Quantitative EEG Analysis for early detection of cognitive disorders

Dr Dharmaratne, Anuja Thimali
Associate Professor, PhD

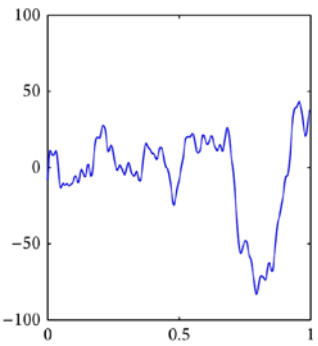
Research expertise: Image Processing, Computer Vision, Machine Learning, Pattern Recognition, Virtual Simulation

E: anuja@monash.edu
T: +603 5514 6085

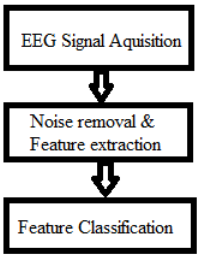
Digital EEG (Electroencephalography) is a widely used methodology for recording, reviewing, and storing internal functioning of the brain on a paper. QEEG (Quantitative EEG), on the other hand, it is not the same as a conventional clinical EEG. Using QEEG, one can evaluate the pattern of the brain functioning but it does not assess the structure of the brain.

Researchers have a belief that both EEG and QEEG data can be utilized to evaluate brain function, and to track the changes in brain functioning.

This concept can be researched further to identify whether the EEG records show some common patterns when it comes to different cognitive disorders such as ADHD, Autism, etc.



A one-second EEG signal



A rough overview of the process

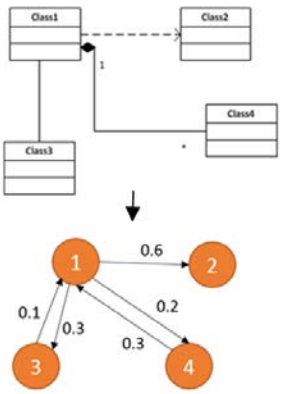
Constrained Clustering Approach to aid in Remodularisation of OO Software Systems

Dr Chong, Chun Yong
Lecturer, PhD

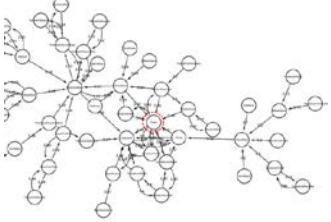
Research expertise: Software Engineering, Software Remodularisation, Software Clustering, Design Recovery, Graph Theory, and Software Bug Prediction.

E: chong.chunyong@monash.edu
T: +603 5515 9704

To aid in maintaining poorly designed or documented software systems, researchers have proposed to apply software clustering to recover a high-level semantic representation of the software design by grouping sets of collaborating software components into meaningful subsystems. This high-level semantic representation serves to help bridge the dichotomy between the perceived software design from the maintainers' view and the actual code structure. Our research focus on representing software using weighted complex network in conjunction with graph theory to help in understanding and analysing the structure, behaviour, as well as the complexity of the software components and their relationships from the graph theory's point of view. Based on the analysis, software clustering is performed to create several disjoint sets of clusters. The clustering results can help in remodularisation of software systems through better comprehension of software design, and alert software maintainers regarding the risk of classes that violate software design principles.



Transforming UML classes into weighted complex network



Applying graph theory metrics to analyse the structure, behaviour, and complexity of software components..

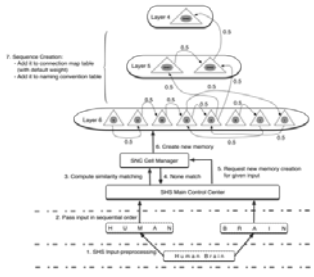
Diverse Applied Machine Intelligence Research: From Intelligent Network to Big Data in Standardized Clinical Documents and Neuroimaging.

Dr Muhammad Fermi Pasha
Lecturer, PhD

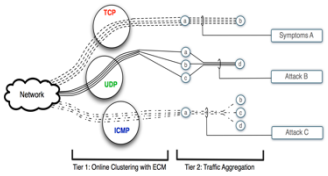
Research expertise:
Evolving System, Adaptive Network Security and Traffic Analysis, Neuroimaging, Big Data in Healthcare, Medical Image Analysis Platform, Healthcare and Radiology IT

E: muhammad.fermipasha@monash.edu
T: +603 5515 9703

The endless goal of machine learning research was to give a sense of intelligence, inspired by the human brain, into a machine via an effective utilization of the machine-learning algorithm. In this regard, our focus is on modelling the neocortex, one of the largest areas of human brain responsible to forms human memory and it is believed that the ability of neocortex in storing and manipulating memory is the foundation of human intelligence. On an application context, there are few on-going and future projects in the pipeline. Firstly, with the blooming usage of IoT, raw (undecoded) network traffic data is becoming a source of big data that can be learned and analysed not only from network security perspective but also from user usage behaviour. Secondly, recent introduction of clinical document standard opens up true big data analytics scenario where no fragmentation of data exists. Our research project focus is to utilize standardised clinical document as a source of big data and provide predictive clinical analytics, evidence-based clinical advices, in addition to business intelligence. Thirdly, we are venturing into frontier neuroimaging research and looking at applying machine intelligence to not only improving the fiber tracking process but also to provide clinical analysis to certain brain diseases as well as cloud infrastructure to efficiently store and retrieve the massive neuroimage data as well as providing an online pipeline for anywhere anytime analysis.



Neocortex-inspired model



Learning Network Traffic Pattern

Corpus Callosum Fiber Tract on Patient with Pineal Gland Tumour

Algorithms and data structures for large scale string processing

Dr Jasbir Kaur Dhaliwal
Lecturer, PhD

Research expertise:
String matching
String mining
String decompression
Information Retrieval for social media

E: jasbirkaur.dhaliwal@monash.edu
T: +603 5515 9661

The Burrows-Wheeler transform (BWT) is a technique that permutes the characters in a string into similar character runs. This permutation is reversible, and such a property is crucial in compression to allow both compression and decompression.

Much research has been carried out on constructing the BWT, but very little on reversing the BWT. For a very large string collection, there might not be enough RAM to reverse the BWT using traditional approaches. In such cases, we have to use external memory and, reverse the BWT on disk. The only previous work on the problem is a theoretical algorithm. We are not aware of any practical implementation of this algorithm.

Currently, together with our collaborator from Chile, we are exploring an implementation the uses simple scanning and compression techniques in external memory.

BWT (banana$) ⟶ annb$aa

BWT for string banana$ is annb$aa

F						L
$	b	a	n	a	n	a
a	$	b	a	n	a	n
a	n	a	$	b	a	n
a	n	a	n	a	$	b
b	a	n	a	n	a	$
n	a	$	b	a	n	a
n	a	n	a	$	b	a

The first column F contains the string characters in order, and the last column L is the BWT

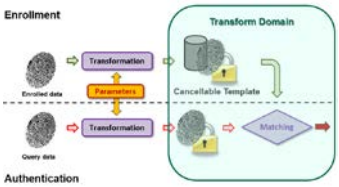
Biometric Security: Practice for Secure Biometric System and Privacy Preserving

Dr Jin Zhe
Lecturer, PhD

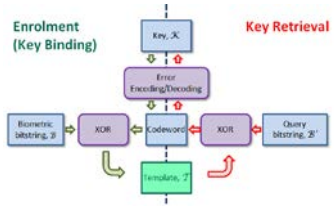
Research expertise:
Biometrics,
Multimedia Security,
Machine Learning

E: Jin.Zhe@monash.edu
T: +603 5514 5813

Biometrics has been integrated in large-scale personal identification systems. However, if biometric is compromised, severe influences of biological nature of human are concerns. Particularly, the damage to person's privacy and security is permanent due to the irrevocability and irreplaceability nature of human traits. Biometric security is created to devote creating feasible solutions for protecting biological data with large variety. Our research is to design secure biometric template, i.e. cancelable biometrics and further develop bio-cryptosystem, including key binding and key generation from biometric traits. Currently, we have several ongoing projects on this area, such as Development of Biometrics-based Key Infrastructure Technology for On-line Identification funded by ETRI, South Korea and Protected Fingerprint Template Recognition and Encrypted Matching funded by Key Laboratory of Jiangxi Province for Image Processing and Pattern Recognition (Nanchang Hangkong University China)



Cancelable biometric design for fingerprint, iris etc.



Biometric Cryptosystem (Key Binding Scheme) for protecting cryptographic key

Work System Design for complex human-system interaction

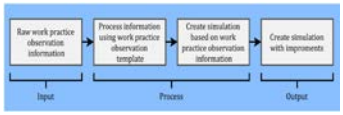
Dr Nik Nailah Abdullah
Lecturer, PhD

Research expertise:
Multi agent system,
Empirical requirements engineering

E:nik.nailah@monash.edu
T: +603 5514 6086

Work system design aims to understand how the computer system and the human system can be most productively integrated. As a model of how work actually occurs using Brahms tool. Brahms is a tool that enables modeling, analyzing, simulating, and designing work systems from a total-systems perspective, integrating people, tools, procedures and facilities. The Brahms modeling language, an artificial intelligence language enables formalizing roles, schedules, procedures/protocols, documents, tools and facilities so that total system and its emergent interactions can be better understood and visualized. The methodology using Brahms for work system design helps designers understand the context in which computer tools are used. For example, a model of practice reveals how information that is entered into a computer database is first acquired by reading a faxed form, by talking to the person in the next cubicle, or by looking up instructions in a manual. How certain aspects of the work practice routine can be automated is designed that improves and fit within the total work practice.

Work practice modeling and simulation using Brahms at a moment by moment activity



One example of using Brahms as part of work system design methodology

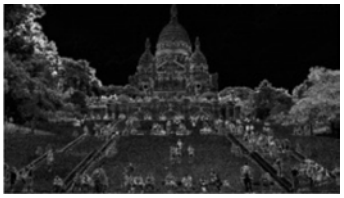
Unified Information Hiding: Solution for Confidentiality, Integrity and Anti-piracy

Dr Wong, Kok Sheik
Associate Professor, PhD

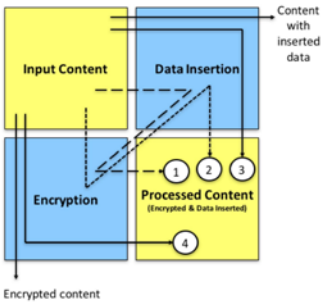
Research expertise: Multimedia signal processing, data hiding, encryption, compression and their joint applications.

E: wong.koksheik@monash.edu
T: +603 5514 6090

With the advent of smart network enabled consumer electronics at affordable prices, multimedia content is nowadays generated and communicated at a staggering rate. This large number of contents needs to be managed for better administrative and storage purposes, where information hiding, including watermarking and fingerprinting, have been largely deployed to secure and trace multimedia contents. On the other hand, the increasing trend of storing contents online using cloud storage further drives the needs of multimedia encryption technology to provide confidentiality. In this research, we aim to strike a balance among the conflicting requirements of data hiding, encryption, and compression to provide extra functionalities to multimedia contents. Currently, we have an on-going project on unified information hiding for multimedia content, which is funded by MOSTI ScienceFund. We also work closely together with our collaborators in Japan (Kakenhi), Taiwan, UK, France (EU H2020), and China.



Information leaked from encrypted image using our research finding



Different ways of achieving unified information hiding

Adversarial Games: the Case of Hidden Thoughts & Real Fakes

Prof Ir Dr Raphael Phan
Professor, PhD

Research expertise: Security, cryptography, privacy, malicious AI, dark side technologies.

E: Raphael.Phan@monash.edu
T: +603 5514 6212
G: https://scholar.google.com/citations?user=wR84XY1kACcC

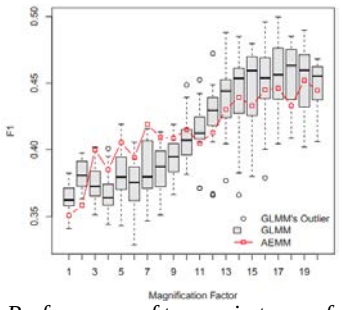
Our main research in recent years has been on technologies for the dark side.

Humans often engage in adversarial games, aiming to conceal and manipulate the other side's impressions and sense of what is actually real. One key research direction we've led is that of recognizing hidden emotions, especially for when individuals aim to suppress what they're really feeling.

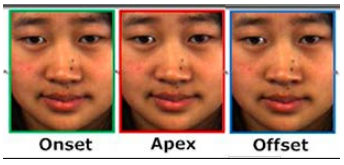
Towards solving this, we have advanced the research techniques for invisible motion magnification.

Our current research focuses on the challenge of deepfakes, which is now plaguing the worldwide community: the risk that anyone's photos could be used to generate video fakes that are visually realistic, showing someone mouthing words s/he did not say, and doing things s/he never did.

Different emotions



Performance of two main types of motion magnifications



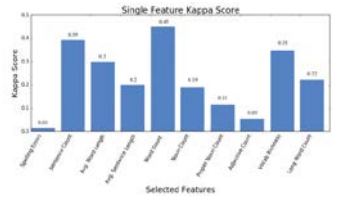
Multimedia (Data/Text/Image) Analytics and Blockchain Systems

Dr Ian K T Tan
Senior Lecturer, PhD

Research expertise:
Multimedia Analytics, BlockChain Systems, Operating Systems, Parallel and Distributed Computing

E: Ian.Tan1@monash.edu
T: +603 5514 4433

Article Clustering and Grading using SVM Based Expert System
This project aims to enhance an SVM based automatic grading of English articles using a set of experts derived scoring system, in other words a hybrid machine learning and rule-based scoring system to automatically grade articles. The final project is expected to be launched online as a service and further collect data to enhance the machine learning component.



Palm Kernel Ripeness Classification using Spikiness and Empty Socket Features
This project aims to feature engineer the spikiness of the palm fruit bunch through edge detection and empty fruit kernel socket detection through shape detection. Through these additional features, the accuracy of automatically classifying the ripeness of the palm fruit bunch can be improved. This project works with actual image data from an oil palm plantation.

Re-parameterization of Blockchain Proof-of-Work Protocol Consensus using Reinforced Learning
The proof-of-work (PoW) protocol allows the code of the blockchain distributed ledger technology to achieve consensus in a distributed manner without the need of a central authority. However, proof-of-work lacks in speed, thus making it unusable as a payment gateway. Thus, there is a need to have the ability to scale with speed and improve on the performance of the PoW protocol.

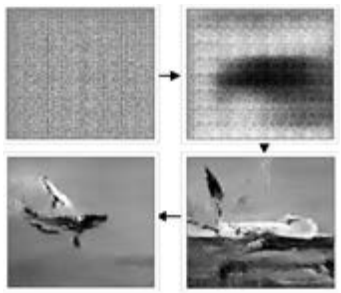
Explainable AI: Integrated Model for High Level Machine Intelligence in Image and Video Understanding

Dr Lim, Chern Hong
Lecturer, PhD

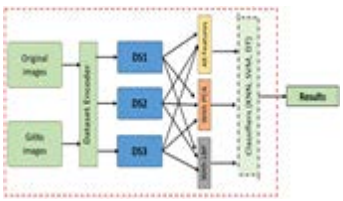
Research expertise:
Image Processing, Computer Vision, Fuzzy Logic, Artificial Intelligence, Machine Learning

E: lim.chernhong@monash.edu
T: +603 5515 9741

Artificial Intelligence (AI) has been widely applied in machines nowadays to achieve desirable goals. Powerful back-end algorithms are developed to support all these intelligence systems, and it is normally denoted as “the brain” of the machine that undertake the thinking and analysis jobs. However, are these systems possess the true intelligence? How far is it comparing to “thinking and reasoning” as humans do? Current state-of-the-art AI based inference systems does not meet this expectation, where the final results are predicted based on “black box” algorithms such as artificial neural network and deep learning. They lack of the explicit declarative knowledge representation that constructs the underlying explanatory model which answer the “Why” questions to a predicted outcome. The main objective of this research is to investigate and implement an effective integrated compositional model for image and video understanding which is capable of explaining the logic of an inference and perform intuitive learning as human do. Currently, we have an on-going project to understand and interpret how Generative Adversarial Networks (GANs) behave in anomaly scene detection.



GANs generator learns to generate examples of normal synthesis scene image (a flying airplane)



Interpretation framework to understand the GANs generated images

Visual and Data Analytics for Surveillance

Dr Lim Mei Kuan
Lecturer, PhD

Research expertise:
Computer Vision, Machine Learning, Pattern Recognition, Swarm Intelligence

E: lim.meikuan@monash.edu
T: +603 5515 9738

Is our social media behavior a window to our mental health?

Motivated by the increasing availability of data from social media and the need to address mental health issues, this project aims to investigate if social media data contains footprint of the behaviour of individuals leading to mental health issues. This project proposes a novel compositional model that integrates the findings from the multimode of variables to predict one's psychological profile.

Do we behave differently in a crowd?

This field of study is motivated by the notion that, "*one who follows the crowd will surpass solitary individual, and together with the crowd would venture beyond places where no lone individual is capable of venturing to"*; a phenomenon known as the emergent behavior. This study explores biologically inspired algorithms towards effective and proactive crowd surveillance.

Sample profile pictures of individuals associated to poor mental health.

Sample of extremely crowded scenes and regions with abnormal crowd flow.

Building Knowledge from User-Generated Content with User Profiling

Dr Lim, Wern Han (Ian)
Lecturer, PhD

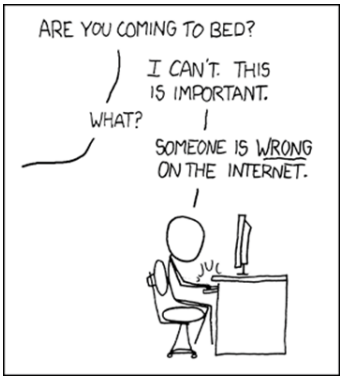
Research expertise:
Information Retrieval, Data Science, Machine Learning, Use Profiling

E: lim.wern.han@monash.edu
T: +603 5515 9662

The World Wide Web (WWW) of today is mainly comprised of User-Generated Content (UGC) through modern Web 2.0 platforms such as Social Networking Services (SNS). The users of today are no longer just consumers of content from expert authors or editors; instead they are now the active contributors and disseminators of content. Collaboratively as a Wisdom-of-the-Crowd (WotC), these content are valuable for information systems. For example, user annotations such as hashtags could describe or provide additional context for an image.

Such influx in UGC however complicates the content management on the WWW particularly content that are of low information quality. This could be due to the variance of both the reliability and expertise of the content contributor. Besides that, some content could be malicious by nature such as the wide spread of Fake News that gained prominence following the 2016 United States of America Presidential Campaign.

My work focuses on the estimation of information quality of UGC. The goal is to identify valuable information that could be mined as knowledge; filtering out unwanted noise or misleading information. To this end, my work would profile the users according to their expertise and reliability; according to their roles and topic of their contribution on the WWW. As a by product, the research enable us to identify experts who we could then encourage to further enrich the density of information on the WWW with new knowledge.



It has been a struggle for everyone in dealing with the amount of misinformation on the World Wide Web (WWW).

User annotations could describe objects in an image without the need for complex image processing.

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Machine Learning Based Knowledge-Defined Networking (KDN) Orchestration for NFV Resource Management

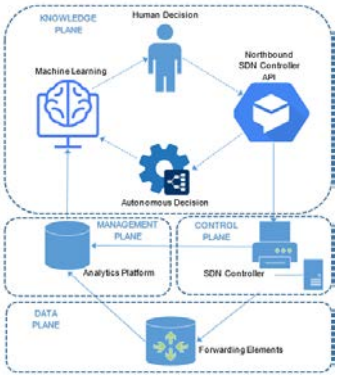
Dr Tan, Chee Keong
Senior Lecturer, PhD

Research expertise:
Software-defined networks, beyond 5G networks, indoor positioning scheme, game theory, machine learning and data science

E: tan.cheekeong@monash.edu
T**:** +603 5514 5608

Knowledge-defined networking (KDN) is a new networking paradigm that mainly relies on software-defined networking (SDN) and machine learning (ML) that may potentially shift the way we operate, optimize and troubleshoot data networks. A knowledge plane (KP) is defined in the context of the SDN paradigm which is able to learn the behaviour of the network and autonomously operate the network accordingly. Based on the network analytics collected by the management plane (i.e., pre-processed data or raw data), KP transforms them into knowledge via ML and uses that knowledge to make decisions automatically or manually (through human intervention).

The resource management problem in a network function virtualization (NFV) is a complex problem due to the complexity of the optimal placement of virtual network functions (VNFs) in NFV deployments. The introduction of KDN paradigm can addresses many challenges posed by NFV resource management problem by characterizing, via ML, the behaviour of a VNF as a function of the collected analytics such as traffic characterization, network element characterization, or network performance modelling. This is useful to optimize the placement of the VNFs and thereby optimize the overall networks.



Emotion Mining for Cyberbullying Detection

Dr Soon, Lay Ki
Senior Lecturer, PhD

Research expertise:
Text Analytics
Natural Language Processing (NLP)
Database Technologies

E: soon.layki@monash.edu
T: +603 5514 6026

Cyberbullying occurs when users post insulting posts, often with profanity, which are directed to specific users. Identifying cyberbullying at the earliest stage is very crucial to prevent any unbecoming negative impact on the victims. Predominantly, supervised text mining that works on labelled corpus has been used for cyberbullying detection. Labelled corpus are normally represented using words or word features where cyberbullying-bound words are given extra weight. Unfortunately, these methods suffer the limitations of having sparse data (infrequent appearance of profanity), inaccurate word contexts (e.g. informal language) and dirty data (e.g. misspelled words). Besides, none of the existing technique takes into account the influence of culture in cyberbully. This project attempts to adapt emotion mining techniques for detecting cyberbullying. Emotion mining aims to identify the emotion expressed in the texts by using affective lexicons. Understanding that cyberbullying can be culturally-bound, this research aims to verify the hypothesis that emotion mining techniques can be adapted to detect cyberbullying effectively.

Examples of false negatives due to misspelled or infrequent words used for cyberbullying:

"Are your parents addicts or what?"

“LOL ur a padophile!”

“Are you immune to being potty trained?"

Examples of false negatives due to culture-bound bullying texts:

Offensive for French:
“Keep jumping, little frog!"

Offensive for Chinese:
“I’ll wear black for your big day XX”

Semi-supervised learning for feature selection of data

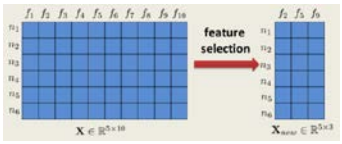
Dr Ganesh, Krishnasamy
Lecturer, PhD

Research expertise:
Machine learning
Computer vision
Image processing
Optimization
Deep learning

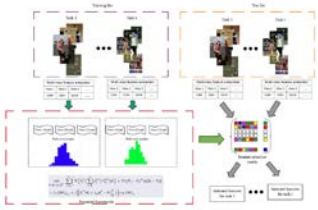
E:
ganesh.krishnasamy@monash.edu
T: +603 5514 5613

Feature selection is widely utilized for data analysis. Recently, considerable advancement has been achieved in semi-supervised multi-task feature selection algorithms, where they have exploited the shared information from multiple related tasks. However, these semi-supervised multi-task selection feature algorithms are unable to naturally handle the multi-view data since they are designed to deal with single-view data. Existing studies have demonstrated that mining information enclosed in multiple views can drastically enhance the performance of feature selection. My work focuses on developing a novel mathematical framework is introduced for multi-view Laplacian semi-supervised feature selection by mining the correlations among multiple tasks. The proposed algorithm is capable of exploiting complementary information from different feature views in each task while exploring the shared knowledge between multiple related tasks in a joint framework when the labeled training data is sparse.

Feature selection



Proposed algorithm



Integrative analysis for cancer biomarker discovery

Dr Ong Huey Fang
Lecturer, PhD

Research expertise:
Artificial Intelligence,
Data mining,
Bioinformatics,
Software Engineering

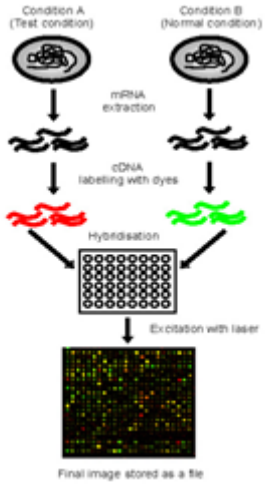
E: ong.hueyfang@monash.edu
T: +603 5514 4488

Cancer is a disease that generally arises due to an abnormality in cell growth. These changes may cause normal cells to malfunction and turn into abnormal cells, which can grow out of control, invasive and eventually progress to cancer. Therefore, early detection of the presence of underlying biomarkers for a specific cancer is invaluable as it helps in early diagnosis, prognosis, and treatment.

Biomarker discovery is the identification and measurement of intrinsic features in high-throughput molecular profiling technology. For instance, our research focuses on the exploratory studies of gene expression data to identify relevant overexpressed and underexpressed genes in sample tissues. The proposed solution is expected to facilitate a fast, accurate, reproducible, interpretable, and systematic prediction when combined with intelligence methods that can address the computational challenges of complex and high-throughput data, such as sensitivity and specificity.

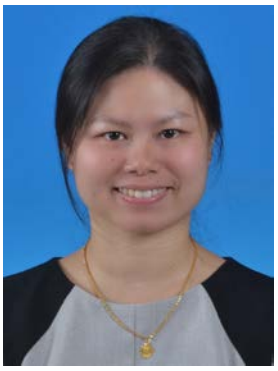
For future research, the wealth of omics data has opened more possibilities for computer scientists to explore many of the current challenges faced in cancer studies and diseases.

Phases of biomarker development



Microarray experimental design to study expression of genes

Emergence of Cloud Computing in E-Learning



Dr Lillian Wang
Lecturer, PhD

Research expertise:
Cloud E-Learning
Educational Technology
Technology Acceptance
IoT for Education

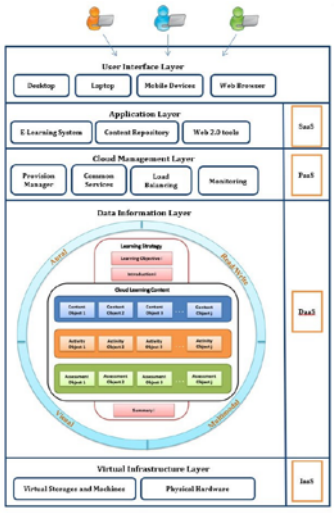
E: lillian.wang@monash.edu
T: +603 5514 6044

Over the years, e-learning has been supporting learning processes with ICT through the Internet, especially in higher education. With the evolution of ICT, many HEIs have migrated from conventional learning methods into upgraded e-learning processes. To support such progression, HEIs must have adequate ICT infrastructure and huge investments, and this has become a challenge to many higher institutions.

How does Cloud computing address the high-cost and high-complexity challenges of the conventional e-learning?

A Cloud e-learning framework is designed to address the high-cost and high-complexity challenges for e-learning in higher education. The novelty of this framework lies at the Data Information Layer where Cloud e-learning objects are developed to optimise resource utilisation.

The Cloud e-learning framework can serve as a base framework in the process of enhancing e-learning infrastructure to build a sustainable and flourishing e-learning for higher education.



Cloud E-Learning Framework

Cloud E-Learning Module

Machine Learning Architecture for Facial Micro Expression Recognition

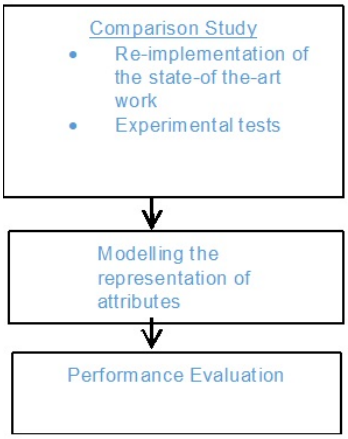
Dr Wee, Mee Chin
Senior Lecturer, PhD

Research expertise:
Learning Technology,
Machine Learning,
Artificial Intelligence and their joint applications,
Mobile Health.

E: Wee.MeeChin@monash.edu
T: +603 5514 4424

Over the last few years, automatic facial micro-expression analysis has garnered increasing attention from experts across different disciplines because of its potential applications in various fields such as clinical diagnosis, forensic investigation and interrogation, and public security systems. However, there is no emotional analysis or evidence to analyse emotional state of individual for personal awareness, and so that the individual can act to it positively. At the moment, all the attributes (facial micro expression has the tiny intensity and *almost* 1/25~1/3s duration) have to be manually annotated by professional psychiatrists, which are very difficult to observe. This is a cumbersome and time consuming process.

A challenge and novelty in this line of research is to explore how to collaborate machine learning algorithm, to improve the micro expression recognition process to a more intelligent manner, for more practically realistic framework. In this research, we will look into several mathematical formulas and algorithms to represent the micro emotional attributes.



A rough overview of the process