MONASH University

MALAYSIA

SCHOOL OF
INFORMATION TECHNOLOGY

# Research Profile

2024/2025

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# Contents

# MESSAGE FROM THE HEAD OF SCHOOL

**Professor Anthony Guo**

Head, School of Engineering
Head, School of Information Technology

**Monash University Malaysia is committed to making a difference. At the School of Information Technology, we strive to achieve this goal through excellence and impact in research, providing an excellent environment and support for academics to develop their careers, and offering world-class graduate research training programs.**

We place overwhelming emphasis on high-quality research. To achieve our goals, we put in place an abundance of support schemes for staff development and graduate research training. Our research spans five main areas, including Artificial Intelligence, Cybersecurity, Data Science, Software Engineering, and Digital Health. Currently, the School of Information has more than 20 active research projects. Our funding sources are government, industry, and international funding agencies, supplemented by our increasing internal funding and investment in research. We host the Advance Computing Platform (ACP), providing the computational resources required by the School of Information Technology and the wider campus community. The high-performance computing facility has been recently upgraded to address the increasing need to train bigger and more complex models.

We offer full-time research programs – Master of Philosophy (MPhil) and Doctor of Philosophy (PhD) in which students work on projects in the five research areas. There is a strong vibrant

Graduate Research Students community in the School, with over 50 of them working on their PhD or MPhil supported by external grants and the campus under the Graduate Research Excellence Scholarship (GRES) and Global Excellence and Mobility

Scholarship (GEMS) schemes. Students can gain global research experience through the campus and school mobility support schemes to visit other Monash campuses or other institutions.

The School of Information Technology also offers three Master's programs by course work, including the Master of Artificial Intelligence, Master of Business Information Systems, and Master of Data Science. These industry-

driven programs are tailored to students and IT graduates who aspire towards career advancement in a competitive and changing global environment, in particular when information technology is applied in every domain. Each Master’s program also offers a minor thesis option as a pathway to our PhD program.

This booklet provides a snapshot of our staff’s research activities. We welcome prospective students to explore the generous research Scholarships offer and the opportunity to work with our academics. We also look forward to potential industry engagements and research collaborations that align with our core commitment to research excellence and impact. Finally we welcome talents joining our school to pursue your career aspirations with us.

The Future is IT!

# RESEARCH HIGHLIGHTS

## Understanding Human Brain Function as Networks

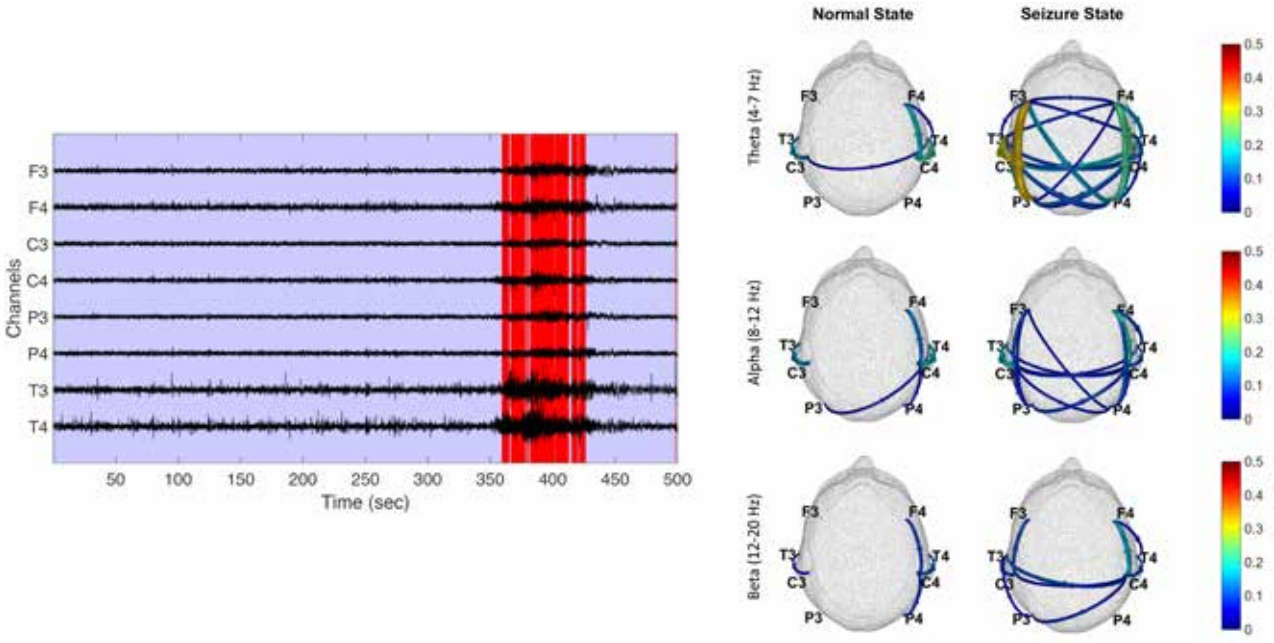
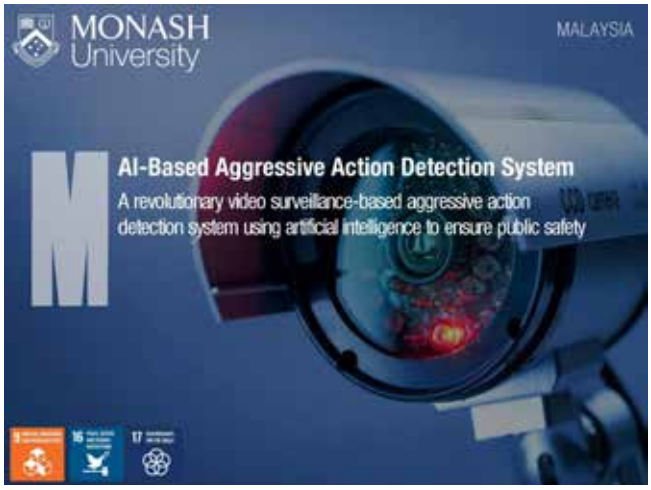



*Figure: Difference in EEG-derived brain connectivity patterns between normal and seizure state in an epileptic patient.*

Different spatially-distinct brain regions interact with each other as a network, just like a group of friends in a social network. The concept of modelling connectivity between brain regions remains very challenging due to complexity of the network data both in space and time, as the brain network topology tends to change over time. This leads to a new research field - network neuroscience, leveraging on recent developments in statistics, machine learning, information theory, and computational neuroscience, to extract patterns and new insights from brain network data.

A/Prof. Dr Chee-Ming Ting secured an international grant (USD 131,040) from the King Abdullah University of Science and Technology (KUAST), Saudi Arabia to explore this new research.

# Sunway-Monash Weapons Detection





The Sunway-Monash Weapons Detection Project is a collaboration between Monash University, led by Assoc Prof. Vishnu Monn Baskaran, Prof. Edwin Tan Chee Pin, Assoc. Prof. Wong Kok Sheik, Dr. Marcus Lim Jun Yi, Dr. Ricky Sutopo, and Sunway Berhad, represented by Dato Tan Kia Loke, Chuan Yong, and Noelle Tan. This innovative project ushers in a new era of surveillance innovation in the field of public safety technology.

At its core, the project utilizes advanced deep learning algorithms to analyze real-time CCTV footage, effectively identifying aggressive behavior and weapons as potential threats. This proactive approach enables early threat detection, a crucial step in enhancing security measures.

One standout feature is its autonomous tracking capability, swiftly monitoring suspect movements within the surveillance network. This feature empowers law enforcement by providing real-time actionable information, enabling quick and effective responses to potential threats. Additionally, the seamless integration with existing infrastructure and centralized processing servers makes it a cost-effective solution, eliminating the need for extensive infrastructure upgrades.

The project's impact extends beyond mere identification, playing a pivotal role in suspect apprehension. By facilitating swift and efficient law enforcement actions, it significantly enhances community safety. Its adaptability across various sectors such as airports, educational institutions, municipalities, that underscores its versatility and potential to revolutionize security measures in diverse settings.

Overall, this project signifies a paradigm shift in surveillance technology, aiming not just to respond to incidents but to proactively prevent them. Through innovation, collaboration, and a focus on proactive security measures, it aims to create safer and more secure communities in an evolving landscape.

# RESEARCH HIGHLIGHTS - BY GRADUATE RESEARCH STUDENTS

## Neuro-symbolic Logic Reasoning Model for Decision Making Support in Legal Scenarios

Legal language can be confusing and challenging to understand, much like trying to decipher Minion language. Words like "consideration" may have a specific legal meaning that is vastly different from everyday English, leading to confusion for those who are not well-versed in legal jargon. However, with the rapid expansion of Natural Language Processing (NLP) in legal documents, there is hope. Our proposed solution involves training a neuro-symbolic model that can identify legal concepts and provide insightful analysis, supported by relevant information like court cases or statutes. With this trained model, we aim to make legal analysis more accessible and easier to understand by answering users' questions with human-interpretable reasoning traces. So, say goodbye to feeling lost in legal jargon - our solution has got you covered!

By Xiaoxi Kang
(PhD candidate)

## Reveal Your Class: Deciphering Students' Emotions During Online Learning


Successful Teaching is not only quality learning content. Emotional interactions with the students are equally important. Rapid transition from physical to online classes, missed “Emotional” piece from the scene. Online learning platforms are getting better at quality content delivery with the advancement of technology. But still we have forgotten the emotions. Can we incorporate Emotion Awareness to online learning? Can machines understand students’ emotions by looking at Facial Expressions, Eye Movement Behavior, and Body Gestures? Is it possible to reveal the emotional state of the online class to the teachers and customize teaching method for a better learning environment in future?

by Yohani Ranasinghe
(PhD candidate)

## Cybersecurity

- Cheat resilience
- Cryptography
- Dark side security
- Deepfakes
- Multimedia security
- Privacy-preserving methods
- Surveillance

## AI

- Computer vision
- Bayesian AI
- Deep learning
- Ethical AI
- Explainable AI
- Generative AI
- Machine learning
- Natural language processing
- Optimisation

## Data Science

- Data management
- Information retrieval and extraction
- Knowledge management
- Recommender systems
- Social media and network analytics
- Statistical data modeling

# The Future is IT

The research activities in the School of Information Technology are classified into five focus areas. Each aims to make a positive impact on communities and the lives of people for a better cyber-physical world.

## Digital Health

- Big data in health care
- Bioinformatics
- Bio-signal and image processing
- Chronic disease management
- Computer-aided diagnoses
- Digital twin and simulations
- Tele-therapy

## Software and System

- AR/VR
- Blockchain
- IOT
- Metamorphic testing
- SE education
- Software engineering in AI
- Software quality
- Testing and maintenance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003


CYBERSECURITY
Data Security
004

# Adversarial Games: the Case of Hidden Thoughts & Real Fakes

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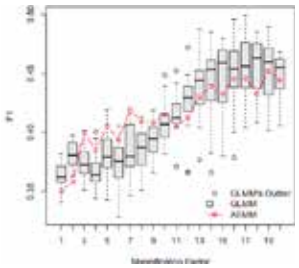
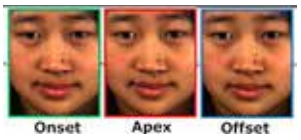
*Different emotions*



*Performance of two main types of motion magnifications*




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.

# Multimedia Security

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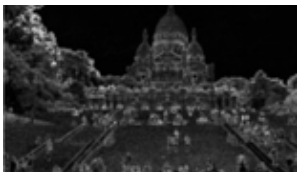
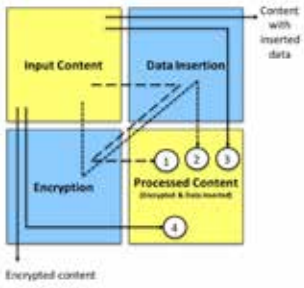


*Information leaked from encrypted image using our research finding*




*Different ways of achieving unified data hiding*

Our research has been revolving around multimedia signal processing, focusing on designing the underlying content manipulation techniques to realize applications such as content watermarking, encryption, authentication, fingerprinting, to name a few. We coined the term "complete quality preservation" in data hiding, where not only does the content appear to be the same before and after data hiding, but the decoded values are also exactly the same, which departs from the conventional approaches where distortion is inevitable. We've also advanced the techniques in providing scalable carrier capacity while preserving quality. On the other hand, we investigate existing systems' vulnerabilities and design solutions to these identified problems. Our research now focuses on new media, such as high dynamic range image and video, as well as non-traditional media, such as PDF, encrypted content, and network packets.

Furthermore, I aim to bring my research output closer to end-users through collaborations with partners who are working closely with end-users/communities.

# Enhancing Robustness of Deepfake Detection Against Adversarial Attacks

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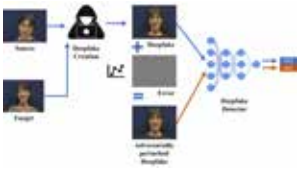
*Crucial features involved in creating a Deepfake detection model.*



*Adversarial Attacks in Deepfake Detection*

I am currently working on Deepfake technology, utilizing generative deep learning algorithms, which create hyper-realistic facial features, challenging traditional detection methods. Presently, many detection methods depend on basic deep neural networks, which are vulnerable to adversarial examples. This vulnerability raises concerns about their reliability. The existing work aims to improve the robustness of these detection systems by employing various techniques such as adversarial training, developing robust models, using ensemble methods, conducting thorough feature analysis, applying transfer learning, and implementing defensive preprocessing.

In future, my focus will be on advancing the effectiveness of adversarial training, refining the development of robust models, exploring new ensemble methods, and putting greater emphasis on feature analysis, transfer learning, and defensive preprocessing. These efforts are aimed at effectively mitigating the impacts of adversarial perturbations in the detection of Deepfakes, thereby enhancing the security and reliability of digital media.

# DATA SCIENCE & AI

# Data Analytics Human-Centric Applications in Supply Chains

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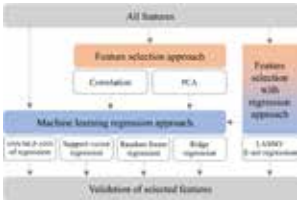
*Blockchain diffusion innovation model*



*Features selection*

Recent advances in technologies such as blockchain, and machine learning have deeply impacted the social, organizational and environmental processes and outcomes involving humans in various ways. These efficient technologies have directed people to promptly act based on the latest information for pre-emptive and precise actions. My research focuses on developing statistical models and computational algorithms for analysis and actions. They characterise the complexity of organisational dynamics relating to the supply chain, logistics, knowledge management and sustainability domains.

Research-in-progress includes feature selections for decision making in logistics supply chain using DEA and machine learning regression; the development of a diffusion innovation model for blockchain technology in agriculture supply chain. I am also keen on using machine learning and geospatial analytics in health epidemiology to predict occurrences of non-communicable diseases. The preceding applied research converges into the realm of human centred computing technology in varied economic sectors.

# Automated Warehouse Systems

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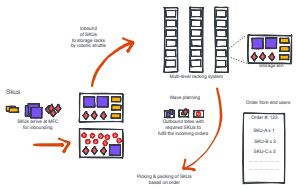

*Flow of inbound and outbound in a fulfilment centre in which multiple store keeping units (SKUs) are allocated to the same storage bin.*

Our main research interest in recent years has been on order management and storage optimisation of fulfilment centres. Modern fulfilment centres often equipped with Automated Storage and Retrieval System (AS/RS) to improve space utilization, productivity and cost effectiveness.

By deploying technologies such as robotic shuttle with lift module, conveyor system, automated fulfilment centres are able to make use of the vertical spaces to increase storage space as compared to traditional warehouses.

We focus on techniques to improve the storage allocation and order fulfilment flow in automated fulfilment centres.

# Building Knowledge from User-Generated Content with User Profiling

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*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.*

The World Wide Web of today consists mainly of User-Generated Content through modern Web 2.0 platforms such as Social Networks. Users 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), such contents are valuable for information systems. Such influx however complicates content management particularly low quality content such as Fake News.

My work focuses on the estimation of information quality. 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 contribution. As a by-product, the research enabled us to identify experts who could then enrich the WWW with new knowledge.

# Predicting Legal Damages: A Natural Language Processing Approach

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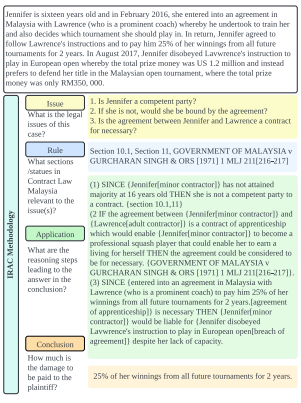


This research explores the intersection of Natural Language Processing (NLP) techniques and legal document analysis to enhance the efficiency and accuracy of legal tasks, particularly in predicting legal damages, which is a crucial aspect of litigation and dispute resolution. There are a few challenges in predicting damage, mainly due to the complexities inherent in legal texts and the nuances involved in quantifying damages. These include the availability of quality benchmarks, multi-faceted factors that could influence legal damages, and the ability of the models in contextual understanding. By leveraging advanced NLP algorithms, this study aims to develop models capable of extracting pertinent information from legal documents, including law statutes, contracts, and judge decisions, to estimate potential damages in legal disputes. Given a case scenario, we aim to first identify factors influencing damage awards, such as breach severity, contractual terms, and mitigating circumstances. Furthermore, the research explores the efficacy of structured data, such as financial records in enhancing the predictive accuracy of the models. One of the anticipated significant contributions of this research is quality benchmarks suitable for legal damage prediction. Ultimately, the findings of this study bring benefit to legal practitioners, researchers, and technologists seeking to harness the power of NLP in the legal domain.

# Enabling Energy-Efficient Internet of Flying Things (IoFT) for Smart City Using Unmanned Aerial Vehicle (UAV) Swarming Intelligence

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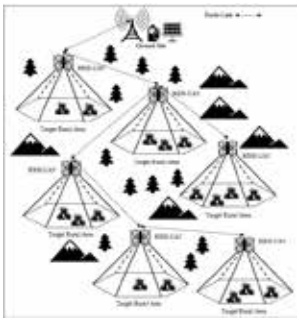

*Fig. 1*

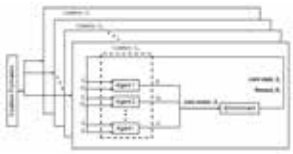

*Fig. 2: Muiti-agent reinforcement learning using CGT-DQN*

The advent of unmanned aerial vehicles (UAVs) has revolutionized the traditional Internet of Things (IoT) framework, giving rise to the Internet of Flying Things (IoFT). UAVs, owing to their remarkable mobility, can now extend connectivity to ground-based IoT devices, presenting a cost-effective means of data collection across geographically dispersed areas lacking adequate terrestrial infrastructure. Nevertheless, the finite battery capacity of UAVs imposes significant limitations on their sensing capabilities and flight duration. This research aims to tackle the energy challenges inherent in UAV swarms by strategically deploying them to maximize coverage while minimizing energy consumption. To achieve this, novel models accounting for altitude and speed variations will be developed, enabling a comprehensive understanding of their impact on energy consumption and coverage. Leveraging UAV swarming intelligence, the integration of deep Q-network (DQN) and coalitional game theory (CGT) will facilitate collaborative efforts among multiple UAVs to optimize energy efficiency and expand coverage. By employing this innovative approach, which merges machine learning with game theory principles, a more pragmatic and effective solution can be realized for the optimal deployment of UAV swarms, thereby enabling energy-efficient IoFT implementations in the context of smart cities.

# Formalizing Intelligence: The perks of befriending causality, context and reasoning for deep learning

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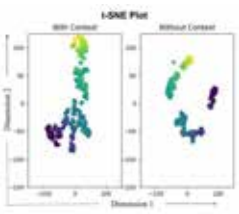
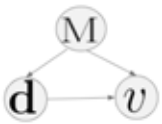



*t-SNE plot : context helps in learning locally continuous feature space.*




*Sample causal graph showing dependencie*


*Reasoning helps in making informed decisions*

One of the cons of deep learning is that it feeds on data and without enough samples it struggles to learn the underlying data characteristics. Context, causality and reasoning increase the expressive power of deep learning systems.

**Context** – helps the deep learning system to incorporate metadata into the learning mechanism in order to approximate the true data distribution and overcome certain types of biases. For instance, considering contextual information like the time and date of an image makes it possible to learn time-space localized image representations.

**Causality** – is used to explain the data through the relationship among its attributes. Such as the relation between the influence of smoking, age, gender etc, on cancer. Essentially, causality answers the whats - what influenced an outcome? Or what may affect an outcome?

**Reasoning** – through reasoning we can guide the purely perceptive deep learning models relying solely on the input features to perform reasoning on the output. This is accomplished by feedback taken from the domain knowledge in the form of complex symbolic rules or mathematical expressions.

# Unleashing Emotions: Membrane-Inspired Fusion for Unconstrained Image and Text Emotion Detection

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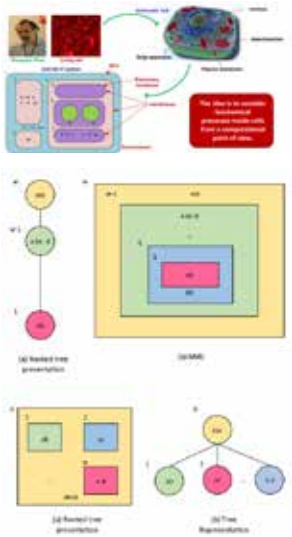

*Membrane Structure*

This research project is driven by the quest to design novel bio-inspired optimization algorithms to address real-world problems. By drawing inspiration from the intricate workings of biological cells, the study aims to propose innovative computational models. The study focuses on the application of membrane-inspired evolutionary algorithms to solve both constrained and unconstrained problems. These algorithms have the potential to significantly improve the accuracy of unconstrained emotion detection, particularly in challenging scenarios. Emotions play a crucial role in understanding human behavior, and by employing natural language processing techniques, computational models can be developed to leverage textual emotion signals effectively. This, in turn, will provide deeper insights into how people think and behave in various situations. A fundamental focus of this research is the exploration of emotion detection from text, accomplished by harnessing the synergistic potential of NLP, deep learning, and membrane-inspired optimization. By integrating NLP techniques, the study aims to unravel the intricate emotional nuances embedded within textual expressions, facilitating the extraction of sentiments, moods, and emotional states. This approach is fortified by the infusion of membrane-inspired optimization, which empowers the algorithms to effectively capture intricate features within textual data.

# Image Enhancement, Video Analysis and AI in Sports

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*Shuttlecock Tracking*


*Badminton Action Recognition Methodology*

My research areas are on image, video, and signal processing. Several mathematical functions and polynomials after some changes to their original form have been used in image processing applications. A typical approach to improve poor quality image is to use a 3x3 mask. Instead of directly using a 3x3 mask to enhance a poor-quality image, we first determine the quality of the image and then relate that quality to the design of the weights in a 3x3 mask. The weights in the mask are created using ABR fractional-order derivative or any other related fractional order derivatives. In an application that uses video processing, we have developed methods to estimate the heart-rate from 4-6 second video frames of a facial image using good resolution digital cameras. However, to be implemented on a handphone with limited computing power and much lower resolution requires several computationally intensive developed methods to be much less intensive without compromising the accuracy.

Video analysis in sports is gaining a lot of attention lately due to AI. Two areas of interest at this moment are badminton and football. Several methods are under study to recognize the actions and the distance covered by the players in a badminton rally. Upon successful development of the algorithms will lead to better strategies employed in a badminton match.

# Active Surveillance using Deep Neural Networks

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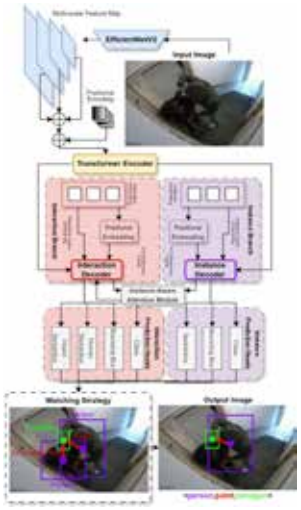

*Architectural overview of the cluster based deep neural networks platform*

Video surveillance for urban security are quintessentially passive driven systems, whereby the recorded or archived content is used as evidence of a criminal activity that has taken place. To improve deterrence against criminal intent, active surveillance represents a viable alternative here. An active surveillance system analyses the content of the video feed in real-time using pattern analysis and feature extraction to identify potential suspicious behaviours leading to criminal intent. However, environmental changes in terms of varying luminance levels and object occlusions degrade detection accuracy in classifying these behaviours.

Nevertheless, the rapid evolution of deep neural networks coupled with significant advancements in computing technology have created new opportunities for a reliable active surveillance framework. As such, our research applies a recurrent neural network algorithm with dynamic temporal behaviour to learn representations of existing criminal video data activities with multiple levels of abstraction. The aim here is to substantially improve the state-of-the-art in suspicious human activity behaviour, specifically in the context of a real-time active surveillance platform for theft classification and notification.

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

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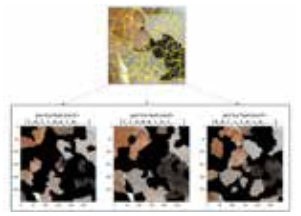

*Multiple image variants created using super pixel combinations for attention analysis in a XAI technique*

*The XAI algorithm, illustrated using a sample from the LIDC cancer dataset*

*The Improved XAI algorithm showing persistent segments used to recognize a Toucan.*

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 undertakes the thinking and analysis jobs. However, do these systems possess true intelligence? How far is it compared to “thinking and reasoning” as humans do? Current state-of-the-art AI based inference systems do not meet this expectation, where the final results are predicted based on “black box” algorithms such as artificial neural networks and deep learning. They lack of the explicit declarative knowledge representation that constructs the underlying explanatory model which answers the “Why” questions to a predicted outcome. The main objective of this research is to investigate and implement an effective integrated compositional model namely Explainable AI model (XAI) for image and video understanding which is capable of explaining the logic of an inference and perform intuitive learning as humans do. Currently, we have on-going projects to understand and interpret how XAI techniques works in medical imaging and computer vision tasks.

# Visual and Data Analytics for Surveillance and Healthcare

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*Sample preferred profile pictures of individuals associated to poor mental health.*


*Sample words used in social media that are associated with negative emotions.*

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

**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. This study provides new avenues for large scale passive monitoring and mental health screening.

**Wisdom of the 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. Swarm intelligence is a trait common in nature, but this project aims to utilise the collective intelligence in swarm to optimise computer vision and machine learning models. Amongst the projects that have applied swarm intelligence successfully includes dynamic object tracking, crowd anomaly detection, and optimal path finding. We are currently exploring the potentials of swarm intelligence in optimising convolutional neural networks.

# Programming Training Data for DL: Equivariance, Invariance Beyond

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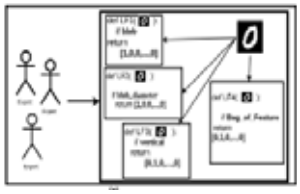
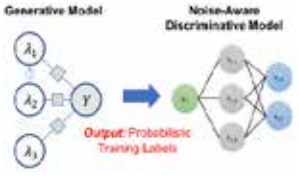


*Domain experts provide weak supervision to the unlabeled data, see image Zero. The noise aware mode, see below, then learns from the weakly supervised data points.*




*The ML model first estimates the label from the consensus of the domain experts. Then, a noise/bias aware DL model learns from those weak supervised data points.*

Deep Learning depends on data - not only the quantity of the data, but also a paucity of the right kind. Deep Learning professionals have shown tremendous progress in developing algorithms but largely skipped the crucial question of **how to leverage production quality labelled data**?

Since the data does not 'show up' out of thin air, we need to request the experts to perform the curation - be it a data collection, or a data pruning, or a data labelling. Creation of large scale hand-annotated datasets is time consuming. Even when data annotation is carried out using crowdsourcing, additional effort is required to measure the correctness, goodness, and most crucially - the biasness.

**Label-It the unlabeled data problem**, is tapping experts' consensus in the right way. Rather than ask an expert to label an unlabeled data point "yes" or "no" for cancer data and blindly expecting the Deep Learning algorithm to find the working principle under the hood - the experts can describe the data labelling process "I see a blob of x cm diameter on the lung". In this way, the experts provide **weak supervision** and not only the class labels. DL then analyses those in aggregate to build a higher-powered algorithm with more nuanced functions, removing bias from the experts' inputs and enabling the system to effectively label data itself.

# AI-enabled IoT Systems for Real-time Applications

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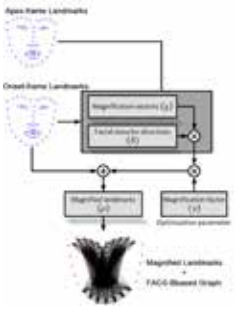
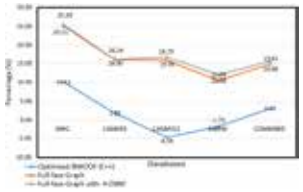


*Invisible Emotion Magnification Algorithm (IEMA) + FACS-based Graph*



*Performance Improvement (%) of Recognition Accuracy*

The use of Artificial Intelligence (AI) and the Internet of Things (IoT) in smart systems for real-life applications is rapidly increasing with the current advancement of technology towards connectivity and speed. In fact, the blend of AI and IoT (described as "AI-enabled IoT") has redefined the way industries, businesses, and economies function today. AI-enabled IoT creates intelligent machines that simulate smart behaviour and support decision making without human interference. However, there are several challenges in the existing methods such as the reliability of a machine's decision and the processing time for analysis.

Specifically, facial emotion analysis for human computer interaction (HCI) is one of the foci of my research. Presently, there are several feature representation methods for invisible changes of facial muscles proposed by researchers in this field. However, due to the subtleness of emotions, recognition accuracy remains a challenge in this field. Looking into this, my research focuses on addressing these challenges by providing a low-computational feature representation method that is able to extract subtle details for every input frame at the required speed. The computed features are utilised to build a ML model for real-time invisible emotion recognition. Moreover, the predicted outputs are uploaded to the cloud for remote monitoring and further analysis.

# Dynamic and Static Graph Autoencoders in Brain Networks for Psychiatric Disorder Detection

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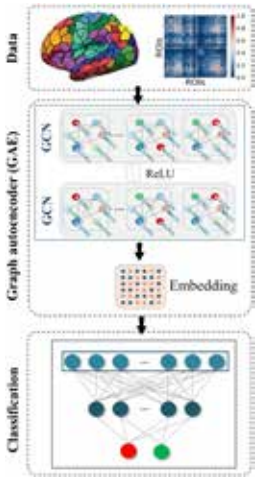
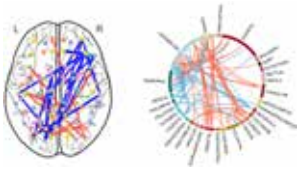



*GAE framework for brain network classification*



*Topological and connectogram of brain network changes*

**Current research mainly focuses on studying the brain's neural activity toward behavioral and disorder prediction.**

The graph deep learning incorporates non-Euclidean information about graph structure in brain networks, making it suitable for classifying brain disorders. Our approach involves proposing inductive graph autoencoders (GAE) to learn higher-order embeddings from brain networks' topological structure and node content. The learned embeddings are then used as feature inputs for a deep neural network to discriminate abnormal from healthy controls.

We also propose an extension to capture dynamic changes in network topology. Dynamic GAE (DyGAE) is designed to leverage the time-varying topological structures of dynamic brain networks for the identification of brain disorders. The GAE captures the complex spatial and topological structure in brain networks which we use it as input to a layer of LSTM to extract more cogent Spatio-temporal features.

The GAE has now been examined for two significant mental disorders, including major depressive disorder and autism spectrum disorder. We also aim to include interpretations of the achieved performance by building higher-order networks constructed from the proposed model to visualize the possible alterations and patterns in brain networks for abnormal compared to healthy controls.

# Machine Learning algorithms and applications for computer vision

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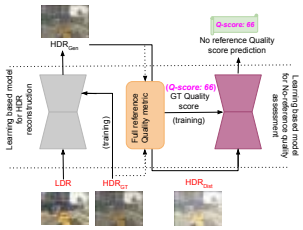


*Typical DL pipeline for HDR reconstruction and no-reference image quality assessment*

### Semi-supervised Image-to-Video Adaption for Action Recognition in Videos

Video-based human action recognition is a fundamental yet challenging task in computer vision research. It has become an important topic due to its wide applications such as in video surveillance and video annotation, etc. In this project, an adaptation framework is proposed to improve action recognition in the video by adapting knowledge from images. Besides, semi-supervised learning is incorporated to the proposed framework, where it can leverage both labeled and unlabeled videos to boost the performance of action recognition in videos.

### Perceptually Realistic and Accurate HDR Content Creation

High Dynamic Range (HDR) content (images and videos) creation has attracted considerable interest in the last five years. HDR content creation has become an important topic for modern media and entertainment sectors as well as gaming and AR/ VR industries. The state-of-the-art methods focus primarily on the reconstruction's structural similarity preservation and pixel-wise accuracy. However, they do not emphasize on preserving the artistic intent of the images in terms of human visual perception, which is an essential element in media/ entertainment/ gaming as well as in AR/ VR. In this work, we make an attempt to study and fill this gap.

# Human Face: Unleashing the Unknown

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*Examples of information revealed when standing in front of a sensor:*

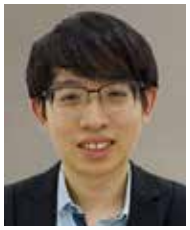
*• Gender • Age • Hair colour • Mood*

*Sample of analysing different regions of face for emotion detection.*

The human face is unique, and it distinguishes a person from other humans. With the development of technology, the uniqueness of the human face is often used as a biometric authenticator representing a person's identity. While enjoying the convenience of the face application, the privacy issue raised by the face application should not be overlooked. Since the human face is non-replaceable, unlike standard passwords, the impact of using a face on a facial recognition system is not limited to a specific system but all systems involving facial features.

My work focuses on analysing and exploring the potential of the human face and understanding the information held in it. While enjoying the convenience brought by the advancement of artificial intelligence (AI), it is vital to understand the role of human faces in face-related systems before heedlessly handing over the unique facial features to such systems.

# Flow-based Deep Probabilistic Model for Transfer Learning



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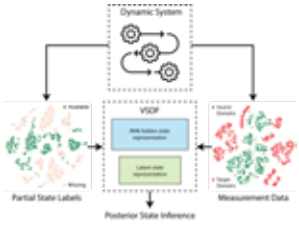
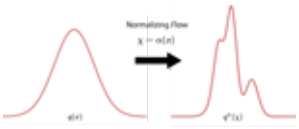



*Deep probabilistic model with hierarchical representations for transfer learning and inference.*




*Normalizing flows transforming a Gaussian to a multimodal, non-Gaussian distribution.*

Following the widespread interest in deep learning, deep neural networks have been successfully applied as probabilistic inference models in autonomous systems and industrial processes.

Nevertheless, most probabilistic models are developed based on the underlying assumption that the training and testing data are drawn from a single system domain with unified distribution. This assumption is highly unrealistic in practice as complex systems under different operating conditions could exhibit very distinct dynamics and data distributions. The discrepancies in data distributions often result in poor inference performance on target application with new operating conditions (target domains), when the models are trained using data collected on the original conditions (source domains).

My research focuses on developing normalizing flow-based deep probabilistic models that learn hierarchical data representations, with a focus on achieving transfer learning across different domains of a dynamic system or process.

# Image enhancement and restoration algorithms for computer vision and human color vision

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*Corrupted and restored images of different illumination conditions.*


*Example of original and enhanced images perceived by the red-green color vision deficient.*

Our research areas are on signal and image processing for computer vision and human color vision.

Outdoor computer vision applications such as traffic monitoring systems, human and vehicle tracking systems suffer from loss of visibility and severe color distortion due to a color cast generated by different illumination conditions that would produce inaccurate results and limit their performance. Thus, one of our current research works focuses on developing an algorithm that can remove the color cast of images under all illumination conditions.

Color images embody information and are a medium of communication. However, people have a color vision deficiency, such as inherited or acquired color vision deficiency, may have experience difficulties in discriminating colors. In this area, our research focuses on developing an image enhancement method to improve their color perception.


HUMAN-CENTRED
COMPUTING (HCC)

# Emergence of Cloud Computing in E-Learning

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*Cloud E-Learning Framework*

*Cloud E-Learning Module*

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 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.

# User Experience and Cross-Cultural Design in Digital Products and Services

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*Scenario Co-Creation Cards: a culturally sensitive method for eliciting values*

*A case study on women's visibility demonstrating the approach of "designing for culturally sensitive cultural change".*

Human-centered approaches to designing technologies not only result in more relevant and usable products but also show a strong correlation with profitability and higher ROIs for businesses. In my work, I explore the underlying forces driving human behavior in the adoption of and interaction with technologies, focusing particularly on values (within Value-Centered Design) and cultures (within Cross-Cultural Design).

My expertise lies in the development of human-centered approaches and methods. One exemplary approach from my previous work involves the utilization of 'Qualitative Secondary Analysis' as an alternative method for cross-cultural design. This approach synergizes the benefits of two prevalent cultural design methods, namely ethnography and cultural models, while also addressing the associated pitfalls. Another notable method is the 'Scenario Co-Creation Cards,' a culturally sensitive tool designed for eliciting values. These cards showcase a systemic approach to incorporating culture into design research for better exploration of human values.

In my work, I assert that designing for values and culture doesn't mean passively adhering to the status quo but also instigating cultural change. This is exemplified in 'Designing for Culturally Sensitive Cultural Change,' an approach I formulated while working on designing for women's visibility in digital media.

As such, my current research interests center around the application of these methods in diverse domains, encompassing education, digital health, and business information systems.

# DIGITAL HEALTH

# Predicting Neuropsychiatric Diseases & Behavior with Human Brain Connectome

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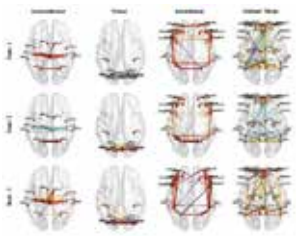
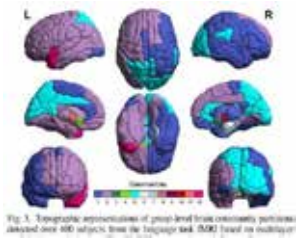


*Brain networks during rest*



*Community structure of brain functional networks during language comprehension*

Different regions of the human brain communicate with each other as a massive complex network during rest or response to stimuli. Recent advances in neuroimaging technology such as fMRI and EEG have enabled measurement of brain activities and network interactions with unprecedented spatial and temporal resolution.

My research focuses on developing statistical models and theoretical complex graph analysis to characterize complex organization and dynamics of human brain networks, with aims to extract novel information to provide deeper understanding of the brain functions.

Abnormalities in brain networks have been increasingly used as neuroimaging biosignatures for various neuropsychiatric diseases with potential application for clinical diagnostics. I am working on deep learning algorithms for automatic identification of brain disorders such as schizophrenia, using the disrupted connectivity patterns as features. I am also keen on using functional brain connectivity maps to predict individual differences in cognitive traits and behaviors, e.g. working memory capacity.

# Computer aided diagnosis (CAD) with Deep Neural Network for Medical Imaging

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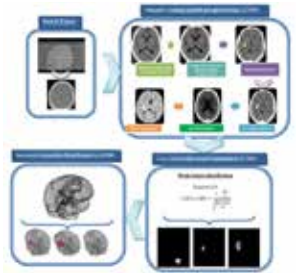
*GUI for breast cancer classification application*



*A rough overview of the CCBLS process.*

Although manual delimitation of lesions by doctors is considered the standard approach, it is time-consuming and depends on the expertise and experience of each doctor. Computer-aided diagnosis (CAD) can help doctors discover patterns of interest relevant to the patient's anatomy during diagnosis and encourage early detection.

In medical imaging, there are ways to characterize and extract textures, shapes and colours associated with various types of disease. After analysing an existing image database of up to billions of volumes, the deep neural network algorithm used can begin to discover relevant patterns (while minimizing false positives) and automatically detect abnormalities within new images for more informed decision-making.

Our research focuses on the application of deep neural networks for medical imaging. For example, convolutional neural network improvement for breast cancer classification and case-control comparison brain lesion segmentation for early infarct detection (CCBLS).

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

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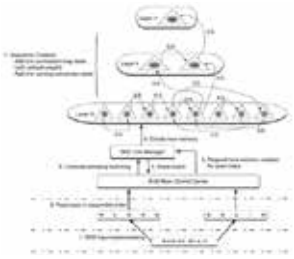
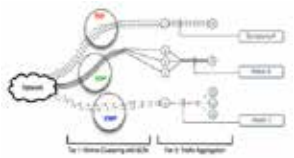


*Neocortex-inspired model*



*Learning Network Traffic Pattern*

*Corpus Callosum Fiber Tract on Patient with Pineal Gland Tumour*

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 the human brain responsible for forming human memory and it is believed that the ability of neocortex in storing and manipulating memory is the foundation of human intelligence. In an application context, there are few on-going and future projects in the pipeline. Firstly, with the blooming usage of IoT, we are working on utilizing intelligent algorithms to reduce HVAC energy consumption. Secondly, 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. We are working on IoT traffic analysis to prevent cyber attacks. Thirdly, on the digital health front, the introduction of clinical document standards opens up a true big data analytics scenario where no fragmentation of data exists. We have multiple on-going digital health research projects: (1) A frontier effort to research intelligent mapping and analytics between FHIR data and legacy standards, (2) exploring mHealth approaches to alleviate depressive symptomatology, and (3) investigating a machine learning approach to analyse child social learning behaviour. Lastly, we are venturing into frontier neuroimaging research to provide clinical analysis as well as dynamic cloud infrastructure to support federated learning.

# Work System Design for complex human-system interaction

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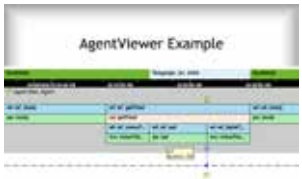
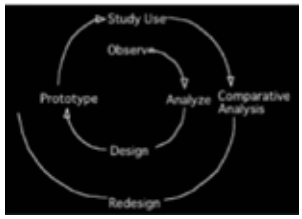



*Work practice modeling and simulation using Brahms at a moment by moment activity*




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

Work system design aims to understand how the computer system and the humanAs 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 system can be most productively integrated. 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.

# Integrative analysis for cancer biomarker discovery

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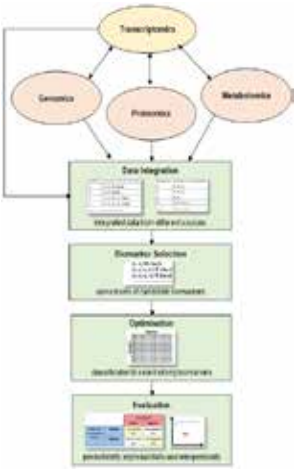
**G:** https://scholar.google.com/citations?user=-aH_YyMAAAAJ&hl=en&oi=ao

*The potential uses of biomarkers*



*An overview of integrative analysis of multi-omics data for biomarker discovery*

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 integrative analysis 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 multi-omics data has opened more possibilities for computer scientists to explore many of the current challenges faced in cancer studies and diseases.

## CONTACT US

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