily lifestyle in HKUST. In a long run, this system can undoubtedly be applied to more general cases and the result will be more influential.

| Supervisor: | QU Huamin / CSE | | |
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| Student: | DU Wei / COMP | Course: | UROP1100, Summer |
| | JIANG Kuo / SENG | | UROP1100, Summer |
| | SHUM Ka Chun / SENG | | UROP1100, Summer |

In order to better understand a university, watching its campus news is one of the best way. However, simply going to the campus news website to watch news is absolutely not convenient enough because it is time-consuming for a person to read all the news articles that are published in different time. And it is also difficult for us to take a full look on one specific aspect of a university. Our project is mainly aim at the people who want to have a quick and holistic understanding of HKUST. By using Python and Javascript for data crawling and data processing, using HTML and d3 methods for visualization, the goal of our system is to provide a webpage with a chart that shows visualized information for users. In the report, we will describe how we find a way to define the similarity of the news and how we finish establishing the project step by step.

| Supervisor: | QU Huamin / CSE | | |
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| Student: | LI Xiang / SENG | Course: | UROP1100, Summer |
| | SONG Sizhe / SENG | | UROP1000, Summer |
| | SUN Yushi / SENG | | UROP1000, Summer |

With the population in the campus rising over time and the cease of coffee shop's catering service, most students have undergone exceeding crowdedness in campus canteens, which wasted our time and brought much inconvenience. If there's a program to process the historical population data of canteens and visualize them in a user-friendly manner, the problem is likely to be solved. It may also help students to avoid rush hours so that they won't waste too much time in a long queue. In this report, we will introduce our work, an HKUST canteen population data visualization tool and how we have designed and developed it.

| Supervisor: | QU Huamin / CSE | | |
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| Student: | WANG Yanbang / COSC | Course: | UROP3100, Spring |

Recent development in techniques has made possible emotion recognition in video streams. However, the newly available information has not been effectively leveraged to provide extra insight in terms of video analysis. This report summarizes my work over the process of participating in research paper writing: Emotion-Oriented Visual Summarization of Classroom Videos. It outlines the working pipeline, and provides clarification and reflection on top of the original paper.

| Supervisor: | QU Huamin / CSE | | |
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| Student: | FANG Juanru / COMP | Course: | UROP1100, Summer |
| | XIAO Tianyi / COMP | | UROP1100, Summer |

Data visualization has been prevalent around the world for years. It is extremely useful in the field of analyzing specific objects' changes over a period of time. In data visualization, we typically adapt tables and graphics to make data accessible and easy to be compared. And we also gather statistics in an interval and process it to see how its corresponding object changes during this interval. HKUST is a technological university accommodating over 10000 students and staff who busily cross through various zones. Therefore, as for our project, we choose people in HKUST to see how they move around in the university every day. How people's locations vary with time and which approach they select interest us a lot. After studying it, we develop a visual web page to demonstrate these contents and draw some conclusions about people's daily lifestyle in HKUST. In a long run, this system can undoubtedly be applied to more general cases and the result will be more influential.

## Efficient Algorithms to Process Gigapixel Images

Supervisor:     SANDER Pedro / CSE
Student:        SUGIMOTO Ryusuke / COSC          Course:          UROP1000, Summer

The final target of this project is to generate video loops of gigapixel panorama from several still pictures. In order to realize this, we will first identify what kind of objects there are in the image and to render the objects using the existing rendering techniques. Therefore, we need to implement several different rendering techniques. We will start from water surface to inspect the validity of our idea since water surface is a common non-static object in our daily scene. As a progress report, we will discuss the basic rendering techniques available today and the techniques to render water surface.

## Heterogeneous Information Network Mining

Supervisor:     SONG Yangqiu / CSE
Student:        CHEN Sixuan / COMP               Course:          UROP1100, Spring
                                                                 UROP2100, Summer

In this report, I would firstly present the overall ideas and objectives with a detailed plan for this project of improving the current meta-path based FMG model.   Precisely, Attention based method is being examined in combine with deepFM model, and metapath2vec would be implemented on it in place of the current embeddings.  The overall introduction is followed by a specific explanation of Attention method, especially focusing on meta-path based co-Attention model (MCRec) and aspect-level deep CF model (NeuACF). Next, some parts of hands-on implementations in code level and my learnings will be covered.  Furthermore, a brief introduction on metapath2vec model would be shown, and the report is concluded with future works on code implementations, and final realization of the entire framework that is fully connected through deep neural network to automatically learn all the parameters end-to-end, that finishes the whole project.

Supervisor:     SONG Yangqiu / CSE
Student:        WANG Yili / COMP                 Course:          UROP1100, Spring
                                                                 UROP2100, Summer

Stack Overflow is a platform for users to ask and answer question on all the fields of computer science. According to [1], Stack Overflow has more than 900,000,000 registered users up to August 2018 and more than 16,000,000 questions up to mid2018. There is a large amount of data embedded in Stack Overflow that we can use to optimize user experience. We are currently working on a project to transfer data sets of Stack Overflow to a heterogeneous information network

and later apply machine learning and data mining models to it.  The goal of our project is to totally struct Stack Overflow to an HIN so that we can learn the knowledge embedding and optimize use experience.


### Natural Language Processing for Social Media and E-Commerce Data

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| Supervisor: | SONG Yangqiu / CSE | | |
| Student: | DU Donghong / ELEC | Course: | UROP1100, Spring |

Natural language processing is a hot topic nowadays with broader and broader applications in daily life where social media and e-Commerce data plays a role. This report basically describe what I experience this innovative field under the instructions of supervisor as well as some other learning process for basics of NLP. First part is experience on utilizing various name entity recognition API to deal with the data and second part is about a simple recurrent network learned from online source.


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| Supervisor: | SONG Yangqiu / CSE | | |
| Student: | BAI Jiaxin / COGBM | Course: | UROP1100, Spring |
| | | | UROP2100, Summer |
| | SUN Xinyu / COSC | Course: | UROP1100, Spring |
| | | | UROP2100, Summer |

This summer we continue working on our original plan. Jiaxin focus on Multiplex Network Embedding for Selectional Preference. MNE is a way to use dense vectors to represent the nodes of a multitype knowledge graph. Meanwhile the dependency graphs are multitype knowledge graph, with words as nodes and dependency types as edge types. As a result, we can get the word embedding by applying MNE to dependency graphs. We evaluated the embeddings with SP-10K dataset. Xinyu focus on grammar correction and helped Hongming to search for the relevant materials. We had a basic model based on Robsut Word Reocginiton via Semi-Character Recurrent Neural Network. And here we have one example:



From this example, we can see that the network's performance is acceptable and this network is very easy. If we add more layers, it will perform much better. The details will be explained in the later part.


### Fair and Efficient Cache Management for In-memory Big Data Systems

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| Supervisor: | WANG Wei / CSE | | |
| Student: | CHENG Xiaohe / COSC | Course: | UROP1100, Spring |

In-memorycachecandrasticallyimprovetheperformanceofdataintensive jobs. In a shared environment, the huge performance advantage and limited size of memory require a well-designed cache sharing scheme that provides both isolation guarantee and high utilization. This scenario deviates from classical resource allocation as the cached files allow non-exclusive access from multiple users, which poses a unique challenge to achieving strategy proofness. Several al location policies have been proposed, but they either fail to prevent harmful manipulation or introduce high computational overheads. In this project, it is shown that cache sharing process can be identified as a potential game. We measure its performance by analyzing the worst-case efficiency, and make comparisons with other cache sharing schemes. It outperforms existing policies and reaches near-optimal global efficiency in simulations.

Supervisor:        WANG Wei / CSE
Student:           YANG Baichen / SENG                Course:          UROP1100, Summer

When dealing with data-intensive jobs, using in-memory cache to store hot files can drastically speed up reading and writing procedure. Meanwhile, under a cloud environment, multiple users can share the in-memory cache non-exclusively, which increase files' utilization. However, while the huge performance benefits are given, memory size is comparatively small and limited. So, this situation encourages strategic users to game the system and get more reward at a lower expense, which is famous as "free-riding" problem. In this project, we treated the caching process of multiple users as a potential game. And we used a Game Theoretical View to design a pluggable cache management system, GTCS, atop Alluxio, a popular memory-centric file system. We measured the performance of the system and give an evaluation for it.

### Research on Mining Course Structure

Supervisor:        WONG Raymond Chi Wing / CSE
Student:           CHANG Yung Wei / COGBM             Course:          UROP1100, Fall
                                                                        UROP2100, Spring

The recent introduction and development of Massive Online Open Courses (MOOCs) has brought many new opportunities to the world of online learning. One of these opportunities is customized learning pathways that offer students with personalized curriculums that are tailor-made to suit their own needs. In order to achieve this, it is critical for us to analyze data gathered from existing MOOCs and extract student performance indicators as well as their correlation to pathway design. This project is a continuation of work performed by Mr. CHEUNG Tsz Him, Ms. LU Xiuyuan, and the author of this report, CHANG Yung Wei, and is carried out under the supervision of Professor Raymond WONG of the Hong Kong University of Science and Technology.

Supervisor:        WONG Raymond Chi Wing / CSE
Student:           CHEN Qixu / COMP                   Course:          UROP1100, Summer

The title of our UROP is "Research on Mining Course Structure". Our final objective is to build a system that can predict the grade of a student based on his/her profile and make recommendation according to the prediction results. My role in this project is implementing the rule-base prediction part. The rule-base prediction serves as a subsystem of the whole course recommendation project. It applies the approach of using association rules to predict the letter grade an individual student will get when taking a course. During this UROP, I have learned a lot about python programming, specifically the library for association rule "Orange3" and the library for data handling "Pandas". This report will give a general idea about how the association rules are generated and formatted, and how the predictor is built.

Supervisor:      WONG Raymond Chi Wing / CSE
Student:        CHEUNG Tsz Him / COMP        Course:        UROP2100, Spring

E-learning opens up a lot of possibilities for students by customizing individual learning experience. One of the customizations can be the generation of different study pathways (different order to study some concepts). For example, in computer science context, student can either learn the topic about primitive type, then variables, then object; or they can learn the topic about object, then primitive type, then variables. It is believed that customized study pathway can lead to better learning experience and efficiency. However, study pathway generation is not straightforward, as it involves a huge number of orders to study the concepts. In order to reduce the search space, this report presents a diversification approach to select some most diversified sequences, simplifying the process of selecting the best pathways for students.

Supervisor:      WONG Raymond Chi Wing / CSE
Student:        DENG Yuqing / COMP        Course:        UROP1100, Spring

In the revolution of education, the traditional teaching that only happens in the classroom is gradually being replaced by online teaching. However, the limitation of communications and interactions between instructor and students is posed by e-learning as well. In order to give better feedback to both students and instructors, we implemented a feedback page in our system. Based on the idea of dependency of learning objects within a course, recommendations can be generated by recognizing highly dependent relationship between learning concepts. Continuing previous students and staffs' work, this project puts main focus on expanding the functionalities in the feedback page which provides advice on e-learning platform.

Supervisor:      WONG Raymond Chi Wing / CSE
Student:        GU Qiao / ELEC        Course:        UROP1100, Fall

Massive Online Open Courses(MOOC) has induced a significant impact on today's learning pattern, and an enormous amount of data is generated about the students' performance on these courses, which can provide important and useful information to improve the education quality. By mining on students' performance on learning objects defined for each course, knowledge about the inner-correlation of the course structure can be discovered and thus recommendation about study patterns can be made for both students and instructors. In this phase of the project, the focus is basically on the integration of the previous work and the implementation of a new system as the instructor interface to achieve the visualization of the discovered knowledge.

Supervisor:      WONG Raymond Chi Wing / CSE
Student:        LU Xiuyuan / COMP        Course:        UROP1100, Fall

Massive Online Open Courses(MOOC) has greatly affected on today's education patterns, which can be regarded as a revolution. However, right now, most learning platforms have fixed the learning paths for students, which greatly limits the outcome. To provide students with personalized education in accordance with their specific conditions, the concept of self-paced learning is born. After analyzing students' current study situation, the system will recommend the most suitable pathway to them, which hopefully can improve students' performance. Last year Mr. CHEUNG, Tsz Him designed a demo system for this concept. And Miss ZHANG, Ziyan design the dynamic learning system used for online learning programs. This project focuses on implementing Miss ZHANG's scoring system into the demo system.

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| Supervisor: | WONG Raymond Chi Wing / CSE | | |
| Student: | WANG Wenlong / COMP | Course: | UROP1100, Spring |
| | | | UROP2100, Summer |

Every time the students look into the courses they could take for one semester, they would always spend a lot of time in deciding which courses to take. The course recommendation platform could suggest the most suitable courses or pathway the student should take, according to the students' own situation. When deciding to suggest which courses to different students, the student would better have a chance to know what grade he would most probably get according to his previous academic (or non-academic) performance. So here comes the grades prediction system. There could be a lot of prediction algorithms, but here I used two most commonly used method, model-based and user-based collaborative filtering.

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| Supervisor: | WONG Raymond Chi Wing / CSE | | |
| Student: | ZHAO Xinran / COMP | Course: | UROP1100, Summer |

The title of my UROP project is "Research on Mining Course Structure". During the UROP, our group is separated into 3 parts. Two of us will mine the past students' course data and demographic data to predict the grade of a course for new students who have not taken yet with Model-based approach and Rule-based approach. Another one was assigned to build the user interface. I was assigned with the job to store the major requirement information, build course dependency graph and find a way to recommend study paths with highest grade. After getting the major requirement sheets and the course data from my.ust.hk, I was finally able to store this information in python class. However, I was not able to find the exact highest-grade path within polynomial time. My UROP study will continue as there are still possible improvements for the requirement and course data capturing and better algorithms could be designed after I am better equipped with algorithm knowledge. These possible improvements and thoughts would be stated more detailedly later in this report.

## Knowledge Discovery over Database

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| Supervisor: | WONG Raymond Chi Wing / CSE | | |
| Student: | CHIU Yik Hei / RMBI | Course: | UROP1000, Summer |

Nowadays, there are many publicly available satellites image data. In this project, we aim to extract useful features from this data. Especially those useful for self-driving car. Such as, region representing road within a given image and sign on the road that hint where the vehicle can turn. I have tried different algorithms for different features. Including J-net for road segmentation and Harris Corner Detection for ground sign detection. The former generates acceptable result while the later failed. CapsNet for ground sign detection is still under implementation at the time of writing this report.

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| Supervisor: | WONG Raymond Chi Wing / CSE | | |
| Student: | LUENAM Phoomraphee / CPEG | Course: | UROP1100, Spring |

A k-Regret Minimizing Set is a useful concept in which a smaller subset of a database is selected while maintaining desirable traits of the original database. Specifically, a k-RMS selects r records from the database such that the regret ratio between the $k^{th}$ best score in the database and the best score in the selected records is minimized for any possible utility function. In this paper, we show that the problem of approximating k-RMS within is NP-Hard when k and the dimensionality of the database are unconstrained. Furthermore, we introduce a discrete version k-RMS which, while seemingly more tractable, can also be shown to be NP-Hard to approximate. However, we will show that there is a

polynomial time approximation scheme for this discrete version which can be used to derive a polynomial time approximation scheme for the original version.

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| Supervisor: | WONG Raymond Chi Wing / CSE |
| Student: | SHI Zhenmei / COSC |

Course: UROP2100, Fall
UROP3100, Summer

This report is a progress report. Our project mainly focuses on designing and implementing a new visual of tracking algorithm by using the trajectory method and deep learning method. Our goal is to participate in VOT 2018 competition held by ECCV 2018. We reviewed the latest method in visual of tracking and proposed our own algorithm. The proposed algorithm is still under construction, which may include deep reinforcement learning in action space, memory augmented structure and a self-located mechanism like a grid cell. These ideas are coming from the latest development in deep learning, tracking algorithm and neural science. We are now building the algorithm by using pytorch and training our model on VOT and OTB datasets with GPU.

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| Supervisor: | WONG Raymond Chi Wing / CSE |
| Student: | ZHANG Jintao / SSCI |

Course: UROP1000, Summer

In this project, our main goal is to build a e-learning platform which provides course pathway planner and grade prediction for students in HKUST using data mining. I am in charge of the web based user-interface design and the integration of data-mining and pathway planner part. The web application is structured using Django, a python based web-app framework, together with a Postgres database. The students demographic information and course history is acquired using copy and paste from HKUST Student Center. All the students' demographic information is stored in an object with the private key of the student's HKUST ID. And with a count model, the number of each course that is inquired in the grade prediction part can be tracked and recorded, intended for further analysis.

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| Supervisor: | WONG Raymond Chi Wing / CSE |
| Student: | ZHOU Yeju / COMP |

Course: UROP1100, Fall

Terrain-Toolkit is a cross-platform tool which is workable on Windows, MacOS and Linux. The toolkit was developed for visualizing and processing terrain data, allowing users to conduct several operations on data with different data formats through a graphical interface. The toolkit p Algorithms and Games in Android Devicesrovides multiple operations in a sole software, including surface distance calculation, surface simplification and format conversion. Nevertheless, the toolkit was first implemented on Mac OS, and then extended to Windows and Linux, making the installation on Windows tedious. A guideline of installation on Windows is provided in the package. As the toolkit was tested on Windows 7 a few years ago, the obsolete installation guideline needs updating to achieve a smooth installation.

## Efficient Queries over Database

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| Supervisor: | WONG Raymond Chi Wing / CSE |
| Student: | LIANG Geyu / MATH-IRE |

Course: UROP1100, Fall

In this final report, the work of me doing the UROP 1100 project on fall semster 2017 will be introduced. The ultimate goal is to produce a compression algorithm that can be applied to the current format for the maps containing lane information. In this report, first we'll focus on the lane infromation in a map and its characteristics and advantages campared with traditional map. Then we'll do a simple review for a trajectory simplification method introduced by

C.Long, R.C.Wong and H.V.Jagadish. Based on that paper, we'll give a problem statement for our new algorithm suitable for lane information. And then, we'll try to develop our own algorithm based on the algorithms that has been mentioned above.

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| Supervisor: | WONG Raymond Chi Wing / CSE | | |
| Student: | WANG Guanzhi / COSC | Course: | UROP2100, Fall |

This report is a group progress report. Our project mainly focuses on implementing Velocity Vector Preserving Trajectory Simplification algorithm, which was done by a previous student attended in UROP program. You may read "Velocity Vector Preserving Trajectory Simplification" for details of the algorithm. This report completely builds on that report and all notations in this paper are same as those in Table 1 of "Velocity Vector Preserving Trajectory Simplification". We implement all three methods including the parallel version mentioned in the report. The implemented codes will be provided below, which follows and improves "Velocity Vector Preserving Trajectory Simplification". We also have a detailed plan to test our algorithm, which is not done yet.

## Learning Analytics for a Personalized E-Learning Platform

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| Supervisor: | YEUNG Dit Yan/ CSE | | |
| Student: | CHAN Wing Kin / COSC | Course: | UROP1100, Fall |

To understand the progress of students' and provide adequate interference for the success of academic study, it is important to provide a novel way to gain insight of students' intrinsic learning state. The extracted intrinsic learning state can be used to conduct other prediction. In this report, the method of extracting students' learning state with Deep Knowledge Tracing (DKT) model is demonstrated. To show the feasibility of DKT model, our team participated in the ASSISTments 2017 Challenge. In the challenge, collected data from an online question answering system is used to predict whether students will enter STEM field. This report will study how the extracted result from DKT is streamlined as an extra feature, which has boosted the predictability significantly.

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| Supervisor: | YEUNG Dit Yan/ CSE | | |
| Student: | LIN Zizheng / MATH-CS | Course: | UROP1100, Fall |
| | | | UROP2100, Spring |

This report will cover discussion, comparison and evaluation of different algorithms of knowledge tracing adopted in the 2017 ASSISTments Data Mining Competition, which aims at using data from a longitudinal study for predicting a brand new outcome of students never studied before by the research community. Specifically, it facilitates research in developing predictive models that predict whether the first job of a student out of college belongs to a STEM field. To tackle this challenge, we first estimate the expected knowledge states of students with respect to different skills using two deep knowledge tracing models including DKT and DKT+. We then combine the learned features expected knowledge states with other features from the static attributes of the dataset to train different machine learning models.

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| Supervisor: | YEUNG Dit Yan/ CSE | | |
| Student: | LIU Ji / COMP | Course: | UROP1100, Fall |

As online learning becomes more and more convenient and widely spread, a huge amount of students are studying on E-learning platforms. However, there are still many drawbacks in existing online learning platforms. For example, problematic students cannot be pinpointed and personalized assistance cannot be delivered accurately to individuals

who need help because of the lack of face-to-face communication. On one hand, online instructors have to know students' learning states to offer help to them. On the other hand, developers need a data visualization scheme to design better prediction and analysis models. In this paper, a data visualization framework is developed to cater for both needs. It visualizes students' learning trajectories through all chapters in a 2D plot, which gives an intuitive representation of their learning state transition.

Supervisor:       YEUNG Dit Yan/ CSE
Student:           WANG Ziyu / COSC                    Course:           UROP1100, Fall

The growing popularity of online courses has been continuously attracting research interests in developing the E-Learning Platforms. Recently, most platforms provide identical service for all students, regardless of the difficulties they may encounter during study. As a result, many students give up and cannot pass the course they enrolled. Personalized E-Learning Platforms, which provide particular aids for students based on their performances, aim at improving their learning motivation and efficiency. This report will focus on student performance prediction on Open edX platform. The features reflecting students' activeness will be extracted continuously throughout the entire semester. Thus, a recurrent neural network with Long short-term memory (LSTM) cells is considered as a suitable prediction model for this project.

### Machine Learning for Modeling Student Behavior on e-Learning Platforms

Supervisor:       YEUNG Dit Yan/ CSE
Student:           LU Xiuyuan / COMP                    Course:           UROP1100, Summer

With the development and popularity of computer and internet, e-learning platforms have greatly affected today's education pattern, which can be treated as a revolution in the education area. Students can study at home conveniently with the help of such platforms. However, studying at home means that there will be no teacher helping them and students can only go through the same materials by themselves and do some practice which greatly limits the outcome. To provide students with some personalized education in accordance with their own study pattern, we need to reconstruct their thinking process and offer personalized education to them. But because of the lack of teachers, we can only restore students' thinking process based on their action on the computer. This project focuses on designing distance formula between students' event sequences and clustering students into different groups.

### Machine Learning for Building AI Teaching Assistants

Supervisor:       YEUNG Dit Yan/ CSE
Student:           YANG Handi / CPEG-HR                 Course:           UROP1000, Summer

For the task of building a robust AI teaching assistant, effective algorithms that automatically recognize a duplicate question from the question bank have a crucial role to play in labour saving. In this report, several state-of-the-art approaches to the duplicate question identification are presented and analysed. Starting from BoW model that doesn't care about word orders, inverse term frequency helps raise its performance a lot. Then the best result from the Siamese architecture, test accuracy of 0.8687, is achieved by the bidirectional GRU with attention mechanism. A non-Siamese approach that enables sentence interaction in the forward phase is also tested with CNN and gets an accuracy of 0.8132. Possible future explorations are discussed in the end.

Supervisor:       YEUNG Dit Yan/ CSE
Student:           YANG Hsuan-ru / COMP                 Course:           UROP1100, Summer

In this paper, we explore methods of determining semantic equivalence between pairs of questions, with a dataset released by Quora. A deep learning approach that uses a Siamese GRU neural network connected to a distance measure layer to determine the semantic equivalence is used in this paper. Variations of the network are explored to improve network performance. Applying an adapted attention mechanism on the GRU network has been found to improve model performance significantly. The effectiveness of several regularization techniques on the GRU cells are evaluated, improving the model performance close to the state-of-art level.

Supervisor:     YEUNG Dit Yan/ CSE
Student:        ZHANG Lin / COSC                 Course:        UROP1100, Summer

The goal of this project is to build an AI TA which can answer questions already having duplicate pairs and corresponding answers in our database. Therefore, how to detect duplicate questions accurately has been a major problem. In this report, we first introduce our baseline method, the vanilla GRU model, to detect duplicate questions. We then propose and analyze several methods to improve the accuracy. They ca be divided into two categories: Improving the model, including using deeper neural network, LSTM networks, Convolutional neural networks, adding POS tags; Or creating augmented dataset, especially applying Variational Auto Encoder (VAE) to generating duplicate questions. Finally, we will discuss the possible future development.

# Department of Electronic & Computer Engineering

## Nanomaterial-based Novel Solar Cells

Supervisor:      FAN Zhiyong / ECE
Student:          CHAN Teresa / BIBU          Course:          UROP1100, Fall

Anodic aluminum oxide membranes gain attention over the past few decades, due to its various applications to different fields by the utilization of diverse nanostructure types. More specifically, its application to photovoltaics as a template for nanowire membrane production is of interest, enhancing efficiencies of the p-n junction activity by an increase in surface area. In this experiment, I explored the conditions for the formation of nanowells with pore size of 250-400 nm, a template form for the nanowire membrane of desire, as well as discuss the further plans for the fabrication of perovskite nanowire solar cells. It was confirmed that the fabrication of AAO with self-ordered nanowells requires delicate control on anodization time, voltage control, and choice of electrolytes, and skillful manipulation on parameters during 2nd anodization are vital in producing desirable nanowell arrangement.

## Semiconductor Nanowire-based Sensors and Electronics

Supervisor:      FAN Zhiyong / ECE
Student:          JEON Sang Hyun / ELEC        Course:          UROP1000, Summer

I first encountered with the impact of memory devices in our modern society. As the importance of artificial intelligence / computer vision / machine learning rapidly increases, the number and speed of computing also becomes greatly important. Thus, it is crucial that hardware memory devices are ready for the speed of these rapidly growing technologies. Without enough or suitable hardware devices, all the research on software cannot be efficiently used. Researching on this area can be challenging as improving efficiency or lowering the cost of production are not easy. I believe one way to improve these are by using smaller materials such as semiconductor nanowires. This is because, electronic devices can be potentially made smaller and consume less power with nanomaterials.

## A Robot Tour Guide - Part II

Supervisor:      LIU Ming / ECE          Co-Supervisor:      SHI Bertram Emil / ECE
Student:          LIN Yuanqiao / ELEC          Course:          UROP1100, Fall

In developing robotic guides, one major factor to consider is to detect and avoid obstacles. Traditional lidar sensor gives a comprehensive understanding of the surrounding environment, with only one major drawback which is indoor glass wall detection. In this project, we tried to solve this problem by adding another ultrasound sensor that could accurately detect glass walls and fusing the map generated by each sensor. Using ROS and gmapping package, one feasible solution is to modify the message 'sensor_msgs/LaserScan' to obtain fused map of one rplidar and one HCSR04 ultrasound sensor. Details of sensor placement and map accuracy need to be further determined.

## A Low-cost Single-wavelength Semiconductor Laser Source Using a Laser Pointer

Supervisor:      POON Andrew Wing On / ECE
Student:          HUI Yat Nga / SENG         Course:          UROP1000, Summer

It is desirable to have a single-wavelength narrowband optical source for high-data-rate optical communications, but this kind of light source are very expensive. A general laser pointer can only emit multiple wavelengths within a spectral band typically. It is hoped to develop that single-wavelength narrowband optical source by engineering a multiple-wavelength semiconductor laser chip from a laser pointer and combine the light into an external cavity through this project. We try different combinations of cavity thickness, tilted angles, feedback strength and voltage and want to find a combination that giving out a spectrum close to a single-wavelength narrowband optical source. It is aimed to give a stable single-wavelength laser source with low cost by the resulting system.

## Autonomous Driving Using Deep Learning

Supervisor:        SHEN Shaojie / ECE
Student:        DEL MUNDO Gian Miguel Sero / COMP        Course:        UROP1100, Spring

Autonomous driving has recently become a hot topic in computer science, but state-of-the-art approaches have not been able to account for non-deterministic scenarios, semantic information, interactions with other agents such as pedestrians, or long-term possibilities. The project explores a proposal by Lee et al. called the Deep Stochastic IOC RNN Encoderdecoder network (DESIRE) to overcome the aforementioned limitations. It consists of two modules, namely the Sample Generation Module (SGM) and the Ranking & Refinement Module (RRM). The SGM produces a diverse set of future trajectory predictions based on the past trajectory of the car, and the RRM scores these predictions based on semantic information retrieved by a convolution neural network (CNN) as well as interactions with other agents

Supervisor:        SHEN Shaojie / ECE
Student:        YANG Handi / CPEG        Course:        UROP1100, Spring

To derive the optimal strategic long-term future prediction in driving behavior, a rich pool of potential samples is the foundation for later ranking and refinement. Based on the paper, "DESIRE: Distant Future Prediction in Dynamic Scenes with Interacting Agents", we reproduce the Diverse Sample Generation Module which accounts for past motion histories on the task of autonomous driving. To tackle the uncertain nature of prediction, a Conditional Variational Auto-encoder (CVAE) is adopted to produce a set of hypothetic paths with introduction of a latent variable. Results of plausible trajectories are compared with the ground truth and baseline methods to evaluate the performance.

## Robust Monocular Visual-inertial Localization and Mapping

Supervisor:        SHEN Shaojie / ECE
Student:        ZHANG Yu / CPEG        Course:        UROP1100, Spring
                                                                UROP2100, Summer

This report briefly summarizes the work done on the UROP project entitled "Robust monocular visual-inertial localization and mapping" under Professor Shen Shaojie in Summer 2018. Most of the work was done on the subproject named mockaswarm which was an all-in-one system for simulation, visualization and control of a swarm of quadrotor drones.  In order to simulate the missions inside the system, a map generation module was improved which includes optimizing the map by removing excess points in order to reduce map data size, generation of a random 2D maze with variable size and generation of a random 3D maze with variable size, cell number and connectivity.

## A Robot Tour Guide

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| Supervisor: | SHI Bertram Emil / ECE | Co-Supervisor: | LIU Ming / ECE |
| Student: | NARAYANA SWAMY Thomas Rohit / IIM | Course: | UROP1100, Summer |

This paper is a continuation and further development on the previous Robot tour guide project for the Electronic and Computer Engineering Department at the Hong Kong University of Science and Technology. The focus of this paper is on the integration work and new implementation techniques to further improve the reliability of the system and also get everything working together as one system. The following paper compares a wide range of ROS SLAM packages such as Gmapping and Google Cartographer. The other focus of this paper will be on the integration technique of the various components of this robot tour guide project such as the user localization based on the Wi-Fi localization method implemented and posting the users location to the robot directly. Furthermore developing the on bot table app that allows the user to post desired destinations directly to the robot system, which returns a real time map navigation for the user to look at.

## Fleet Formation Control

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| Supervisor: | SHI Ling / ECE | | |
| Student: | CHEN Yifei / ELEC | Course: | UROP1100, Summer |
| | CHEN Zhuo / CPEG | | UROP1100, Summer |
| | DU Donghong / ELEC | | UROP1100, Summer |
| | LYU Shengrui / ELEC | | UROP1100, Summer |

Our goal is to realize the fleet formation control in our FYP, which entails the technique of designing a rational path for individual boat, analyzing the path and realizing the relevant control on the boats and finally letting the group of ships 'interact' in effective way and adjust their path to make the whole transportation system work properly. The whole project will be divided into 3 milestones: individual path planning, eschewing obstacle during the path and finally the fleet formation controlling. For our UROP project, and main endeavor will be placed in the first part.

## Robot Maze

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| Supervisor: | SHI Ling / ECE | | |
| Student: | XU Xinyuan / SENG | Course: | UROP1100, Summer |

The project is to generate a random maze each time, using searching and AI algorithm to solve it and finally integrating the algorithm to the real-world robot so that it can solve a real-world maze. The robot only knows the location where it started and where the exit is. It needs to explore the maze, remember it and finally find a way from the origin to the destination. Equipped with some basic AI algorithm, it can find the optimal way to solve the maze at the second time after exploring at the first time. The integration of algorithm and robot is still in progress.

## Indoor Autonomous Driving Robots

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| Supervisor: | SONG Shenghui / ECE | | |
| Student: | CHENG Tim Ta-ying / CPEG | Course: | UROP1100, Spring |

This report aims to identify the process of using machine learning models to explore patterns and compare with traditional models to investigate the effectiveness. The exploration can be separated into two aspects: Applying linear regression model on pressure sensor values to determine a person's position on the mattress and using neural network

to determine a robot's position through wifi data. In the first exploration, it is discovered that the traditional mean and variance model of the weight distribution provides a higher accuracy than applying linear regressions in the situation. The second exploration implied that machine learning can be very effective in determining the position of the car within an acceptable range of error with limited data.

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| Supervisor: | SONG Shenghui / ECE | | |
| Student: | DONG Tian / ELEC | Course: | UROP1100, Fall |
| | LUK Wing / ELEC | | UROP1100, Fall |
| | JIN Menghe / ELEC | | UROP2100, Fall |

In the recent years, autonomous driving is becoming the main trend in the market and is applied to more and more areas. In autonomous driving, sensor is an indispensable component to extract the information from the surrounding environment. In this project, we try to enhance the existing sensor system of the Kobuki turtlebot and make it possible to detect the transparent objects. We did several experiments based on the result we got in the summer UROP and understood more about the sensor. However, at this stage, the problem of sensor accuracy and sensor frequency still need further improvement.

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| Supervisor: | SONG Shenghui / ECE | | |
| Student: | KANG Yanming / COMP | Course: | UROP1100, Summer |
| | WAN Yuxuan / SENG | | UROP1000, Summer |

This project is aimed to use machine learning to discover the minimum time needed for a robot car to travel one lap on a certain track. We use the Arduino Uno chip to guide the car and to set the speed, as well as to collect the data. We use Tensorflow (an open-source machine learning library) to process the data. The task is split into two parts. First, a model is trained to predict whether a given set of speed will make the car go out of the track. Second, another model is trained to predict the travel time and find the shortest time without leaving the track.

### Fabrication and Characterization of a 2000-Atmosphere Pressure Sensor

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| Supervisor: | WONG Man / ECE | | |
| Student: | TANG Zili / ELEC | Course: | UROP1100, Fall |
| | | | UROP2100, Spring |
| | | | UROP3100, Summer |

Many current applications, ranging from oil drilling down the ocean to vehicles on the road, require precise measurement of high pressure. Therefore pressure sensors that can perform under high pressure and harsh environment are a popular research topic. The high pressure sensor that I am working on is a tiny bulk-type device made of n-type silicon that includes a device part and a cap part. There are piezoresistors on the pressure sensor device part whose resistance will change under different hydrostatic pressure loads, resulting in different voltage outputs that indicate pressure. Finite element simulations of the sensor will be presented below.

### Nanofluidic Chips for Biomedical Applications

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| Supervisor: | YOBAS Levent / ECE | | |
| Student: | LEUNG Ziuwin / BIOT | Course: | UROP1100, Spring |

We investigated microfluidic devices with nanostructures that promotes EDL overlapping, leading the ICP phenomenon, and hence the generation of perm-selective membrane for counterions. This device rectifies current like that of a diode and hence termed nanodiode. In this project, we looked into the application of nanostructures (eg. nanoslits and nanopores) for diagnostics of cardiac diseases through the detection of Troponin T protein concentrations in blood. We investigated parameters, such as pH, buffer electrolyte concentrations, nanostructure geometry and electrode system for accurate measurements, to better understand the I-V curve characteristics from its limiting and over limiting phase. Besides its application in diagnostics, this device hasshown promising molecular enrichment capabilities which could be useful in various bioanalysis microsystems owing to its simplicity, performance, robustness, and potential in integrability, resulting in a multiplexed device.

Supervisor: YOBAS Levent / ECE
Student: QIAN Shiyi / ELEC          Course:          UROP1100, Summer

In the recent years, bio-sensing technology has been used in the detection of biological molecules as a sensitive, label free and electrical tool. Many conventional bio-sensing techniques such as enzyme-linked immunosorbent assay (ELISA), microcantilevers, and surface plasmon resonance (SPR) can almost fulfill the demand of identification of specific biomarkers. However, these techniques have problems of either a relatively lower sensitivity or a slower processing speed. Those flaws of these techniques limit the applications of bio-sensing to realize an ideal point-of-care (POC) devices in diseases diagnostics. In this article, we will introduce a highly sensitive integrated nanofluidic diode which can detect and quantify biological molecules rapidly using a unique nanofluidic diode structure.

# Department of Industrial Engineering and Decision Analytics

## Quality Control via Vision System

Supervisor:     TSUNG Fugee / IEDA
Student:     LIN Chuan-en / COMP     Course:     UROP1100, Spring

This research project presents a crack identification methodology. With deployment of high definition cameras on hangers and drones, a building's exterior surface may be captured and stored as a series of image frames. The frames are then converted to grayscale by utilizing morphological image processing techniques and thresholding operations. Using edge detection and object classification algorithms, we overlay the frames with guiding points of possible crack locations and allow expert users to select the valid cracks manually for use as the dataset of correct images to build our learning model. By applying transfer learning to Google's Inception CNN, we can build a customized classifier for identifying cracks.

# Department of Integrative Systems and Design

### Synthetic Tactile Sensing For Prosthetic Fingers

Supervisor:      LEUNG Suk Wai Winnie / ISD
Student:          WONG Tat Hang / CPEG        Course:        UROP1000, Summer

This project is part of Project SPARTHAN1, started by students in HKUST and Politecnico di Milano, aimed at providing affordable 3D printed myoelectric prostheses to amputees. Project SPARTHAN has designed a mechanical hand, control electronics and myoelectric signal processing algorithms. To continue developing this project, an artificial fingertip with synthetic tactile sensing was needed to allow amputees to feel with their prosthetic fingers and to enable prosthetic fingers to grab delicate objects using tactile feedback. This design report documents the process of manufacturing a low-cost (22 HKD), lightweight (3g), waterproof and 3D printed fingertip capable of sensing temperature and applied forces up to 200N.

# Department of Mechanical & Aerospace Engineering

### Resuspension of Aerosols from Building Surfaces

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| Supervisor: | CHAO Yu Hang Christopher / MAE | | |
| Student: | JEYAKUMAR Aadhithya Vignesh / MAE | Course: | UROP1100, Fall |

The UROP study is led by Professor CHAO Yu Hang Christopher. The resuspension phenomenon of an aerosol from different building surfaces was studied. It is of relevance because the resuspension phenomenon is of concern in various processes such as disease transmission, contamination during manufacturing of microelectronics, surface decontamination and filtration. This project aims to study the effects of different surface roughness of the plastic PMMA substrate on the resuspension behaviors of the liquid droplets. The liquid droplets used were glycerol. The substrate used was poly(methyl methacrylate) (PMMA). Different surface roughness was achieved by sanding process. The centrifuge method was employed.

### Proton Sensing Electrodes for Electrochemical DNA Sequencing

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| Supervisor: | CHEN Qing / MAE | | |
| Student: | WANG Zhien / CHEM | Course: | UROP1100, Fall |

Among the newly-developed DNA sequencing technology, electrochemical DNA sequencing stands out for its high efficiency and low cost. Using direct electrical detection of pH changes during DNA synthesis, the sensitivity and stability of pH sensing electrode is closely related to the accuracy. In our experiments, the transparent conducting oxide, Indium tin oxide $(ITO)_2$ is used as the pH-sensing electrode. Its high transmittance in visible light region and high electrical conductivity promise the potential implementation in DNA sequencing. We investigated the stability and proton sensitivity of an ITO electrode is investigated. The result shows an approximate linear relationship between pH and voltage in basic solutions but low stability of ITO in acidic environment. We will discuss a possible explanation of instability and propose methods to improve it at the end of this report.

### Design of Optical Encryption Device by Objective Structure and Twisted Light

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| Supervisor: | CHEN Sherry / MAE | Co-Supervisor: | DU Shengwang / PHYS |
| Student: | LI Bohan / PHYS-IRE | Course: | UROP1100, Summer |

Twisted light is defined to be a form of EM field that exhibit a diffraction free property, which is also known as Bessel beam. Twisted light as a rigorous expression of Bessel beam consists of two Bessel functions of different order and with left-circular and right-circular polarization; it could be considered as a sum of those two independent Bessel beams. We divide a spatial light modulator into two regions and use each of them to generate an independent Bessel beam. Two beams are combined together through optical alignment and switch to left and right circular polarization using a quarter wave plate.

### Design of Energy Conversion Device from Heat to Electricity

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| Supervisor: | CHEN Sherry / MAE | | |
| Student: | SUEN Ho Yuen Henry / MAE | Course: | UROP1100, Summer |

This process report is aim to report the process of design a tool to characterize the migration in phase transformation temperature of single crystal ferroelectric materials under electric field (differential scanning calorimetry (DSC)) and the learning outcomes of this summer through UROP 1100. The design of the DSC involved mature engineering design, machining and electric microcontroller. Skills required are Solidworks, milling machine, LabVIEW and microcontroller (Arduino). This device is significant for future characterization of ferroelectric materials. Select the proper ferroelectric materials to build energy conversion device from heat to electricity.

## Development of Innovative Na-ion Batteries

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| Supervisor: | CIUCCI Francesco / MAE | | |
| Student: | FONG Wai Ting / SENG | Course: | UROP1100, Summer |
| | YU Tsz Tat / SENG | | UROP1000, Summer |

Batteries are essential to everyday convenience, one of the most common (types of) batteries is Lithium battery; lightweight, compact, yet easily shaped and thus very useful. However, the safety issue that it brings had be more noticeable as they are more utilized, causing economic loss and had risen concerns. Worst still, the supply of lithium is also doubtful due to the wars and the geographic reasons. Considering that the battery usage will be increasing, and that evolving sustainable energy system would require a lot of batteries, scientists and engineers; there is a need to develop a novel, safe, Na-ion batteries. Sodium was selected because of the similar chemical properties and great abundance. Encouraging results were saw at different test.

## Multidimensional Modeling of Nanoionics

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| Supervisor: | CIUCCI Francesco / MAE | | |
| Student: | SIT Chun Yat / CENG | Course: | UROP1100, Spring |

This Research Aims to study and understand battery modelling by the use of electrochemical impedance Spectrometry (EIS) and its modelling method, an in-situ method to predict and monitor the performance of battery while the battery is still in operation (in operando). EIS is a useful, non-complicated and non-destructive technique to evaluate the porous material/electrode behavior in terms of impedance from experimental data and allow to separate bulk and interfaces process. However, without a model with physically meaningful parameters defined, it is difficult to analyse the EIS data in order to characterize the porous material. Therefore, the modelling to interpret the EIS Data arouse the interest of the researchers. TLS and DDT are two existing models for EIS data analysis, but the two models has its limitation and inaccuracy, which lead to the necessity of developing a new model to analysis the EIS data.

## Solid-State Supercapacitor

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| Supervisor: | HUANG Baoling / MAE | | |
| Student: | MUK Lai Kan / MAE | Course: | UROP1100, Fall |

Two symmetric flexible solid-state capacitors made up of CNT-GO active material coated graphite paper and solid PVDF-co-HFP electrolyte soaked with Lithium salt were fabricated with "as-dried" electrolyte and "wet-coating" additive electrolyte respectively. Cycle Voltammetry and Galvanostatic Tests were conducted on both samples to compare the effectiveness of such "wet-coating" technique. It was found that the electrolyte solution addition to the electrodes before assembling the electrodes and electrolyte film can facilitate the interfacial contact between the active material and electrolyte, and thus better utilize the active materials micro pores to achieve a higher specific capacitance of 210 F/g at current density of 2.0 A/g, and have a higher capacitance performance under bending.

### Fly-over Noise Measurement on Campus

Supervisor:      HUANG Xun / MAE
Student:        LEUNG Kai Lok / MAE        Course:        UROP1100, Spring

The aircraft noise is usually regarded as one of the major environmental impact of the aviation industry. A large numbers of research have been conducted in the aeroacoustics area to study the aircraft noise in term of decibel metric (dB), while a few numbers of research focus on the acoustic feature of aircraft noise. Regarding to the niche, this research aims to use a machine learning approach to study the acoustic feature of aircraft noise. At first, sufficient numbers of labeled aircraft noise sample will be collected and will be analyzed with mel frequency cepstral coefficients (MFCCs) analysis to extract its corresponding acoustic features. After the preliminary analysis and pre-processing, these labeled samples and their corresponding normalized MFCCs spectrum will be used to train and build up neural networks. The trained neural networks is expected to be able to summarize the acoustic features of aircraft noise and be able to distinguish the noise produced by the corresponding aircraft.

### Development of Low-cost Smartphone-based Microscope for Global Health

Supervisor:      LEE Yi-Kuen / MAE
Student:        CHAU Long Hei / MAE        Course:        UROP1100, Summer

As the use of smartphone-related electronics becomes more popular, the cost for acquiring such tools becomes lower and the quality of images captured improves significantly. This could benefit the development of low-cost smartphone-based microscope, and in turn improve the health care in resource-poor environments by providing diagnosis of diseases such as malaria and tuberculosis. Three mobile phone microscopes were reviewed in the report, as well as a student-designed fluorescence microscope prototype. The background and physical structures of each design were studied. The student-designed prototype was then evaluated according to its cost and portability, as compared to the aforementioned designs.

### Robot-Assisted Biomedical Experiments to Speed Up Low-Cost Cancer Diagnosis: Hardware Track

Supervisor:      LEE Yi-Kuen / MAE
Student:        KIM Eunyoung / MAE        Course:        UROP1100, Fall

Metastasis, as a major cause of death for cancer patients, can be detected with CTC chip blood analysis. To provide an inexpensive and relatively fast cancer diagnosis system, this paper presents modified designs for syringe and syringe pump cages of a robotic automation to conduct the cancer diagnosis. With implementation of a hybrid linear actuator for a syringe pump mechanism, the vertically oriented opening with slider locking mechanism were applied for the ABS based cage design.

### Low-cost Wireless Arduino-based Micro Energy Sensor for Smart Energy-Efficient Buildings in the era of Internet of Things

Supervisor:      LEE Yi-Kuen / MAE
Student:        LUO Yijun / MAE        Course:        UROP1100, Fall

Robots have been improving people's daily life and been making considerable contributions to scientific research, especially making the exploration of places, which is difficult or even impossible for human-being to go, possible, the ocean, whose vastness implies the uncertainty of research work in it, for instance. Hence, the portable maritime robot is

in strong need, with which, the difficulty of marine research can be surmounted. This UROP requires to build an open-source and modular underwater robot which can autonomously navigate.

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| Supervisor: | LEE Yi-Kuen / MAE | | |
| Student: | WICAKSANA Jeffry / ELEC | Course: | UROP2100, Fall |

Control of HVAC (heating, ventilation, and air conditioning) takes up around 40% of total energy consumption in United States, which costs around $40Billion every year. By utilizing a smart-automated energy efficient building approach, up to 28% of the consumption can be reduced and thus lead to a higher rate of energy conservation. In order to do so, an automated data collecting device of both temperature, humidity, and air flow of an environment has to be designed. This research project will focus on developing the data collecting device using commercial products. Data collected will then be integrated into enthalpy or energy contained in the room. All of this can be easily accessed through cloud system which will be updated every minute.

### Helical Modes in a Hydrodynamically Self-excited Jet

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| Supervisor: | LI Larry / MAE | | |
| Student: | CHOW Ka Kin Kenny / MAE | Course: | UROP1100, Spring |

Compared with the more conventional bi-wing configuration, a tandem-airfoil configuration, with one airfoil at the front and one at the back, can offer improved aerodynamic performance, but only if the stagger and gap distances are appropriately chosen. Furthermore, the lift generated by the two airfoils would be farther apart along the longitudinal axis, resulting in improved stability and control. In this project, the design principles, merits, drawbacks and state-of-the-art knowledge of the tandem-airfoil configuration have been examined, with a view towards developing a new design framework by which tandem-airfoils can be optimized for use in the next generation of micro aerial vehicles (MAVs). Various diagnostic methods, ranging from direct force measurements to particle image velocimetry, were explored under different operating conditions, including when the airfoil is stationary, plunging or pitching – or a combination of the three. An extensive database was constructed to record the aerodynamic conditions explored in previous experiments and numerical simulations, laying the foundation for a future feasibility study and prototype development of a tandem-airfoil MAV.

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| Supervisor: | LI Larry / MAE | | |
| Student: | HUI Wai Mong / MAE | Course: | UROP1100, Spring |

Low-density jets are known to exhibit global instability in the form of self-excited axisymmetric oscillations, but the presence of self-excited helical oscillations are still unknown. The conditions of the emergence of these global oscillations in low-density axisymmetric jets and the boundary of absolute-convective instability are examined in this project. The jet-to-ambient density ratio (S = $\rho_j/\rho_\infty$), momentum thickness ($D/\theta_0$), and Reynolds number are the key parameters affecting the onset of global hydrodynamic modes in axisymmetric jets. By studying the concepts behind the self-excited axisymmetric oscillations, it is possible to advance further experiments to search for the existence of helical modes. Such global hydrodynamic instabilities can be used in industrial and environmental applications such as aircraft engines and pollutant dispersion in the future.

Supervisor:  LI Larry / MAE
Student:  KIMISHIMA Hiromi / MAE  Course:  UROP1100, Spring

Compared with the more conventional bi-wing configuration, a tandem-airfoil configuration, with one airfoil at the front and one at the back, can offer improved aerodynamic performance, but only if the stagger and gap distances are appropriately chosen. Furthermore, the lift generated by the two airfoils would be farther apart along the longitudinal axis, resulting in improved stability and control. In this project, the design principles, merits, drawbacks and state-of-the-art knowledge of the tandem-airfoil configuration have been examined, with a view towards developing a new design framework by which tandem-airfoils can be optimized for use in the next generation of micro aerial vehicles (MAVs). Various diagnostic methods, ranging from direct force measurements to particle image velocimetry, were explored under different operating conditions, including when the airfoil is stationary, plunging or pitching – or a combination of the three. An extensive database was constructed to record the aerodynamic conditions explored in previous experiments and numerical simulations, laying the foundation for a future feasibility study and prototype development of a tandem-airfoil MAV.

### Forced Synchronization of a Capillary Jet for 3D Printing Optimization

Supervisor:  LI Larry / MAE
Student:  FAN Zhiyuan / MAE  Course:  UROP1100, Fall

To better understand the physical process of droplet formation, the mean formation frequency of water droplets from a capillary tube is examined over a wide range of flow rates (Q) and nozzle diameters (D). The mean formation frequency is found to be predictable within a broad range of Bond numbers (G), i.e. a broad range of tube diameters, and Reynolds number (Re)/Weber number (We) from virtually zero to pure jetting. A universal scaling is proposed to predict the natural frequency of droplet formation, based on the Strouhal number (St), G, Re and We. It is found that for pure water, i.e. for a small subset of Ohnesorge numbers ($0.0030 < Oh < 0.0052$), the mean droplet formation frequency is well predicted by the proposed scaling.

### Universal Scaling Laws for Droplet Formation in Capillary Jets

Supervisor:  LI Larry / MAE
Student:  FAN Zhiyuan /AERO  Course:  UROP1100, Spring
  PARK Jungjin / MAE    UROP1100, Spring

The natural frequency of droplet formation from a capillary jet of water is examined over a wide range of flow rates (Q) and nozzle diameters (D). The mean natural frequency is found to follow a universal scaling relationship within a wide range of Bond numbers (G), Reynolds numbers (Re) and Weber numbers (We) – from very low flow rates to pure jetting. The scaling relationship contains the Strouhal number (St) and G with Re and We corrected by G. The proposed scaling is benchmarked against existing literature, and shows potential to be robust in a variety of flow configurations.

Supervisor:  LI Larry / MAE
Student:  WU Sen / AERO  Course:  UROP1000, Summer

A theoretical study of the incompressible aerodynamics of soft morphing wings has been carried out in this summer UROP project. In contrast to mainstream computational and experimental studies of bio-inspired soft morphing wings, this project aims to identify general solutions of the acceleration profile of the material points of soft morphing wings, with boundary conditions defined by membrane and wing roots. A simple theoretical problem with direct physical

relevance has been defined. Solving this foundational problem can help solve other problems defined by more complicated wing configurations, such as the aerodynamics of cloth-based wingsuits.

## Forced synchronization of a low-density jet

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| Supervisor: | LI Larry / MAE | | |
| Student: | REN Da Wei David / PHYS | Course: | UROP1100, Fall |

Low-density jets are a canonical model of fuel injector flows within aircraft and rocket engines. It is well known that low-density jets can exhibit global instability in the form of self-excited axisymmetric oscillations. It is less well known, however, that such jets can also exhibit global instability in the form of self-excited helical oscillations. The existence of such helical modes has been predicted before in the local linear spatiotemporal stability analysis of Coenen, Sevilla, and Sanchez for long circular injectors with thick shear layers, but they have yet to be found in experiments. We report experimental evidence that low-density jets can exhibit global helical modes. We characterize the dynamics of the jet with time-resolved Schlieren imaging and quantify the departure from axisymmetry with the phase angle between diametrically opposite shear layers. On decreasing the non-dimensional injector length $L-1$ $t = (Re\ a)/lt$ (where Re is the jet Reynolds number, a is the jet radius, and lt is the injector length), we find that global instability switches from an axisymmetric mode to a helical mode, with the latter being weaker than the former. This shows that it is possible to create self-excited helical modes in laboratory low-density jets, provided that the shear layer at the nozzle exit is sufficiently thick. Realisation of helical modes within combustion chambers may yield more homogeneous fuel-air mixing and more turbulent flow. This may improve the environmental-friendliness, safety, and noise of combustion devices.

## Designing Novel Efficient and Quiet Amphibious Aircraft for General Aviation

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| Supervisor: | LIEM Rhea Patricia / MAE | Co-Supervisor: | ZHANG Xin / MAE |
| Student: | HUI Wai Mong / AERO | Course: | UROP1100, Fall |
| | LEUNG Kai Lok / MAE | | UROP1100, Fall |

The aviation industry is expected to continuously grow in the coming decades, especially in rapid developing economies like Asia. However, some places, like islands, are often inaccessible through existing conventional aircraft. The constructions of airport in urban areas are also limited due to insufficient lands, where the infrastructures of rural areas are not well-developed. Thus, some research and development efforts have been focused on designing amphibious aircraft, which can take off and land on ground and on water surface. In this project, a group of final year students are going to develop, build and fly a model-size amphibious aircraft. A reference model, ICON A5, will be used as the template and different improvements, including ducted propeller and morphing wing designs, will be implemented to the model and tested for their effectiveness. In this work, the efficiency of thrust generation in ducted propeller and the airfoil shape of morphing wing are studied. Experimental results of ducted propeller and the comparison result of airfoil shapes of morphing wing are summarized and evaluated to aid the design of the amphibious aircraft model.

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| Supervisor: | LIEM Rhea Patricia / MAE | Co-Supervisor: | ZHANG Xin / MAE |
| Student: | HUNG Kin Ting Ken / AERO | Course: | UROP1100, Spring |

This project explores different designs for amphibious aircraft which is designated for areas which are previously not accessible by traditional aircraft. In particular, this report focuses on the relationship between the presence of hydrofoil and the take-off performance in water. Using CLARK-Y as a model of the hydrofoil for the amphibious aircraft, Computational Fluid Dynamics (CFD) simulations are carried out to find out the lift coefficient and the drag coefficient of

the hydrofoil, as a consequence of buoyant effect, hydrostatic pressure and cavitation effect. The characteristics of the lift and drag coefficient will be discussed in this report.

## Design of a Remote Control Vehicle

Supervisor:     MA Lok Wang / MAE
Student:        LIU Jun Bang Adrian / SENG          Course:        UROP1000, Summer

This research project aims to contribute to the IMechE HK Branch Greater China Design Competition 2018-2019 -- 8th GCDC Energy Relay. A team will be led by Dr. Robin MA to represent HKUST and join the competition in March 2019. Our team is required to design and manufacture 4 autonomous vehicles to run a relay race with different energy sources. At this very early stage of the preparation for the competition, I am going to explore the rules and regulations of the competition, feasibility of different energy sources, and possible designs in this progress report. It is hoped that this study can be used as a reference for future works towards the competition.

## Metallic 3D Printing with Ultrasonic Excitation

Supervisor:     MA Lok Wang / MAE
Student:        YAU Wing Ting / SENG          Course:        UROP1000, Summer

The aim of metallic 3D printing with Ultrasonic Excitation is to produce parts with higher mechanical properties (like hardness, Young modulus) and reduce cost at the same time. To examine the mechanical properties of the samples (with and without ultrasonic excitation), polishing and nanoindentation have been carried out. This report would demonstrated different techniques that polishing samples and performing nanoindentation required, followed by preliminary data obtained from nanoindentation testing indicating hardness and Young modulus of metallic 3D printed sample with and without Ultrasonic Excitation. Repetition of nanoindentation are required in order to have conclusive result on the mechanical properties deviation from samples with or without Ultrasonic Excitation.

## Study of Flexible Wing Kinematics of a Free-Flying and/or Controlled-Flying Dragonfly

Supervisor:     QIU Huihe / MAE
Student:        HO Man Lee / AERO          Course:        UROP1100, Fall

This project is aimed to design a flexible flapping wing for micro air vehicles that can simulate the flight of a dragonfly. This is a progress report explaining the methodology of the design process and the stage we are right now. The study of the mechanical properties and structure of the dragonfly wing and the flight characteristic is the first step of the projects, and therefore experiments were set up to measure the properties of dragonfly wing and visualize the flapping pattern and air flow when dragonfly flapping. Then a simplified model of the dragonfly wing was used to imitate the wing of the dragonfly and this is the stage right now. After this, the wing will put to mimic the flapping pattern of actual dragonfly. Ultimately, a set of wings for the MAV to perform flight close to dragonfly is designed.

## Biomimetic Design of Flexible Flapping Wings for Micro Air Vehicles

Supervisor:     QIU Huihe / MAE
Student:        MAK Ho Yi Lydia / SSCI          Course:        UROP1000, Summer

The design of flapping-wing micro air vehicles (FMAVs) is greatly inspired by the flexible flapping wings of insects. In this study, biomimetic flapping wings are fabricated using dragonfly wings as reference. Velocity measurements and force measurements are used to analyse the performance of the wings. The flapping motion of the artificial wings is being observed using the Particle Image Velocimetry (PIV) system and high speed cameras. The changes in pitching angle, phase lag of the pitching angle relative to flapping angle at different flapping frequencies and amplitudes and the formation and deformation of vortices are studied. The results are compared against that of real dragonflies to identify the differences and further optimize the aerodynamics performance of the artificial wings.

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| Supervisor: | QIU Huihe / MAE | | |
| Student: | WONG Ki Wan / MAE | Course: | UROP1100, Fall |

Micro air vehicles (MAVs), conceptually limited to the size within about 15 cm can play vital role to dangerous site exploration, surveillance and in entertainment. Flapping flight locomotion is considered as best solution for indoor flight missions. Naturally bio inspired designs mimicking birds and insects are seen to provide solution to the challenge of building a versatile, robust and efficient MAV. As a prime subject of such concepts, dragonflies are widely studied. Here we focus on the dynamic shape deformation measurement of dragonfly wings an aspect that is a very important component of how to achieve superior flight agility by the insect as well as MAVs.

### Underwater Robot for Maritime Exploration

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| Supervisor: | SEO Jungwon / MAE | | |
| Student: | LUO Yijun / MAE | Course: | UROP1000, Summer |

Robots have been improving people's daily life and been making considerable contributions to scientific research, especially making the exploration of places, which is difficult or even impossible for human-being to go, possible, the ocean, whose vastness implies the uncertainty of research work in it, for instance. Hence, the portable maritime robot is in strong need, with which, the difficulty of marine research can be surmounted. This UROP requires to build an open-source and modular underwater robot which can autonomously navigate.

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| Supervisor: | SEO Jungwon / MAE | | |
| Student: | O Kit Long / MAE | Course: | UROP1100, Fall |

The Underwater Robot for Maritime Exploration project initiated by Zhuo Quan IM has been proceed for several semesters which the underwater robot was constructed and could move in different direction. In this semester, our team has improved the attitude control. After that, a few swimming pool tests were conducted to test the performance of the control system. Finally, we were working on constructing more spare robots for accelerating the data collection process. This report summarizes the new knowledge I have learnt in this UROP1100 course. This includes the application of PID control, electronics knowledges, software coding and robotics mathematics. It also presents the progress of the maritime exploration underwater robot project during Fall 2017 semester.

### Robotics Gripper Development for Warehouse Automation

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| Supervisor: | WANG Michael Yu / MAE | | |
| Student: | PANG Cho Hei / MAE | Course: | UROP1100, Spring |
| | | | UROP2100, Summer |
| | TANG Can-yao / MAE | Course: | UROP1100, Spring |

UROP2100, Summer

Gecko-inspired robotics gripper can operate on the most severe conditions due to its nature in adhesion application. Base on the development of Spring semester 2018, the aim of this project in this semester is to design and build an experiment platform, including the designing of overall installation of robotics gripper adhesion testing platform, the control of motor and the feedback from the force sensor, for the testament of robotics gripper. Due to the requirement of precision up-to micrometer movement, design and choice of the motor require more effort. A platform for testing the product and the control program for motor has been built near the end of this semester. The overall design of the platform and the data of the gecko-inspired gripper gleaned from the testament will be further discussed in the following section.

## Design of smart wearables for fall prevention of the elderly

Supervisor:    YANG Jinglei / MAE
Student:    TANG Yifei / ELEC    Course:    UROP1100, Fall

Falling of elderly is becoming a serious problem nowadays as it leads to great damages to the elderly, their family and also the government. A smart wearable which can prevent falling-caused damages may help to solve such a problem. This project mainly focuses on designing such a product from different aspects like availability, price, market needs and so on. After making investigations on the existing similar products, a simple model is designed and we are still progressing to optimze the design. Hopefully, we will continue this research project and may complete the design in the near future.

## Neural Nets for Mechanics

Supervisor:    YE Wenjing / MAE
Student:    JEYAKUMAR Aadhithya Vignesh / MAE    Course:    UROP1100, Spring

This UROP had the aim to apply machine learning techniques to accurately and quickly predict the mechanical properties of various designs of materials. The current targeted problem is the mechanical property prediction of meta materials. Meta materials are a new class of man-made materials of which the properties depend on the internal structure of their building blocks instead of their chemical constituents. Accurate and fast prediction of their properties is vital in the design of these materials. This project shall work on using a Variational Autoencoder (VAE) used for image reconstruction and generation, and a Convolutional Neural Network (CNN) for prediction of material properties given a certain design in an image.

## Stretchable LED Display Driver Circuit Design

Supervisor:    YU Hongyu / MAE
Student:    CHOW Pok Man / MAE    Course:    UROP1100, Spring

The research of flexible display for wearable devices, based on LED/OLED display has been carried out extensively in recent years. One idea of flexible LED display will be the concept of using origami-like designs incorporated into the LED matrix, to allow folding and shape-changing capacities. In this progress report of UROP 1100, a preliminary testing circuit based on passive drive, line scan methods, for the fabricated foldable LED display (size 16*16) is successfully developed, with good potential of cascading, to allow larger LED display being tested. Several future improvements have also being proposed.

**Improvement of the Noise Performance of a Ducted Fan for Quiet UAV Development**

| Supervisor: | ZHANG Xin / MAE | | |
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| Student: | CHEN Ruihong / MAE | Course: | UROP1100, Spring |
| | HUR Jun / MAE | | UROP1100, Spring |

Despite the rapid growth of the UAV industry, especially in the quadcopter-type drone section, the loud level of noise generated by the propellers, as well as safety hazards presented by the open propellers, hinder them from expanding their applications. This UROP project aims to investigate the use of a novel duct, that can be mounted over the propellers of drones in order to reduce the overall level of noise generated by these drones, as well as to increase safety. In this UROP, aerodynamic ducts with, and without sawtooth serrations have been designed, fabricated, and tested in an anechoic chamber. Further analysis of the experimental data shall determine the next step of the project.

Undergraduate Research Opportunities Program

Proceedings
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SCHOOL OF
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MANAGEMENT

# Department of Accounting

### Bank lending practices and human capital in the financial industry

Supervisor:     LI Xinlei / ACCT
Student:        CHAN Kwok Cheung Kelvin / ECOF          Course:          UROP1100, Spring

During the data collection process, our group has discovered that there is a relation between high-level manager and an MBA degree. Our further research revealed that companies' desire for employee that possess MBA has significantly increased during the past ten years. Seeing that employees in the US are willing to pay oodles of money to pursue an MBA degree, our project objective is to find out the factors which may affect the decision of an employee, whether to pursue an MBA or not. Our research used a regression analysis with four regressors (timetaken, DRD, Jobchange & Rank) to explain the rationale behind employees' decision. Our findings are: 1. all coefficients resulted in a correct sign with our hypothetical logics; 2. employees with business related Bachelor's degree are less likely to pursue an MBA; 3. 25% of the studied targets contain a Finance/Accounting related Bachelor degree; and 4. More experience person without being promoted are more likely to go for MBA programs. It is hoped that this study will act as a reference for employees who are considering to pursue an MBA degree for the purpose of getting a managerial title.

Supervisor:     LI Xinlei / ACCT
Student:        CHANG Jiacheng / MAEC          Course:          UROP1100, Summer
                LIANG Zexian / QFIN                             UROP1100, Summer
                TANG Zidan / ACCT                               UROP1100, Summer

In the professional world, choices made at the preparation or starting stage can pose a great influence on the whole career path and achievements. To study this influence, our research focuses on the relationship between the early-year experiences and promotion opportunities of people working in the finance field. The educational background and the entry-level job experience are used to represent the subject's early-year experiences; and the time the subject got promoted from his entry-level position to CFO is used to proxy the efficiency of promotion. Our results show that a finance/accounting-related college major can accelerate the speed of getting promoted to CFO; however, acquiring an entry-level job in finance-related positions or the combination of a finance/accounting-related college major and a finance-related entry-level job doesn't have a statistically significant impact on the improvement of promotion efficiency.

Supervisor:     LI Xinlei / ACCT
Student:        CHUAH Jin Yin / ACCT          Course:          UROP1100, Spring
                KUMAR Anish / GBUS                            UROP1100, Spring

We study the role of education as a catalyst of being successful in the finance industry. Specifically, we examine how does having a finance-related or business-related education background affect one's entry into the finance industry and how does such education background affect one's speed in achieving a higher position in the industry. In this study, we find that it is a more common pathway for non-business undergraduates to take MBA prior to joining the industry. We also find that averagely, those without a master degree obtain a higher position faster than those with a master degree. Further, among those master degree holders, those having non-business undergraduate degree achieve a higher post faster compared to those who did business undergraduate degree.

| Supervisor: | LI Xinlei / ACCT | | |
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| Student: | CONG Rong / QFIN | Course: | UROP1100, Spring |
| | YIN Yuhan / IS | | UROP1100, Spring |

This research is writing to discover the relationship between job promotion opportunities and prior working experience in financial industry. Promotion scheme is an important factor for financial institutions to retain valuable employees and effectively utilize human resource to accelerate future business development, when facing fierce competitions. Therefore, this report own practical value for business and individual as it describes the potential factors that may affect the promotion phases, which could be quantified as the year of the promotion they needed for certain position, and its significance on it. After studying the promotions process from more than 100 the actual experience of industry expertise, the results indicate that a few times of job-hopping, about once or twice, is beneficial for promotion speed while more times may turn to bad influence. Meanwhile, the job hopping has less significant impact on the promotion process in corporates comparing with financial industry. We also find that financial industry possess the characteristic of a relatively faster and standard promotion track. Overall, the results are consistent with the double-side effect between job-hopping frequency and promotion speed.

| Supervisor: | LI Xinlei / ACCT | | |
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| Student: | DIAO Liangke / ACCT | Course: | UROP1100, Spring |

We study the interaction between an advanced business degree and people's early career. Specifically, we examine how the attainment of a MBA degree affects people's choice on how long they stay in their first jobs. We find a tendency that the MBA degree affects the inertia (period people stay on their first jobs), with the group of MBA holders leaving their first positions quicker than the group without a MBA degree. This is consistent with the reasoning that MBA degree equips its holders with better knowledge and skill; thereby the degree empowers them to choose the next companies after the first ones more easily. We also find that the impact of MBA degree is present but different to the extent across banking and non-banking industries. This could be explained by the naturally tight relationship between banking industry and MBA degree. Overall, the results are consistent with the recognition in the job market and the bargaining power a MBA degree is supposed to bring to its holders.

| Supervisor: | LI Xinlei / ACCT | | |
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| Student: | DONG Yu / SBM | Course: | UROP1100, Summer |
| | LUNG Tsz Wah Kent / SBM | | UROP1100, Summer |

We investigate the role of educational level in employment opportunity in the financial industry. Specifically, we focus on subjects' educational background and examine its relationship with their competitiveness in the job market, their promotion speed within corporations and their accessibility to the first handsome errand. We find that top school non-business graduates have competitiveness in the financial industry nowadays. We also discover that the higher MBA ranking of the university, the faster its graduates to reach their first desirable job. This research not only owns practical value for financial institutions to gain a better understanding of human resources management (HRM) but also benefits job-hunters in terms of career planning.

| Supervisor: | LI Xinlei / ACCT | | |
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| Student: | LIU Xinyu / MAEC | Course: | UROP1100, Spring |
| | LO Chun Lum Jeffrey / ECOF | | UROP1100, Spring |

The intended research question is to identify the golden period in a successful banker's career. "Gold period" means the time period when the bankers can obtain big progress of their career, getting fast promotion or having chance to work in a more well-known company. By randomly choosing people working in banking industries, we collect their information in terms of their companies and positions, which defines their career achievement (occupation quality) together, in different periods. Consequently, the project focuses on the relationship between the subjects' years of experience and their corresponding "occupation quality" in their career span. The ultimate aim of the project is to compare the rate of upward movement in the job ladder for bankers.

# Department of Economics

## Anti-competitive behavior among firms and policy implications

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| Supervisor: | FONG Yuk Fai / ECON | | |
| Student: | FU Xiao / ECOF | Course: | UROP1100, Fall |

This report focuses on comparisons between the antitrust law enforcement on resale price maintenance (RPM) in U.S and China. The report starts with the introduction and comparison of the 3 main legal doctrines applied in law enforcement: Per se illegal rule, rule of reason and forbidden with exemption. Though typical case analysis, it further briefly analyzes the different factors the Courts took into account to evaluate economic effects of RPM in U.S. and China when they adopted different legal doctrines. By conducting general comparisons between the two countries through real case analysis, the report is aiming at providing useful information for transnational corporations who want to take RPM practice in U.S. and China. This report also gives a reference to future research on economic theories behind the law enforcement on RPM.

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| Supervisor: | FONG Yuk Fai / ECON | | |
| Student: | HUANG Silin / MAEC | Course: | UROP1100, Fall |

Built on the idea that high-end consumers tend to search less for a lower price, the passive searcher model (Professor Fong's Note) shows that in vertically differentiated markets, offering only the high-quality product with an absence of the low-quality product can facilitate price collusion. With the as-sumption that people with higher income are more likely to be passive searchers and purchase higher-quality goods, the model could be applied to explain price collusion among high-quality product com-panies. The objective of this project is twofold. First, it aims to investigate the plausibility of the pas-sive searcher model in explaining firms' practices. The practices discussed include the Hong Kong auto-fuel market and the issue of tuition price-fixing in private colleges. Second, the paper provides in-depth analysis of luxury goods markets to evaluate the model by comparing it with alternative ex-planations. Welfare analysis of the luxury goods is also presented to study the necessity of anticom-petitive regulation in luxury markets.

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| Supervisor: | FONG Yuk Fai / ECON | | |
| Student: | LIU Shuangrui / SBM | Course: | UROP1100, Fall |

Ministry of Commerce (MOFCOM) is the antitrust authority responsible for merger control in China. This article aims to evaluate how MOFCOM's merger analysis on horizontal merger has been convergent toward that in Europe and America. The article focuses on the role of antitrust economics in MOFCOM's decisions and considers the influence of China's industry policy on the trend of convergence. The study is mainly based on MOFCOM's published cases, including its most recent merger control decision. For an individual case, comparisons with western authorities' decisions and MOFCOM's decisions on similar cases are drawn to analyze the evolvement of MOFCOM's merger control. The article finds out that China's horizontal merger control has used increasingly more sophisticated economic reasonings to support its decisions since China adopted a formal merger control framework in 2008. More consistencies of MOFCOM's merger control with other jurisdictions and among its own decisions should be expected in the future. However, concerns due to China's industry policies may still be a potential cause of inconsistencies.

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| Supervisor: | FONG Yuk Fai / ECON | | |
| Student: | LO Wai Yau / MAEC | Course: | UROP1100, Fall |

This paper shows the possibility of presence of cartel can explain the pricing phenomenon in the periodic market, such as Hong Kong Book Fair, Flower Market in Chinese New Year and Flea Market. Our model shows that the difficulty of sustaining the collusion in a periodic event is increasing from day to day. Therefore, one of the ways for sellers to sustain the collusion is to drop the price of their products in later days of the event which is consistent with the pricing phenomenon in some of the periodic market. Some real life examples will be presented to support our findings.

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| Supervisor: | FONG Yuk Fai / ECON |
| Student: | MASLIN Jason / ECOF |

Course: UROP1100, Fall

This paper is based on understanding predatory pricing and how it is proven in courts. Predatory Pricing is the act of selling goods at such low prices that it's impossible to make profits without driving out competitors, upon which prices are inflated to recoup losses ultimately harming consumers. Common methods used to prove predatory pricing such as as-efficient competitor and Areeda-Turner tests are discussed. To understand the court's judgement and firm's strategies, the report will review cases involving Intel, Bombadier, and others. Criticism against predatory pricing such as misusing predatory pricing laws are also discussed. The research shows that while commonalities exist between cases, there remains notable differences in the verdicts due to differing laws and precedence in different regions.

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| Supervisor: | FONG Yuk Fai / ECON |
| Student: | ZHAO Liang / MAEC |

Course: UROP1100, Fall

This paper examines the effects on the tacit collusion of the increased price transparency on the consumer side in a Bertrand case. The analysis is provided to explain intuition and the mathematical model is developed to provide theoretical support. Different from traditional research conclusion which suggests that the higher price transparency destabilizes collusion, in this paper, it is shown that by lowering the search cost on the consumer side, the increased price transparency facilitates the tacit collusion. Hence, the paper provides different angles of analysis on the effect of the price transparency which may serves as a complement or derivative of the existing study of the effect of price transparency on tacit collusion.

## Game Theoretical Analyze of Remarriage Market

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| Supervisor: | FONG Yuk Fai / ECON |
| Student: | WANG Jiahui / MAEC |

Course: UROP1100, Fall

Remarriage is performing a new trend nowadays and many studies have been done in recent years. However, previous papers on remarriage are usually from the view of social sciences and the findings are usually summaries of statistics. Few mathematical models were raised. Inspired by the lack of rigorous modeling in this area, this paper built a model of determinant functions for remarriage to predict the decision of remarriage as a bargaining game. The model included income distribution, age gap and costs of stepchildren as main determinants. And different properties of the functions for husband and wife are explained. With this model, several well-founded patterns of remarriage by previous studies can be explained and further modification may be applicable to it.

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| Supervisor: | FONG Yuk Fai / ECON |
| Student: | XU Feiting / MAEC |

Course: UROP1100, Fall

The increasing spouse poaching phenomena lowers the general marital satisfaction which draws the attention of economists. This report analyzes the reasons of spouse poaching by applying signaling model and argues that successful

marriage serves as a stronger signal to indicate the high quality of people and thus spouse poaching could increase the expected marital satisfaction. Based on this finding, it is suggested that people's moral belief should be educated and extra punishment should be imposed to people involved in spouse poaching in order to reduce the spouse poaching phenomena. Further extensions could be applying more game theory models to analyze the marriage market and give more rigorous arguments and rational suggestions.

### Firms in Globalization: Evidence from China

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| Supervisor: | LI Yao / ECON | | |
| Student: | LIU Yiming / ECOF | Course: | UROP1100, Spring |
| | LU Lingfei / ECOF | | UROP1100, Spring |
| | WU Xueying / ECOF | | UROP1100, Spring |
| | ZHANG Jiayue / ECOF | | UROP1100, Spring |

China and the United States are the two largest economies in the world. The potential trade war between these two countries has a wide effect on the global trading system. The purpose of our research is to show the trade relationships between China and U.S. by analyzing their import and export data from 2014 to 2015. The analysis identifies the sizes of import and export of China to U.S. and compare them with the total amount annually. We also compared our findings with the data from the Chinese General Administration of Customs to check for accuracy. And these findings can be used for further analysis of how the two countries plan the tariff product list of the potential trade war.

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| Supervisor: | LI Yao / ECON | | |
| Student: | LIU Zining / ECOF | Course: | UROP1100, Fall |
| | TAN Dongni / ECOF | | UROP1100, Fall |
| | WANG Chen / QFIN | | UROP1100, Fall |

This report focuses on the firm dynamics in the leather shoe industry in China and the impact of tariff on firms' import decisions. We first convert the HS2002 productcode to HS1996 productcode for data consistency. Then we analyze the industry composition represented by entry and exit dynamic pattern from the year 2000 to 2006. Finally, we incorporate CIECustoms0006 import data, tariff data into the leather shoes panel and get a new dataset specifying firms' yearly import products with the corresponding tariff. We use cust2000-2006 import data to do the same merge, and find out using CIE data can generate higher matching rates.

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| Supervisor: | LI Yao / ECON | | |
| Student: | LO Pui Sum / ECOF | Course: | UROP1100, Summer |

This paper summarized the progress of the investigation of the impacts brought by the One Belt, One Road Initiatives (OBOR) to the trade flows between China and its trading partners. Bilateral trade panel data between China and 215 countries, including 71 OBOR countries, are worked on based on the years before and after the OBOR initiation by applying the Gravity Equation. World Integrated Trade Solution (2018) and CEPII database (Gravity CEPII, 2018) for the years of 2010 to 2016 were used to analyze whether being a member of OBOR would bring an advantageous effect on trading for both China and its trading partners as stated as one of the initiative goals. Other controlling factors, weighted distance and GDP, were also included in the model so as to allay potential biases. The findings showed a positive result towards the hypothesis of the present of a beneficial impact on trade between China and OBOR countries.

| Supervisor: | LI Yao / ECON | | |
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| Student: | LU Lingfei / ECOF | Course: | UROP2100, Summer |
| | SO Kwok Wai / ECOF | | UROP2100, Summer |
| | ZHANG Jiayue / ECOF | | UROP2100, Summer |

This progress report outlines the procedures to construct the updated Taiwanese-invested firms in China (TIFs hereafter) sample. With the original sample, firms producing non-electronic products were excluded from the sample by setting up some screening keywords. Then, non-TIFs were distinguished and dropped according to their registration type and pack-in-capital. The last step was to identify the missed observations from the Chinese Industrial Enterprises (CIE hereafter) data, since we found that large number of firms unreasonably existed only in a short period of time. This might due to irregular expression of company name or change of company representative code (crc hereafter). The identified observations were checked manually to adjust their crc, and then merged back to the sample. These procedures as a result produced a much larger sample size.

| Supervisor: | LI Yao / ECON | | |
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| Student: | OUYANG Jing / MAEC | Course: | UROP3100, Fall |
| | PENG Cong / ECOF | | UROP3100, Fall |
| | SO Kwok Wai / ECOF | | UROP1100, Fall |

The project focuses on studying behaviors of domestic- and foreign-invested firms in mainland China under globalization. Our team dealt with custom data of targeted Taiwan-invested firms (TIF). In the previous semester, our work mainly focused on generating a "year-firm-product" panel data and correcting the problem of inconsistent identifiers of sampled companies, analyzing the annual sales growth rate of the sampled companies, and finding out the pattern of appearance of sampled companies before and after 2010. Later, with calculated average growth rate of sales income for years before 2010, we projected sales income for years after 2010 and summarizing the reasons of discontinuity. In this semester, we continue the project by analyzing the export behaviors of TIF by improving the data source and generating export variables.

| Supervisor: | LI Yao / ECON | | |
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| Student: | REN Jiaqi / MAEC | Course: | UROP1100, Summer |

This progress report summarizes the proceedings of my UROP1100 project, Firms in Globalization: Evidence from China, in Summer Semester 2018. By collecting the data from the General Administration of Customs of the People's Republic of China and the United States International Trade Commission, I compared the current tariff schedule of each country with that before the trade war. Using the software Stata, I kept track of the products subject to higher tariff by creating dummy variables. Since this is a progress report, the more detailed analysis of the datasets still requires further investigation.

### Building on flooding plains: the economic cost of sea level rise

| Supervisor: | LIN Yatang / ECON | | |
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| Student: | HONG Rongtao / ECOF | Course: | UROP1100, Summer |

This project is mainly aiming to explore why people still built on regions that are likely to be flooded in the future as sea level rises. A prominent factor is that the citizens may not able to receive the enough amount of information about sea level rise, as well as that public policy has been failed to provide guidance appropriately. So, we would like to find out the determinants of the building permits in the coastal region of the United States of America. To reach this goal, we

want to merge the dataset of building permits and some other datasets, like the house price, to investigate: 1. Whether the regions where are more likely to be submerged will receive less building permits or not. And 2. Whether or not the correlation between those two facts mentioned in 1 will be lower in the regions whose house prices are higher.

## The motivation and career choices of public workers

Supervisor:     LIN Yatang / ECON
Student:        HAN Xinze / MAEC                     Course:        UROP1100, Spring
                                                                   UROP2100, Summer

The intended research question is to identify the influence of anti-corruption campaign in China on the career choice of civil servants. Since the research is in its infancy period, the main job is to obtain the data which could reflect the popularity of job among candidates, in which case we choose the minimum score line to enter the interview session of China's national examination for admission to civil service to measure. We collect data starting from year 2008 from several institutions in terms of department, position and minimum score to enter the interview session, etc. For each year, we merge all data in a worksheet in order to do further analysis. In addition, some data collection work about information of Shanghai metro stations has been done.

## Department of Finance

### Climate risk tools, usage and implications

Supervisor:        BENZ Entela / FINA
Student:           LIU Suwan / EVMT                     Course:          UROP1100, Spring

As Paris Accord was put into effect, climate change has been gaining attention from all parties and sectors. Financial market is no exception. Although a unified scoring tool for companies' resilience against climate change risks is expected, nowadays, there is no well-established tool that are applicable to all. This report intends to implement one of the tool to real-life scenario and illustrate the implications of climate risks on companies' financial performance.

Supervisor:        BENZ Entela / FINA
Student:           HUI Yiting / EVMT                    Course:          UROP1100, Summer

Nowadays, investors are facing increasing two-sided climate risk to their assets: physical risk and transition risk. Physical risk is linked to potential adverse impacts resulting from climate change, extreme weather patterns, sea level rise etc. Transition risk is the consequence of tightening climate policies and regulations across the world, trying to drive a low-carbon economy and combat global warming. Both physical risk and transition risk can lead to real financial impact on companies and assets. This study aims to investigate the extent of correlation between climate risk of companies and their business performance across different countries and across different sectors. Hopefully this study will give investors more insight on the influence of climate risk on companies' valuation and profitability and motivate them to shift their capital to low climate risk businesses and operations.

### ESG factors in Asia: Development, Trends and Market Usage

Supervisor:        BENZ Entela / FINA
Student:           LIU Yaoyang / QFIN                   Course:          UROP1100, Spring

ESG investing is an increasingly popular and significant topic worldwide, and has a fast growth and potential in Asia particularly. This report studies the predictability of ESG factors on the key financial performance of companies, and then step further which specific indicator has the most explanatory power in each section. To realize fair comparison, all the ESG scores are normalized by the industry average. The regression results show that S factor has the best performance in predicting stock return, while E and G are also statistically significant in determining forward PE and ROE. For certain sections, companies are recommended to focus on water intensity per sales in environmental factor, total recordable incident rate in Social factor and percentage of independent directors and board size in governance factor. The overall results give an integrated strategy for investors and corporates to develop their own business.

Supervisor:        BENZ Entela / FINA
Student:           RUAN Kaiyue / QFIN                   Course:          UROP1000, Summer

An increasing number of companies start ESG investing, and an increasing number of investors have focused on the ESG impact behind their capital allocation decisions. To date however, the prior academic literature has not distinguished the useful E scores in China A-shares market. We investigate the effect of E scores on the valuation multiples. Using a normalized sample of 221 Chinese companies co-listed in China A-Shares and MSCI China Index, we find most of E scores are statistically important. Total GHG $CO_2$ Intensity per Sales and Percentage water recycled have significance in

determining P/B value. These results speak to the significance of E factors in company valuation in China A-Share market, and also have implications for asset managers who have committed to the integration of E factors in their capital allocation decisions.

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| Supervisor: | BENZ Entela / FINA | | |
| Student: | WONG Pan / QFIN | Course: | UROP1100, Spring |

Although investors around the world are being increasingly aware of the growing trend of ESG (Environment, Social, Governance) driven allocations, this investment concept in Asia, especially in China, is underdeveloped and not widely acknowledged. As the financial markets of China is expanding unprecedentedly and going international in recent years, we should also consider incorporating ESG concepts in investing in China A-shares. However, stocks market in China is not identical with other financial markets worldwide, under a unique economy and different regulatory measures. This paper focuses on ways to help incorporating ESG investment approaches like screening ESG score in China A-shares. Besides, it includes analysis on the statistical importance of ESG factors towards China A-shares in company prospects and firm values.

### How green are the green bonds?

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| Supervisor: | BENZ Entela / FINA | | |
| Student: | JAIN Aakash / FINA | Course: | UROP1100, Spring |

This paper investigates the differences between green and vanilla bonds in different countries. In Australia, green bond issues are dominated by banks, and there is no significant green premium. In Japan, there is no green premium. In the U.S., green bond issues are dominated by corporations (supranationals and financial firms), which issue 55% of all green bonds by value. In the U.K., green bonds have been relatively more volatile and there is no significant green premium. The global green bond market has grown exponentially over the past five years, with much of the growth coming from Chinese corporates. This growth could slow down due to tightening credit rules. There are also more concerns over greenwashing.

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| Supervisor: | BENZ Entela / FINA | | |
| Student: | LO Chun Hang / ECOF | Course: | UROP1100, Summer |

Since World Bank Group's first issuance of Green Bonds in 2008, the Green Bond Market has been emerging rapidly in almost every part of the world. With less than a decade, the Global Green Bond Issuance has already reached USD 161 billion. Despite the fact Green Bond Issuers tend to have better credit ratings, several unique risks are often associated with Green Bonds, for instance, the Environmental, Social and Governance (ESG) risks. This paper intends to align and compare between the Green Bond Issuers' Environmental, Social and Governance Risks between Asia and the U.S. This static comparison will be performed in 3 dimensions, across sectors within Asia, across countries within Asia and against U.S.

### An Empirical Study of China's Structured Mutual Funds

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| Supervisor: | LI Kai / FINA | | |
| Student: | HU Haoyang / QFIN | Course: | UROP1100, Summer |

This paper discusses the return and risk characteristics of A tranche, B tranche and the parent fund of China's structured funds and their correlation with the benchmark. The analysis is based on empirical data of 15 structured funds from their inception date to May 2018. Structured funds were first developed in China in 2007. The A tranche has fixed-income characteristics while the B tranche is like investing into equity market with leverage. Other than that, some special design of structured funds, such as redistribution schemes and redemption methods, increased complexity of this financial instrument. Therefore, analysis of their previous performance can shed some light on the understanding of structure funds and facilitate further research.

Supervisor:     LI Kai / FINA
Student:        LIU Xinyi / ECOF                     Course:        UROP1100, Summer

The objectives of this project are to have a deep understanding of China's structured mutual funds and to prove the inner relationship between the fund and the tracked index. We first spent nearly one month to study what a structured mutual fund contains and how it works. After knowing its special mechanism of liquidating, I began to focus on the relationship between sub-fund A's price and the index when the fund price is close to liquidation. I did linear regression on these two variables to prove that they are negatively correlated. The result shows that the change of fund A's price and the change of index in different time are negatively correlated. It is proved that fund A has predictability to the index in short term but how big and how long the effect is stays unknown.

Supervisor:     LI Kai / FINA
Student:        TSANG Wai Kit / FINA                 Course:        UROP1100, Summer

This research paper is an empirical study and theoretical verification of the value computation method introduced by Haidong Zhang in his article "Research to the Structured Fund Embedded Option Pricing". The research computation using Zhang's pricing method to compute the theoretical upper limit and lower limit for A tranche value, then uses ADO as a replication for the possibility of downward conversion to compute the theoretical value for A tranche and simultaneously compute the theoretical value for B tranche. The result shows a great coherence in its trend with minor deviation between theoretical price and actual price, which are possibly caused by the assumption made for simplification during computation, such as constant variance.

Supervisor:     LI Kai / FINA
Student:        ZHANG Wenhao / ECOF                  Course:        UROP1100, Summer
                ZOU Haoxiang / RMBI                                  UROP1100, Summer

China's structured mutual funds are special and complex financial vehicles in the world. Most of them are divided into two tranches, with a low-risk fixed income tranche (A tranche) and a leveraged equity tracking tranche (B tranche). The design of the funds fully reflects the two basic mentalities of investors in the financial markets, which are risk-averse and risk-loving. The purpose of this research is to understand the principles and the potential opportunities of China's structured mutual funds, by conducting back-testing on the wheel trading strategy in a long time period. The core analysis included the building of the proper fund's database and the design of the whole back-testing procedures. We also conducted basic analysis to evaluate the performance of the structured funds in the database. These findings can be applied to the real markets and provides some guidance to the individual investors.

**An Empirical Study of Real Estate Investment Trusts (REITs): Experience from United States, Hong Kong and Singapore**

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| Supervisor: | LI Kai / FINA | | |
| Student: | LAW Yin Ting Janita / QFIN | Course: | UROP1000, Summer |

To tackle China's overheated housing market, China is starting the development of Real Estate Investment Trust, allowing people to invest in the housing market without actually buying properties on this own but investing in a security serving similar purpose. We would like to observe the pricing behavior of REITs and its relationship with other factors, by getting the reference in some matured market, ranging from United States, Singapore to Hong Kong. In this summer, we conducted a fundamental research to analyze the relationship between the returns of REIT and returns of Market Index first. We attempt to predict the pricing of REIT or whether it is fairly priced in China and the securities can replicate the execution from other countries.

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| Supervisor: | LI Kai / FINA | | |
| Student: | LI Houchen / QFIN | Course: | UROP1100, Summer |

This report is a case study about the largest real estate investment trust in Asia – Link Real Estate Investment Trust. Link REIT is the first REIT which was listed in the Hong Kong Stock Exchange. In less than 13 years of development, Link REIT now owns properties spanning from Hong Kong to mainland China, with about 9 million square feet of retail space, around 61,000 car park spaces, and about 3 million square feet of office space. pThis report provides a detailed study about Link REIT's portfolio structure, asset allocation, properties valuation, financial performance and competitor analysis. This report shows the reasons why Link REIT has continuously growing revenues, high occupancy rates and reversion rates, and how Link REIT manages to outperform its competitors.

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| Supervisor: | LI Kai / FINA | | |
| Student: | MA Ming Hei / SBM | Course: | UROP1100, Summer |

This report is to construct the fundamental analyze of Yuexiu Reit in the fields of business improvement, rising financing costs, the acquisition of Wuhan project, and the cash model. With different aspects of analyzes, the core value of Yuexiu is sharped and summarized in this report. Through the data collected, the fundamentals of Yuexiu reit are analyzed through the method of CAPM to see if Yuexiu reit is priced as expected. The last two pages are the research collected to describe the corporate structure of Link and Yuexiu.

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| Supervisor: | LI Kai / FINA | | |
| Student: | XIAO Yidi / MATH-SFM | Course: | UROP1100, Summer |

The report discusses the possible relationship between current return of REITs in Hong Kong and the mainstream market indexes of the previous month and build a linear regression model to demonstrate this relationship numerically. R code was used during the study to collect data and generate the regression model. Among eight proposed variables, Adjusted Hang Seng Index and Market Yield of Grade A Offices and Retail of the previous month were proved to have a significant negative relationship with the REITs return of current month. Due to lack of indicator of latest news in the model, the model performed poorly when predicting periods with breaking news such as the recent trade war.

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| Supervisor: | LI Kai / FINA | | |
| Student: | ZHANG Xiao / SBM | Course: | UROP1100, Summer |

Real estate investment trusts (REITs) are a kind of investment portfolio that sells shares in a trust that owns a collection of real estates. They have already been popular and developed finical products in many countries like the US, Singapore, and Hong Kong. In this report REITs listed in Hong Kong will be studied by calculating their Sharpe ratios and correlations with real estate's market in Hong Kong. In this way, it can be concluded that the performances of different REITs listed in Hong Kong have huge gaps in terms of Sharpe ratio while irregular distribution has not been figured out and more regression models will be tried in UROP project next semester.

### Corporate Risk Management Practices: Global Survey of BRICS-Country Firms

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| Supervisor: | MACKAY Peter / FINA | | |
| Student: | FU Yingying / FINA | Course: | UROP1100, Fall |
| | | | UROP2100, Spring |
| | ZHANG Ziyue / QFIN | | UROP1100, Spring |

In the real world corporate operation practices, there are numerous factors that can potentially generate risk for company such as exchange rates, interest rates, commodity prices, domestic equities and credit spreads. Company normally conduct different strategies to control total risk exposure. They may hold cash balances, minimize debt usage, maintain lines of credit, perform natural hedging, etc. This project is aiming to conducting the first large-scale comparative analysis of corporate risk-management practices of firms domiciled or operating in the BRICS countries (Brazil, Russia, India, China, and South Africa). In partnership with GARP (Global Association of Risk Professionals), the project has finished survey planning and currently under the survey execution stage.

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| Supervisor: | MACKAY Peter / FINA | | |
| Student: | WU Minyue / SBM | Course: | UROP1000, Summer |
| | YE Muyang / SBM | | UROP1000, Summer |
| | ZHANG Ziyue / QFIN | | UROP1000, Summer |

This project aims at identifying characteristics of corporate risk management, focusing on firms that are domiciled or operating in the BRICS countries (Brazil, Russia, India, China, and South Africa), through objective statistical surveys and analyses. Corporate risk management refers to all of the methods and processes that a company may use to optimize risk portfolio and minimize financial losses. In the previous phase of the project, the team has finalized a questionnaire on corporate risk-management. At this stage of execution of the questionnaire survey, efforts have been done to refine as well as translating the questionnaire from English to Portuguese and Simplified Chinese etc., design the online format and then publish it in Qualtrics.

### Corporate Risk Management: What Can We Learn from Financial Statements?

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| Supervisor: | MACKAY Peter / FINA | | |
| Student: | WANG Xinyue / QFIN | Course: | UROP1100, Fall |
| | ZHANG Ziyue / QFIN | | UROP1100, Fall |

A hedge is an investment to decrease the potential loss incurred by adverse price movements in an asset of oil refiners. This project mainly focused on discovering the hedge accounting activities, and analyzing the intensity of hedge from revenue and cost sides. A big obstacle faced by previous empirical research on this topic was lack of publicly available information on corporate hedging activities. Therefore, we adopted another approach and collected financial reports for each oil refiner in our sample, and divided them by a five-year time interval to analyse the change of hedging policy for

each firm. During the research process, special attention was paid to the accuracy of data collection to guarantee the quality of work.

# Department of Information Systems, Business Statistics & Operations Management

## Family Consent and Organ Donation

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| Supervisor: | HUI Kai Lung / ISOM | | |
| Student: | ZHAI Qinwen / MAEC | Course: | UROP1000, Summer |

Objectives: To investigate what effects family consent has on organ donation rate across different countries through certain years. Data sources: The organ donation rate data are from International Registry in Organ Donation and Transplantation (IRODaT). Law information is collected from official website or documents from different sources listed in the appendix file 2. Conclusion: Need of family consent when the deceased's wish is unknown legally shows negative effects on donation rate from regression results. However, due to constraints of our model, there may be other omitted factors such as culture, religions and infrastructure in healthcare that can influence donation rate, thus reduce the extent family consent can account for the differences in donation rate across countries.

## Deep Learning for Stock Prediction

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| Supervisor: | KWOK James Sai Ho / ISOM | | |
| Student: | LAU Yiu Lung Peter / ECOF | Course: | UROP1100, Fall |
| | | | UROP2100, Spring |
| | LUI Leung Yau / QFIN | | UROP1100, Spring |

In this report, the applications of Discrete Wavelet Transform (DWT) and Stacked Autoencoders (SAEs) on pre-preprocessing financial data are studied. Preliminary testings of DWT and SAEs on S&P 500 data and MSCI China data are conducted. Details on the data collection, model architecture, optimization process and preliminary outputs are presented. We found that DWT is useful for denoising financial time series by simply attenuating all detailed coefficients can reduce the variations. However, it cannot avoid disposing of the huge ups and downs of the financial time series. For SAE, we found that it is a good feature extraction tool in a sense that it can extract the most important features representing the variation in the original dataset (i.e. the deep features). Future research directions are also proposed.

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| Supervisor: | KWOK James Sai Ho / ISOM | | |
| Student: | LIU Weiyang / QFIN | Course: | UROP1100, Summer |

This paper explores a deep learning approach implementing Long Short-Term Memory (LSTM) network to predict a next-minute market direction, based on 1-minute historical data of prices and volume of stocks on the Hong Kong Stock Exchange (HKEX). We evaluate some technical indicators derived from price and volume and find that they do not contribute much to this binary classification problem. Discrete Wavelet Transform, a common denoising method, brings little improvement either. We also conduct tests on tuning different hyperparameters but have not discovered any significant ones yet. A two-layer LSTM network has an acceptable performance of 76.02% directional accuracy on stocks traded frequently but fails to predict the Hang Seng Index. Its application to forecasting lower-frequency stocks requires more investigation.

## School of Business and Management
### Department of Information Systems, Business Statistics & Operations Management

Supervisor:       KWOK James Sai Ho / ISOM
Student:           POON Benjamin Cheuk Bun / GBUS      Course:        UROP1100, Fall

Throughout the Fall semester, our team has explored several aspects of deep learning and investigated into its application in stock market prediction. We examined multiple areas in the field where there were potential research opportunities. We also took into consideration our team's strengths and weaknesses in the decision of where to focus our research efforts on. After a few failed attempts, our research focus is now settled on volatility prediction. We are hoping to continue with the project and this report will hopefully serve as a reminder of the past mistakes that we should avoid in the future.

### Risk Management

Supervisor:       SO Mike Ka Pui / ISOM
Student:           CUI Ningshan / MATH-SFM         Course:        UROP1100, Fall

With the arrival of the era of Big Data, the explosion of discrete data online stimulates the researchers to create and improve a variety of text processing model with sophisticated statistical structures. As one of the most important milestones, Latent Dirichlet Allocation Model was born with solid theoretical foundation and great practicability to serve as an important tool for topic-based text document classification. In this paper, I summarized the features of a few precursors model, and for sure LDA itself, a three-level hierarchical generative probabilistic model. Also, when it comes to applications, it needs to use variational inference and EM algorithm to approximate several unknown but essential parameters to enable the model to process un-seen documents. The variational inference procedure is also presented in this report, followed by a discussion of the application on Wikileaks Afghanistan War Logs. At last, another model called Correlated Topic Model is presented, serving as the derived model from LDA with improved features.

Supervisor:       SO Mike Ka Pui / ISOM
Student:           HE Jianyao / QFIN                Course:        UROP2100, Fall

This project is follow-up research on implementation of latent space model in dynamic network continuing from UROP1100. Having obtained fundamental knowledge on latent space model, Bayesian analysis and Markov Chain Monte Carlo sampling, the project moves forward to application of the above theories and analyse the dynamic network. Over the past few weeks, I first reviewed the MCMC sampling scheme, especially Metropolis-Hastings to have a thorough understanding. Then, I revisited Latent Space Models for Dynamic Networks and its supplementary material to fully understand the whole process of how to implement MCMC sampling and Bayesian analysis to study the changes of dynamic network relation with respect to time.

Supervisor:       SO Mike Ka Pui / ISOM
Student:           WANG Ziyi / RMBI               Course:        UROP3100, Spring

Professor Mike So has proposed a cross-sectional vine copula model to incorporate correlations among high dimensional high frequency stock return series and market factors, giving a new dimension of risk management. During the past two sessions, we have built the research frame, organized the statistics rationale and successfully testified the model estimation feasibility. As the third session of the research project, I mainly worked on preparing for the research paper and further explore the real life impacts and applications of the model. The report will summary my research process in mainly two parts: Understand financial return dependencies and explore the application of the model.

## Bitcoin Text Analysis

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| Supervisor: | YANG Yi / ISOM | | |
| Student: | KAN Chunyue / IS | Course: | UROP1100, Summer |

Bitcoin has become one of the most trending topics nowadays. It marks the dawn of cryptocurrencies and increasingly attracts public's attention. The price of Bitcoin is proliferating, however, the volatility casts huge concern and uncertainty on its value. The advent of online Bitcoin forums plays a significant role in facilitating public discussion and exchange of opinions for related issues. This paper utilized a set of text mining techniques to analyze the content and sentiment people posted and expressed on BitcoinTalk, the largest and the most popular online forum, in order to quantify the distribution of topics people discussed along with the variation displayed in their emotional behaviors as Bitcoin price moved along.

## Department of Marketing

### Luxury Marketing in Emerging Markets

Supervisor:     HELSEN Kristiaan / MARK
Student:        ZHU Lin Da Linda / MARK                Course:          UROP1100, Spring

This paper investigates the impact of luxury brands' online presence on customer attitudes. While luxury brands take pride in their exclusivity and premium status, the Internet seems to provide the exact opposite – ubiquity and accessibility to everyone. Customer attitude was measured based on the five most important attributes for luxury purchase as discovered from interviews, namely brand prestige, quality of products, usability of products, customer service, and price. Across four different luxury product categories, the online presence mostly impacts customer attitude in a positive way, although the likelihood of online purchase seems to be independent from customer attitude. It is recommended for luxury brands to continually build up their online presence as it may have positive long term effects.

### Technology in Consumer Behavior

Supervisor:     HONG Jiewen / MARK
Student:        ZHU Lin Da Linda / MARK                Course:          UROP1100, Summer

This ongoing project is about how technology affects the patience of consumers. As technology becomes more prevalent in our daily lives, the desire for instant gratification gets fulfilled much more easily. Therefore, we predict that technology causes people to become more impatient. Literature about technology primarily investigated some causes and effects of online shopping and how device interfaces affect consumer behavior, but little has been done regarding the impact of technology on patience level. Factors affecting patience has been widely researched but the causes of instant versus delayed gratification remains to be investigated further. After reviewing the relevant literature, we see a need for further research to examine the effects of technology on consumer patience.

# Department of Management

## Human Decision Making and Strategic Behavior in Social Systems

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| Supervisor: | DANIELS David Peter / MGMT | | |
| Student: | CHEN Pei / SSCI | Course: | UROP1000, Summer |

Quantitative models and machine learning methods have become popular in social science researches in recent years. We survey one such method, Structural Topic Model, and apply it to a data set which captures how people evaluate different strategies in a classic game theory setting. A preliminary analysis of the effect of different strategies and respondents' background then follows. This report reviews the origin and mechanism of Structural Topic Model, describes the experiment that yields the data set and presents the result of the analysis that illustrates the merit of the method.

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| Supervisor: | DANIELS David Peter / MGMT | | |
| Student: | HANDAYA Clara Louisa / GBUS | Course: | UROP1100, Spring |

Demographically different people tend to face a vital challenge in nurturing supportive relationships in organizations, and thus affecting performance and efficiency in task completion. This is further amplified when the diversity distribution within groups are not as equally distributed. Based on survey responses, this report examines the various reasons why and how diversity can affect workplace effectivity. Common reasons for these differing behaviors include the subconscious instinct to seek approval from group members which will be affected by surface-level diversity which is imminent at first observation. This report will discuss in light of their implications for organizational workgroups in which contribution of expertise is critical to group performance.

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| Supervisor: | DANIELS David Peter / MGMT | | |
| Student: | HO Chun Yin Patrick / FINA | Course: | UROP1100, Spring |

This research aims to explore the influence of conspicuousness to branded goods to employment decisions. It is discovered that branded goods users are generally less preferred by recruiters. Three factors of organizational characteristics, gender, and age are studied to provide more details of the relationship. Whereas organizational backgrounds have limited impacts, females have more negative attitudes towards luxury product consumers than males, while younger people have more positive attitudes towards them. Brief explanations are provided to justify the research outcome, and the paper concludes with discussing its limitations and room for further research.

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| Supervisor: | DANIELS David Peter / MGMT | | |
| Student: | PARK Seo Hyun / GBUS | Course: | UROP1100, Spring |

This paper explores the hypothesis that people's willingness to approach strangers change according to whether they are accompanied by someone with interest in the same question. The experiment classifies approaching strangers as asking them for directions on the street. 135 participants were given three different situations at random, the first with the participant with no companion, the second has a companion with shared interest in the question to be asked to the stranger, and the third with an indifferent companion. The result shows that people are most likely when accompanied by a companion with a shared interest on the answer.

Supervisor:          DANIELS David Peter / MGMT
Student:             WONG Yuen Ting / RMBI                Course:          UROP1000, Summer

Decision making by people is based on several different aspects and many people realized that they can make rational decision. However, researchers found that people are easily affected by environment when making decision. In the paper, results from a survey done by David Daniels is extracted and being analyzed. Decision are made by interviewees based on information provided in the survey and they will be asked the reason of making such decision. Hoping to get the strategy that people make decision, text mining is done on the answers. Summarizing the existing theoretical foundation and the result from the survey, it spells out that decision made by people can be affected by information given.

**Using Big Data to Understand Labor Market Dynamics**

Supervisor:          ZHOU KOVAL Christy / MGMT
Student:             DATTA Siddhartha / GBUS                Course:          UROP1000, Summer

This research aims to explore the underlying relational dynamics between people on freelance work platforms, between employers and employees, and within employees themselves. Particular interest will be placed on gender correlations and the objective to locate the most important variables involved in reasonable pay, as the aim of the study is to identify biases on the platform. Data was obtained from the work platform, such as tests taken, work histories, skills listed, and general personal descriptions.

# SCHOOL OF
# HUMANITIES &
# SOCIAL SCIENCE

# Division of Humanities

## Korean War Prisoners Oral History Interview Transcription

Supervisor:     CHANG David Cheng / HUMA
Student:        LEE Wing Tung / ECON                  Course:        UROP1100, Fall

The paper aims to provide a clear and simple review to the UROP project, Korean War Prisoners Oral History Interview Transcription. The project focuses on the transcription of two rounds of oral history interviews with Korean War Prisoner, Mr. GAO Wenjun, conducted by Prof. David C. Chang in April and August 2013. This paper consists of five parts, targeting to provide readers a thorough picture to the project required tasks with the methodology, project schedule, challenges faced, and skills developed.

## Representation of Sacred Landscapes

Supervisor:     FU Li-tsui / HUMA                  Co-Supervisor:   KWONG Anna Y N / HUMA
                                                                   CABOARA Marco / LIB
Student:        LAW Ka Yin / ECON                  Course:          UROP1000, Summer

Apart from religious paintings depicting the biblical figures, representations of Jerusalem landscape, including ancient maps, artwork and architecture, did also play a key role in tracing the development of Christianity in the Middle Ages as features of representations of landscape changed in the 4 periods of the Middle Ages. Representations of Jerusalem landscape in different periods reveal the impact of Christianity in different period at the same time served as a tool to help developing Christianity. Proving with different forms of representations of Jerusalem landscape, the development of Christianity before Renaissance was fluctuated yet the influence of Christianity was increasing gradually, leading to its great impact on the Renaissance artwork and the whole world religiously in the future.

# Division of Social Science

### Examining Cognitive Development through Children's Conversations

Supervisor: CHEN Eva E / SOSC
Student: TAN Jingjing / GCS                    Course:        UROP1100, Fall

Previous research has discovered that children develop awareness of person's personality at fairly young age. By using trait terms, on the one hand, preschoolers are able to make inference about themselves or others verbally. On the other hand, their ability to form impression or make judgment of other people can be observed and investigated by studying the utterances produced by them. Parent-child verbal exchanges are expected to impose influence of the uses of trait terms by preschool children. In order to verify the potential impact of that, this study will study transcripts from CHILDES database of a girl (Sarah) from the age of 2 to 5 with the focuses of 2 trait terms: "good" and "bad", via applying a 4-stepped coding strategy. The results showed that parents are more inclined to initiate trait terms in the conversations in the way that children would learn linguistic terminology from them. However, the extent of influence of parent-child conversation towards preschoolers' use of trait terms could not been determined.

### Chinese and English Media Representation of Migrant Domestic Workers in Hong Kong

Supervisor: GROVES Julian M / SOSC
Student: SIU Tsz Chun / GCS                    Course:        UROP2100, Spring

Studies on verbal and visual representation of migrant domestic workers in Hong Kong media have been popular since handover. Some agreed that local media constructing negative images of migrant domestic workers. that racial and gendered stereotypes of workers were tools of local media marginalizing workers. However, in the wake of Erwiana physical abuse case in 2014, reportage on migrant workers was expanded to different areas, for example abuse cases, welfare, rights and misconduct of workers. In this paper, we will conduct content analysis of news articles and videos. This aims to show the association between reporting perspectives and readership. Also, we will provide with reasons for the difference in reportage between Chinese and English media.

### Economic Development, Pollution and Health in China

Supervisor: HE Guojun / SOSC
Student: LU Wenxin / BTGBM                    Course:        UROP1100, Spring
                                                              UROP2100, Summer

Past researches have shown the possibility of using the night light luminosity data measured from satellites as a proxy for economic and socioeconomic statistics such as gross domestic product (GDP). This proxy is particularly useful for developing countries with low political transparency and poor measurements. This report investigates the correlation between nightlight luminosity and socioeconomic statistics in China from 1998 to 2008. It also generates a framework that can be used to predict GDP level with nightlight.

Supervisor: HE Guojun / SOSC
Student: ZHANG Yifan / FINA                    Course:        UROP1100, Fall
                                                              UROP2100, Spring

Accompanied with the Chinese Typhoon dataset, this report plays a critical role in explaining the dataset records and addressing underlying concerns. The report also includes a detailed introduction of the main techniques applied during data collection. Brief introduction of the data's prime sources, as well as potential concerns among both the prime sources and dataset arrangement process are also included in the second part of the report.

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| Supervisor: | HE Guojun / SOSC | | |
| Student: | ZHUANG Qinru / EVMT | Course: | UROP1100, Fall |
| | | | UROP2100, Spring |

This UROP project is the extension of the last one (UROP 1100) I have done, which aims to understand the relationship between economic development, pollution and citizens' health in China. In last semester, I took part in the study of academic paper and data analysis. This semester, my task is still data analysis, but is more inclined to visualization of the data. I was assigned with the same water pollution data and was asked to learn ArcGIS, a system for working with maps and geographic information. During the semester, I managed to master ArcGIS and visualize the water pollution data, which is of great importance and help to my environmental research.

## An Analysis of Media Reports on Hong Kong's Democracy Movement

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| Supervisor: | HONG Jean / SOSC | | |
| Student: | LAM Cheuk Yuet / GCS | Course: | UROP1100, Spring |

This report serves as a summarization and analysis on the newspaper critics and columns' commentary on the critical political events happened from the period of 2016 to 2018 in Hong Kong. Five papers are under review for each critical event, these papers are namely, Apple Daily, Hong Kong Economic Journal, Ming Po, Sing Dao Daily and Tai Kung Pao. The five critical incidents touched upon in this report are 2016 Legislative election, the 2016 Legislative Oath Taking incident, the 2017 Chief Executive Election, 2017 Xi's visit to Hong Kong and 2018's China constitution reform.

## Spatial and Social Origins of China's Educated Elite, 1865-2014

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| Supervisor: | LEE James / SOSC | Co-Supervisor: | CAMPBELL Cameron / SOSC |
| | | | REN Yunzhu / SOSC |
| Student: | JIANG Wenhao / GCS | Course: | UROP1100, Fall |
| | | | UROP2100, Spring |

This project deals with the social origins of university employees in early PRC period by constructing a micro-level historical database. Based on over 1500 university staff's registration forms ca. 1951-53 collected from Liaoning Provincial Archive, this research finds that while most Republican university students came from well-off urban families, the senior faculty in the Northeastern universities and institutions I study, came disproportionally from rural landlord and rich peasant families. Moreover, the most accomplished senior faculty not only came disproportionally from rural families, but even more disproportionally from the rural poor. Such an expected high-level social mobility in the educational circle was either accomplished by a differential selectivity of students' academic potential relative to the social origins in Republican universities, or rooted in the particularity of Northeast in China.

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| Supervisor: | LEE James / SOSC | Co-Supervisor: | CAMPBELL Cameron / SOSC |
| | | | REN Yunzhu / SOSC |
| Student: | LI Haoyuan / QSA | Course: | UROP1100, Summer |

Higher education had been developed within revolution in Republican China, which accounts for the fundamental difference of education system between ancient China and contemporary China. It could be better understood by study the information in its educated elites. This report is based on Republican China University Faculty Dataset in 1941 and 1944. By analyzing the origin, occupation and educational background of the faculties, it can primarily be concluded that the regional origin of this group tends to centralize in the area where historically resourceful in education. The occupation distribution responses to the location and different investment in higher education in Republican China. The information of university faculties can also partially reflect the general situation of Republican China.

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| Supervisor: | LEE James / SOSC | Co-Supervisor: | CAMPBELL Cameron / SOSC |
| | | | REN Yunzhu / SOSC |
| Student: | YEUNG Tsz Wang / GCS | Course: | UROP1100, Summer |

This report describes and examines data on four characteristics of Chinese overseas doctoral students in Europe, 1907-1962: the European university which awarded them their PhD, their research subject, the dates of their post-tertiary European education, and their age. My data source comes two books by Yuan Tongli, A Guide to Doctoral Dissertations by Chinese Students in Continental Europe, 1907-1962 (1964 ) and Doctoral Dissertations by Chinese Students in Great Britain and Northern Ireland, 1916-1961 (1963) . A pioneer in the development of modern libraries in China, Yuan Tongli was the chairman of the Tsinghua University Library from 1916-1920, the Librarian of Peking University from 1925-1926, the Librarian of Peking Metropolitan Library from 1926-1929, and the Librarian and Associate Director of the National Library of Peiping from 1929-1942. The purpose of this report is to use quantitative methods to analyse the major patterns of behaviour of the student in Europe. This report consists of four parts which include an introduction, method and materials, results, and conclusion.

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| Supervisor: | LEE James / SOSC | Co-Supervisor: | CAMPBELL Cameron / SOSC |
| | | | REN Yunzhu / SOSC |
| Student: | ZHANG Zixin / GCS | Course: | UROP1100, Fall |
| | | | UROP2100, Spring |
| | | | UROP3100, Summer |

This report discusses Chinese overseas postgraduate doctoral students in the United States from 1905 to 1960. These students account for half or more of all Chinese PhD students during this long half-century. Moreover, because of the generous support of the Boxer Rebellion Indemnity Scholarship, 1907-1929, they include many of China's 'best and brightest.' By comparing a list of all successful Chinese doctoral students who graduated from the United States between 1905 to 1960 and by supplementing these data with information from the Chinese University Student Dataset – Republic of China, CUSD-ROC, and the Chinese University Employee Dataset – Republic of China, CUED-ROC, I discover that while most of this influential and important group of future scholars later became senior faculty in hundreds of US universities as well 50 Chinese universities ca 1941 and 100+ Chinese universities ca 1947/1953, they typically graduated from no more than 10 tertiary institutions in China and post-tertiary institutions in the United States. This pattern of highly localized tertiary and post tertiary education but national and even international employment differs considerably from current education and employment patterns in both China and the United States.

## Belt and Road Initiative

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| Supervisor: | PARK Albert Francis / SOSC | Co-Supervisor: | CHEUNG Chi Man / SOSC |
| | | | ANGELA TRITTO / IEMS |
| Student: | DENG Weiye / GCS | Course: | UROP1100, Spring |

This report summarizes the supervisee's two pieces of work contributed to the research project "Belt & Road Initiative" (BRI) with the guidance of Prof. Albert Park and his research assistants Mr. Cheung Chi Man and Ms. Tritto Angela. Firstly, to establish a framework of the various theories about the determinants of the Foreign Direct Investment (FDI), this first period saw the accomplishment of a literature review about the FDI theories published in the renowned journals in finance and economics. Since the supervisee is also undertaking a Capstone Project with a topic of the Chinese Outbound Direct Investment (ODI), Mr. Cheung assisted conducting linear regression analyses on the determinants of the Chinese ODI on two different datasets compiled separately from the CEIC data company and the American Enterprise Institute. The preliminary results provide insights into the general picture of the Chinese ODI and identify several interesting features.

## China/Africa Links Project

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| Supervisor: | SAUTMAN Barry Victor / SOSC | | |
| Student: | LAI San Yu / PHYS-IRE | Course: | UROP1100, Fall |

This investigation was centered upon the behavior of Chinese citizens and migrants in Africa and their relationship with African locals, both personally and economically, by documentary analysis. In the first part, individuals and companies engaged in upstream and downstream agricultural services, such as agricultural processing and production of agrochemicals, are examined; various examples are found in reports and their actions in Africa documented. In addition, the degree of isolation of Chinese people living in Africa, in aspects such as linguistic, physical and social isolation, especially as compared to other non-local peoples, are investigated as a part of the research; the result shows that other populations, not limited to the Chinese, engage in self-isolation.

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| Supervisor: | SAUTMAN Barry Victor / SOSC | | |
| Student: | ZHANG Xinyuan / GCS | Course: | UROP1000, Summer |

The objective of this essay is to analyze the situation of Chinese Foreign Direct Investment in Ethiopia from existing data. The essay is going to start with a background introduction of Africa and Ethiopia in the Belt and Road. Then follows the analyze of Chinese investment from the perspectives of both countries. It is found through this process that Chinese FDI in Ethiopia has experienced a growth and generated benefits for both countries. This research provides a preliminary overview of the Chinese investment in Ethiopia under the Belt and Road Initiative, conducted based on mainly second-hand data. In-depth investigations in this issue are still encouraged in the future.

## Internet Finance and Microcredit in China

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| Supervisor: | TSAI Kellee Sing / SOSC | | |
| Student: | ZHANG Junyao / GCS | Course: | UROP1000, Summer |

Driven by the policy support for inclusive finance, P2P lending platforms as an Internet financial product in China have experienced an explosive growth over the past few years. Nevertheless, since online P2P lending ascended from an almost regulation void in China, problems related to investment risks began to emerge and rang the alarm bells for the

regulatory authorities. This report aims to investigate systematic risks of P2P lending and related regulatory development in China. Firstly, it will introduce the burgeoning market of internet finance in China. Secondly, operating models and common illegal practices of P2P lending would be illustrated through the case study of a collapsed platform. Thirdly, both the effectiveness and deficiency of the current regulatory regime will be analyzed to emphasize the great supervision difficulty. Based on the above, further research topics are also mentioned for more in-depth investigation.

### Early Childhood Intervention Study to Alleviate Poverty and Promote Productive Aging in Hong Kong

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| Supervisor: | WANG Yanrong / SOSC | Co-Supervisor | WU Xiaogang / SOSC SUNG-CHAN Po Lin Pauline / IPP |
| Student: | LEE Hojun / QSA | Course: | UROP1100, Summer |

The goal of this study is to explore the relationship between parenting stress and development of children between the ages of 24 months and 48 months. The study focuses on literature review on studies that have analyzed the various risk factors that may be associated with parenting stress, and with these identified risk factors, the study estimates the level of parenting stress. In the future studies, statistical models will be used to analyze the data collected in this research program. From the findings in literature, the analysis is expected to reveal a correlation between parenting stress and cognitive, linguistic, and motor development.

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| Supervisor: | WANG Yanrong / SOSC | Co-Supervisor | WU Xiaogang / SOSC SUNG-CHAN Po Lin Pauline / IPP |
| Student: | LI Zonghao / GCS SIU Tsz Chun / GCS | Course: | UROP1100, Fall UROP1100, Fall |

The social inequality and poverty are still at unimaginable scales posing challenges to the healthy development of all economies, particularly for Hong Kong. The city has hit a record of high Gini coefficient in 2016. It has been discussed extensively by social policy makers and social scientists the possible ways to mend the widening gap. One way is to guarantee each citizen a healthy childhood and consequently an equal opportunity on social mobility in the future. Bearing these objectives, in the first part of this research, we studied the possible sources of inequalities in parenting and reviewed previous studies on the same topic in different contexts. In second part, focusing on situations in Hong Kong, we combined our field work observations with the established theories in this research area. This paper mainly focused on literature about parent-child interactions and toddler development, with an aim to discuss about parenting involvement and practices, like feeding habit and language environment, that play essential roles in the cognitive development of preschool children, specifically, the language acquisition.

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| Supervisor: | WANG Yanrong / SOSC | Co-Supervisor | WU Xiaogang / SOSC SUNG-CHAN Po Lin Pauline / IPP |
| Student: | TAN Jingjing / GCS | Course: | UROP1100, Spring |

Under the international division of labor, more and more female labor migrates from under-developed countries to industrial societies to serve as reproductive labor. The global prevalence of independent female migration entails the problem of "Missing Mothers" which has twofold of influence, including both the absence of migrant mothers as well as the relatively class-privileged working mothers. The potential influence brought by the "Missing Mothers" on both the sending and receiving families of domestic helpers would be investigated, including the reasons of "Missing Mothers" and its influence on intergenerational relationship as well as the development of the affected children. Results

demonstrate that live-in domestic helpers in Hong Kong would exert negative influence on the development of communication, problem-solving and personal social skills of preschool children.

### Environmental movement in the midst of Democratization: The case of Hong Kong

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| Supervisor: | WONG James K. / SOSC | | |
| Student: | WONG Alvin Y H / EVMT | Course: | UROP1100, Spring |

The environmental movement in Hong Kong has transformed from focusing on collective actions to a more lifestyle-based movement. Several factors have contributed to this change, including the institutionalization of environmental NGOs into advisory organizations for the government; the specialization of environmental groups which limits the opportunity for collective actions; and Hong Kong government's activeness in social media and co-ordinations of environmental groups in setting the agenda for environmental issues. As a result, environmental groups have become less able to pressure the government with collective actions for environmental policy change.

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| Supervisor: | WONG James K. / SOSC | | |
| Student: | WU Wai Ming / CHEM | Course: | UROP1100, Summer |

Many lands in Hong Kong's New Territories have high ecological values. For most cases, property development and environmentalism are antagonistic, especially in the development of the Deep Bay Wetland, which has become a major battlefield in Hong Kong's environmental movement for the past three decades. How do developers, governments and society make trade-offs between development and conservation? This report focuses on three construction projects in the Yuen Long Deep Bay Wetland, namely Nam Sang Wai, Fung Lok Wai and Park YOHO, to investigate the attitudes of developers towards environmental conservation and the wrestling among various stakeholders behind the development of ecologically valuable lands.

### Innovations in Environmental Governance: Smart Cities

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| Supervisor: | WONG James K. / SOSC | | |
| Student: | JAIN Shlok / CEEV | Course: | UROP1000, Summer |

This report investigates the smart city initiatives for Tokyo and New Delhi by reviewing various government documents, proposed plans, and declarations of upcoming legislations. The focus is on how the smart city initiatives relate to environmental sustainability and what the reasoning behind these initiatives are. The report will serve as a foundation for future research on the feasibility for governments to focus on smart city development in lieu of economic growth or development of social infrastructure.

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| Supervisor: | WONG James K. / SOSC | | |
| Student: | LI Zonghao / GCS | Course: | UROP1000, Summer |

Smart cities are flourishing in many parts of the world. Apparently, we are entering a new stage of urbanization when many smart solutions are on the plate for innovative cities to choose. This report will introduce the new stage of urbanization as such and present several cases on how cities under the challenges of global warming find their ways in smart and sustainable developments. In particular, the report will focus on the core values these initiatives share in

common. It will show that the smart city solutions deep down are about fostering new citizenships as well as serving the needs of individuals and community.

Supervisor:     WONG James K. / SOSC
Student:        PARK Jungjoon / EVMT                    Course:          UROP1100, Spring

This report investigates how the existing academic literature, Hong Kong's government officials, and entrepreneurs in Hong Kong define the objectives and key benefits of smart city development. A portion of remarks that explicitly allude environmental improvementz to be one of the objectives of smart city development come relatively less from governmental officials and press releases, in comparison to those from academic papers and interviews of people in private corporations. Inconsonance of administrative expectation towards identical meaning may lead to policies with digression from academic and business understanding of the term 'smart city'.

### The Politics and Policy of Mental Health

Supervisor:     WONG James K. / SOSC
Student:        MOK Ho Ying / GCS                       Course:          UROP1000, Summer

Mental illness has long existed as an individual and social problem from the social science perspective. How has Hong Kong society responded to mental illness over time? This paper examines the evolution of mental health policy from the colonial era (1842-1997) to present days. The mental health policy in present days is shown to carry a more specific definition of 'mental illness', emphasizing more the provision of diversified and personalized services to patients as well as involving more elements of bottom-up approaches in the discussion of policy, compared to the past.

### Emotion and Culture

Supervisor:     YIK Michelle / SOSC
Student:        CHO Tze Hei / IIM                       Course:          UROP1000, Summer

Despite the abundance of literature on the influence of culture and language on subjective experience of emotion, there is an absence of empirical evidence of their independent effect. An approach on investigating the relationship of culture, language, and emotion was proposed, with in-depth discussions on various prerequisites and hypotheses.

### Returned Scholars and University Reform in China

Supervisor:     ZWEIG David Stephen / SOSC
Student:        CHEN Yuk Pui / MGMT                     Course:          UROP1000, Summer

The most popular topic among returnees is the employment status of returnees in China's job market. It is becoming more common that returnees cannot find a good job after they are back. However, many still believe that going abroad can gain them advantage in job hunting, comparing with local students. This report will discuss the views of two parties — the returnees and recruiters of famous Chinese firms. For returnees, the focus is on the difficulties they are facing and their career plans. For recruiters, the focus is their thoughts on the returnees and the current job market. Government's policies will also be briefly mentioned in explaining the job market status.

# INSTITUTES & CENTERS
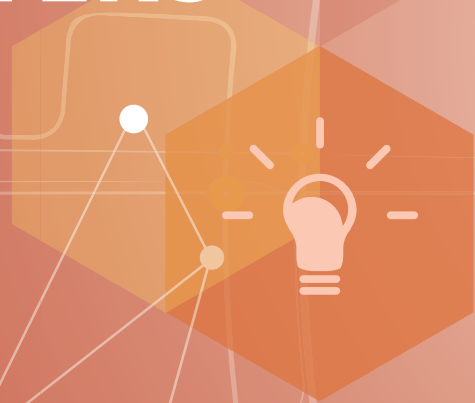
# Institute of Emerging Market Studies

### Trade and Investment under China's Belt and Road Initiative - Implications for Hong Kong

| | | | |
|---|---|---|---|
| Supervisor: | TRITTO Angela / IEMS | Co-Supervisor: | PARK Albert Francis / ECON |
| Student: | JUNAEDI Victoria Amanda / ECOF | Course: | UROP1100, Spring |

The Belt and Road Initiative (BRI), first announced in 2013 by the government of the People's Republic of China, will bring about economic cooperation among countries in Europe, Asia, and Africa. Indonesia is one such country, and Chinese investments span across infrastructure, mining, and energy sector. However, from a socio-cultural point of view, there still exists some form of hostility towards Chinese-Indonesians and China itself, which may present a challenge for Chinese investments in Indonesia. In this project, we look at two distinct topics: the industries that receive most BRI investments and Indonesians' general sentiment towards Chinese investments.

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|---|---|---|---|
| Supervisor: | TRITTO Angela / IEMS | Co-Supervisor: | PARK Albert Francis / ECON |
| Student: | JIANG Wenda / ECOF | Course: | UROP1100, Summer |

China's Belt and Road Initiative has secured international attention due to its influential geopolitical and economic impact on the countries interspersing the historical trade routes. Within these countries, the complexity of sentiments towards China could not be disguised under the monolithic official laudation. The intensity, polarity and other more sophisticated sentiments attributes towards China and its investments vary across different countries. My main tasks are to assist some regression analysis and try to establish a comprehensive database of China-related news articles, a foundation for the further sentiment analysis. After merging two China FDI datasets, I have been cooperating with a data science Ph.D. student to download over 100,000 articles and start larger-scale data retrieval. This whole process has taught me how arduous a research project could be and how rewarding it is to push outward the current limits.

# |IROP Overview & Projects

2018 marks the 7th year for the International Research Opportunities Program (IROP). In the summer, we sent out five aspiring undergraduate students to the Massachusetts Institute of Technology (MIT) to learn from some of the world's best researchers.

Five MIT students came to our Clear Water Bay campus to explore their interested topics under the guidance of our faculty members. They also connected with other HKSUT UROP students by working together on the research projects and enjoying the summer time in a different culture.
On July 26th, a mini conference was held for both the MIT students and the UROP students to present their projects to their fellow students and project supervisors.

The projects done by the MIT and HKUST students are listed as follows:

## MIT Students

**Thomas BENAVIDES**
*Major in* Materials Science
*Supervised by:* **Professor Angela WU / Division of Life Science**
*Project Title:* Fabricating Microfluidic Devices for Biological Applications

**Jose GUAJARDO**
*Major in* Computer Science & Electrical Engineering
*Supervised by:* **Professor Rhea LIEM / Dept. of Mechanical & Aerospace Engineering**
*Project Title:* Probabilistic Approach in Flight Trajectory Modeling For Fast and Efficient Noise Contour Generation

**Meital HOFFMAN**
*Major in* Computer Science & Engineering
*Supervised by:* **Professor Pan HUI / Dept. of Computer Science & Engineering**
*Project Title:* AR Campus

**Xiqing WANG**
*Major in* Mechanical Engineering
*Supervised by:* **Professor Jinglei YANG / Dept. of Mechanical & Aerospace Engineering**
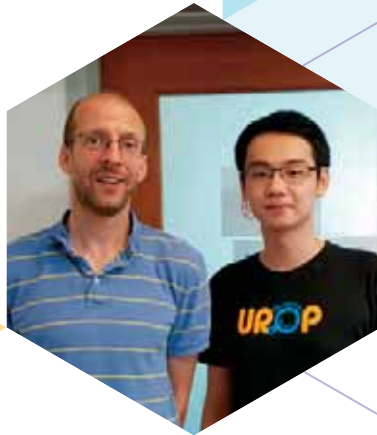*Project Title:* Design of Smart Wearables for the Elderly

**Lawrence WONG**
*Major in* Computer Science & Molecular Biology
*Supervised by:* **Professor Jiguang WANG / Division of Life Science**
*Project Title:* Effective Computational Pipeline for RNA Sequence Variant, Allele Specific Expression, and Loss of Heterozygosity Identification

## HKUST Students

**Qiao GU**
*Major in* Electronic Engineering and Computer Science
*Supervised by:* **Professor Thomas HELDT / Dept. of Electrical Engineering and Computer Science**
*Project Title:* Characterizing Fluid Response and Sepsis Progression by MAP, HR Time Series during ED Stay

**Ziuwin LEUNG**
*Major in* Biotechnology
*Supervised by:* **Professor Charles SODINI / Dept. of Electrical Engineering and Computer Science**
*Project Title:* Continuous and Non-invasive Blood Pressure Monitoring using Ultrasonic Methods

**Zhi Yong Ignavier NG**
*Major in* Computer Science and Mathematics
*Supervised by:* **Professor Una-May O'REILLY / MIT Computer Science and Artificial Intelligence Laboratory**
*Project Title:* Lipizzaner: A System That Scales Robust Generative Adversarial Network Training

**Guanzhi WANG**
*Major in* Computer Science and Mathematics
*Supervised by:* **Professor Thomas HELDT / Dept. of Electrical Engineering and Computer Science**
*Project Title:* Drowsiness Detection from Video Recordings Obtained from Consumer-grade Electronic Devices

**Yanbang WONG**
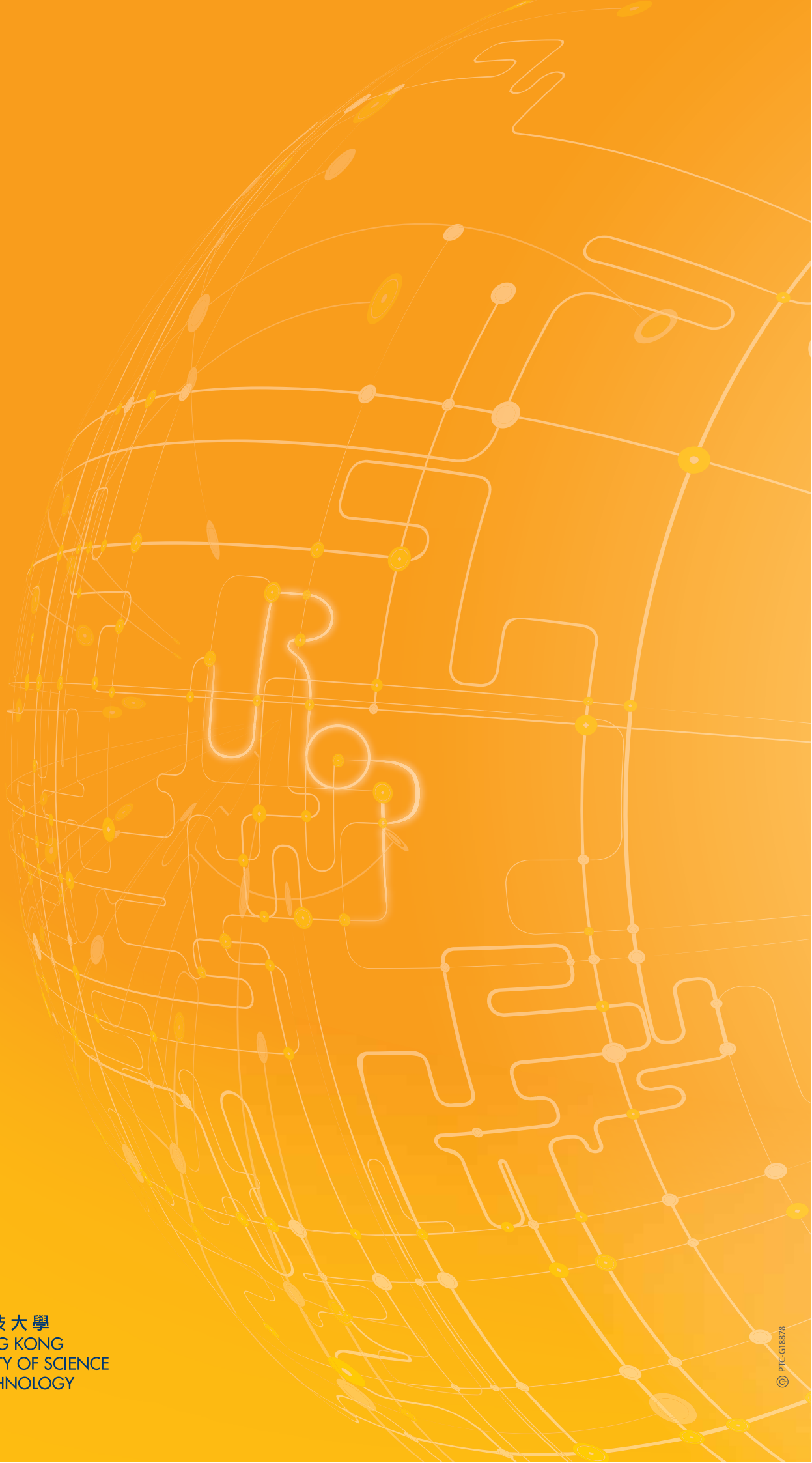*Major in* Computer Science and Mathematics
*Supervised by:* **Professor Una-May O'REILLY / MIT Computer Science and Artificial Intelligence Laboratory**
*Project Title:* Using Detailed Access Trajectories for Learning Behavior Analysis

f HKUST's UROP 🔍

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