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An analysis of the influence of temperature related weather changes on humans' activities of daily living

Ruijie Ni
Project Supervisor: Dr Stefan Poslad

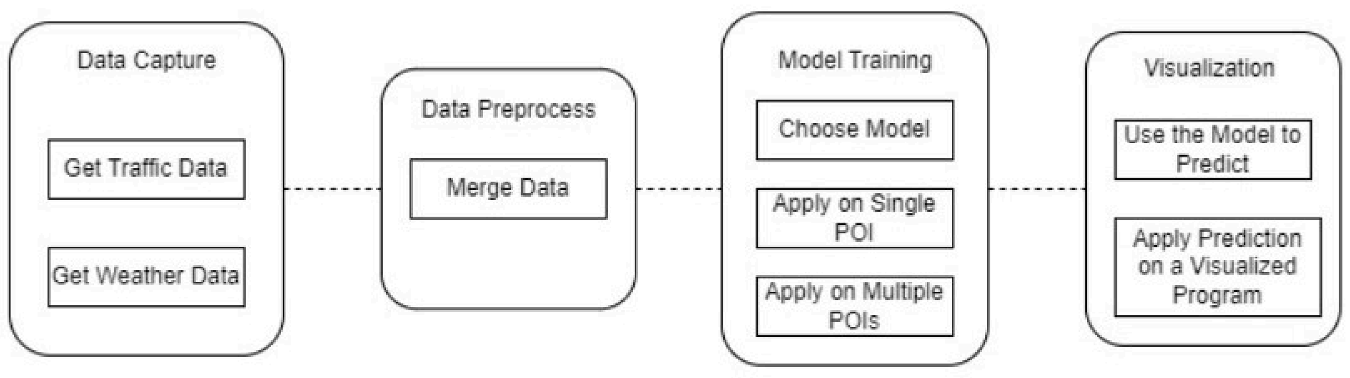
Objective & Background

This study uses Chinese urban traffic data to model how temperature changes affect population activity and distribution in different places of interest (POIs). A deep learning approach is used to predict the population density around POIs based on temperature and POI data. The results are visualized on an interactive map and can help government departments in urban planning and management.

- **POI: Point of Interest**

A POI is a location that is useful or interesting to someone to do something specific. POIs can be used for various applications and have some basic attributes. Different sources may have different POI databases and APIs.

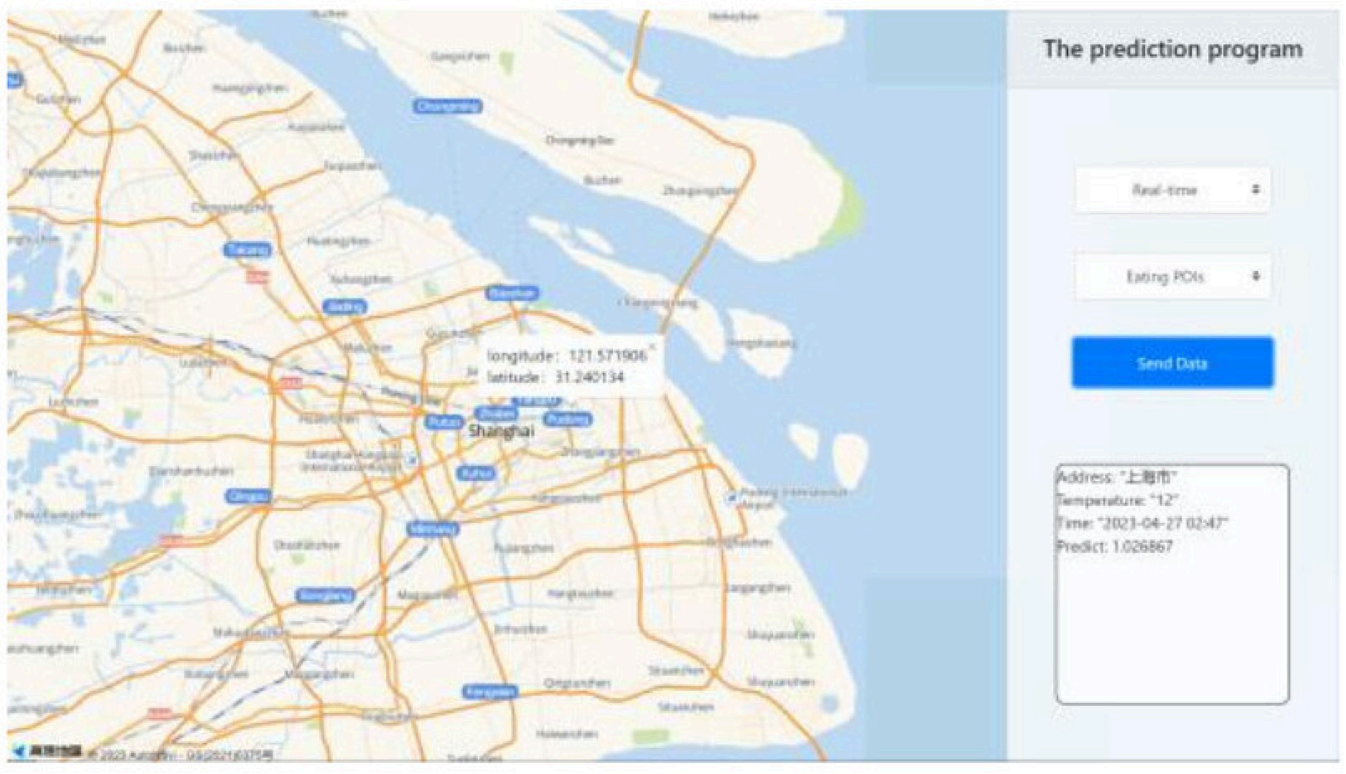
Overall Design



Outcome

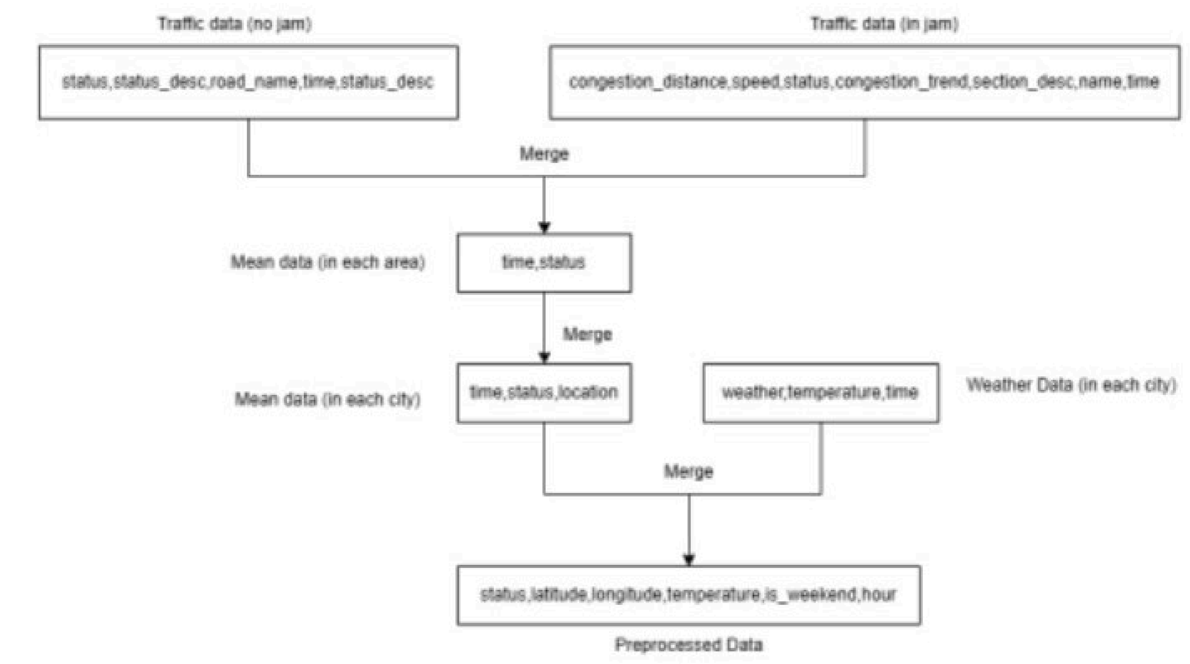
An interactive Population Prediction program

Scan the QR code for a video demonstration



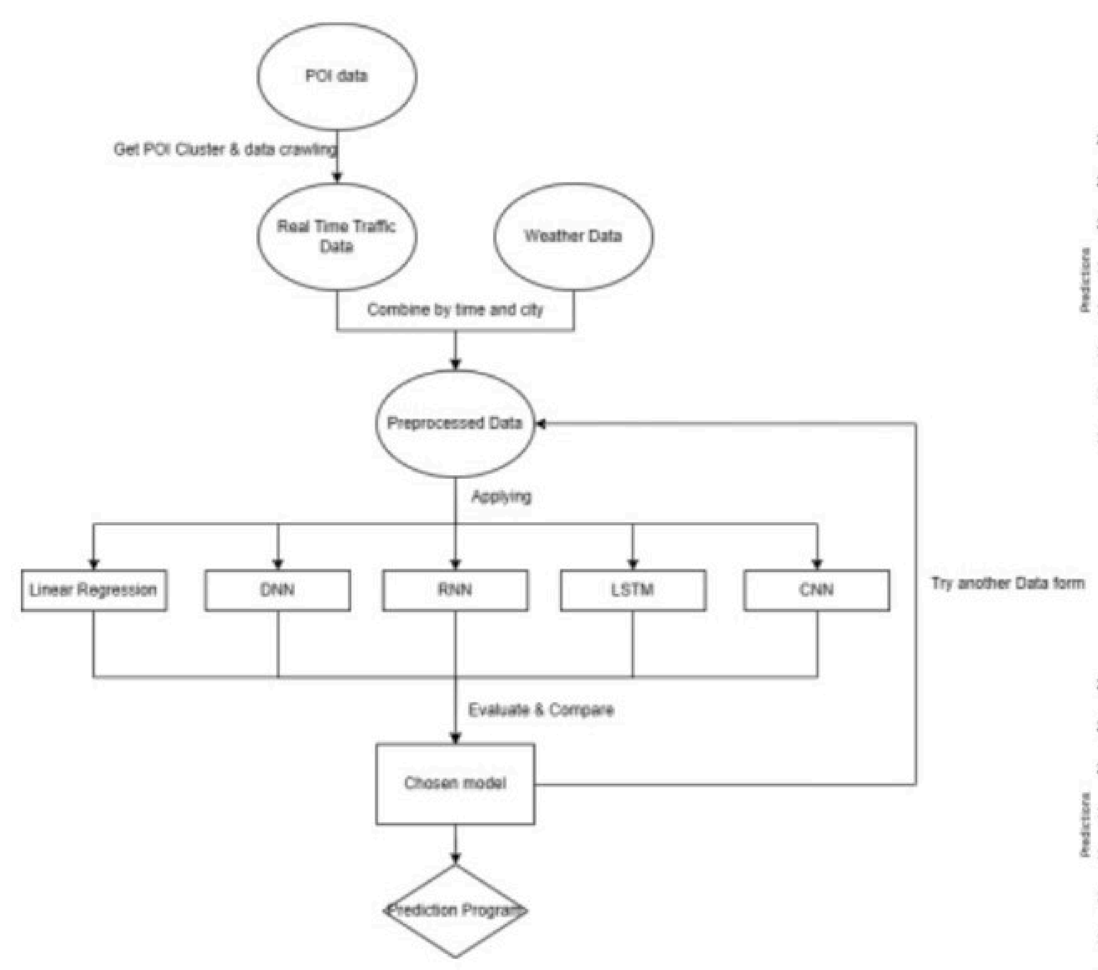
Data Capture & Merge

- No access to real-time population data from data platforms
- Estimate population density from traffic congestion instead
- Traffic status values from 1 to 4, indicating from smooth to congested.
- Data included: POI, Traffic status, Temperature
- Data Platforms: Baidu & Gaode open platform
- Group POIs into clusters by location for analysis

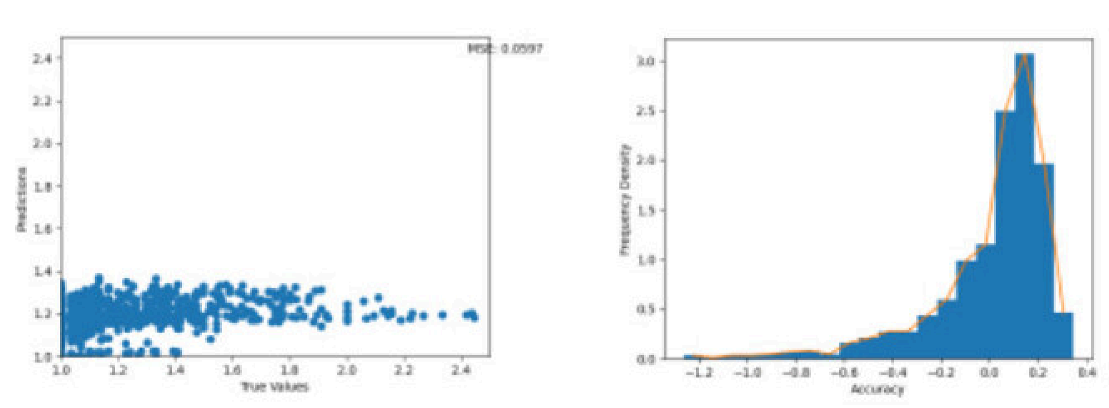


Model Training

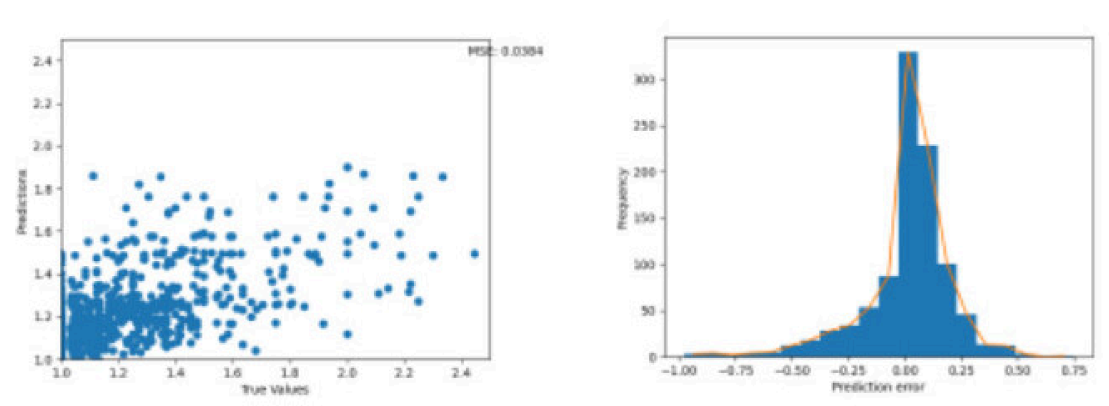
- Use Linear Regression as baseline
- Apply different neural networks to find the best one - DNN



Linear Regression

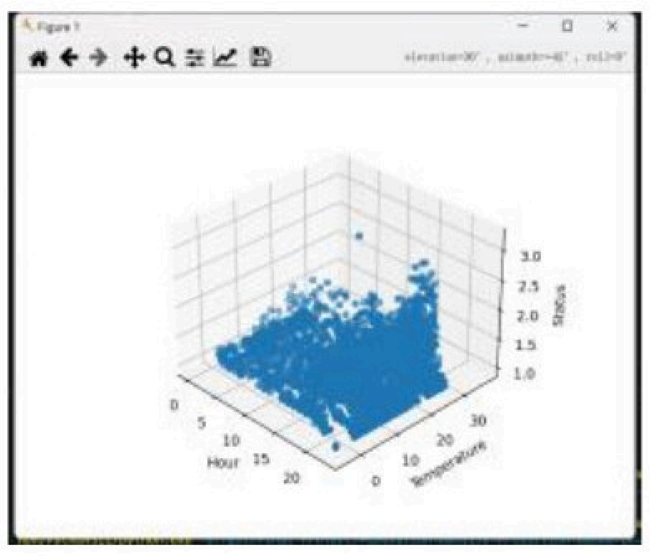


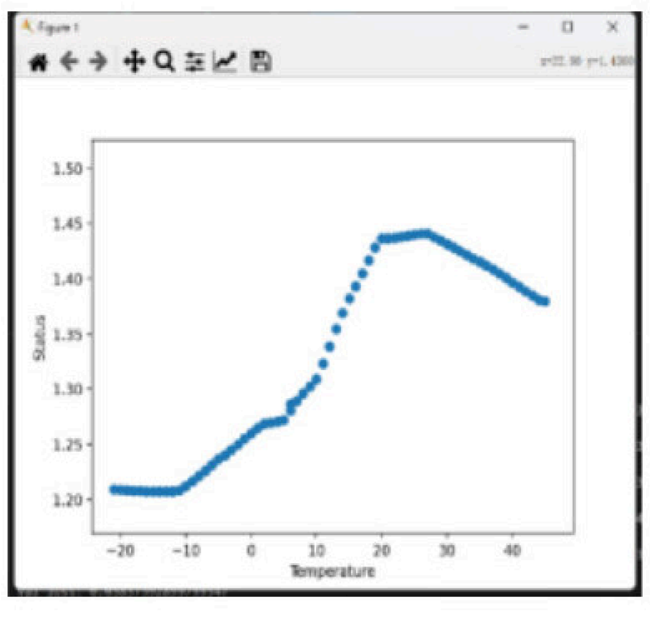
Deep Neural Network(DNN)



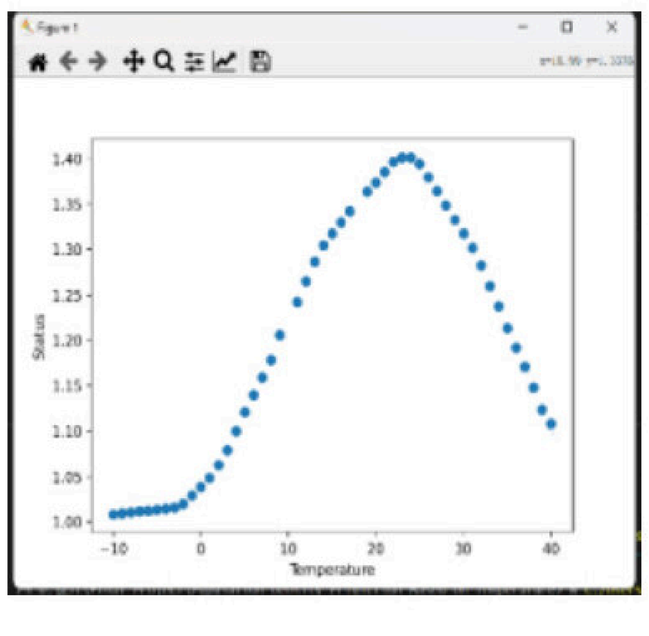
Visualisation & Analysis

- Real data is influenced by multiple factors
- Using prediction model - fix other factors
- Analyze the effect on POIs

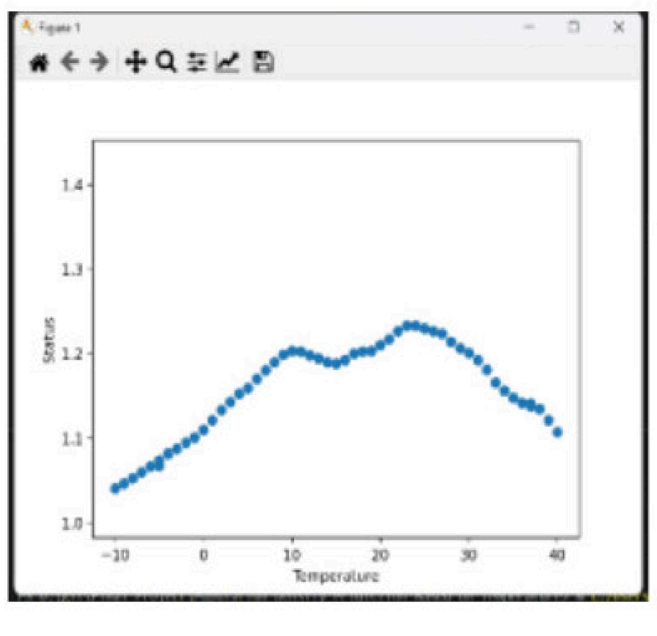




Eating out



Sightseeing



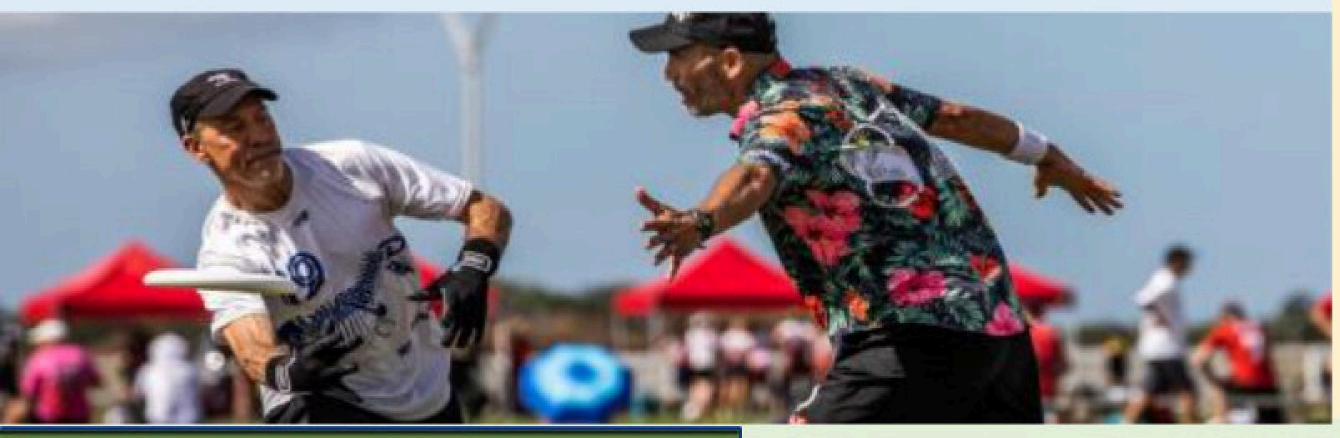
Sports

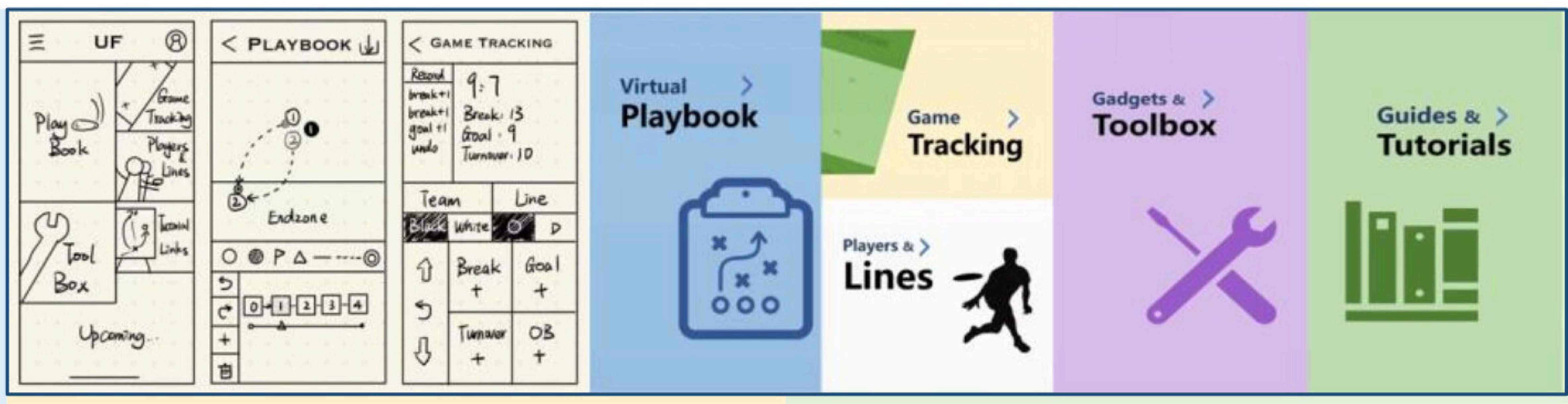
An Ultimate Frisbee App

Mengshi Li
Project Leader: Dr Ling Ma

Objective & Background

Ultimate Frisbee is a popular non-contact team sport played with a disc. Tactical arrangements and game analysis are vital for a team to success in this sport. However, traditional paper-based methods are of low intuitiveness and efficiency. The project designed and implemented a smartphone app for Ultimate players and coaches, which provides features like a virtual animated playbook and a digitalized game analysis module, which is verified to have a positive impact on the game performance of Ultimate teams.



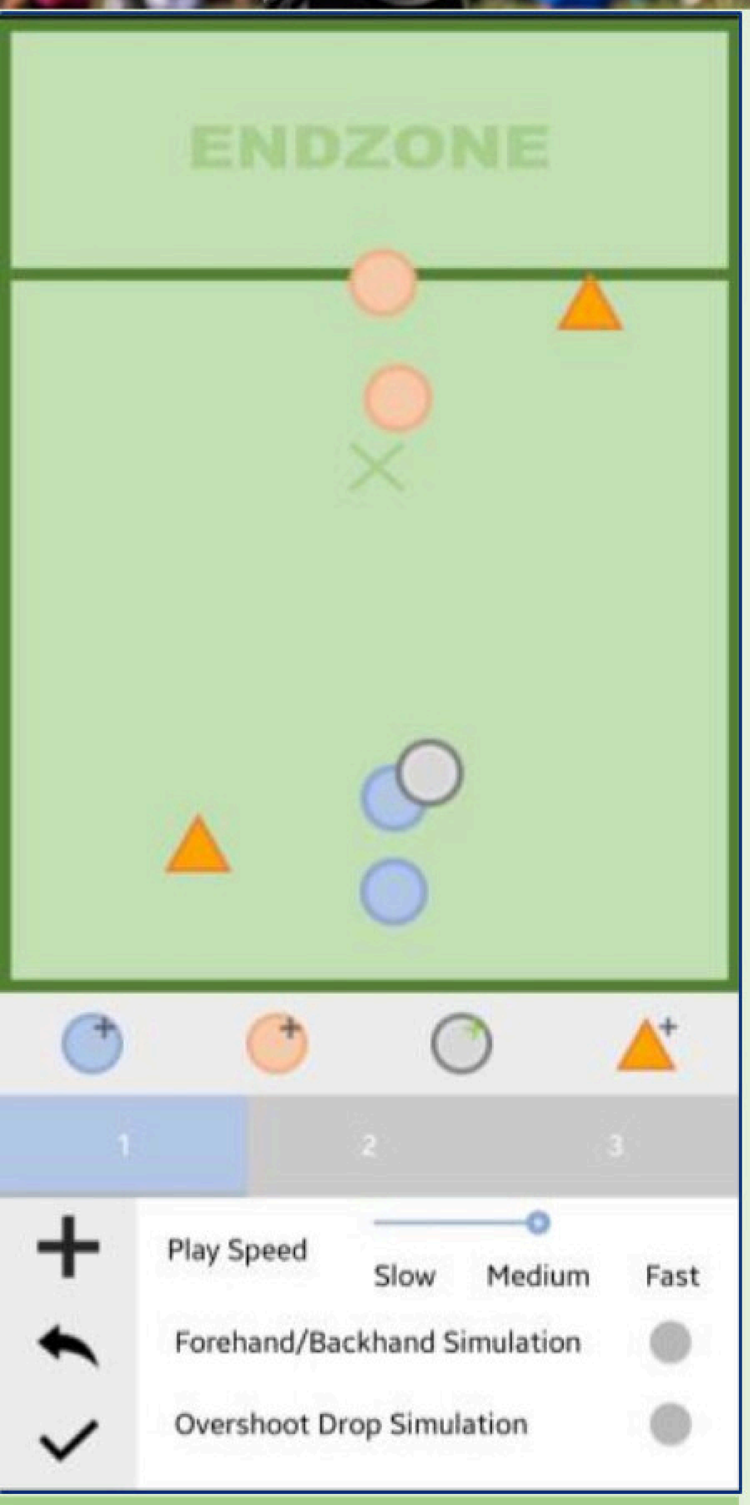


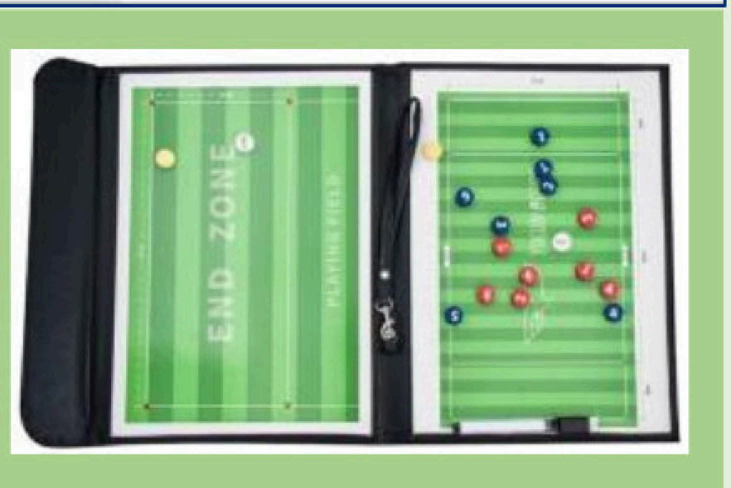
Pre-work & Requirements

- Similar app evaluation
  - 4 Apps
- Potential user interview
  - 7 pro players & coaches
  - Offline interview
- User stories and requirements
  - Summarized from interview records and app evaluation report
- Sketch prototyping
  - Planning basic layouts of the app

Development and Testing

- Agile Development Process
  - Iteration based, rapid increment, constant user feedback
  - 3 main iteration
- Android development
  - Android Studio
  - Java, XML
- Version Control
  - Based on Git
- Testing
  - Unit + system testing
  - Real-world testing





Traditional playbook

main module #1
the Virtual Playbook

The virtual playbook allows the users to **design and deliver Ultimate tactics** in an intuitive and efficient way.
The "**Drag and Drop**" feature allows the users to quickly and accurately set up a formation of any nodes in a tactic.
The users can generate a realistic **non-linear animation** of their tactic with a single click.
They can also switch to any node of a tactic easily or adjust parameters of the simulation.
This **helps fast and precise delivery of tactical arrangements** to team players.

main module #2
Game Tracking

This module allows the users to **record real-time data** during the game and provides **data analysis with a visualised presentation** of multiple useful information.
The users can quickly set the current players on the field before the game.
During the game, the users can record the events occurring on the field and the players corresponding to the event, such as passes, turnovers, drops, etc.
After the recording is done, the application will automatically generate important data analysis of the game and present it in a visualised way.

Anime Recommender System

Yiran Wang
Project Leader: Dr Mona Jaber

Introduction

The rapid development of the anime industry needs a recommender system that produces satisfied and precise recommendations for anime fans. In this project, a recommender system that combines results from matrix factorization and k-nearest neighbors is developed. The new proposed combined model is evaluated using Root Mean Squared Error (RMSE) and human evaluation, reaching a 1.39 RMSE value and a 4.24 human satisfaction score.

Design & Implementation

We first gather user information through questionnaire no.1 and concatenate it with information from the public datasets. Then we feed the information into the algorithms. Next, we classify users into 3 groups and adopt different result combination policies for different user groups. Finally, we send the results to the user, and ask the user to rate their satisfaction with the results through questionnaire no.2.

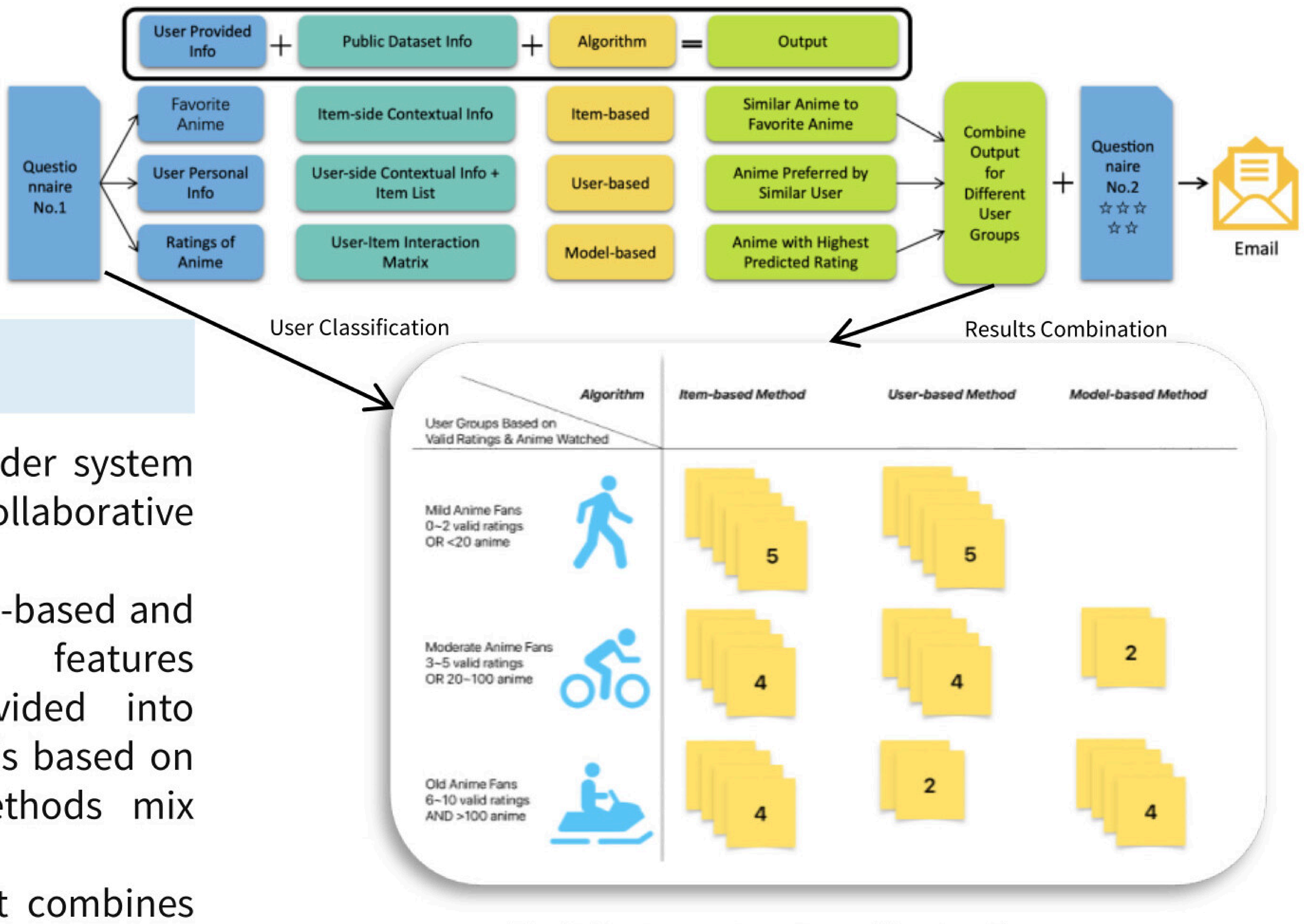


Fig 3 System structure illustration

Background

There are three categories of recommender system algorithms: contextual methods, collaborative methods and hybrid methods.
Contextual methods are divided into item-based and user-based methods based on features used. Collaborative methods are divided into memory-based and model-based methods based on whether models are used. Hybrid methods mix contextual and collaborative methods.
We proposed a new hybrid method that combines results from the model-based collaborative method, the user-based contextual method, and the item-based contextual method.

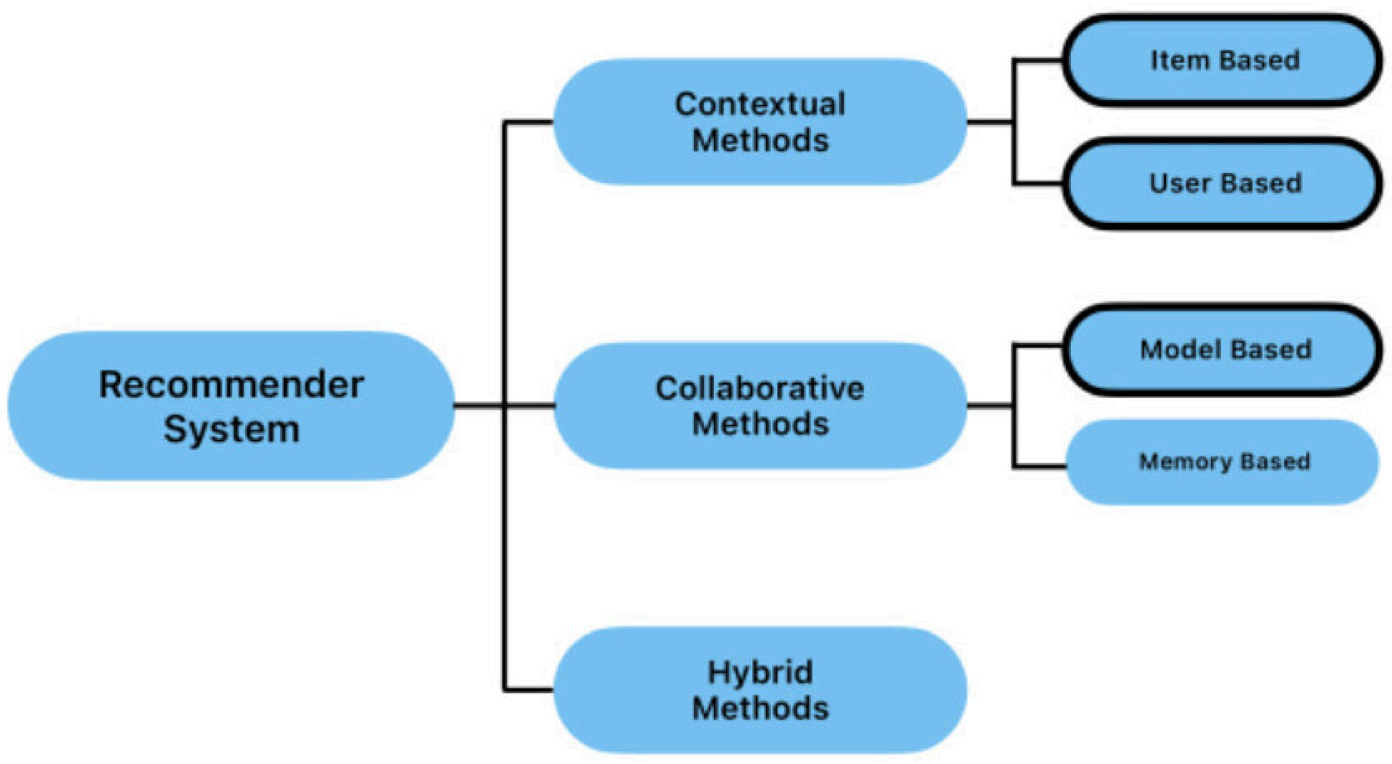


Fig 1 Recommender system algorithms categorization

Anime Recommender System Test 动画推荐系统测试

Anime Recommender System Evaluation 动画推荐系统评价

Fig 2 QR code for questionnaire no.1(left) & questionnaire no.2(right)

Results & Conclusions

We evaluate the system from metrics-based evaluation and human-based evaluation. The metrics-based calculates the root mean square error, which represents the distance between the predicted rating and the ground truth and smaller value means better performance. The human-based involves real people to rate their satisfaction with the recommendation results, with ‘5’ meaning very satisfied and ‘1’ meaning very unsatisfied. The system reached a 1.39 RMSE after comparing 3 algorithms and 4.24 human satisfaction score after 2 rounds of testing.

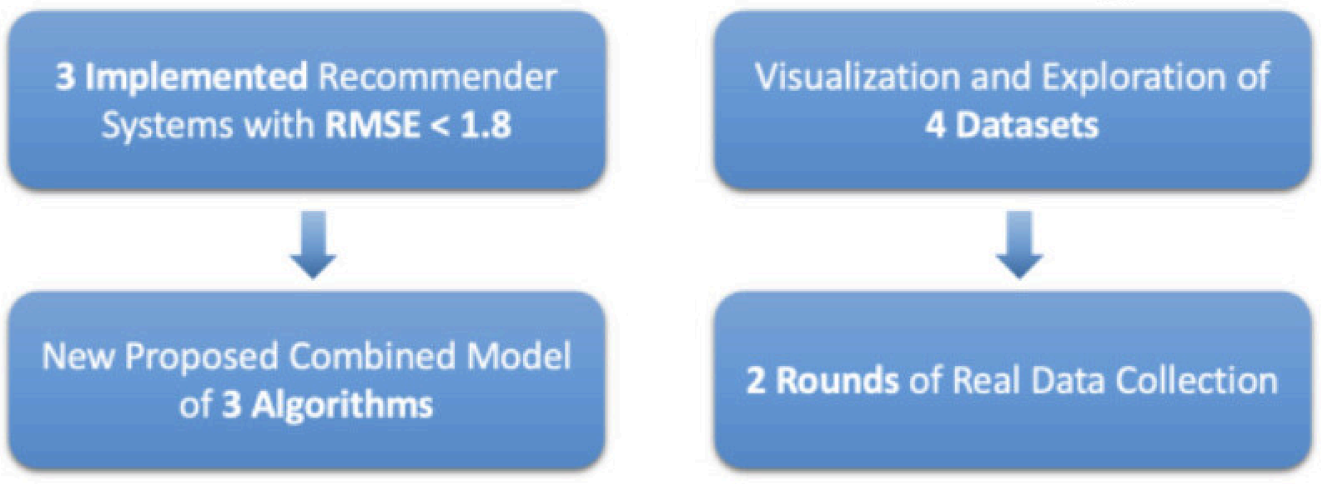


Fig 4 Work conclusions

Basketball AI referee

Jingqing Zhang, Xingtianwen Zhang, Jiahui Cui
Project Leader: Mona Jaber

A.Introduction

- This project investigates how AI can be used to referee a basketball game and detect violations such as travelling or double dribble.

B.Three components to this project

- Use an existing dataset with accelerometer data to detect the action of a single player at any time: dribble, pass, shoot, pick up, hold. Next, a sequence of actions will be analyzed to detect violation.
- Use hardware implementation to collect more data from players - the data will be used to improve the AI model for detecting violations.
- Website and database design to detect violations remotely based on sensor data.

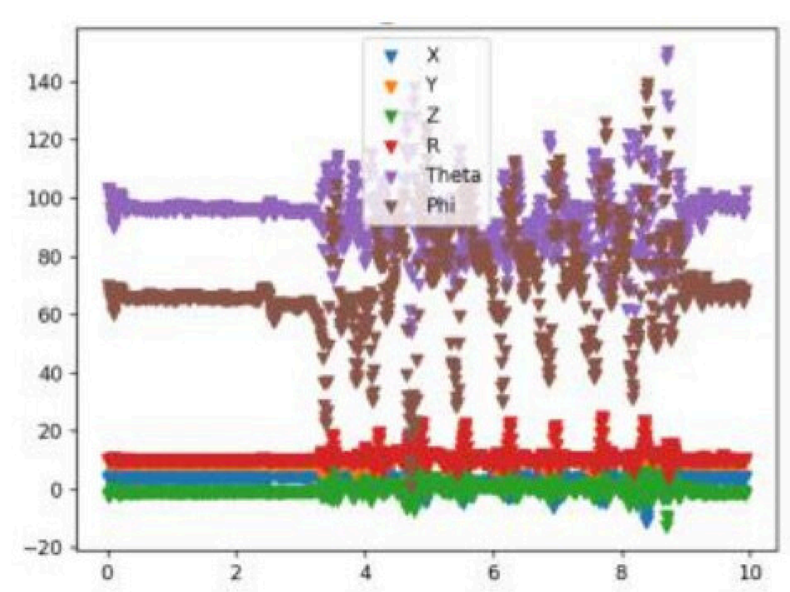
C.Dataset (partially displayed)

We used a dataset , which consists of 80 text files collected by three testers.
Accelerometer (x, y, z):Located at the right arm.
Gyroscope (R, phi, delta):Located at the right arm.
Same app use, as the accelerometer.
Example:

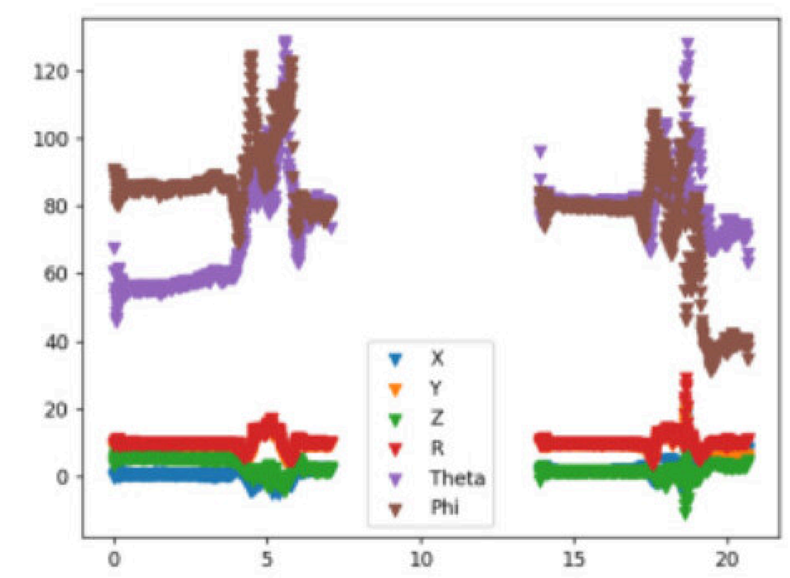
Time(s)	X(m/s2)	Y (m/s2)	Z (m/s2)	R (m/s2)	Theta (deg)	Phi (deg)
0.00000	3.4284	9.1123	-2.0470	9.9488	101.87	69.381
0.00970	3.4476	9.2859	-2.3319	10.176	103.24	69.631
0.01973	3.5063	9.2128	-2.2445	10.109	102.82	69.631
0.02970	3.7038	8.9722	-1.9907	9.9087	101.59	67.568
0.03980	3.9025	8.7998	-1.5454	9.7496	99.120	66.083
0.04981	3.9947	8.5975	-1.0845	9.5421	96.526	65.078
0.05997	4.2509	8.7639	-0.7852	9.7721	94.609	64.124

D.The sensors and application we used

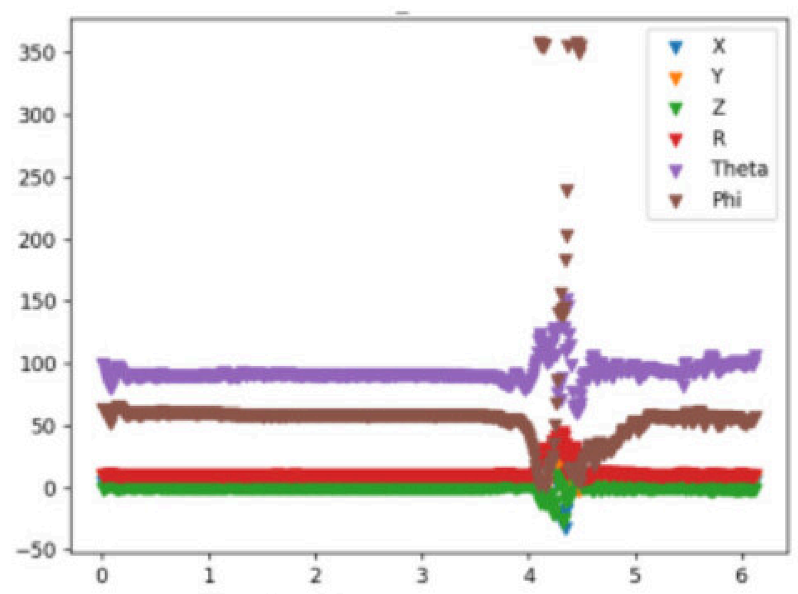
E.Visualization & Classification



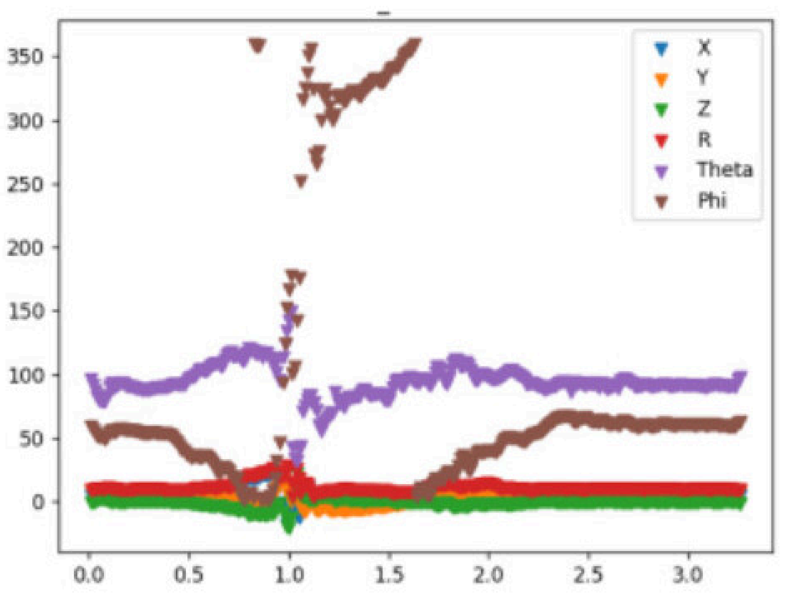
(a)Dribble



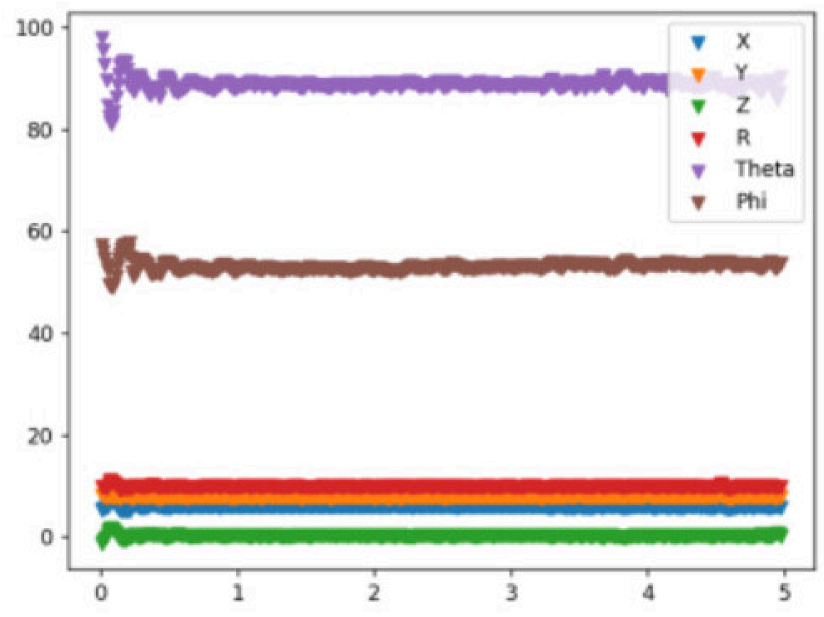
(b)Pick up



(c)Pass

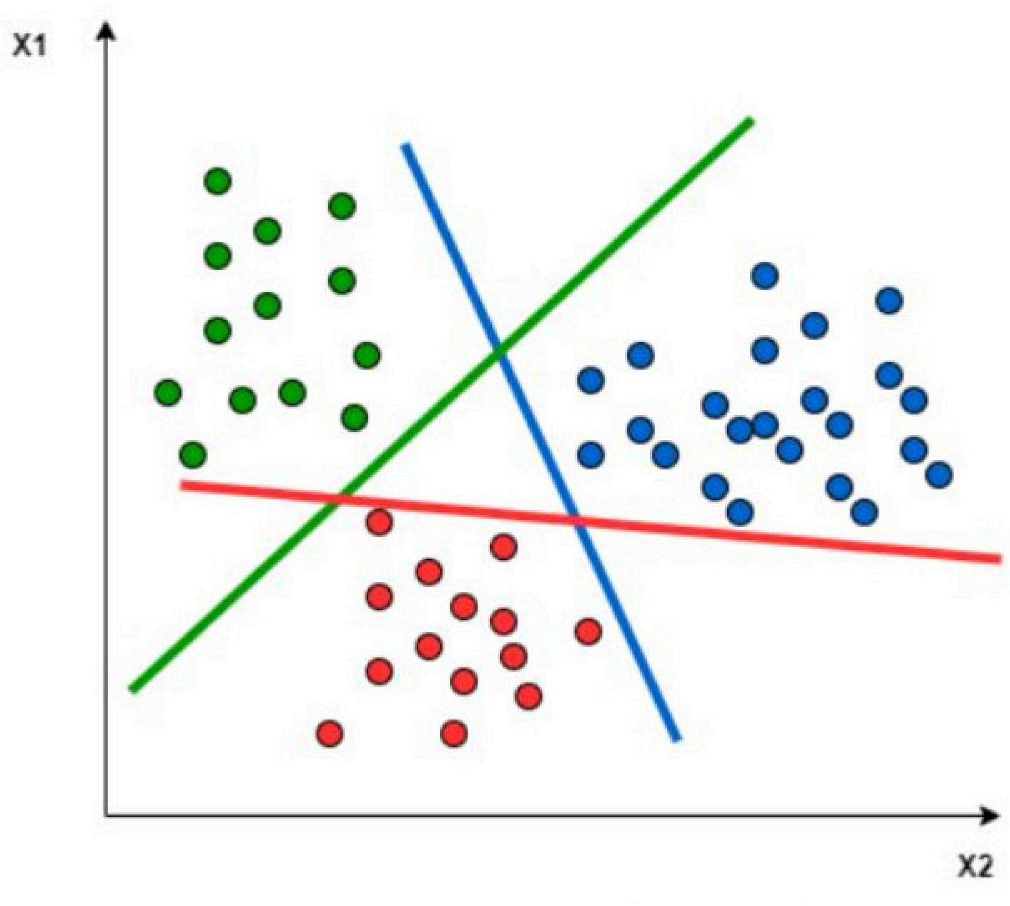


(d)Shoot



(e)Hold

F.Support vector machine (SVM)




```
TEST IN SHOOTDATA
Accuracy (Polynomial Kernel):  47.97
F1 (Polynomial Kernel):  64.84
TEST IN PICKUPDATA
Accuracy (Polynomial Kernel):  70.55
F1 (Polynomial Kernel):  76.54
TEST IN PASSDATA
Accuracy (Polynomial Kernel):  46.46
F1 (Polynomial Kernel):  63.44
TEST IN DRIBBLEDATA
Accuracy (Polynomial Kernel):  61.85
F1 (Polynomial Kernel):  76.43
TEST IN HOLDDATA
Accuracy (Polynomial Kernel):  99.21
F1 (Polynomial Kernel):  99.61
```

Brain Cognitive Project

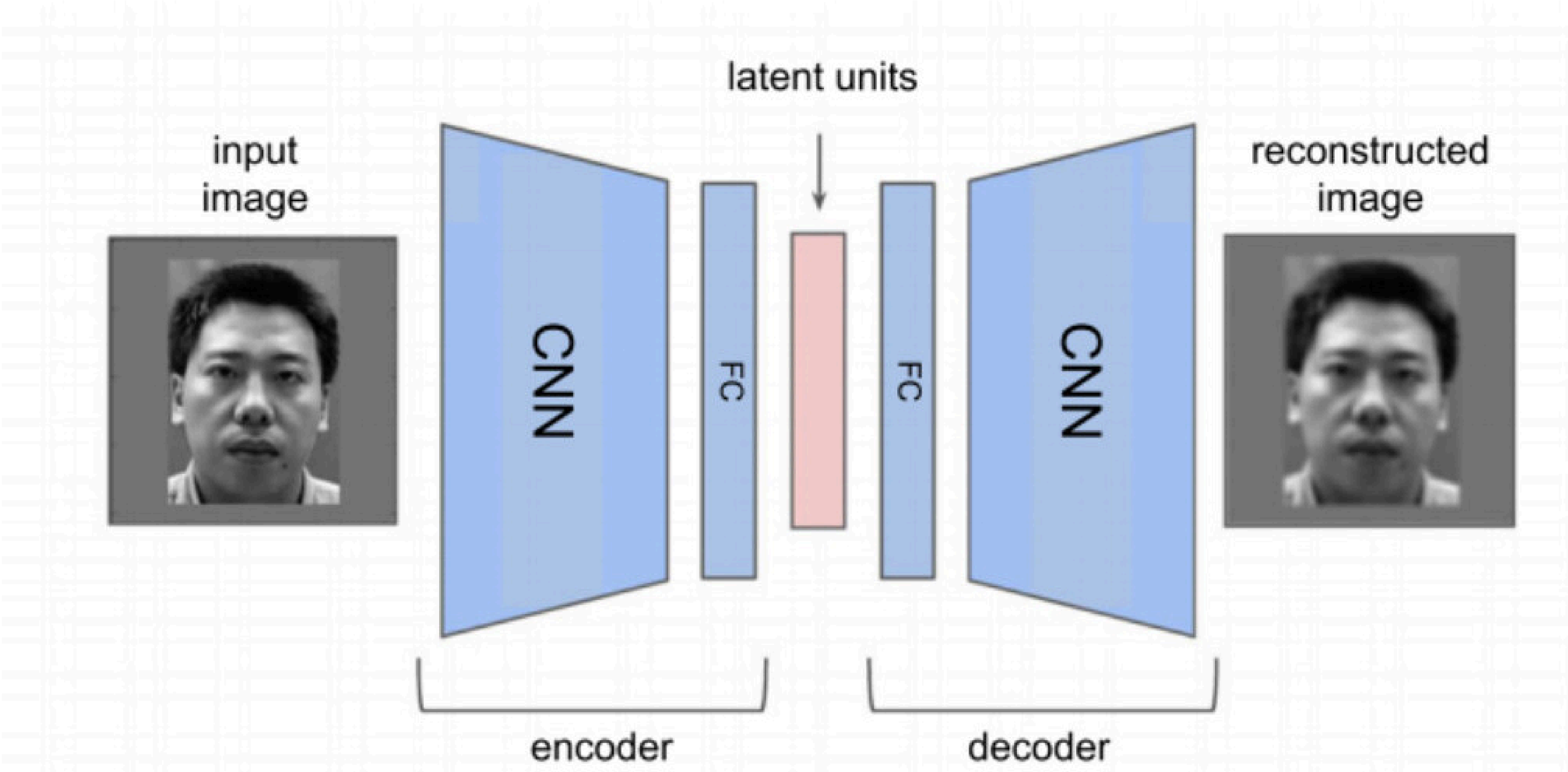
Jifeng Xu, Zhixiang Zhang
Project Leader: Dr. Cindy Sun

Background

With the development of artificial intelligence image feature recognition, people try to explore the corresponding relationship between human brain neurons and face image features. After acquiring the electric signal data set of ape neurons after observing face images and combining with β-VAE model based on convolutional neural network, our team obtained the correlation matrix between neurons and latent variables of human face after a series of mathematical operations.

Model : β-VAE

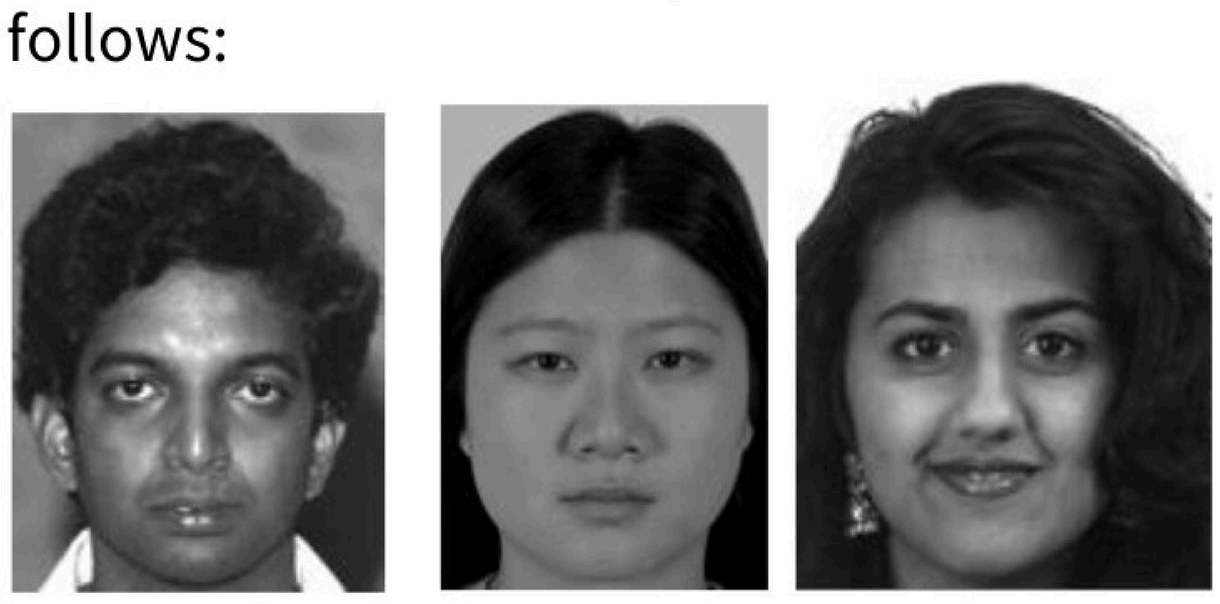
β-VAE is a deep learning model based on convolutional neural network.[2] Images are inputed in the form of matrix. After four layers of convolution operation, images are unwrapped, and after four layers of deconvolution operation, images are reconstructed. The sketch map is as follows.[1]



https://github.com/google-research/disentanglement_lib

Dataset

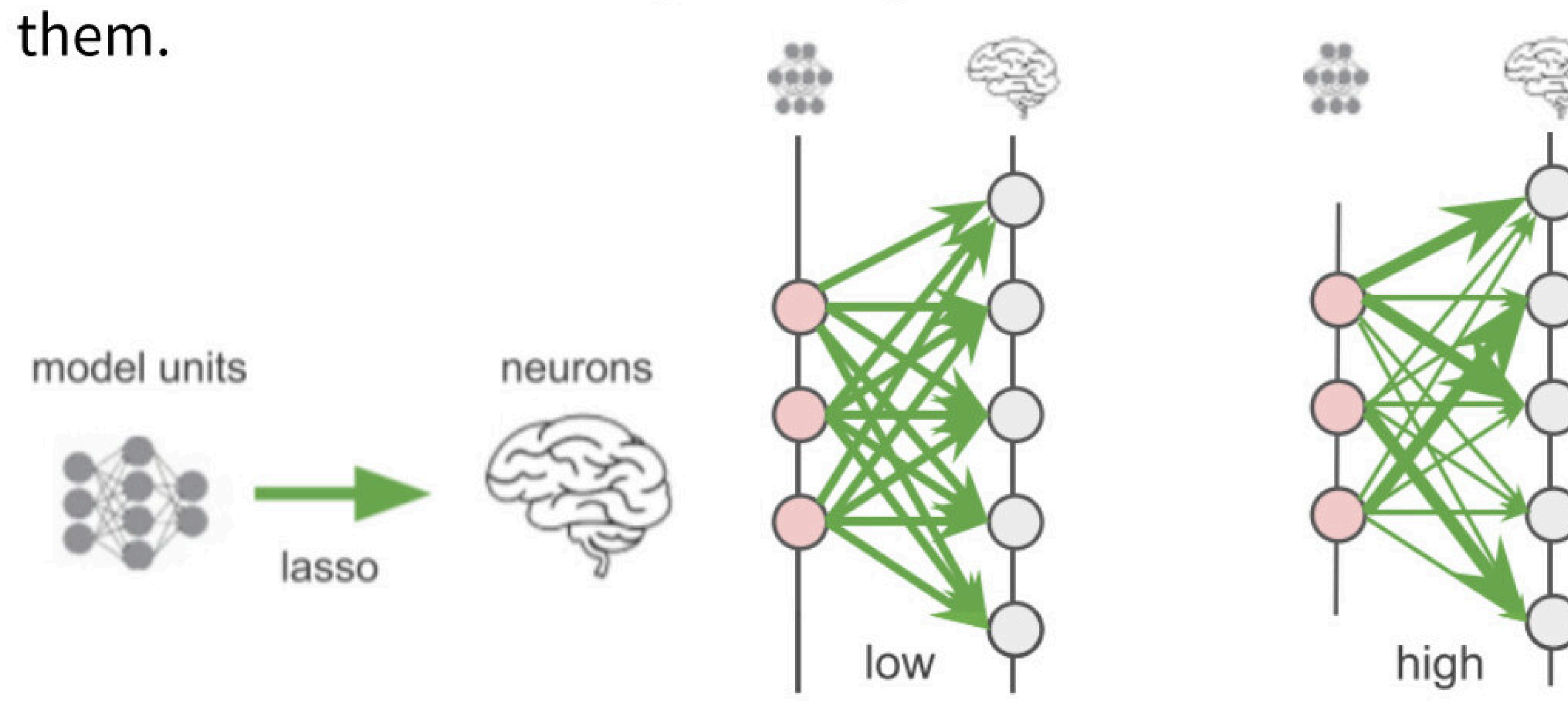
① A matrix of electrical signals from neurons in the brains of apes looking at a dataset of faces.[1]
② A total of 159 neurons responded to 2,100 pictures of faces. An example of face data set is as follows:



Pictures are from the AR Face Database, CelebA, Chicago Face Database, CVL, FERET, MR, PEAL dataset.

Method

The above face data sets are inputted to β-VAE model[2] in the form of matrix, and latent variable unit matrix is extracted during training model, including its mean and variance. Then take the ape EEG data set, take the average operation and calculate the mean variance. The correlation coefficient between the latent variable unit and the ape EEG signal was calculated, and the Hungarian algorithm was used to match them.



Output

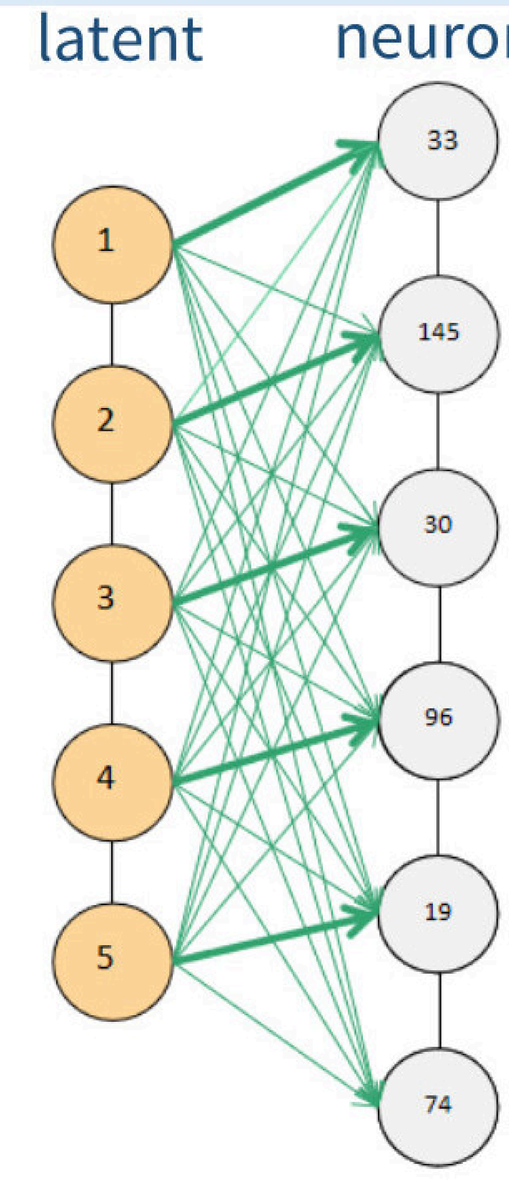
The Pierce correlation coefficient of neurons and latent variables become the elements of the correlation matrix D_{ij}, as shown below.

$$D_{ij} = \begin{bmatrix} Corr(Z_1,R_1) & \cdots & \cdots & Corr(Z_1,R_{159}) \\ \vdots & \cdots & \cdots & \vdots \\ \vdots & \cdots & \cdots & \vdots \\ Corr(Z_{50},R_1) & \cdots & \cdots & Corr(Z_{50},R_{159}) \end{bmatrix}$$

$$D_{ij} \in (0,1)$$

$$Corr(Z_i,R_j) = \frac{E(Z_iR_j) - E(Z_i)E(R_j)}{\sqrt{D(Z_i)}\sqrt{D(R_j)}}$$

Correlation matrix of neurons and latent variables



1-to-1 mapping

Conclusion & Next Step

By applying the Hungarian algorithm to the correlation coefficient matrix, we observe 7/50 neuron-latent pair with correlation value above 50%.

How to interprete the meaning of latent regarding face recognization?

neurons	latent	Correlation
3	18	0.9477
10	34	0.8658
96	4	0.8477
104	45	0.7628
109	17	0.6711
110	28	0.6595

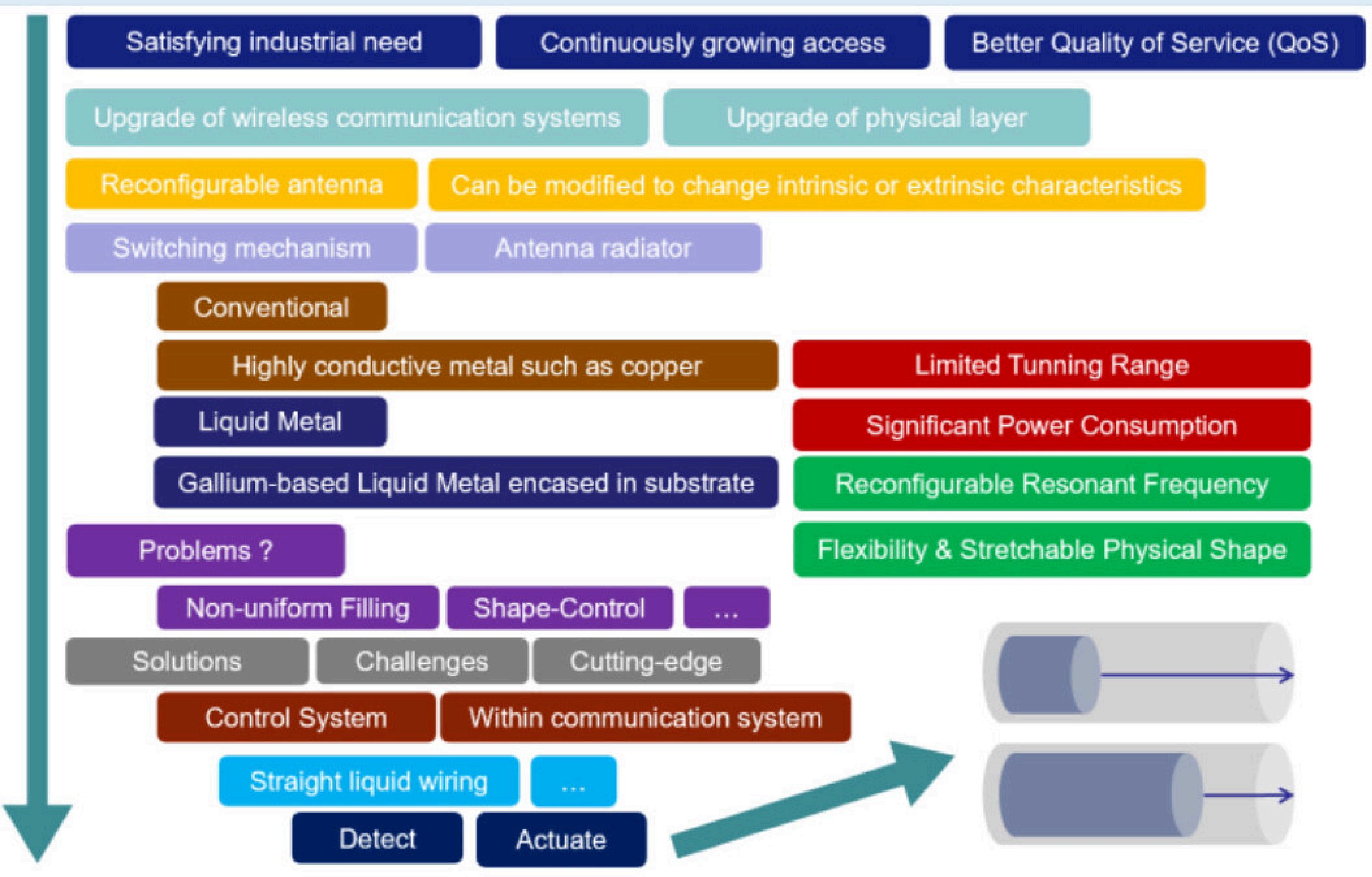
Reference

[1]Zhang, Y., Chen, Y., Zhu, X., et al. (2021). Deep learning for high-throughput quantification of oligodendrocyte ensheathment at single-cell resolution. Nature Communications, 12(1), 5427. https://doi.org/10.1038/s41467-021-26751-5
[2]Higgins, I. et al. β-VAE: learning basic visual concepts with a constrained variational framework. In Proceedings of the 5th International Conference on Learning Representations, ICLR (ICLR, 2017).

Control system for reconfiguring straight liquid wiring within advanced communication system

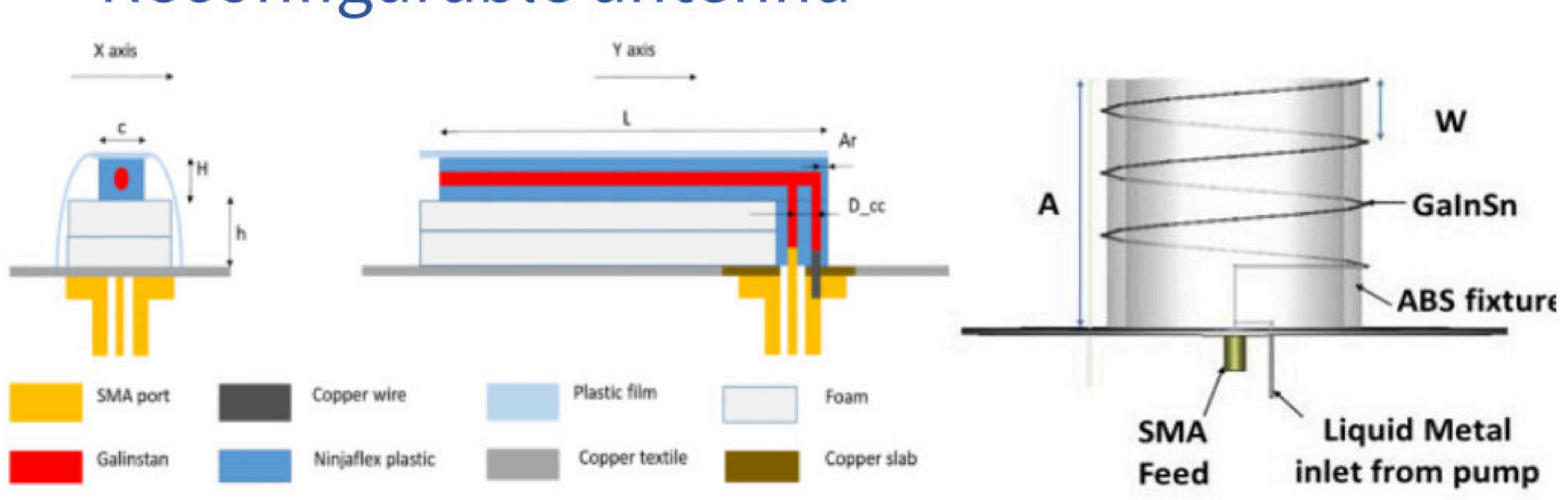
Yuanxin Xu
Project Leader: Dr James Kelly

Purpose of the project

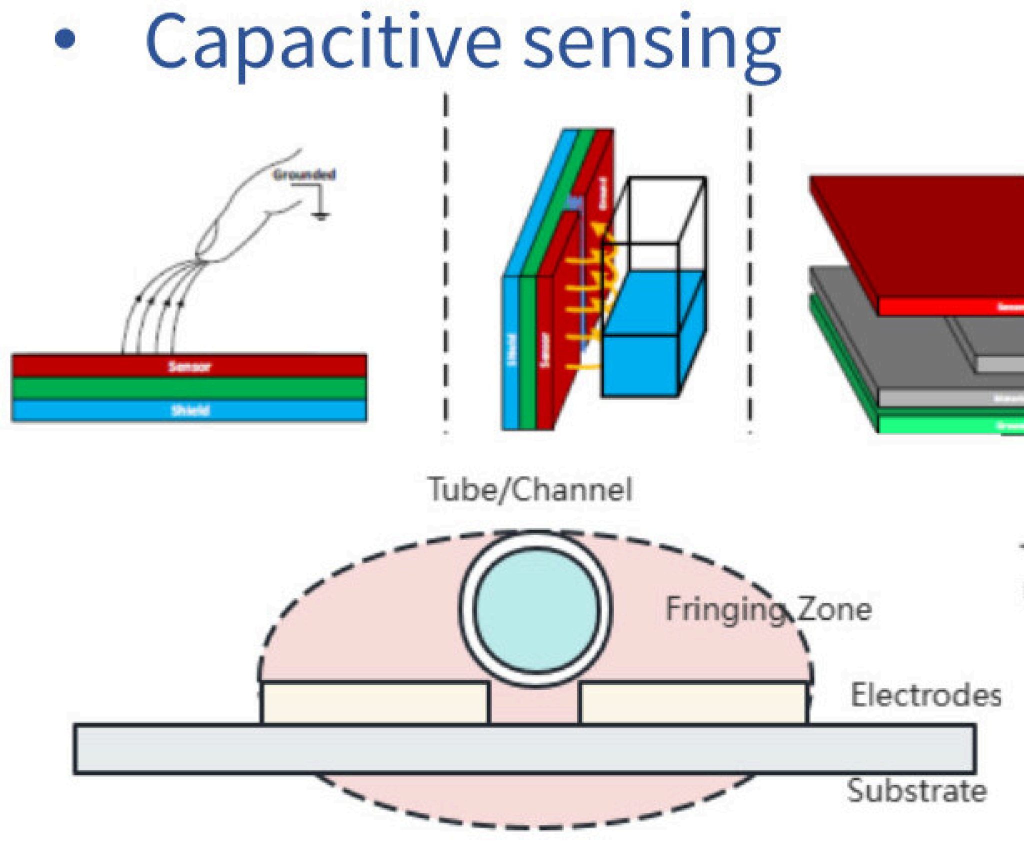


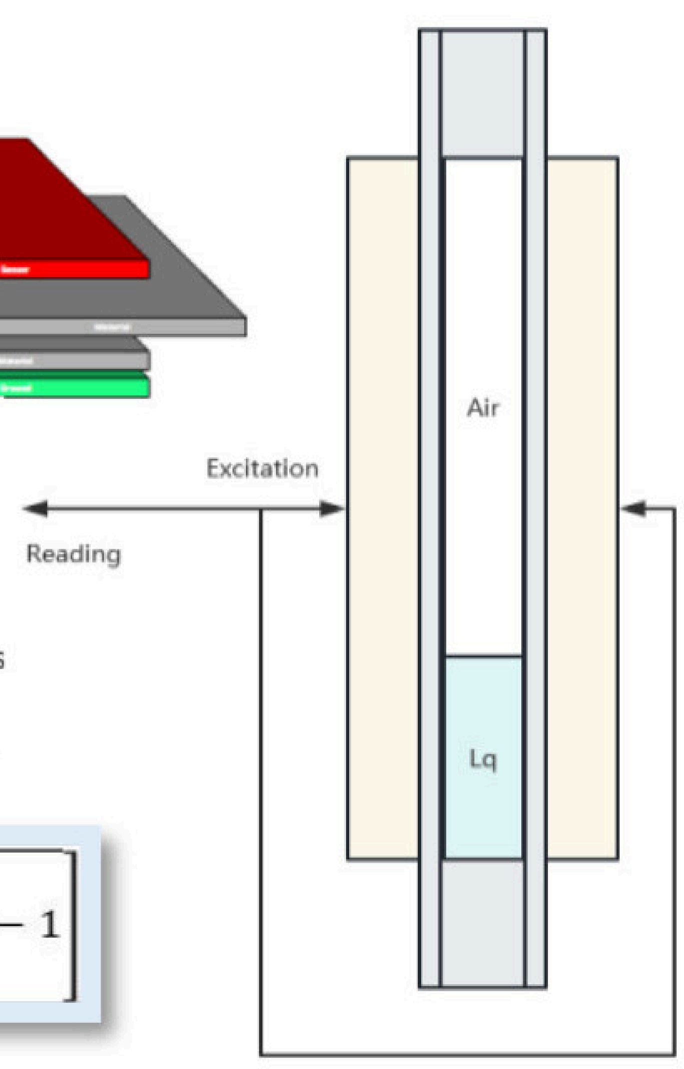
Background

- Reconfigurable antenna



- Capacitive sensing

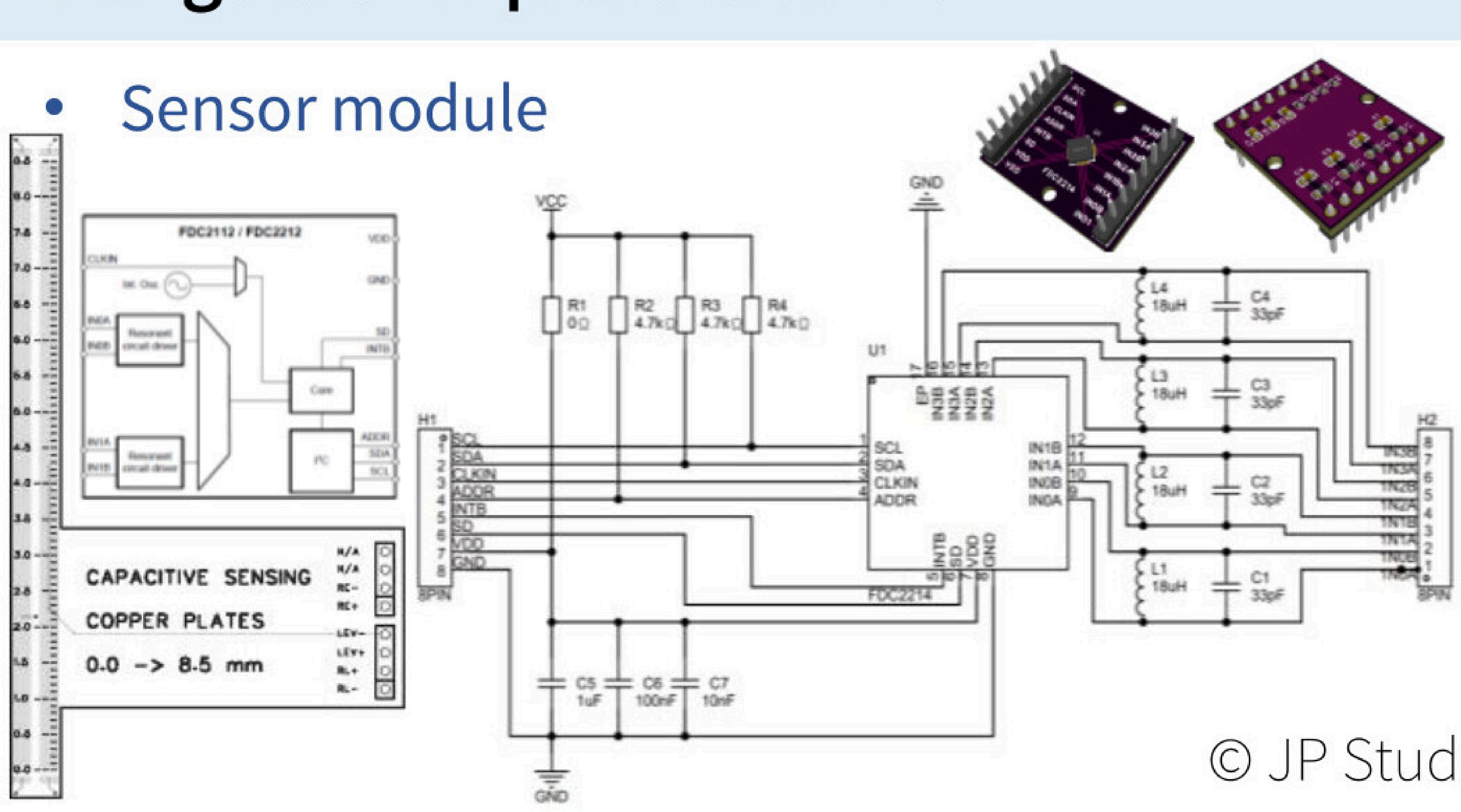




$$C = \frac{Q}{2V_0} = \frac{2\varepsilon_r\varepsilon_0}{\pi} l \cdot ln\left[\left(1+\frac{w}{a}\right) + \sqrt{\left(1+\frac{w}{a}\right)^2 - 1}\right]$$

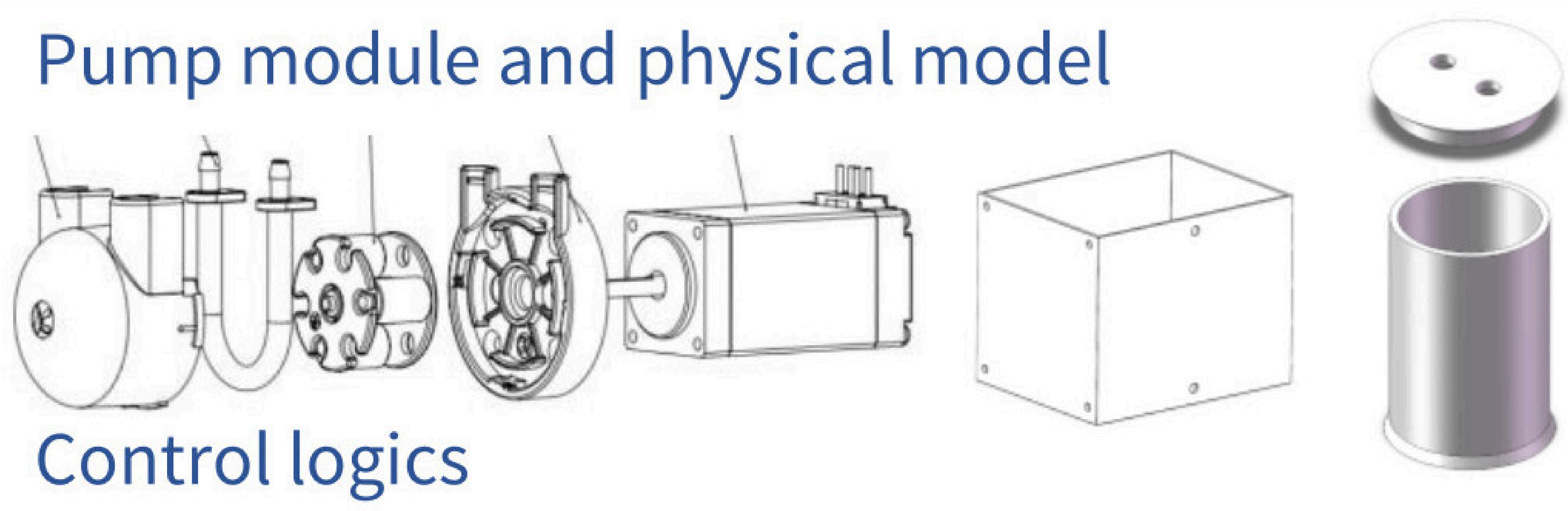
Design and implementation

- Sensor module

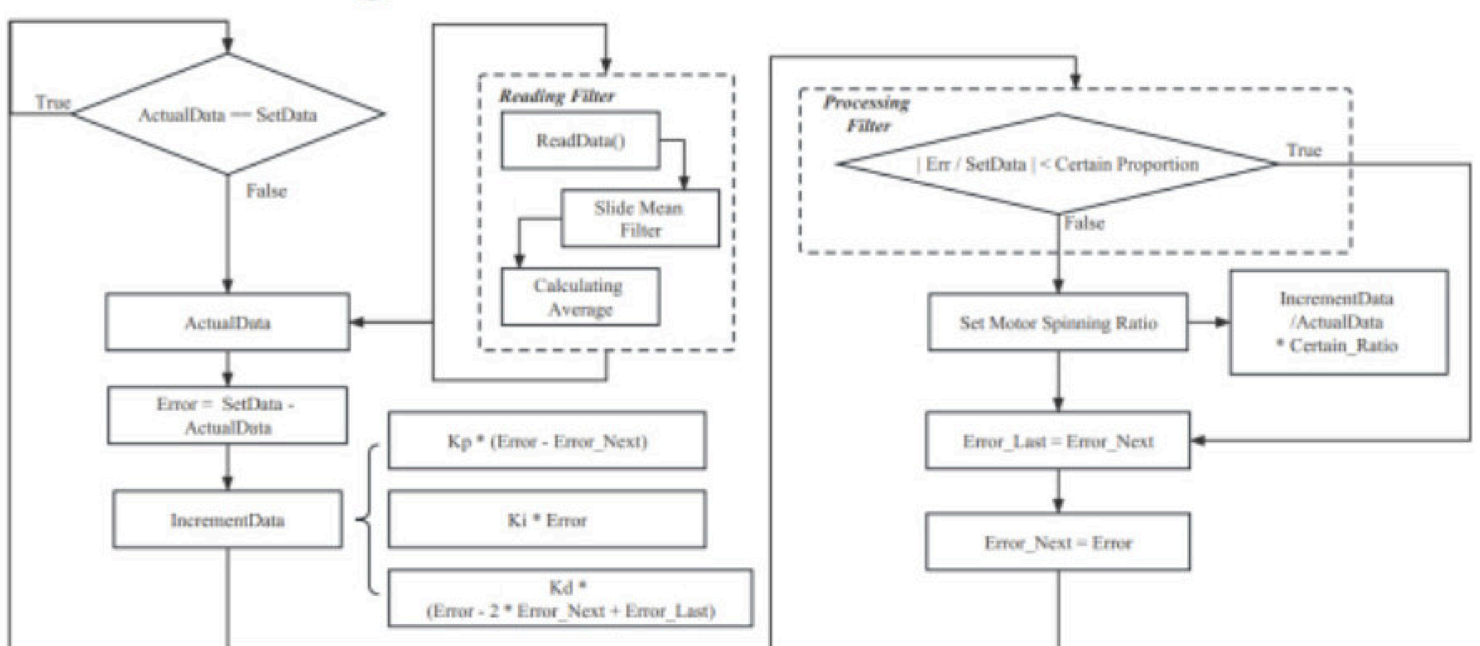


Design and implementation (Continue)

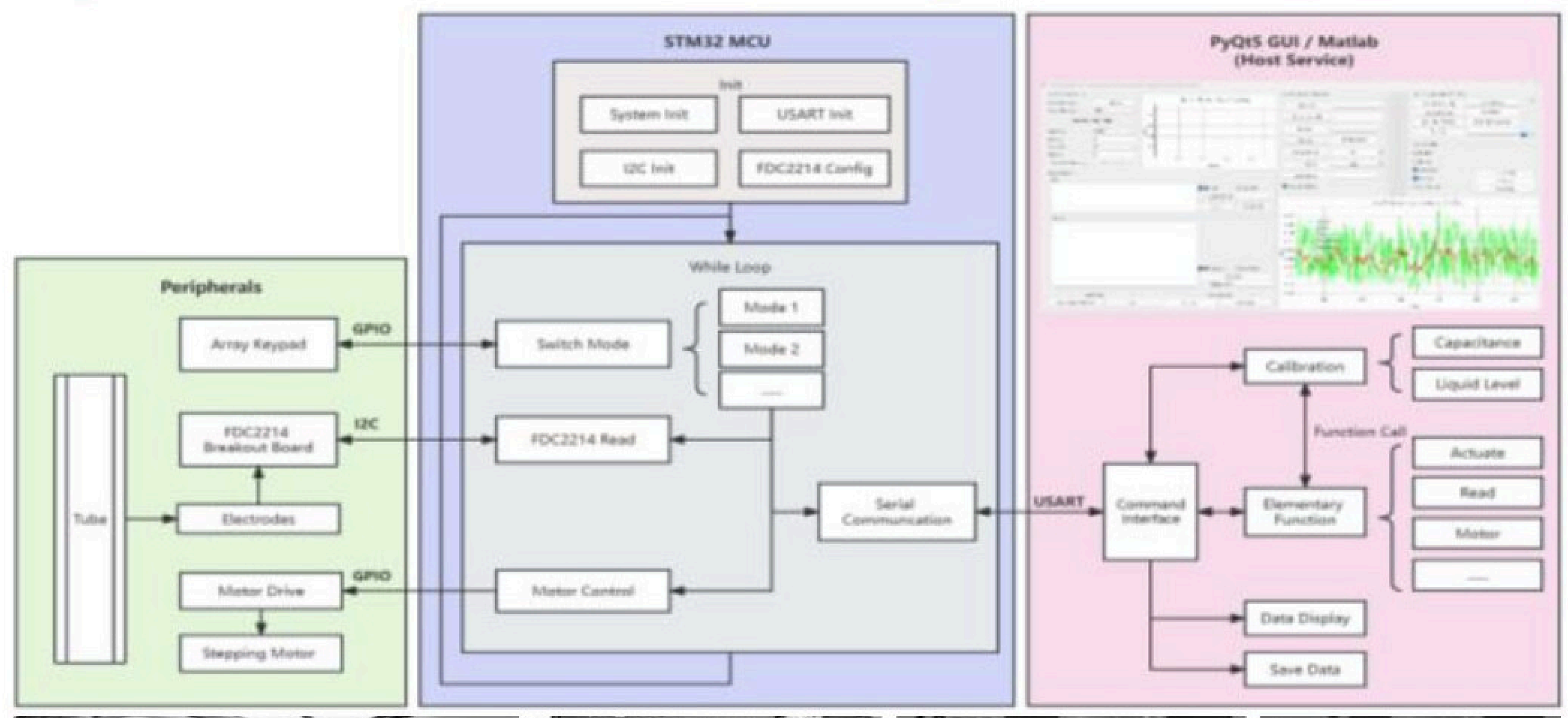
- Pump module and physical model



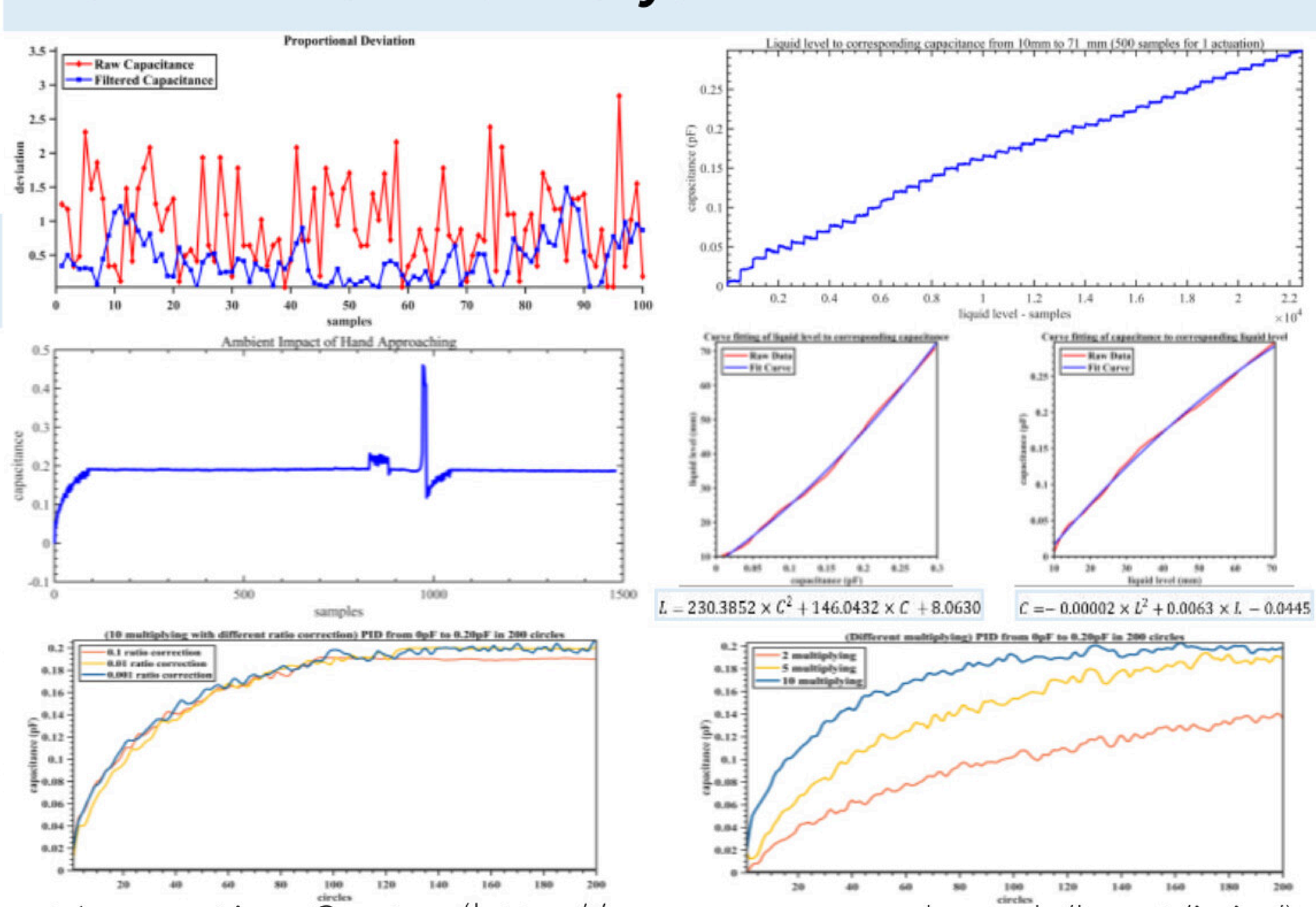
- Control logics



- System architecture and integration



Performance and analysis



Design and Evaluation of Learner-Facing Learning Analytics Dashboards

Yingting Hao
Project Leader: Dr Marie-Luce Bourguet

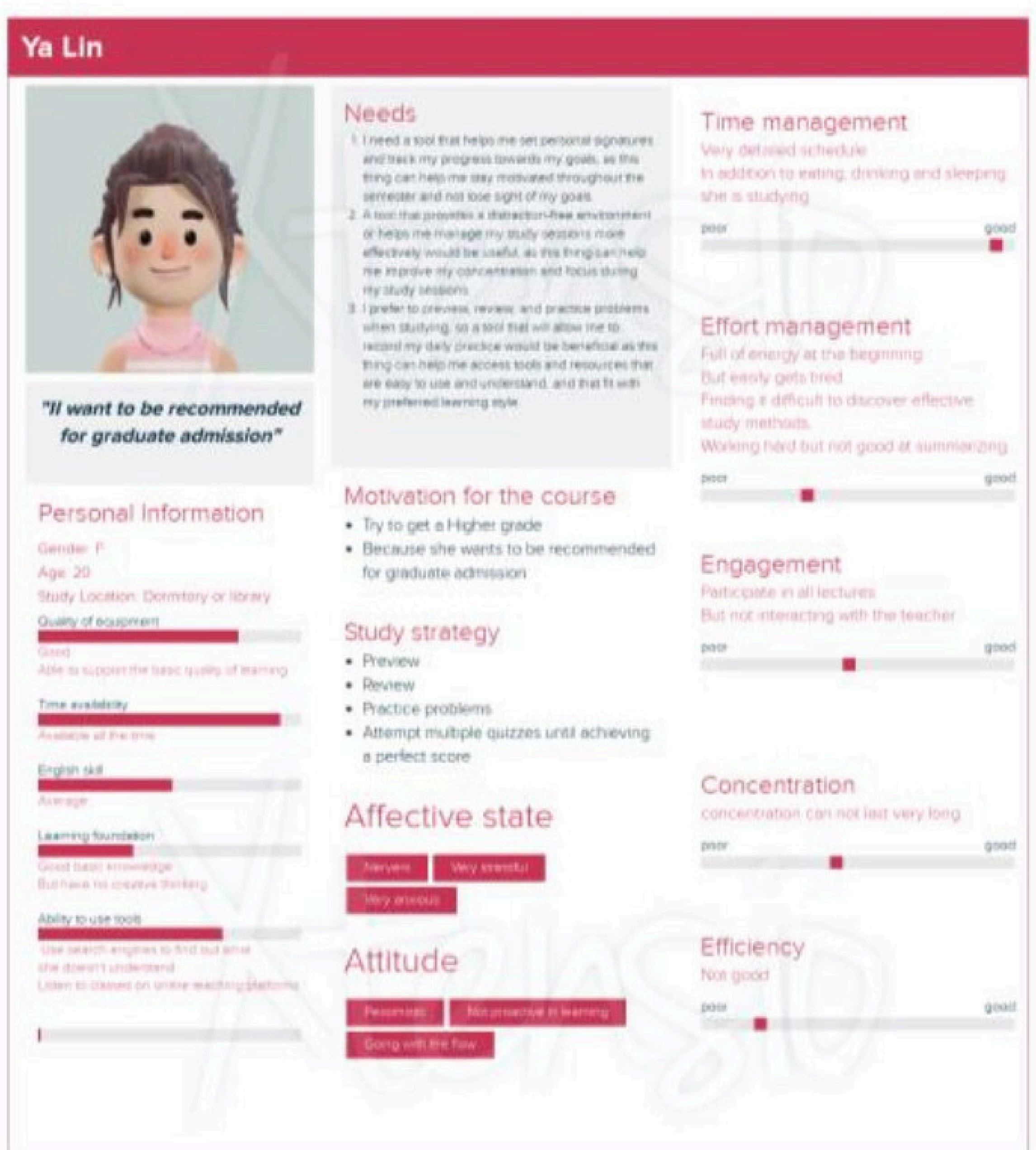
Intruduce

This project aims to design, develop, and evaluate Learner-Facing Learning Analytics Dashboards (LADs) for learners to better understand their learning progress. To achieve Student-Staff Co-creation, participatory design methods were used to collaboratively develop design documents with student users through a series of meetings. Three different layouts of LADs were implemented using Python. The effectiveness of LADs were evaluated through methods such as surveys, eye-tracking, and think-aloud protocols, indicating that it is an effective learning support tool that can improve learning outcomes and enhance the overall learning experience. This project provides new ideas and methods for the field of learning analytics and offers better learning support tools for students, making significant contributions.

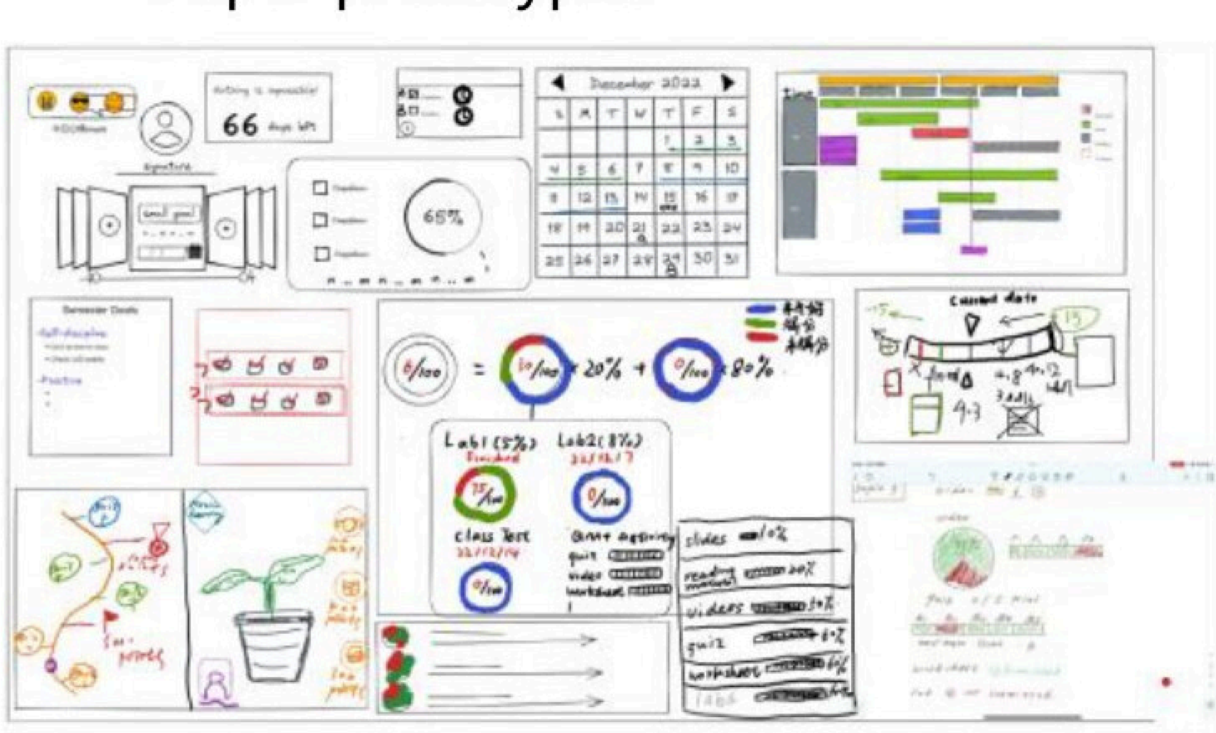
Design

Participatory design of the LAD

- Personas

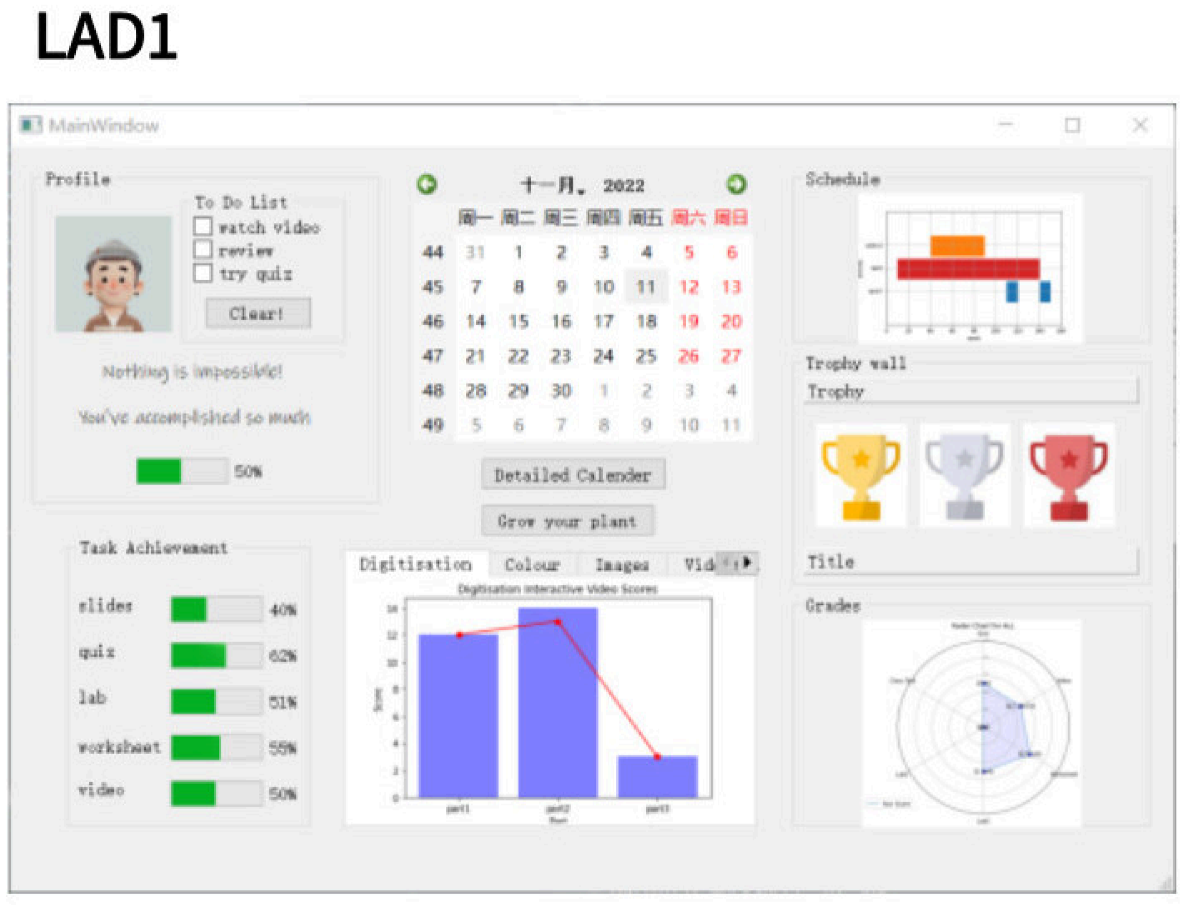


- Paper prototypes

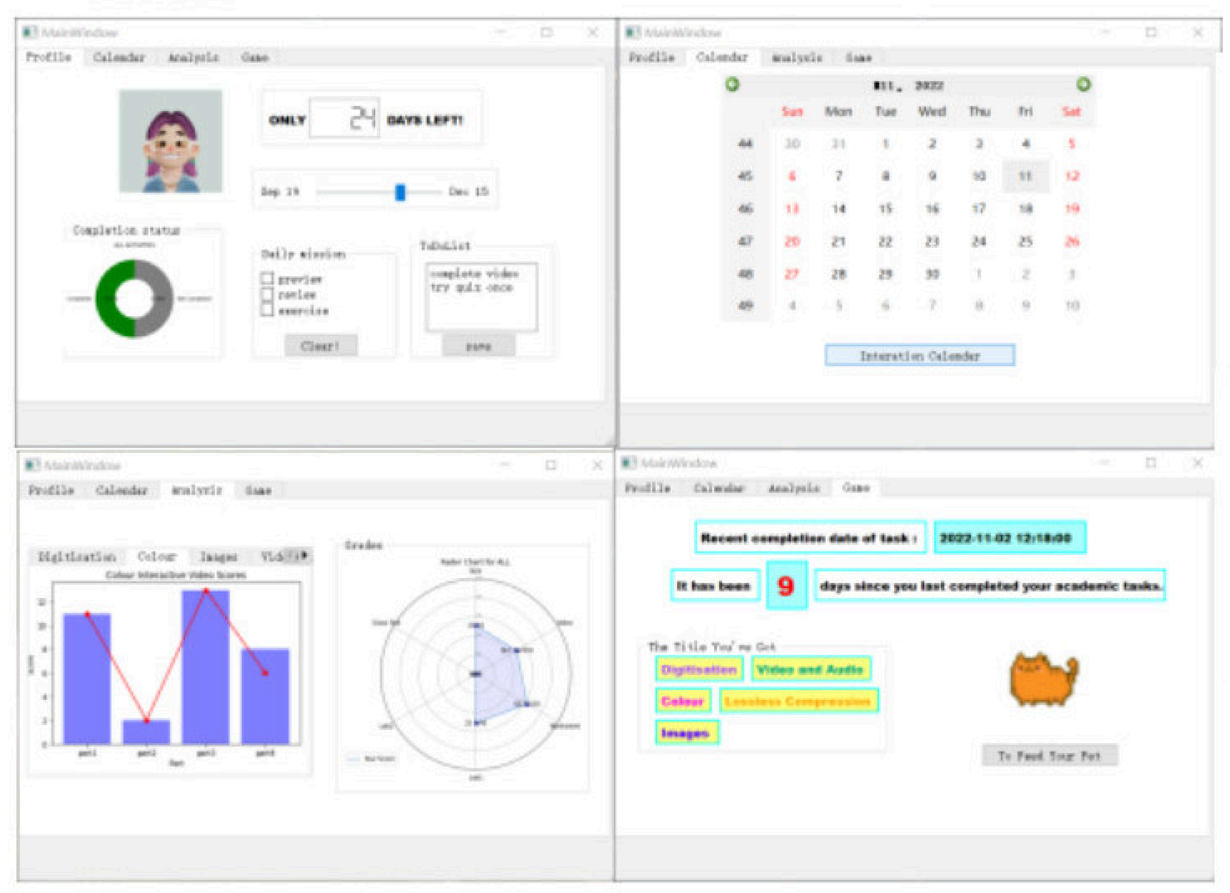


Implementation

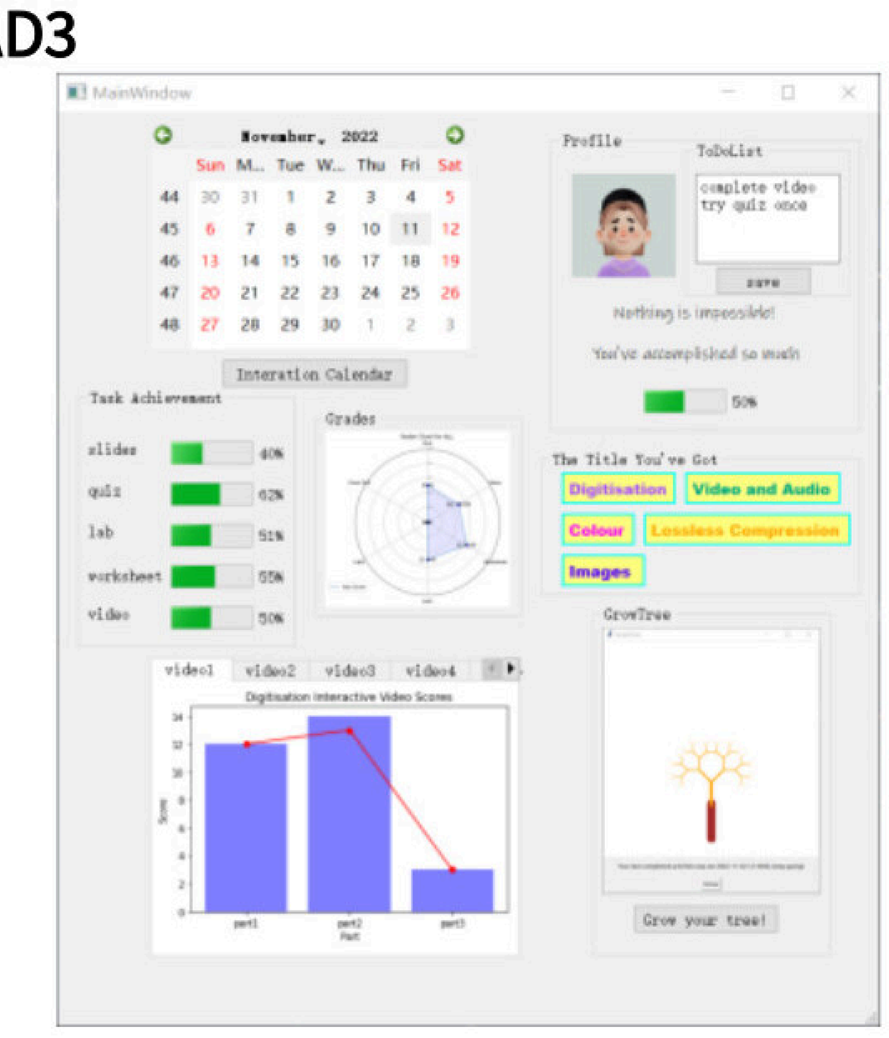
LAD1



LAD2

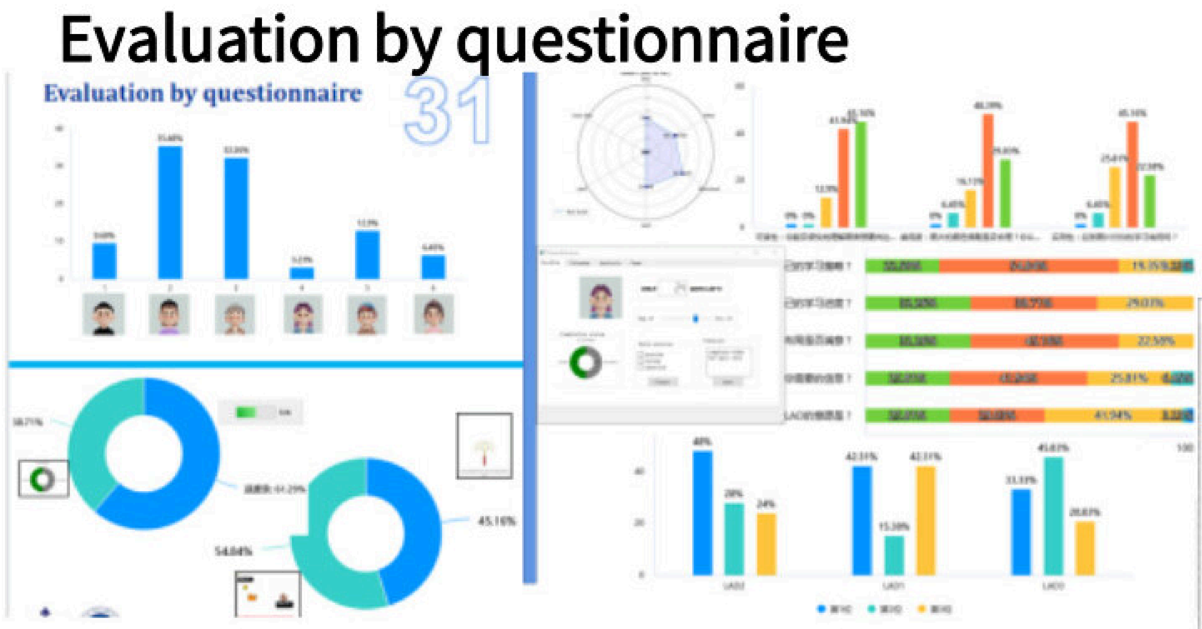


LAD3

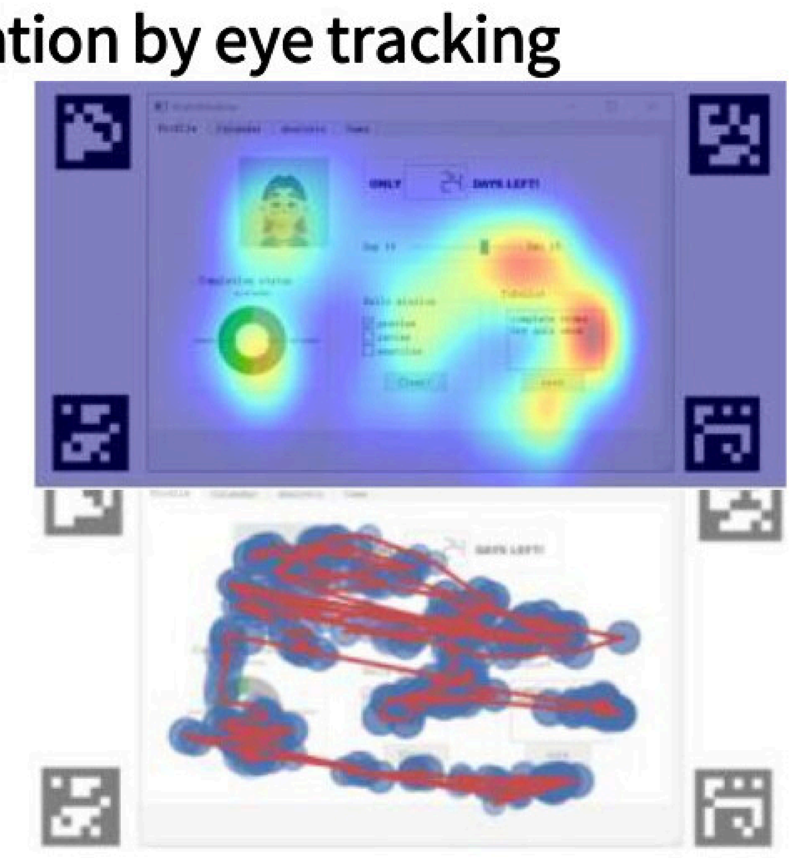


Evaluation

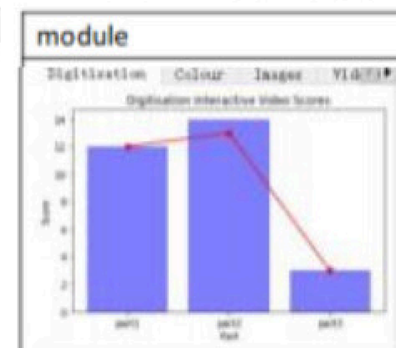
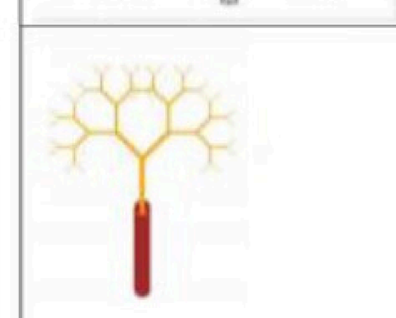
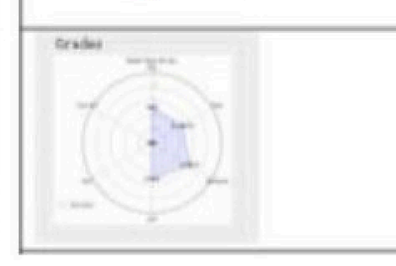
Evaluation by questionnaire



Evaluation by eye tracking

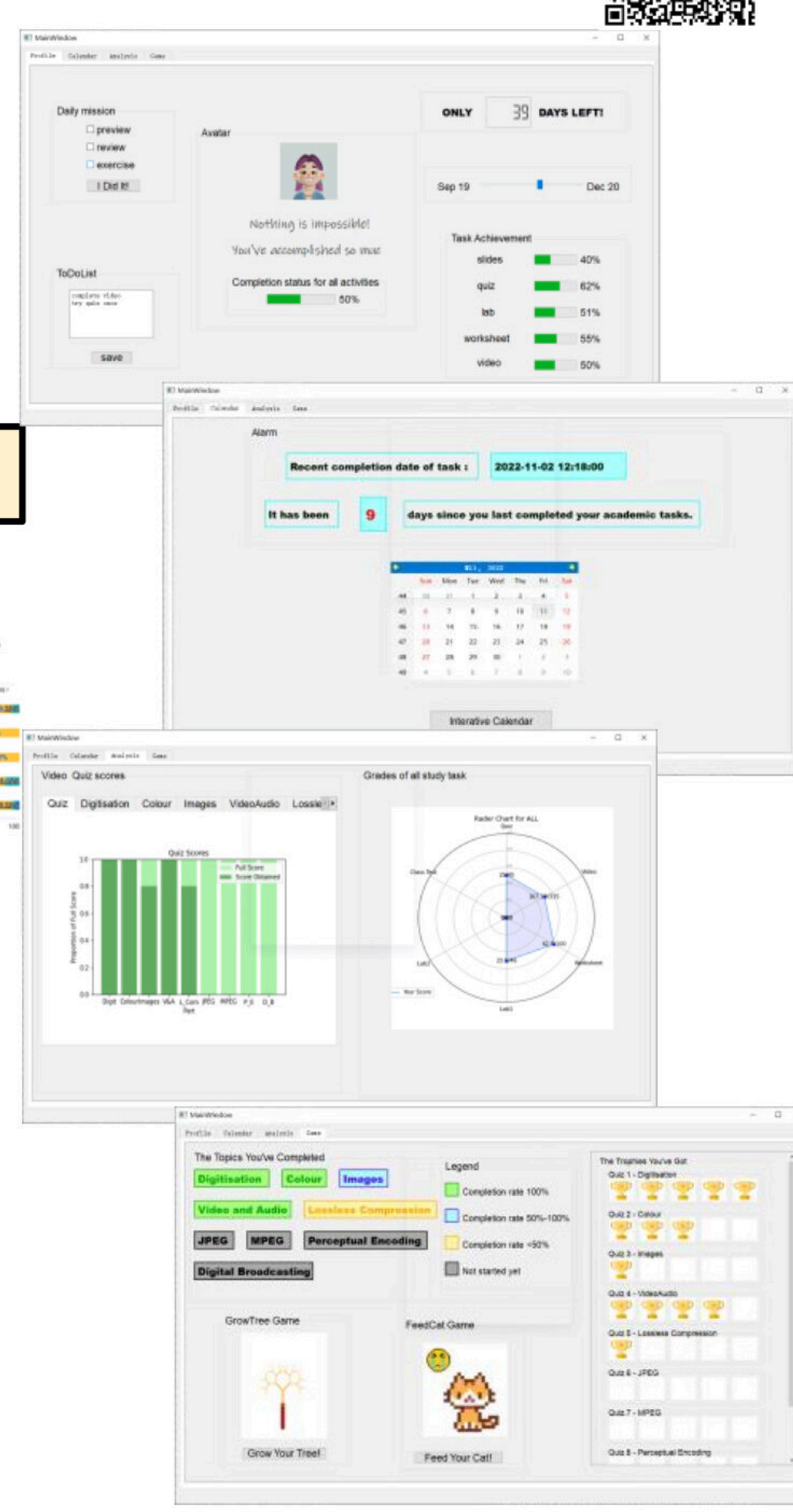


Evaluation by think aloud protocols

module	thoughts	response
	This chart shows the scores of three videos for each unit, but I am not sure how the scores are shown.	Explanation is needed. The bar chart represents the full marks, and the line chart represents the scores.
	The chapter section titles can be placed on this tree, where they can expand into some textual content.	It's not very easy to understand, and improvements are needed.
	This is the score, but the image is too small to see.	The image needs to be enlarged a bit

Optimized LAD design

You can scan this QR code to see the demonstration.



Design and Implementation of Aspect-based Sentiment Analysis for Game Reviews

Songyun Yang
Project Leader: Prof. Li Ruifan

Problem Definition

The aspect base sentiment analysis is the subtask of NLP task, which aiming to find the fine-grain aspect and the attitude towards it in reviews.

The **graphics** are nice although the **weapon** is poor --game comment

input

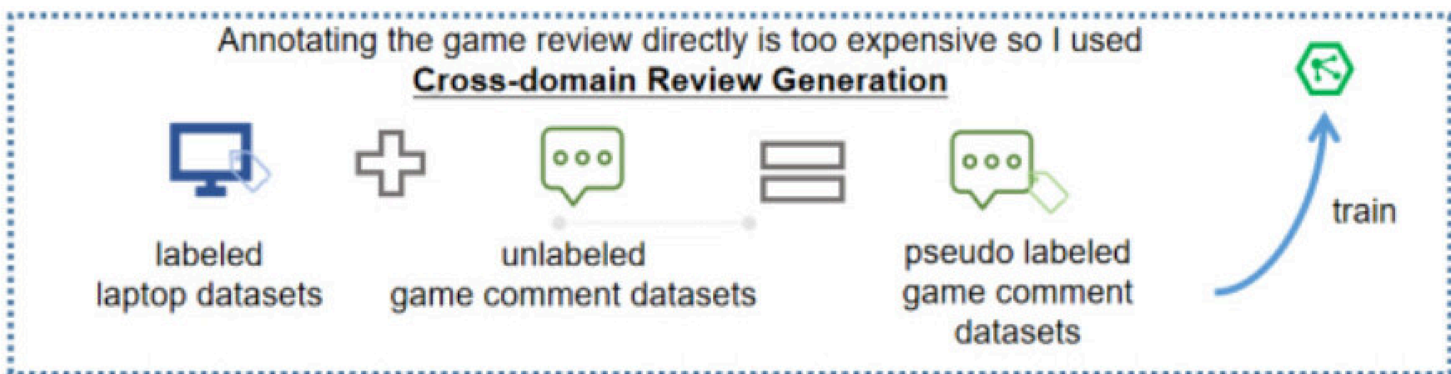
aspect	opinion
graphics	postive
weapon	negative

output

An example of ABSA task.

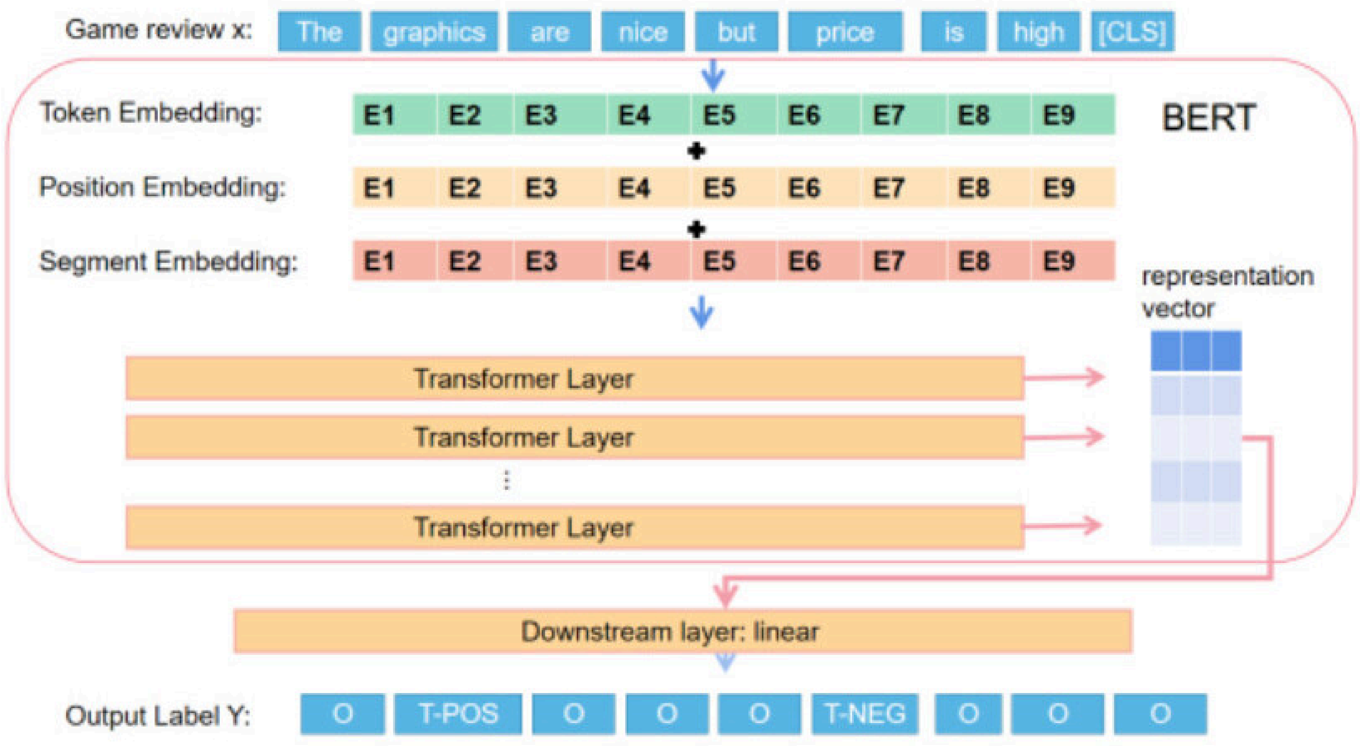
- **Major Work**

- Collect and process game reviews dataset for the task.
- Use crossing-domian data generation method to train a neural net work model of ABSA task.
- Design an interface for users to use the ABSA system.
- A series of experiments are done to verify the reliability of the model.



Cross domain review generation
-To label all the game reviews is too expensive. So I used another domain dataset with label to generate the game reviews and its label

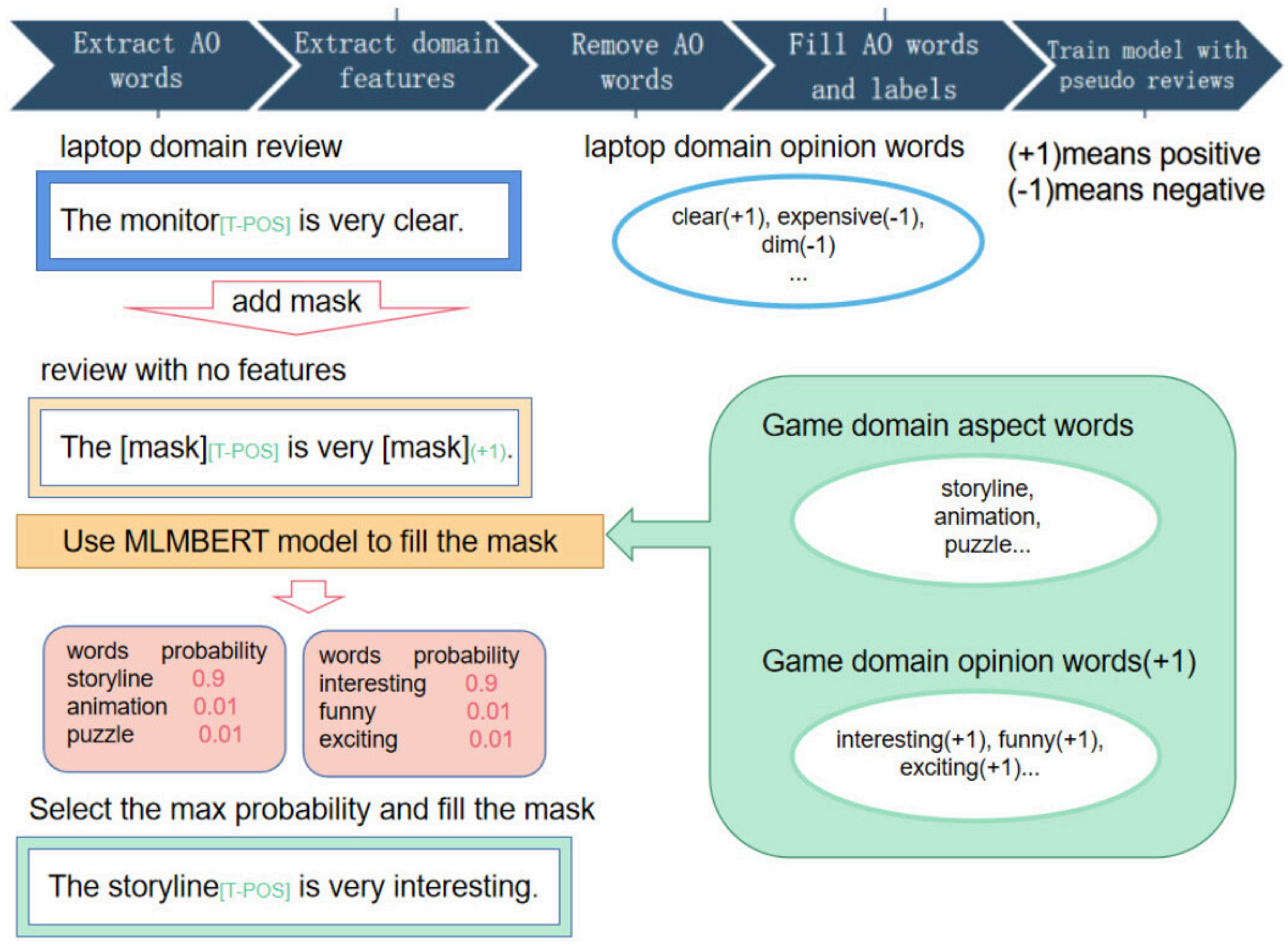
• Neural Network



The structure of the neural network model.
Model is designed based on BERT base model.

Methodology

Processing steps



Experiments

Performance of BERT fine-tune (NOT cross-domain)

Dataset	precision	recall	F1-score
Laptop	0.64	0.58	0.61
Restaurant	0.71	0.72	0.72
Device	0.61	0.58	0.6

Performance of the cross-domain reviews generating method in high-quality datasets' domain

Source domain	Target domain	precision	recall	F1-score
Laptop	Restaurant	0.53	0.5	0.52
Restaurant	Device	0.28	0.32	0.3
Device	Restaurant	0.58	0.51	0.54
Rest	Laptop	0.43	0.37	0.4

Performance of the cross-domain reviews generating method in game domain. (red:best perfomance)

Source domain	Target domain	precision	recall	F1-score
Laptop	Game	0.31	0.28	0.29
Rest	Game	0.37	0.31	0.33
Device	Game	0.41	0.44	0.42
Laptop+Game	Game	0.33	0.29	0.31
Restaurant+Game	Game	0.34	0.38	0.36
Device+Game	Game	0.45	0.48	0.46

Performance of the GPT compare with the Best model

	precision	recall	F1-score
OpenAI-Davinci	0. 31	0. 87	0. 45
Cross-domain Best performance	0. 45	0. 48	0. 46

Eye tracking data analysis and visualisation software

Han Di

Project Supervisor: Dr Marie-Luce Bourguet

Abstract

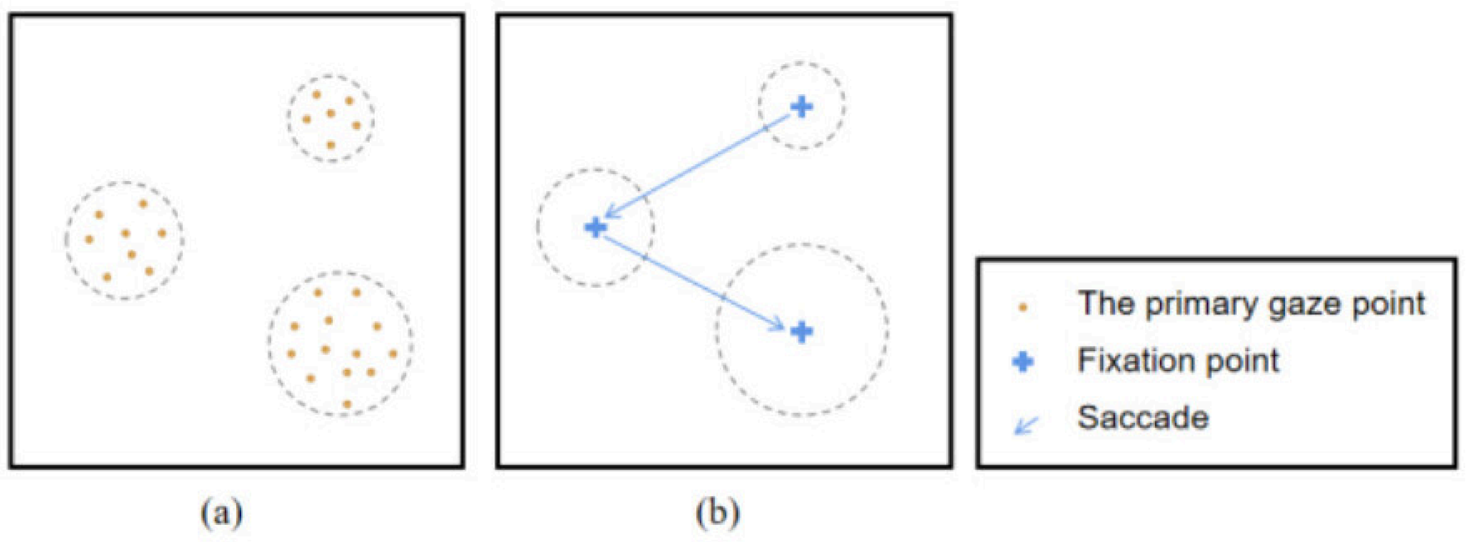
Eye tracking is the process of measuring and recording the movement and gaze position of a person's eyes as they look at visual stimuli. The project aims to design software that can：

- Capture and record gaze data in real time
- Perform data analysis
- Create data visualisations

Eye tracker used to record eye movement
(Device from Pupil Core)

Eye movement classification

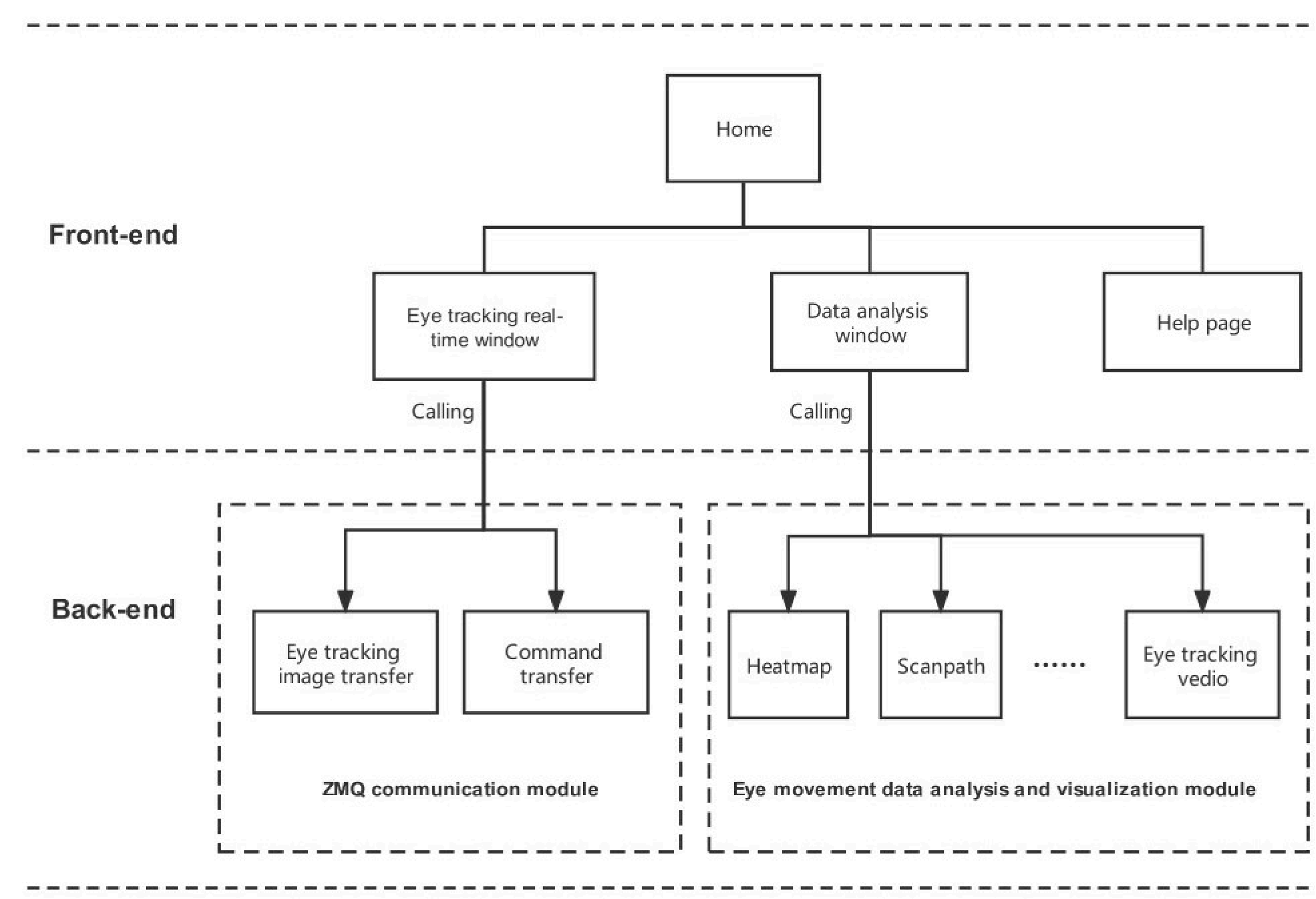
- Fixation (a) ： the gaze stays on the area of interest (AOI) for a certain amount of time.
- Saccade (b) ：the gaze moves from one AOI to another AOI.



Algorithms

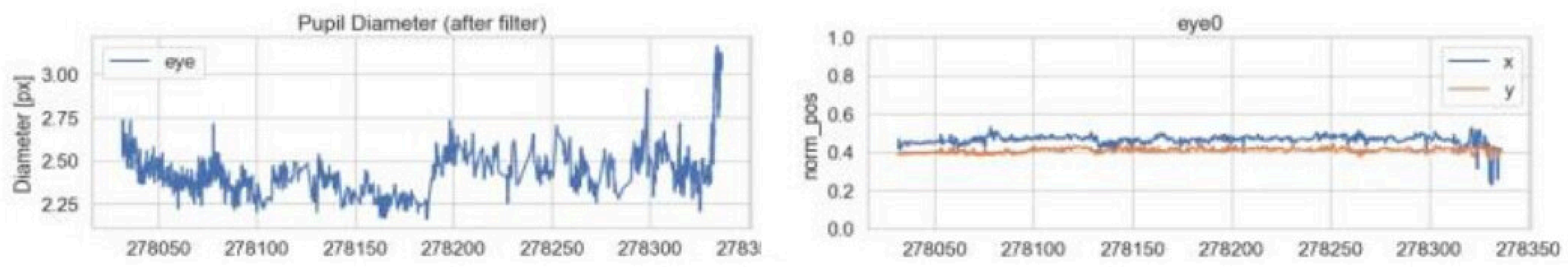
- Fixation detector ：dispersion threshold identification (I-DT) method.
- Heatmap generator: histogram statistics method, and Gaussian filtering

Software Design

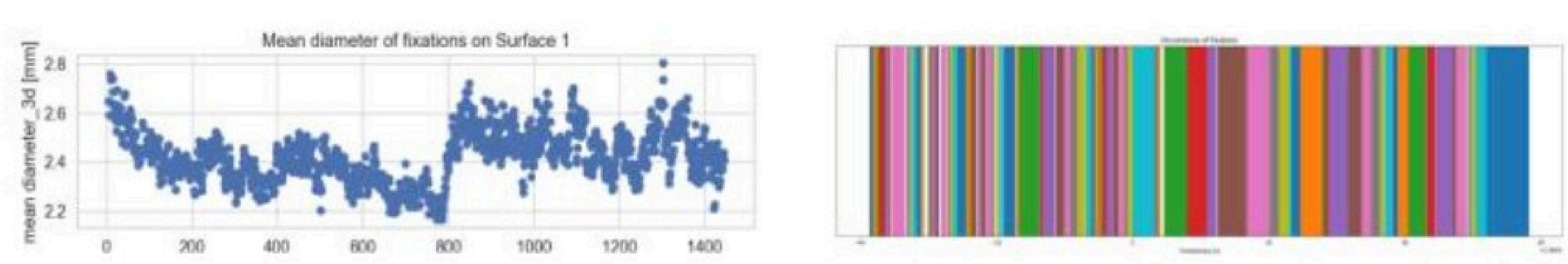


Visualisation results

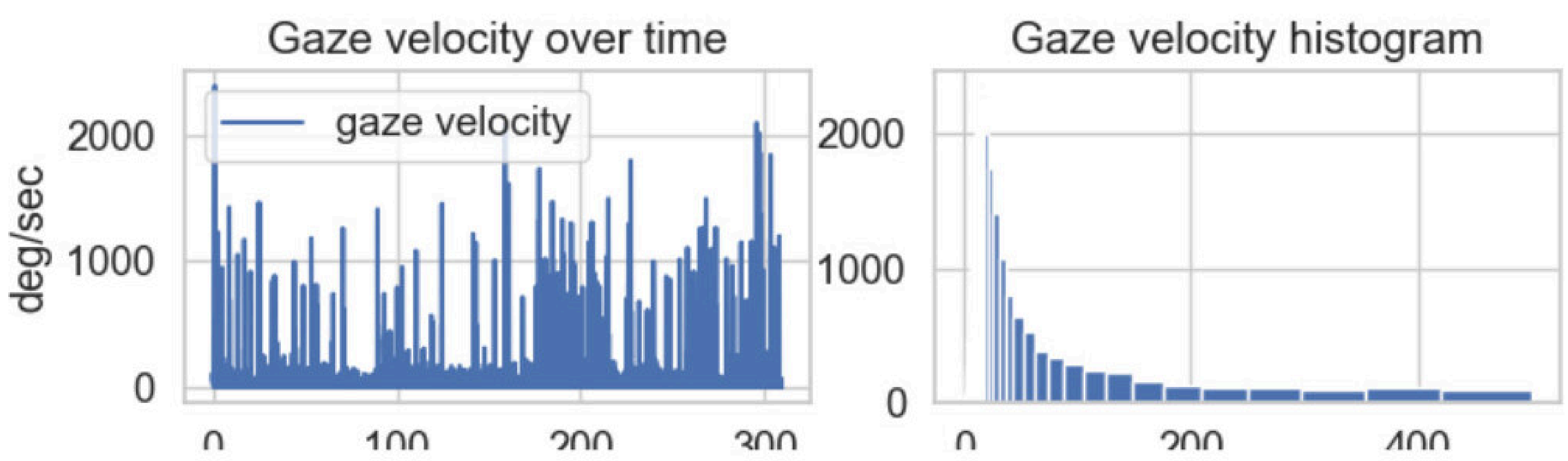
(a) Heatmap (b)Scanpath



(c) Pupil diameter over time (d)Pupil position over time



(e) Pupil diameter of fixations (f)Occurance of fixation



(g) Gaze velocity over time (h)Gaze velocity histogram

Queen Mary University of London

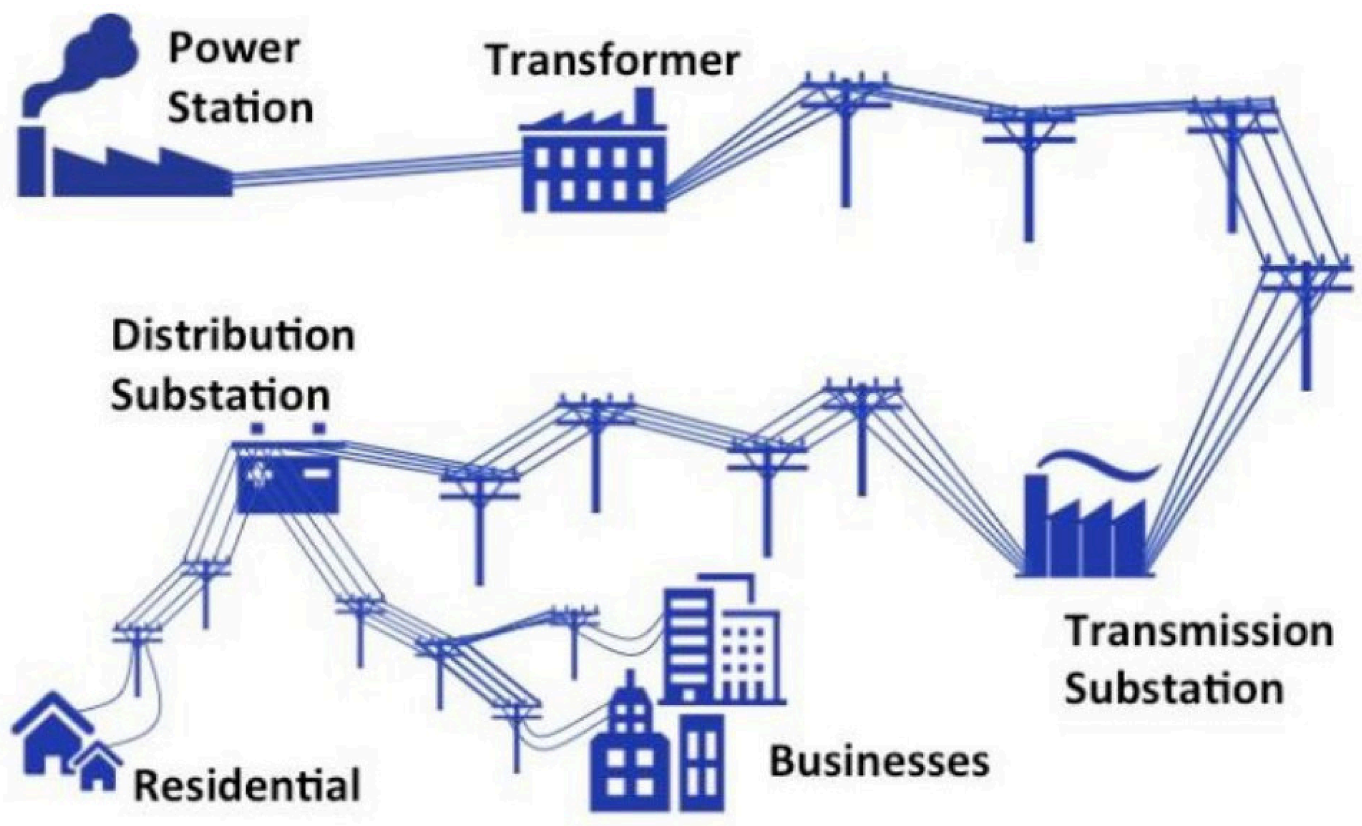
QMUL-BUPT JP/JEI
JP Student Innovation Centre (JPIC)
Annual Showcase 2022/23

Intelligent-based Prediction Model for the Smart Electricity Grid

Yulin Song
Project Leader: Ethan Lau

Objective & Background

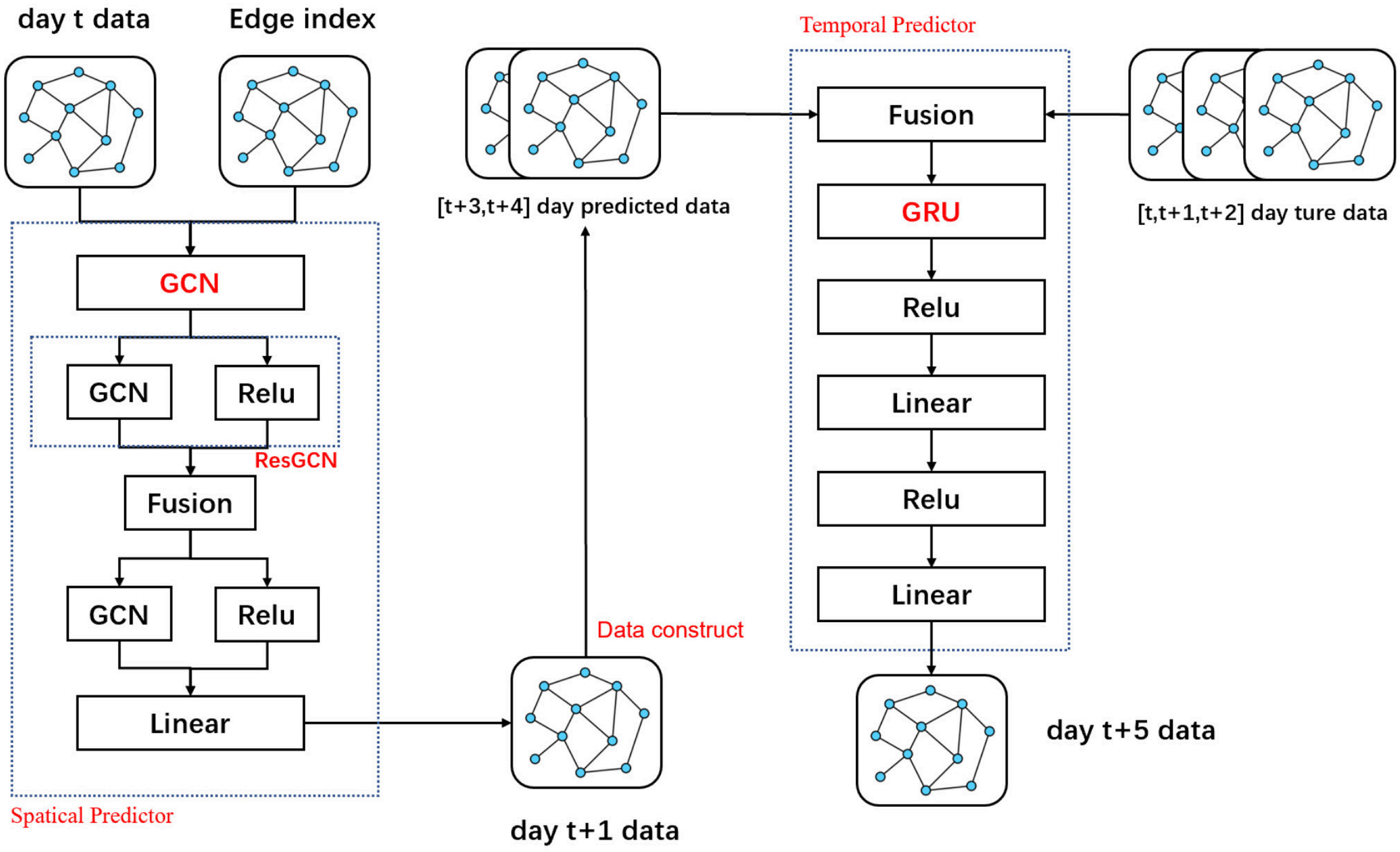
Traditional methods cannot fully capture the dynamic characteristics of multiscale energy systems due to the excessive unused renewable energy, uncertain energy consumption, and insufficient amount of energy storage facilities in general power systems, which leads to inaccurate forecasting and inefficient system operation. To tackle these issues, this paper proposes a deep learning approach to accurately predict the fundamental states of a classic electric grid with the consideration of power network spatial topology and potential temporal relations.



Power Grid Structure

Model Structure

we propose a spatial and temporal deep learning model called STNet to accurately predict the system's node state.



STNet Structure

Study Result

Simulation results show that the proposed deep learning approach outperforms other basic forecasting tools when predicting the state of a typical power system. These promising results provide significant benefits in power grid operation.

Method	MSE	RMSE	MAE	MAPE (%)
MLR	$2.749 * 10^{-4}$	$1.658 * 10^{-2}$	$8.414 * 10^{-3}$	61.7
AR	$1.6 * 10^{-3}$	$4 * 10^{-2}$	$5.12 * 10^{-3}$	91.7
SVR	$1.75 * 10^{-5}$	$4.18 * 10^{-3}$	$2.178 * 10^{-3}$	29.46
CNN	$3.994 * 10^{-5}$	$6.32 * 10^{-3}$	$3.3 * 10^{-4}$	507524
KNR	$1.21 * 10^{-5}$	$3.48 * 10^{-3}$	$1.648 * 10^{-3}$	30.48
RNN	$2.98 * 10^{-6}$	$1.72 * 10^{-3}$	$6.2 * 10^{-4}$	27.22
LSTM	$3.78 * 10^{-2}$	$1.95 * 10^{-1}$	$9.74 * 10^{-2}$	108
STNet	$3.69 * 10^{-9}$	$6.07 * 10^{-5}$	$4.65 * 10^{-5}$	31.3

Iterative Development of Market-Compatible Mobile Apps for Local Insurance Company

Xuanyu Chen, Qianhang Feng, Hantang Zhang
Project Leader: Dr Xianhui Che

Abstract

Mobile technology has made mobile apps crucial for enterprise competitiveness. This project combines mobile apps and cloud to explore the practical use on Android and iOS platforms to create impressive UI that will spark interest in customers, while also examining potential security risks and network communication processes with Firebase and Stripe for online transactions.

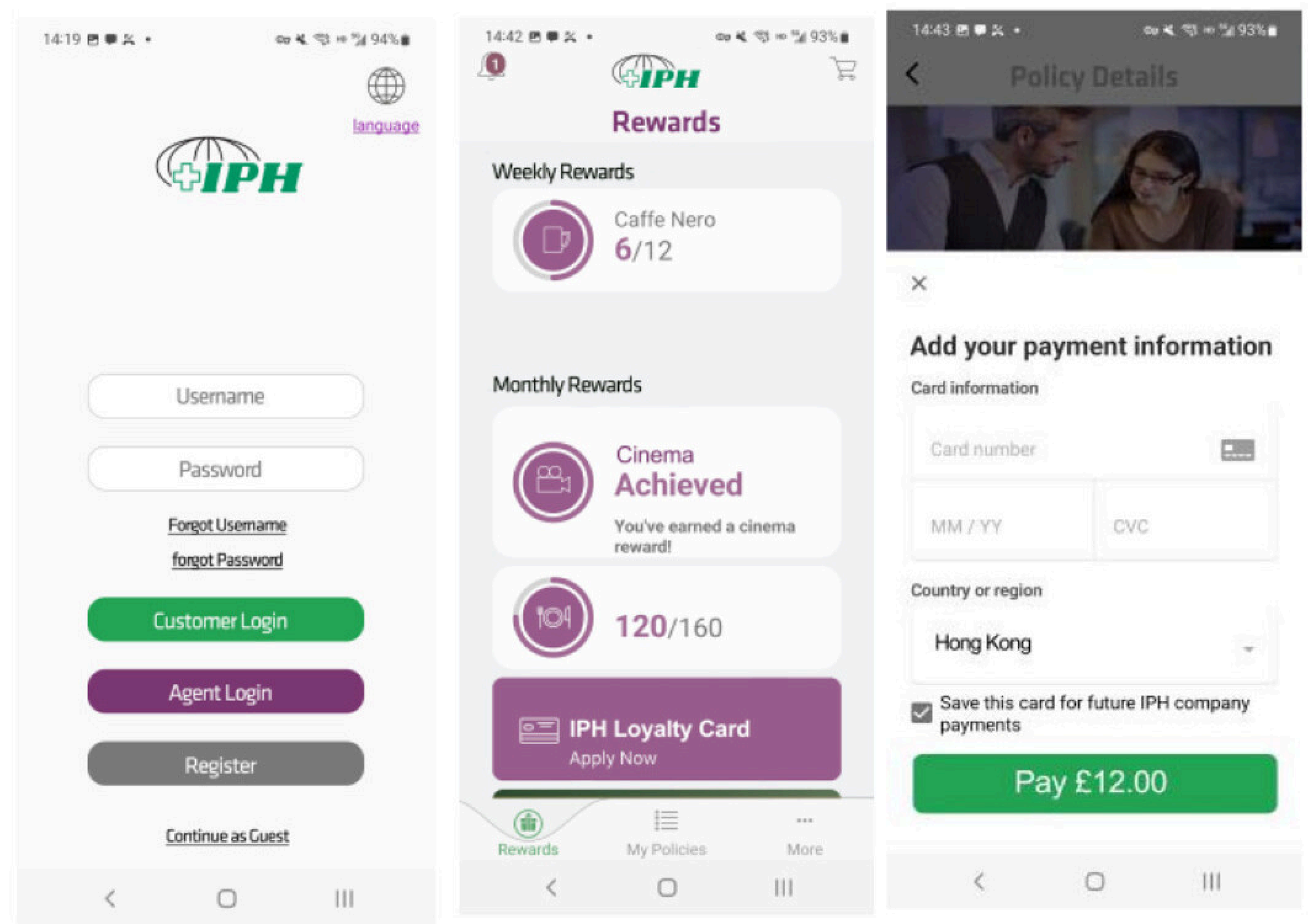
Difficulties

- Make pages informative and consistent
- Implement design patterns, including MVP and MVVM
- Explores the components' lifecycle in detail
- Learn and master the mobile app development environment
- Relevant resource searching in object customisation
- Visual impact design and implement
- Remote database construction and real-time network communication

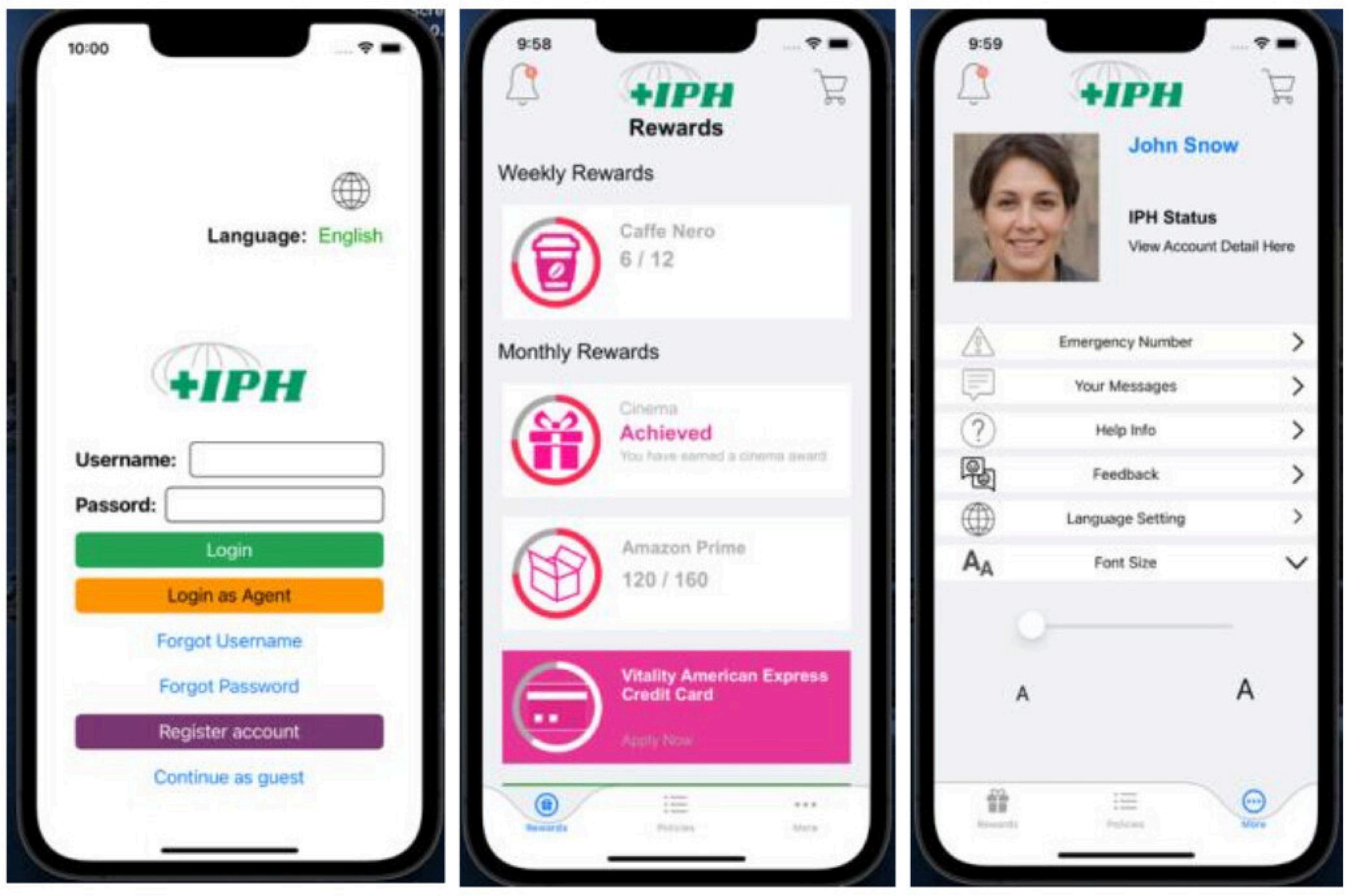
Results

- Develop two identical insurance sales mobile apps on Android and iOS
- Customized user interface
- Build remote server and database
- Make network communication with remote server
- User authentication and management with Firebase
- Stripe online payment function

Android Mobile App



iOS Mobile App



Future Work

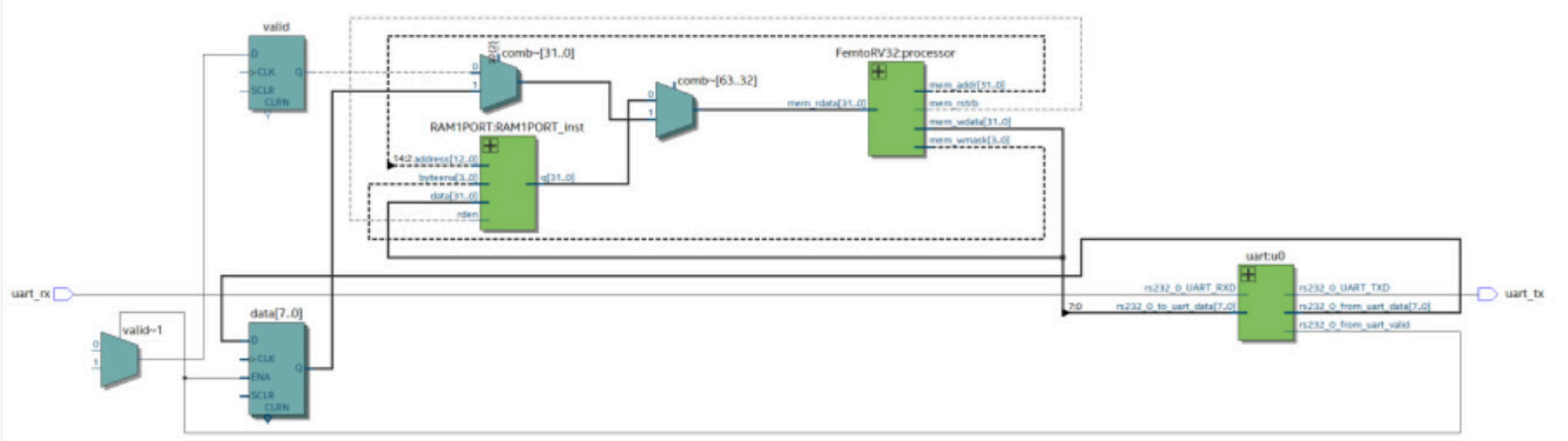
- UI optimization. It is a continuous process after the app is put on the shelf according to the customer's feedback
- Improve functionality. Add more app features is in line with the company's business expansion and market demand
- Optimize integration and usage with remote database

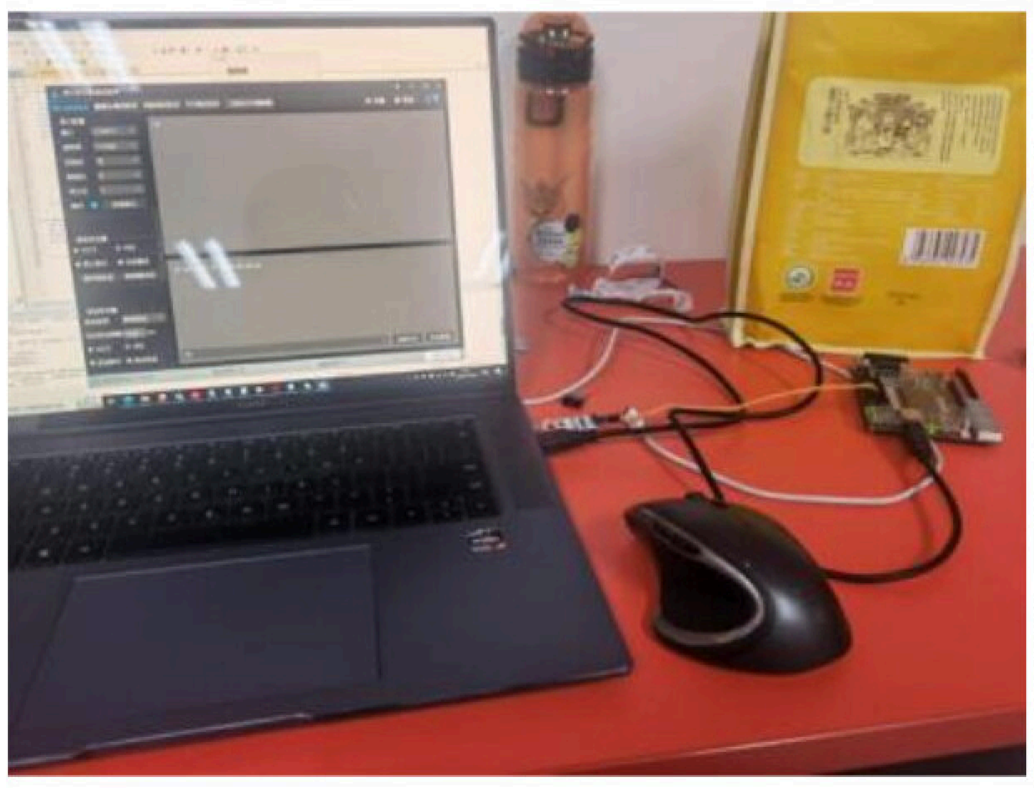
Minimal RISC-V Microprocessor Design

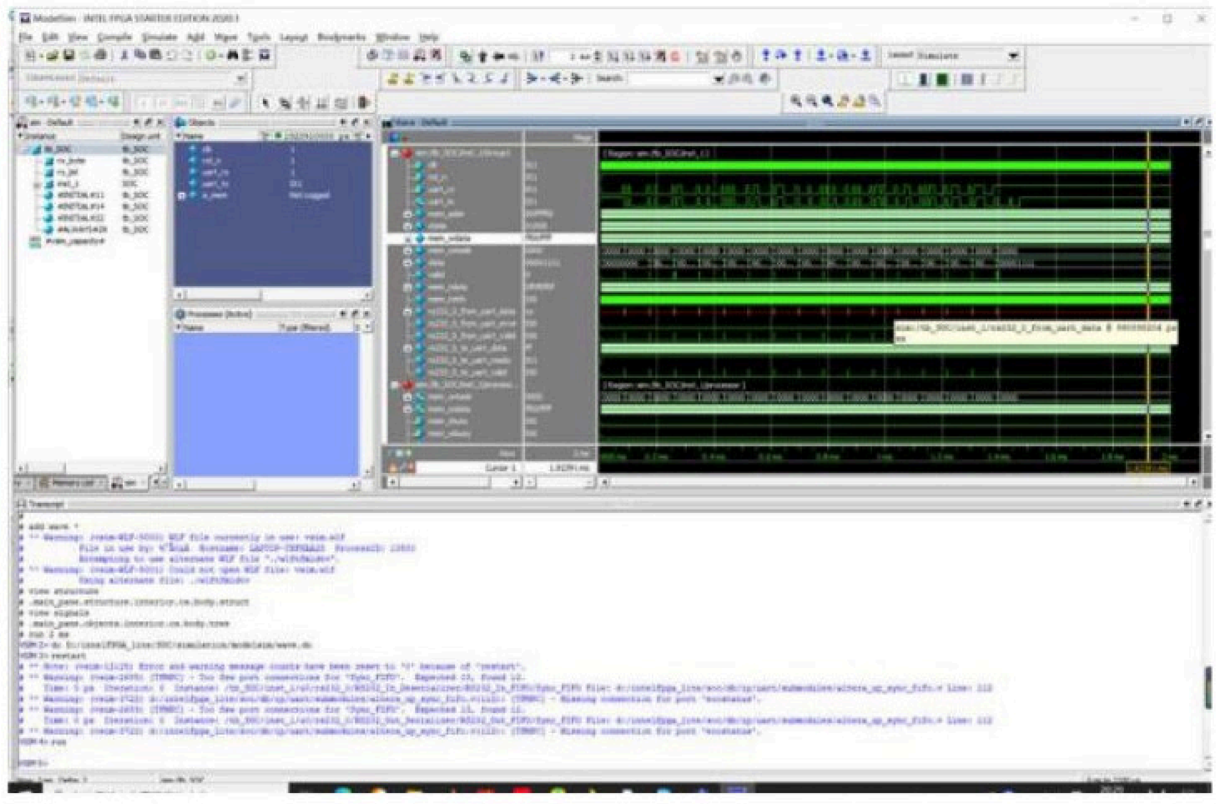
Pengdao Jiang, Haotian Liao
Project Leader: Dr. Matthew Tang

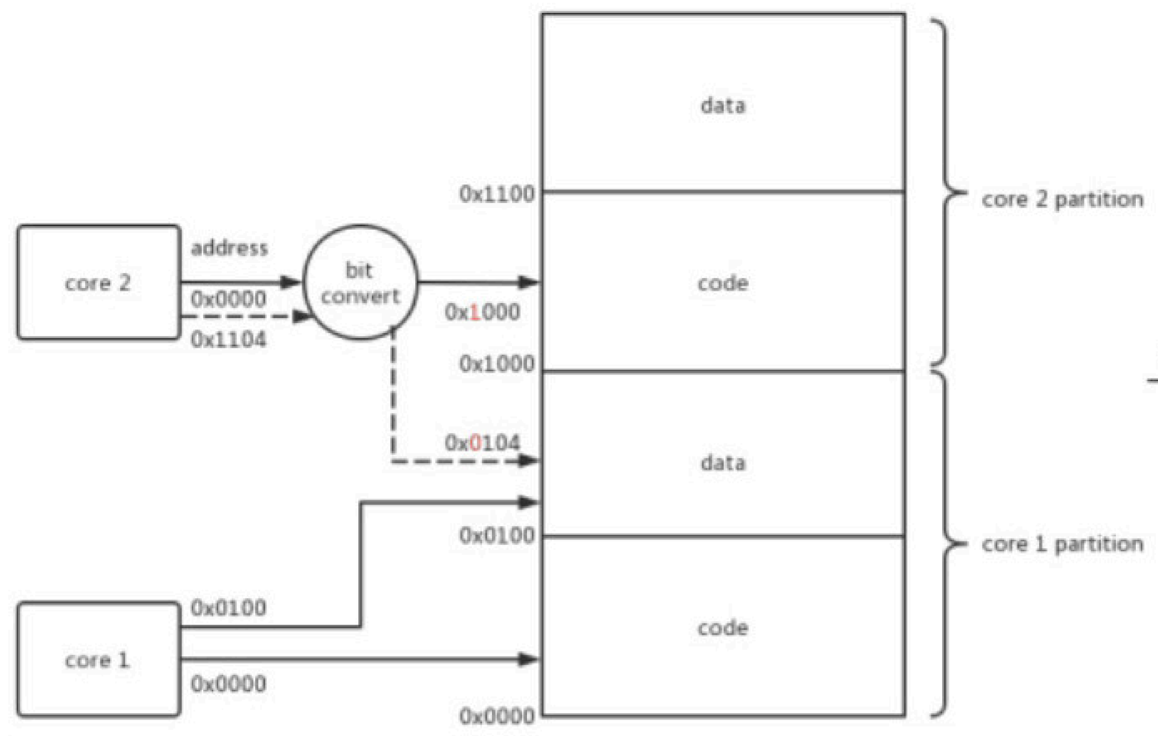
Build single-core system-on-chip(SOC)

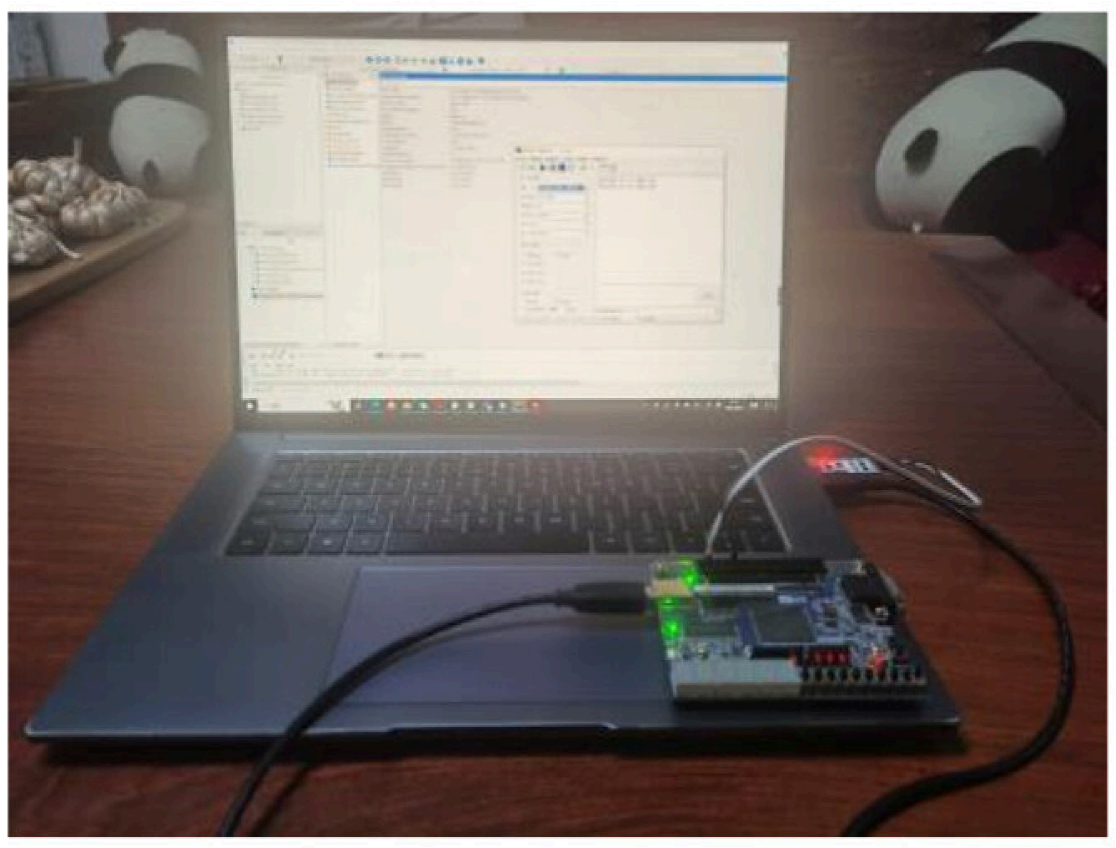
- Study the characteristics of the RISC-V instruction set and computer architecture, and design a SOC that can be implemented on FPGA.
- Use the hardware description language to implement the system and verify the system on the development board.

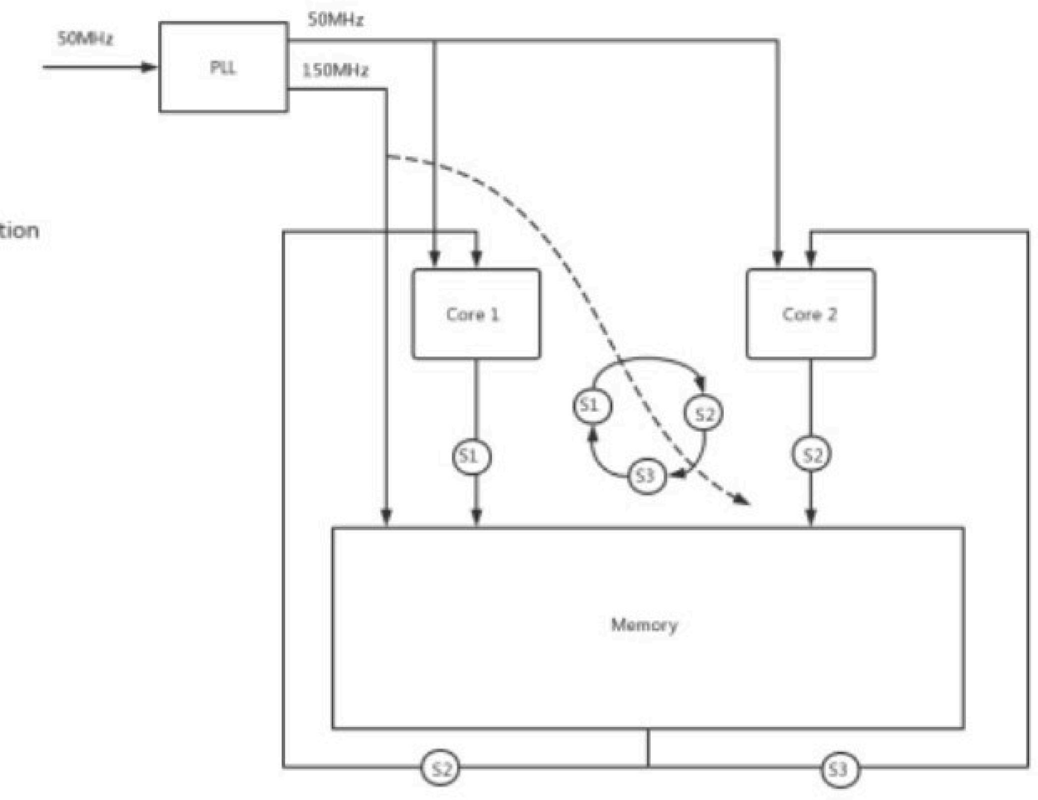










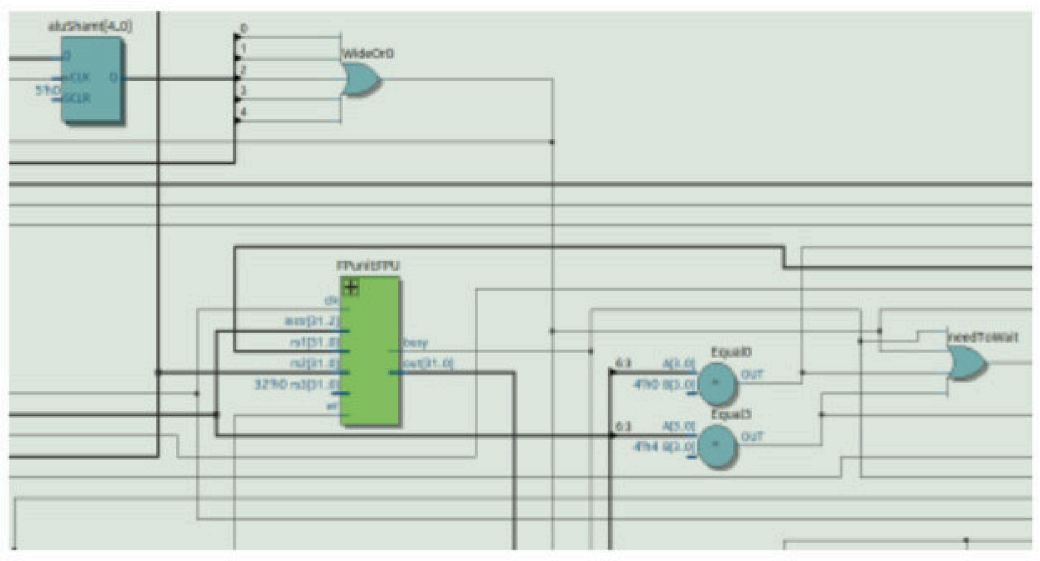


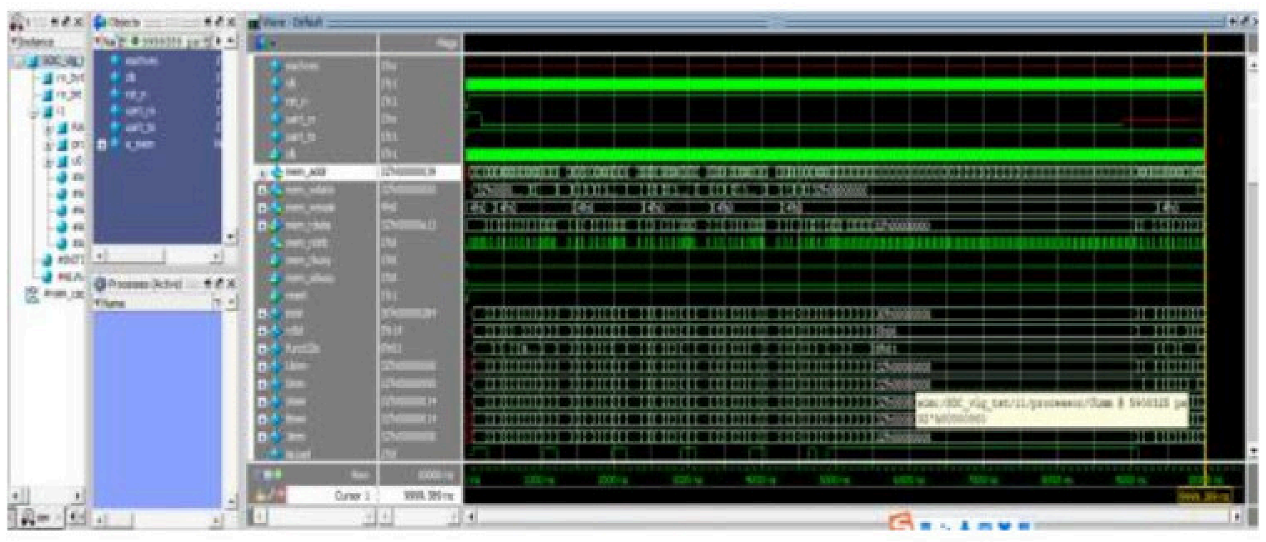
Build multicore SOC

- Delve into the core timing properties and explore specific multicore system design options.
- Verify the stability of the multicore system.
- Design the benchmark firmware to verify the speed-up compared to the single-core system.

Add Floating Point Unit

- Design the floating point unit to support the RV32F instruction set.
- Implement the FP-unit to the base processor system.
- Compare execution cycles and power consumption. Disscuss about the application of our approach.





Processor	Code size	Execution cycles	Power dissipation
Without FP-unit	61	29575	10.95mW
With FP-unit	20	4621	11.13mW

Quantifying and Supporting Students' Learning Behaviour and Engagements

Wenrui Li
Project Leader: Dr Ethan Lau

Summary

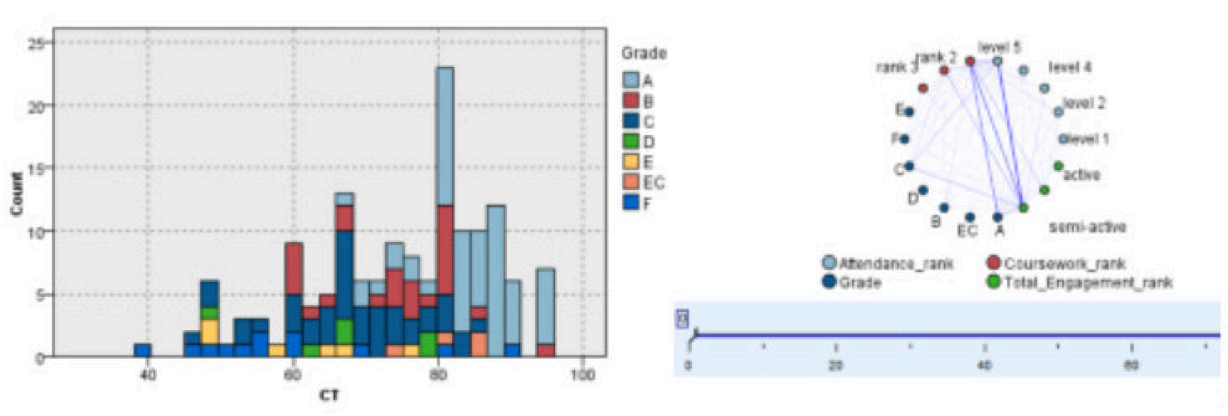
In 2019, COVID transformed traditional learning into online learning, which resulted in limited observations of students' behaviour, high drop-out rate and insufficient interventions from teachers. The project aims at quantitatively model students' learning behaviour and performance and provide generalized AI solutions driven by DS/ML/DL.

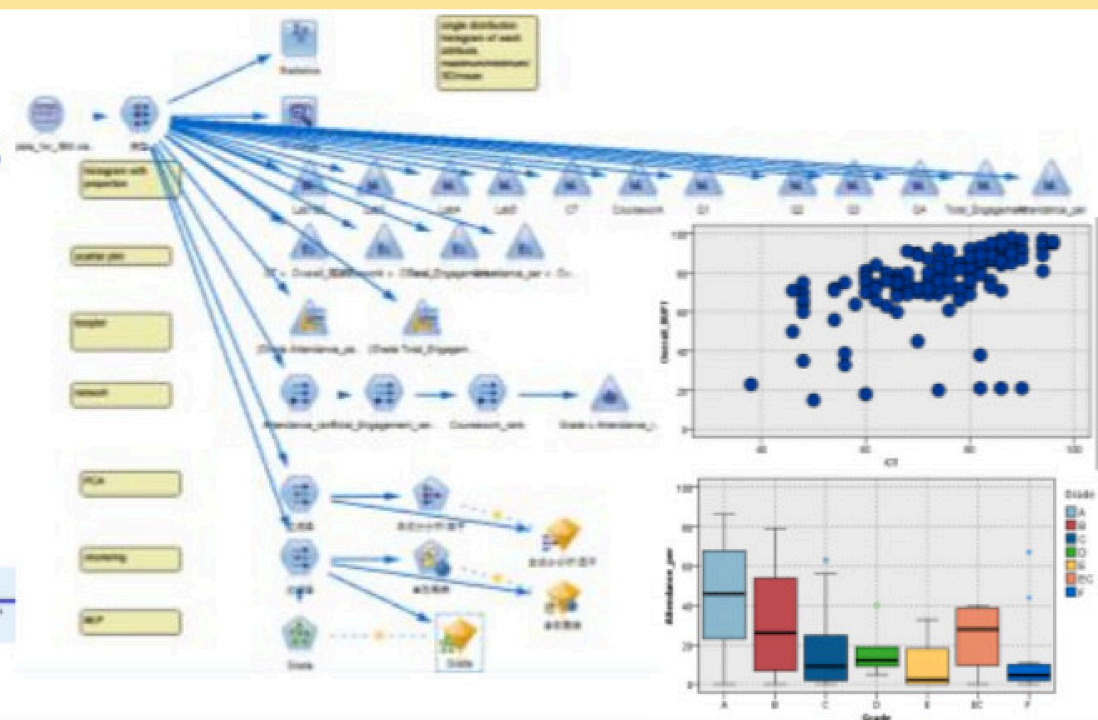
The contributions are:

- Compare DL methods and ML baselines (91.39% uniclass, 70.2% multiclass, 87.24% regression).
- Model students' performance diversely with Bi-directional Bayesian Prediction, learning example, learning styles, probability learning curves, etc.
- Utilize in-course dataset and consider learning as an envolving process with RNN and EHMM.
- Design a smart interactive system (SPEES) with educational insights.

Stage 1: Information Collection & Statistical Analysis

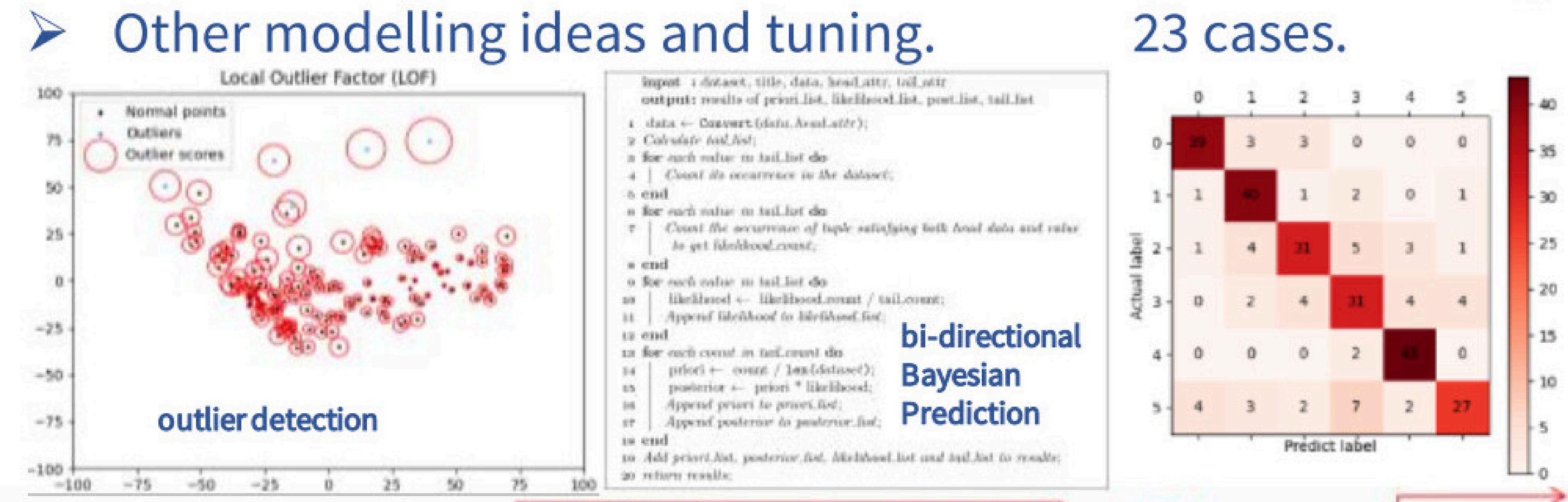
- Literature review/datasets/methodologies.
- Data preprocessing and statistical analysis (IBM SPSS Modeler 18.0).



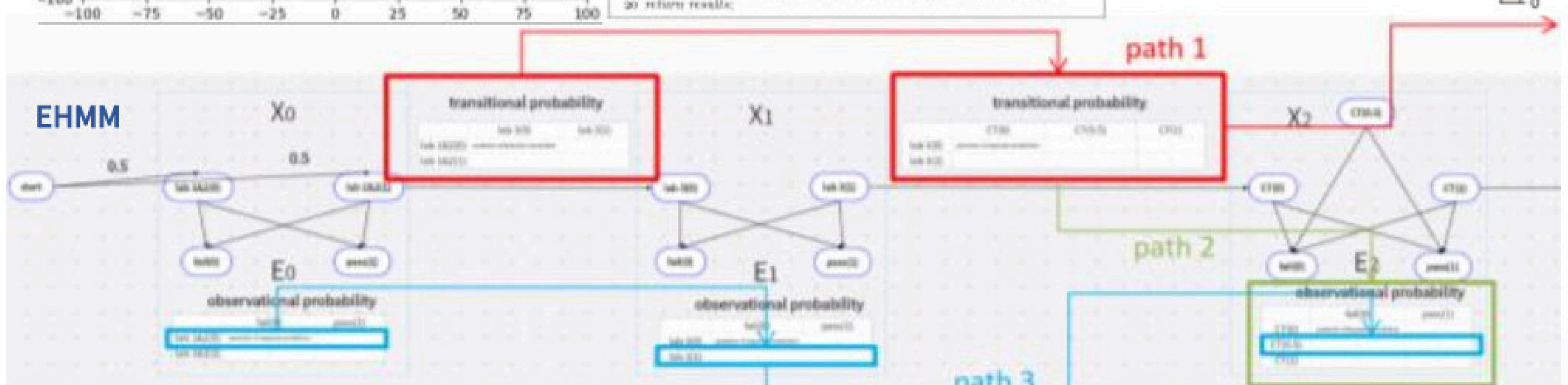


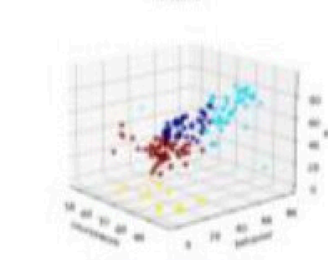
Stage 2: Modelling & Decision Making

- Data preprocessing (Python) and outlier detection.
- Other modelling ideas and tuning.
- Experiments for uniclass/multiclass classification/regression, 12 methods and 23 cases.



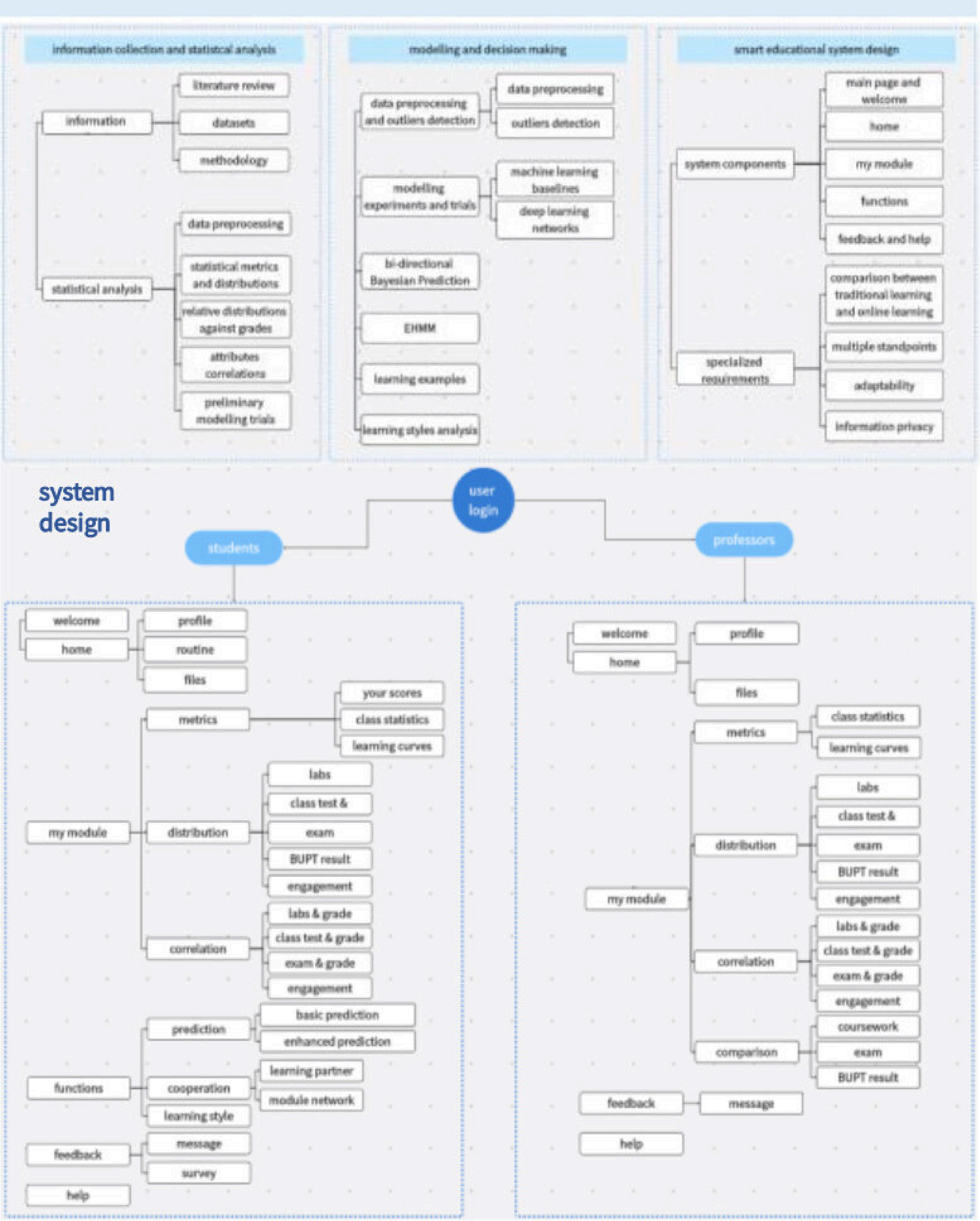
Methods	Datasets	Metrics ACC	PRE	REC	F1	AUROC
SVM	train	84.77	85.23	99.22	91.70	51.80
	test	78.66	87.30	85.27	86.27	69.78
DT	train	**91.39**	**91.37**	**99.22**	**95.13**	**78.90**
	test	**80.49**	**87.60**	**87.60**	**87.60**	**70.94**
GaussianNB	train	86.09	89.63	94.53	92.02	66.80
	test	58.54	79.05	64.34	70.94	50.74
RF	train	90.73	90.14	100.00	94.81	69.60
	test	78.66	78.66	100.00	88.05	50.00
GBDT	train	84.77	84.77	100.00	91.76	50.00
	test	78.66	78.66	100.00	88.05	50.00
ABC	train	86.75	90.30	94.53	92.37	69.00
	test	78.66	78.66	100.00	88.05	50.00
MLP	train	85.43	85.81	99.21	92.03	53.96
	test	78.05	82.98	90.70	86.67	61.06
RNN	train	84.77	84.77	100.00	91.76	
	test	78.66	78.66	100.00	88.05	50.00
RNN_bi	train	84.57	84.76	99.73	91.63	
	test	76.83	78.98	96.12	86.71	50.91
LSTM	train	84.24	85.20	98.55	91.37	51.39
	test	78.66	78.66	100.00	88.05	50.00
LSTM_bi	train	84.77	84.77	100.00	91.76	
	test	78.66	78.66	100.00	88.05	50.00
GCN	train	77.81	38.91	50.00	42.61	





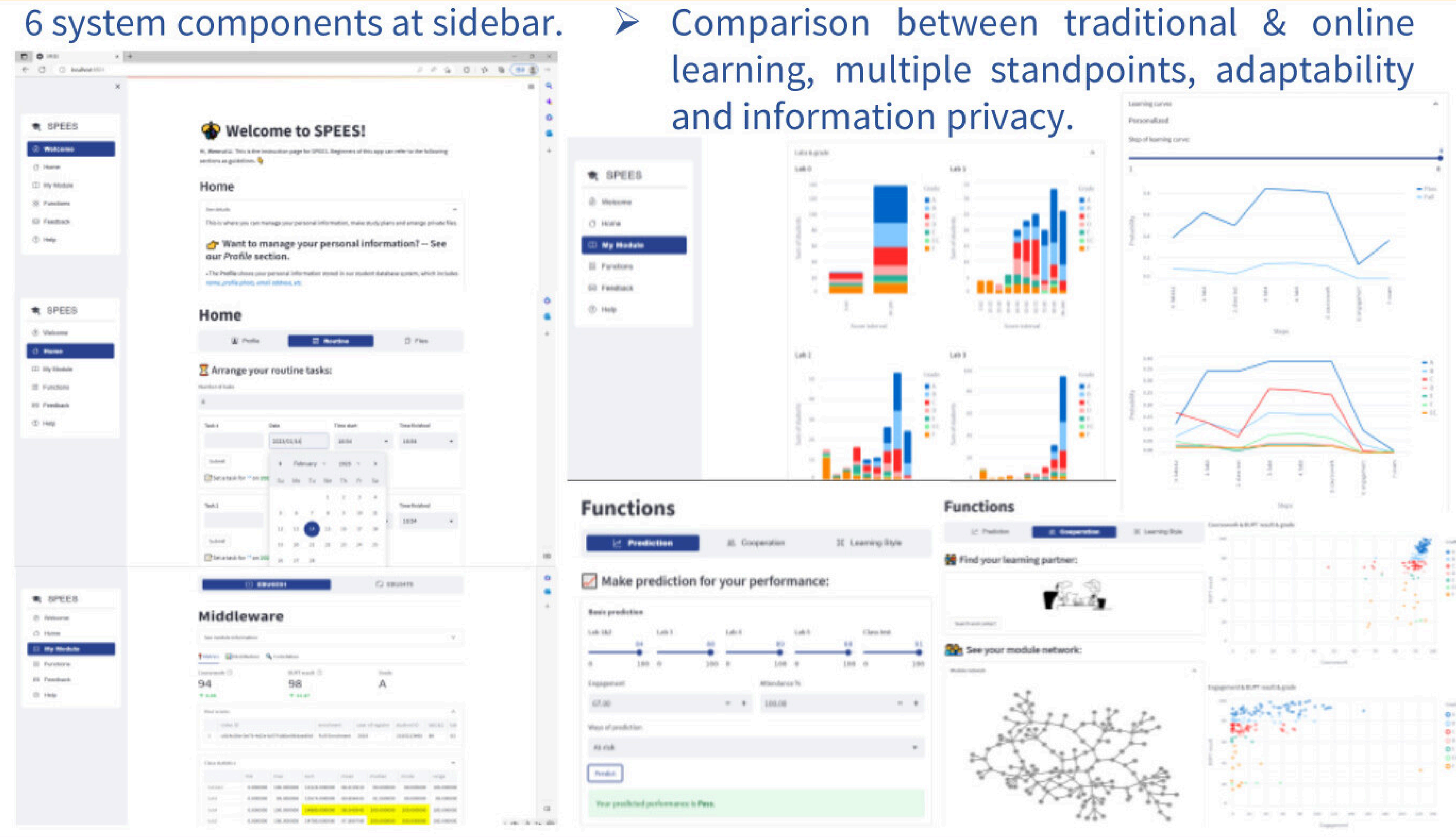
learning example & learning styles

Design & Implementation



Stage 3: Smart Educational System Design (SPEES)

- 6 system components at sidebar.
- Comparison between traditional & online learning, multiple standpoints, adaptability and information privacy.

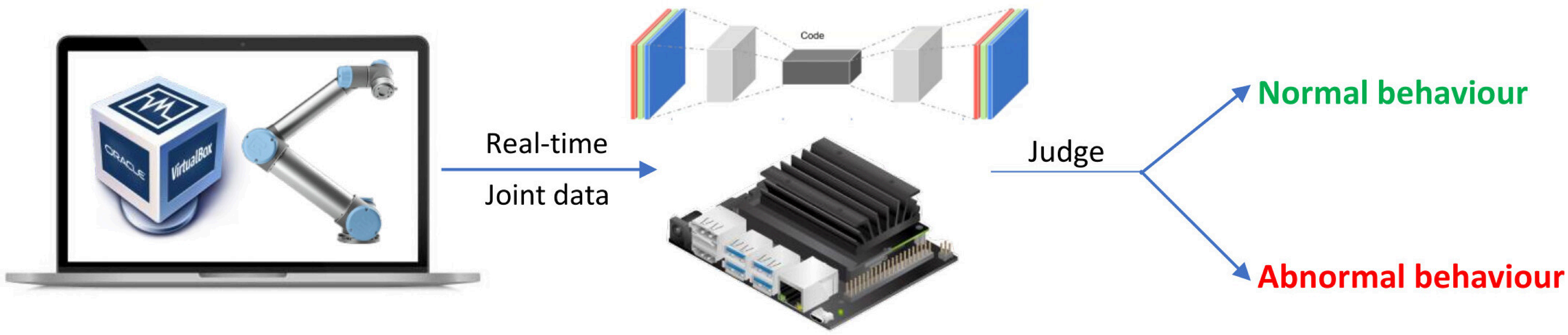


Problems, Conclusion & Future Work

- **Problems:** Multipage design & small dataset (cross-validation/ensemble learning/data augmentation with SMOTE).
- **Conclusion:** Students' behavior and ability influence performance. Learning patterns of various courses are different.
- **Future:** Online model with increments; more potential of ML/DL with temporal information; user-friendly system.

Real-time LSTM-Autoencoder Behaviour Anomaly Detection for Industrial Robot Arm on Nvidia Jetson Nano

Ruiqi Wan
Project Leader: Prof. Jonathan Loo



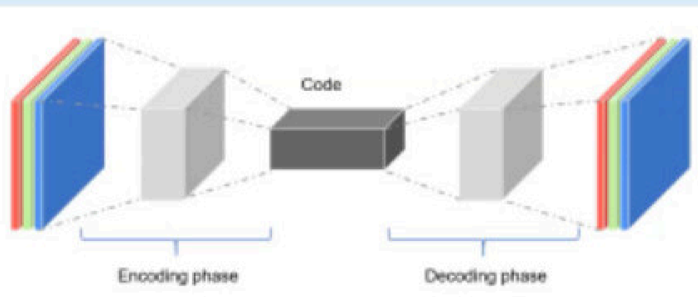
Problem Definition

The action control and monitoring of industrial robot arm need to be accurate, and it is difficult to capture extremely subtle errors.

Purpose of the Project

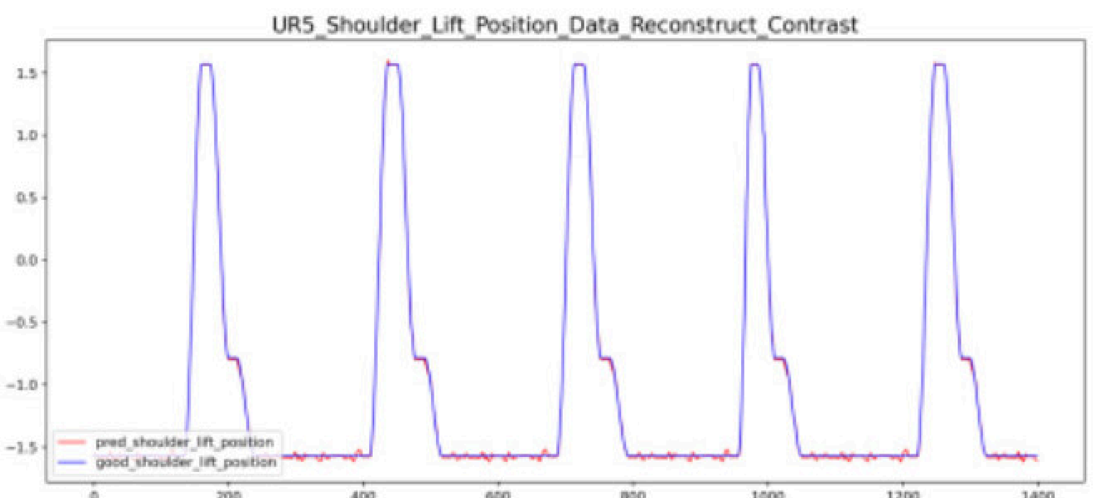
Develop LSTM-Autoencoder model to efficiently and effectively detect abnormal actions of robotic arm

Principle

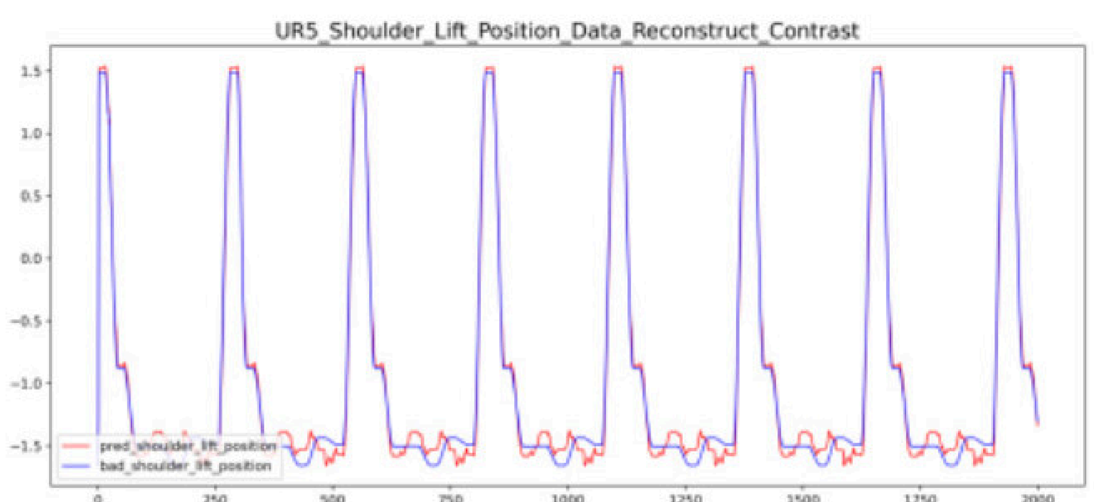


$$h = \sigma(W_{xh}x + b_{xh})$$
$$z = \sigma(W_{hx}h + b_{hx})$$
$$error = ||x - z||$$

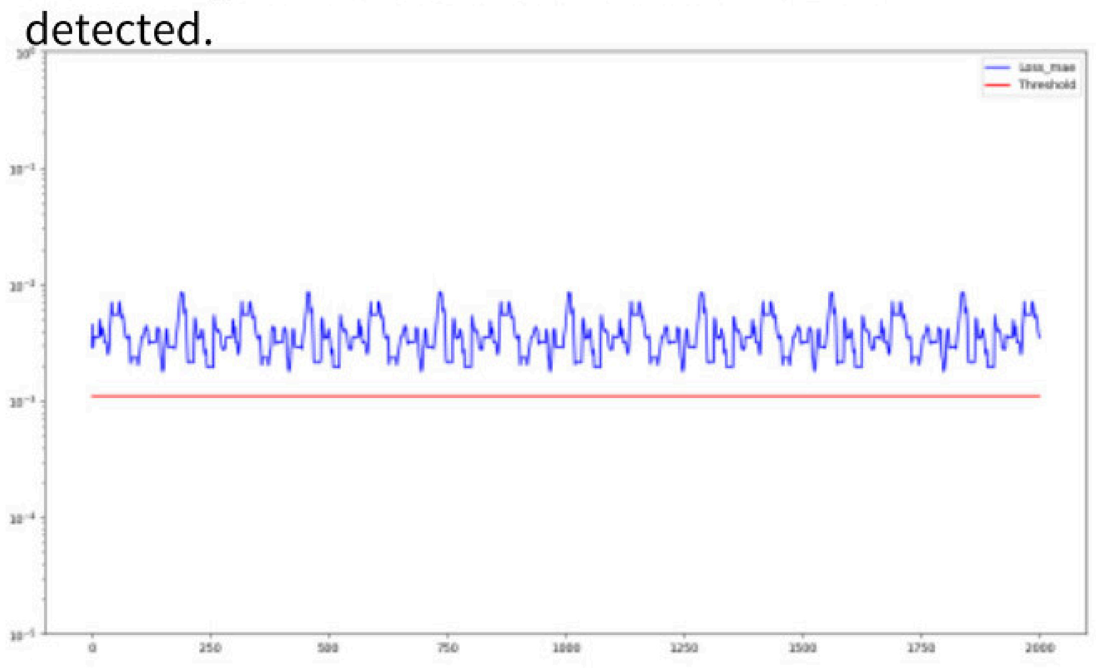
The well-trained autoencoder could reconstruct pattern which is nearly closed to normal pattern.



The reconstruct of abnormal quite different and cause the reconstruct error exceed the threshold.



Set up a threshold above the max loss of good pattern and input the bad data. The reconstruct loss. are far beyond threshold and abnormal are detected.



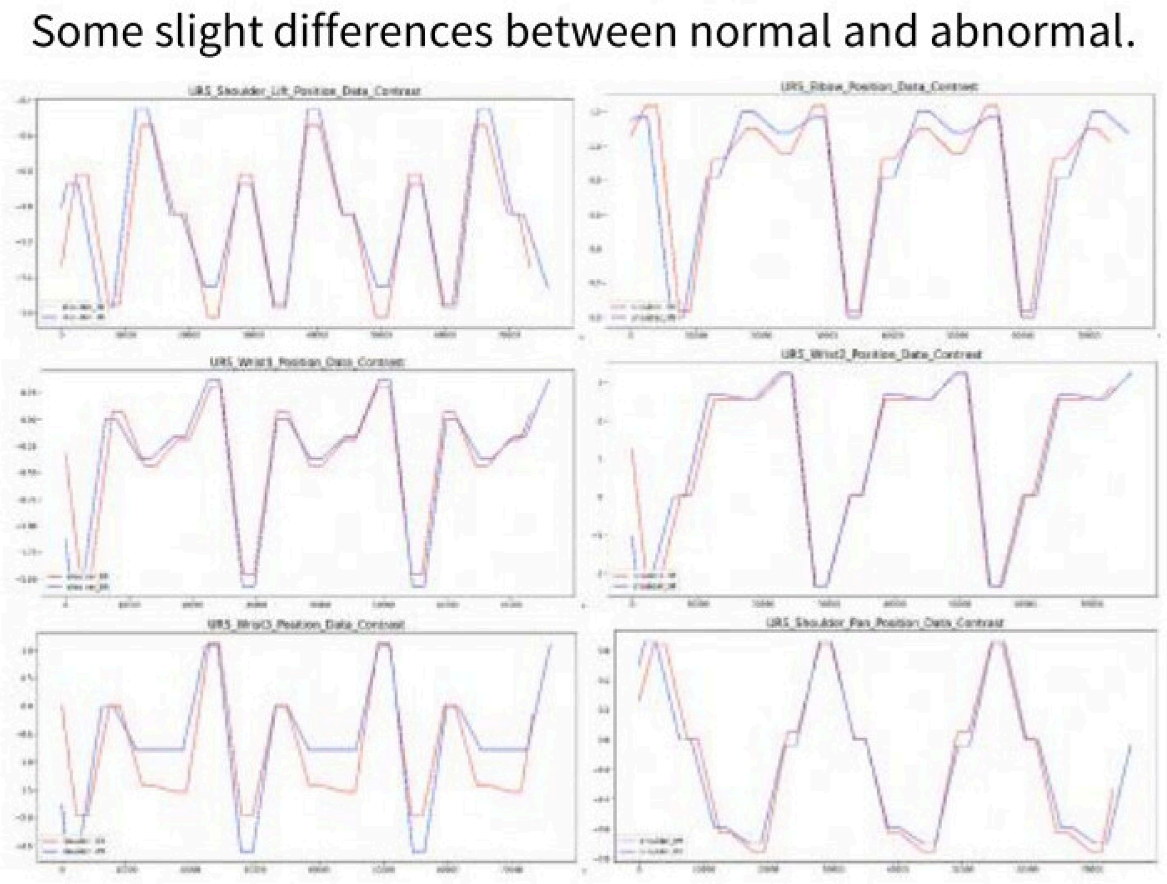
Demo video

Scan the Blue or Red QR code to watch a voice-over demo video with subtitles, which might take up to two and a half minutes.
Scan the Green QR code to explore the experimental record

Watch on Bilibili | Watch on Youtube | Record on Yuque

Data

These data both normalized to [-1,1].
Some slight differences between normal and abnormal.



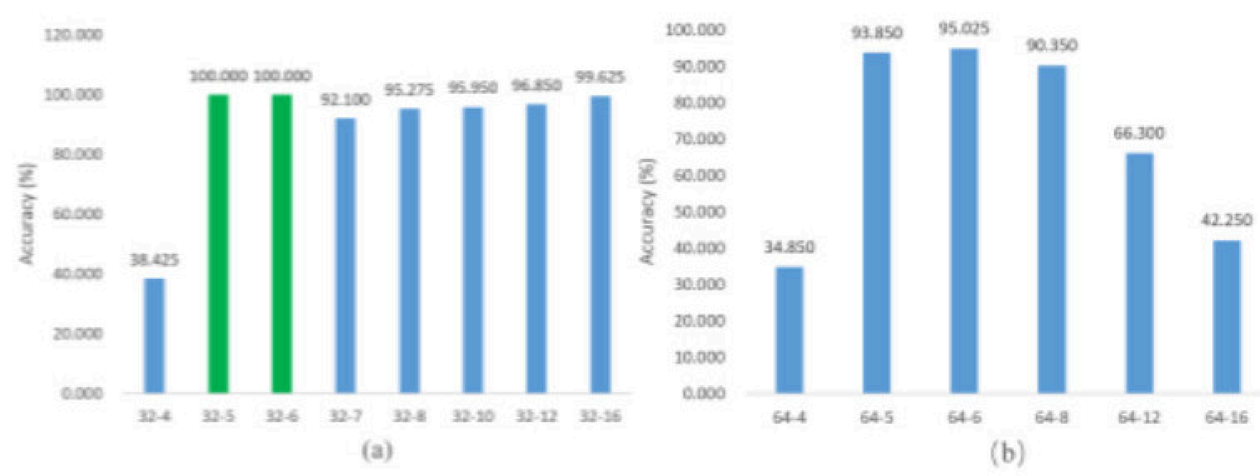
$\mu = 0.5$, $3\sigma = 0.5$	Good Pattern	Anomalies (in degree)	Anomalies (in radian)	Bad Pattern
shoulder_pan_joint	0.785	0.458475508	0.008001907	0.7930
shoulder_lift_joint	-1.57	0.38297492	0.006684173	-1.5633
elbow_joint	0.785	0.735591428	0.012838492	0.7978
wrist_1_joint	0.785	-0.442592894	-0.007724703	0.7773
wrist_2_joint	0.785	0.606553478	0.010586355	0.7956
wrist_3_joint	0.785	0.45056705	0.007863879	0.7929

σ is standard deviation and satisfies 3σ less or equal than μ and the area within is 99.730020%. This limitation was set to make nearly none of distribution of anomalies cross the zero point, then the distribution of anomalies would be approximately considered as symmetric about the zero point.

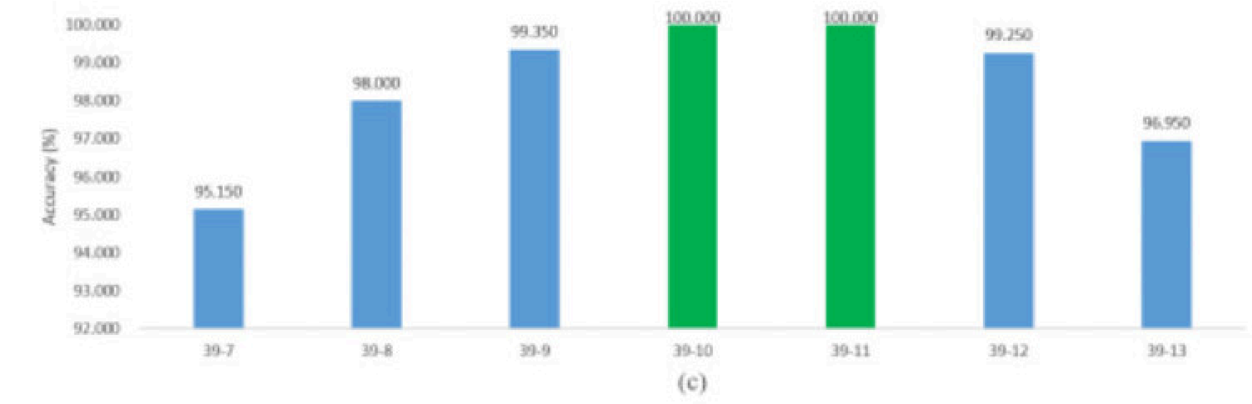
$$P_{b,i}(radian) = P_{g,i}(radian) + A_i(radian)$$
$$A_i(radian) \approx 57.3248 \times a_i(degree)$$
$$a_i(degree) = Sign \times \frac{1}{\sqrt{2\pi}\sigma}\exp(-\frac{(x-\mu)^2}{2\sigma^2})$$
$$3\sigma \le \mu$$
$$P(Sign = x) = 0.5 \ \ (x = -1,1)$$

Evaluation

Within the "32" 1st Latent layer group, models with 2nd Latent layer feature numbers of "5" and "6" exhibited excellent performance, but it experienced some of performance decline when increased to "8-16".



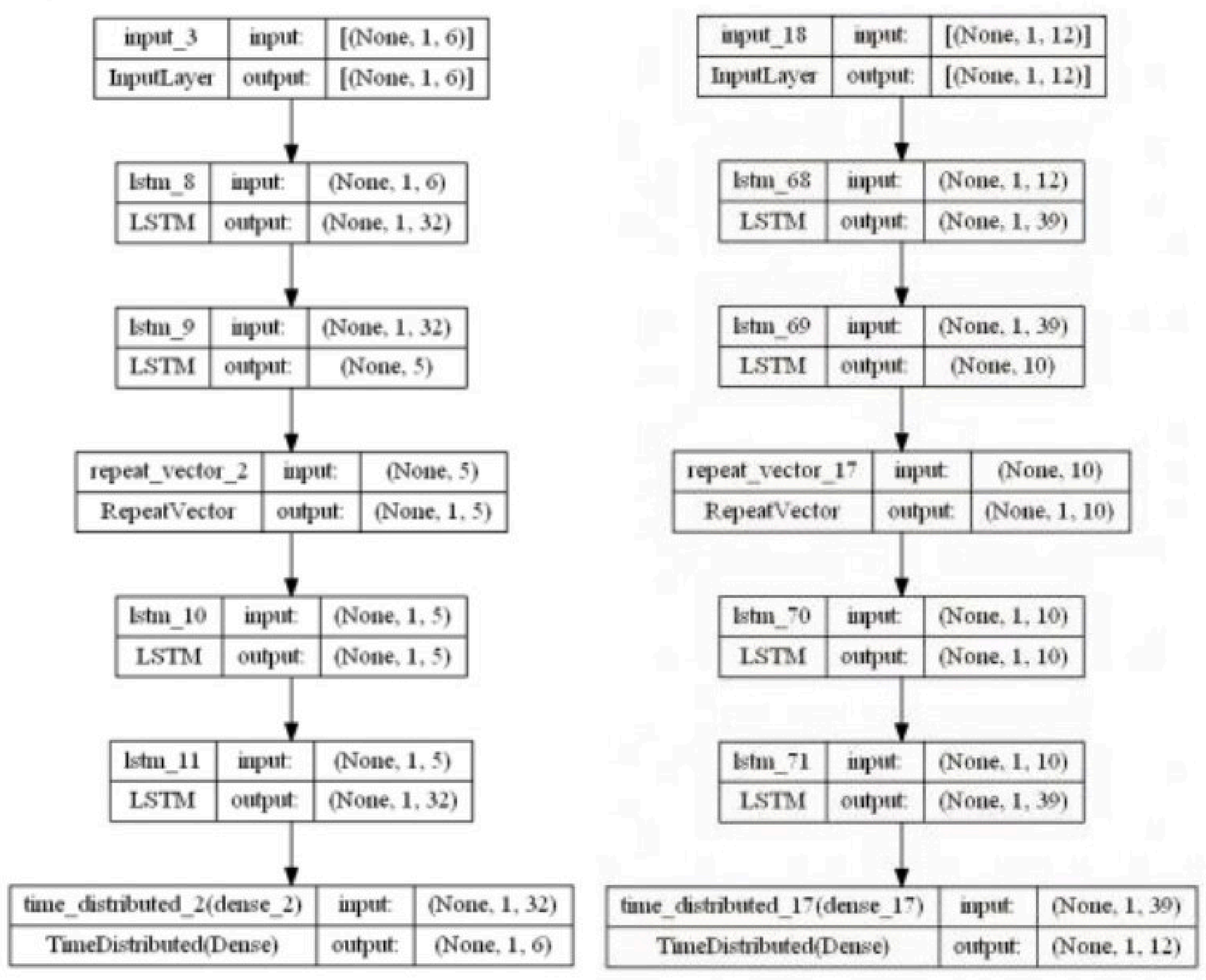
Similarly, in the "64" 1st Latent layer group, significant performance decline when 2nd Latent layer features were increased to "16".



Architecture

One possible explanation is that, if the number of neurons in the latent layer exceeds that of the input layer, the neural network may be given too much capacity to learn the data. In extreme cases, it may simply copy the input values to the output values, including noise, without extracting any basic information.

Complex network structures may have excessive reconstruction and generalization capabilities, which lead to the failure to demonstrate significant errors in reconstructing abnormal patterns.



Acknowledgements

I want to express my most sincere gratitude to Prof. Jonathan Loo who ignited the idea inspiration of this project (also this poster). Your useful and detailed guidance documents sharing, your constant support and your unwearyingly enlightened.
I would like to express my great thanks to Ms. Maggie Li, Ms. Alice Zhao and Ms. Gina of Administration QM-BUPT JP/JEI (Beijing) for device support of Nvidia Jetson Nano.

About the author

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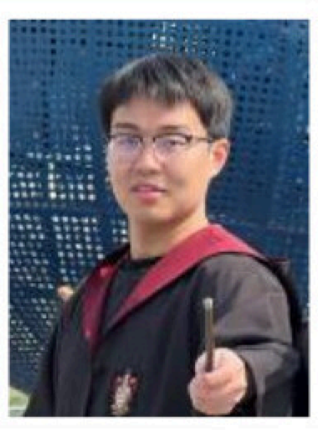
Ruiqi Wan is an undergraduate student about to graduate at JP programme QMUL with BUPT with research interests in machine learning and interesting AI.

"Good luck to you, and to me as well."



Queen Mary University of London

QMUL-BUPT JP/JEI
JP Student Innovation Centre (JPIC)
Annual Showcase 2022/23

Research on Brain White Matter Dynamic Functional Connectivity in Patients with Brain Arteriovenous Malformations (AVM)

Student: Qiji Shi **Project Leader:** Dr Fangrong Zong

Introduction

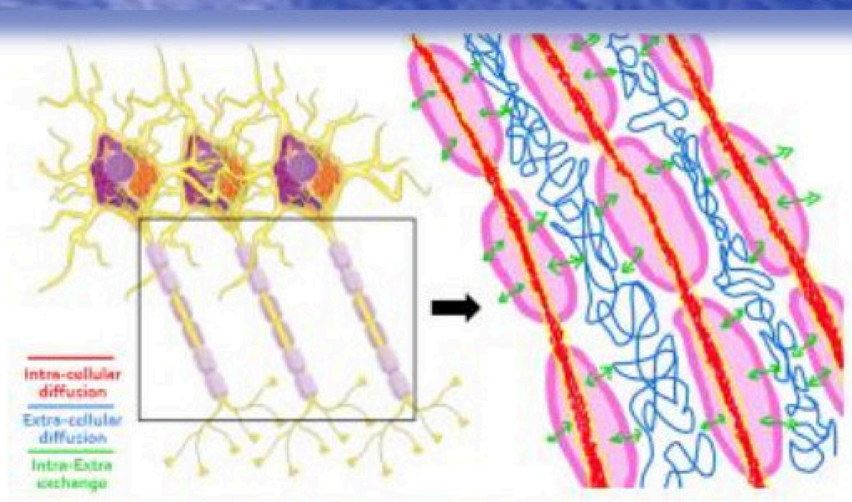
Brain arteriovenous Malformations (AVM) belongs to a rare congenital lesion, which may involve language areas but the patients usually have no language barriers. AVM thus becomes a unique model to study the cognitive function mechanism.

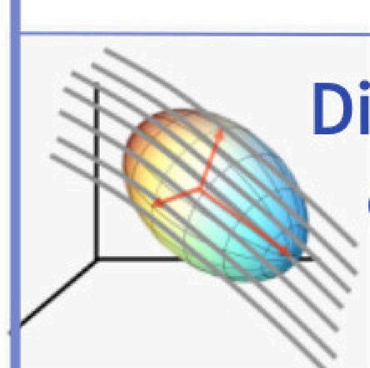
Aim

The purpose of this research is to explore reorganisation patterns of AVM patients in terms of white matter functional connectivity, which is a quantitative parameter obtained from **diffusion MRI** and **functional MRI** (fMRI) datasets.

Background

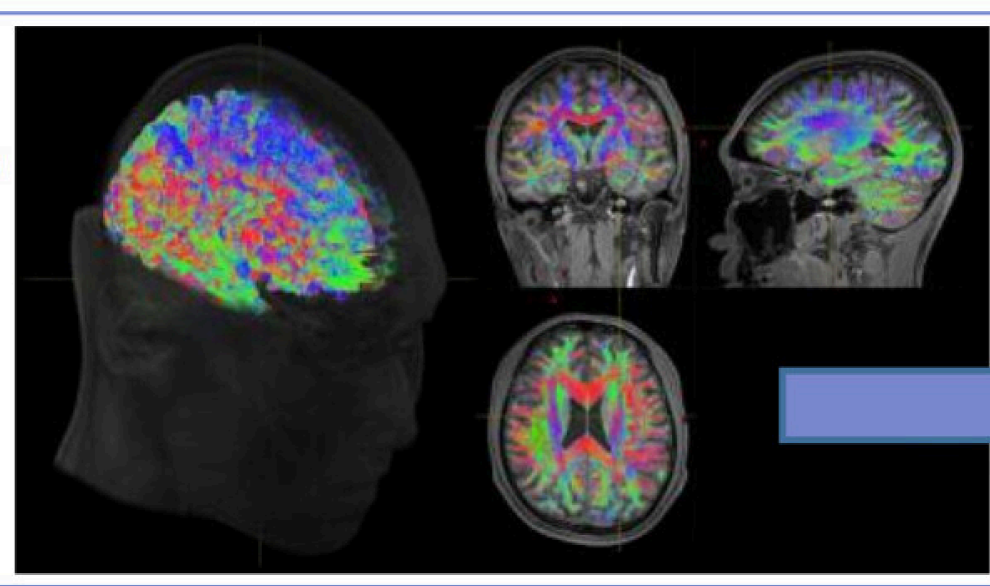
Diffusion MRI: Modeling the white matter pathways (neurite) by measuring the water molecule diffusion.





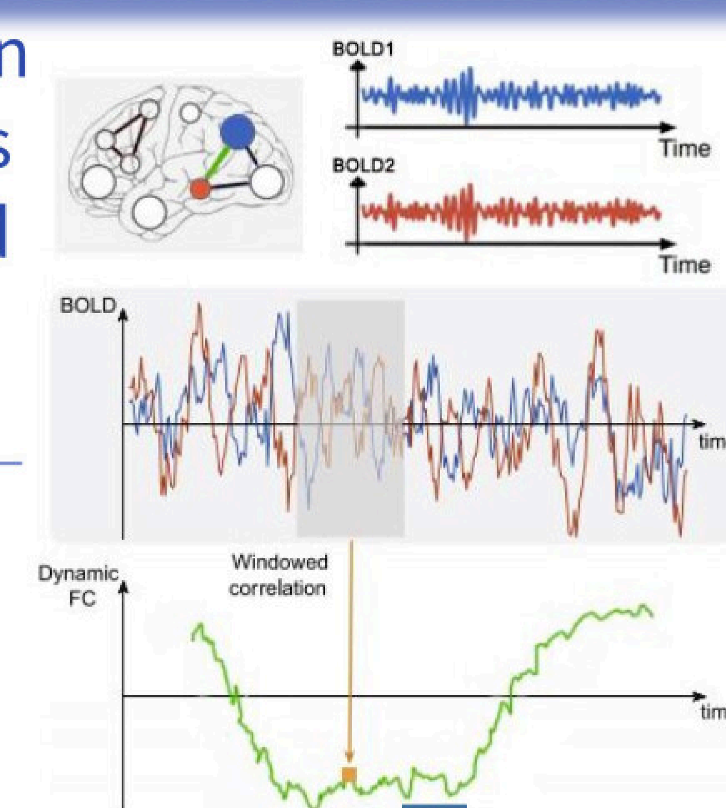
Diffusion tensor imaging (DTI): 3D ellipsoid model characterize the diffusion of water molecules with 3 orthogonal eigenvectors [1].

Tractography (Fiber tracking): Generating 3D representations of white matter pathways based on the primary diffusion directions.

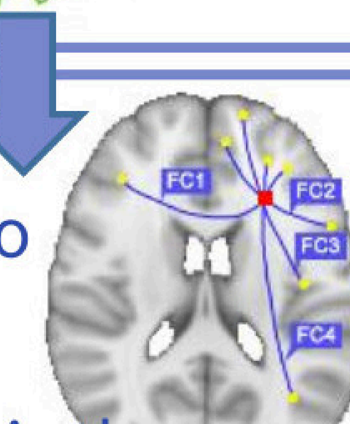


Functional MRI: measure brain activity by detecting changes in oxygen in the blood: blood oxygen level dependency (BOLD) signals.

Functional Connectivity (FC): Temporal correlation of the BOLD signals between distinct brain regions.



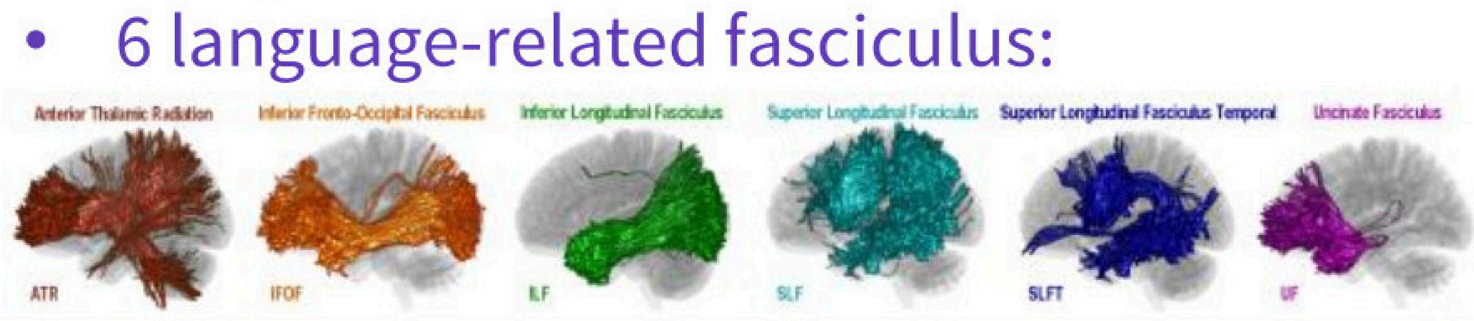
Track-weighted dynamic Functional Connectivity (TW-dFC): mapping the FC to corresponding white matter pathways



$TWdFC(v,t) = \frac{1}{N_v}\sum_{i=1}^{N_v} FC_i(t)$, where N_v is the number of tracts traversing a specific voxel v [2].

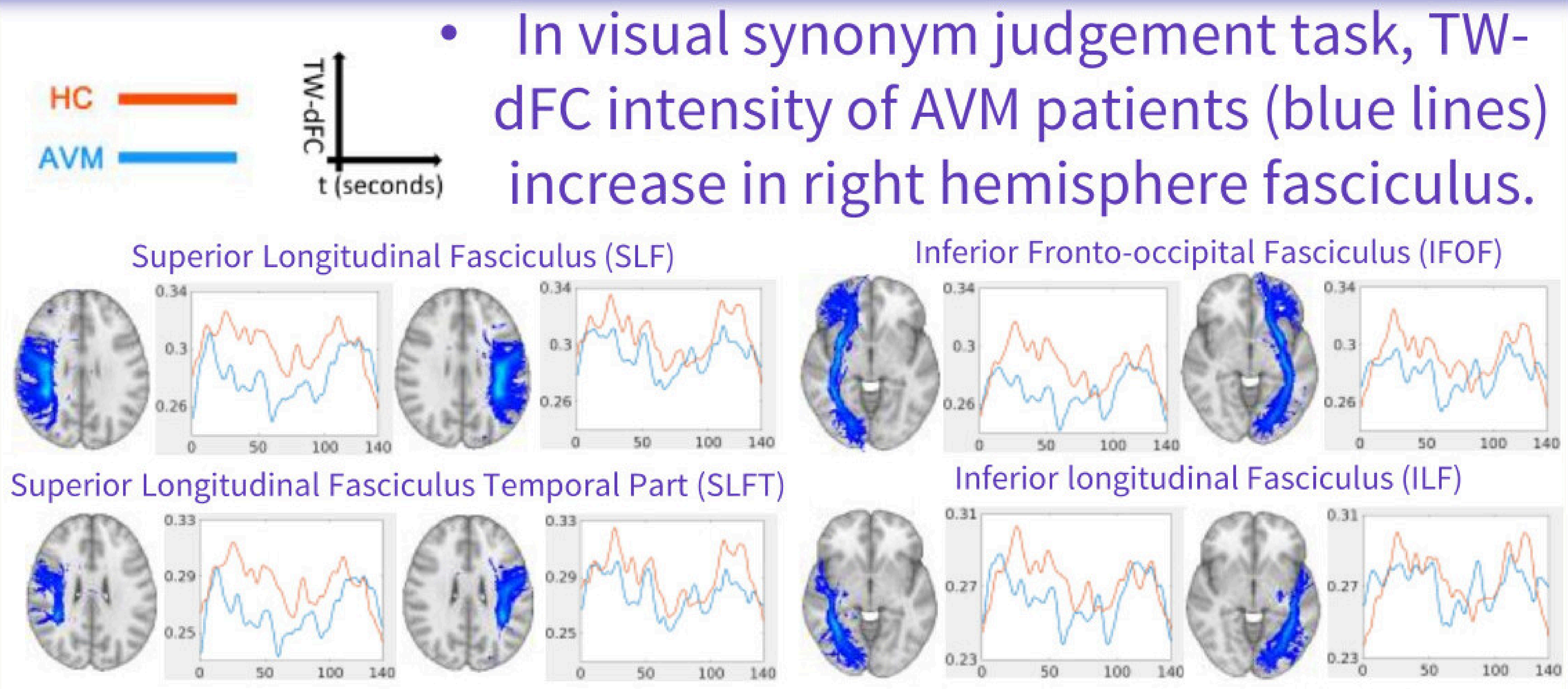
Methods

- Subjects: 34 left hemisphere AVM patients VS 32 healthy controls (HCs).
- 3T fMRI scanning while performing visual synonym judgment, oral word reading and auditory sentence comprehension tasks.
- DTI images: b = 0, 1000 s/mm^2 with 64 diffusion directions.
- Tractography: calculated by constrained spherical deconvolution (CSD) [3].
- Regional-average within each group.
- Two sample t-test to detect the specific reorganization area of AVMs.
- 6 language-related fasciculus:

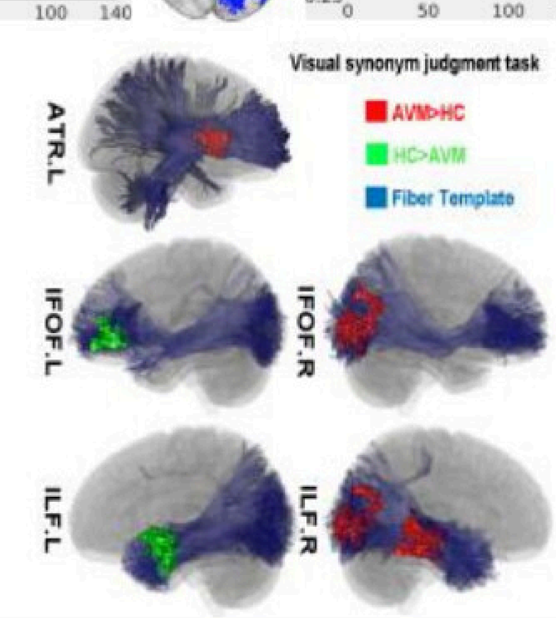


Results

- In visual synonym judgement task, TW-dFC intensity of AVM patients (blue lines) increase in right hemisphere fasciculus.



In visual synonym judgment task, the TW-dFC intensity of AVM was higher than that of HCs in the left ATR, IFOF and ILF. While in the left hemisphere fasciculus, the TW-dFC value of HCs is significantly higher than that of AVM.



Conclusion

It is the first study to compare the TW-dFC intensity and found AVM patients reorganize their language function mainly in the right hemisphere fasciculus in visual synonym judgment task.

Reference

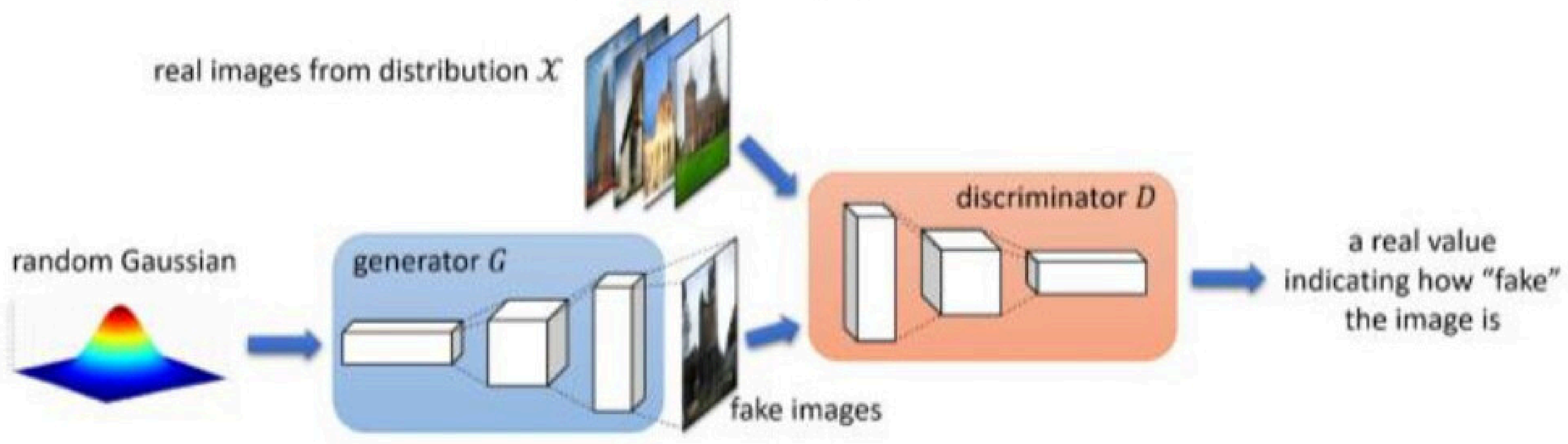
[1] Basser, P.J et al. J. Magn. Reson. Ser. B. (1994),
[2] Calamante, F. et al., Brain Struct Funct. (2017),
[3] Tournier, J.D. et al, NEUROIMAGE. (2007).

Synthetic-to-Realistic Object Rendering for 6D Object Pose Estimation

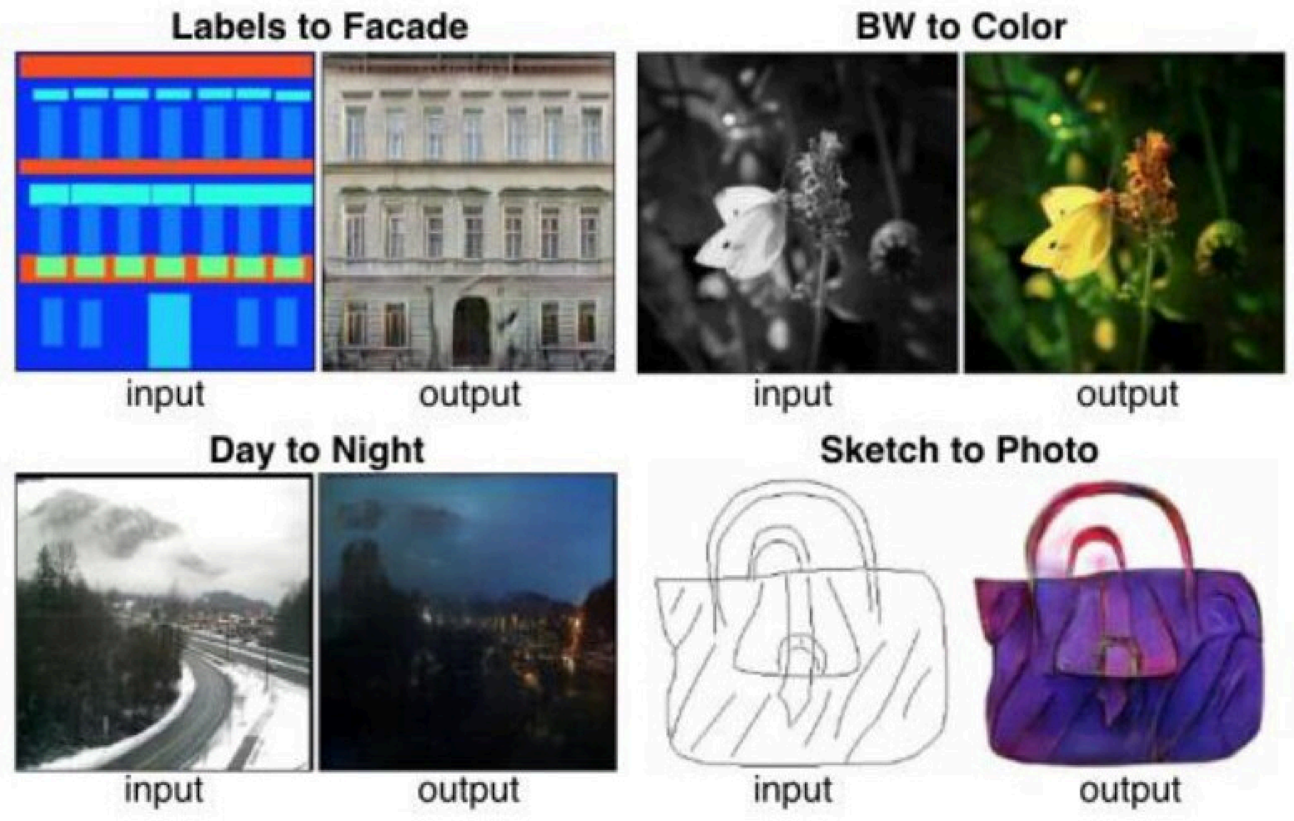
Zhiyang Chen
Supervisor: Dr Changjae Oh

GAN based Image2Image Translation

- Generative Adversarial Networks (GANs):
  - Two neural networks (A **generator** and a **discriminator**) simultaneously trained via an adversarial process [1].

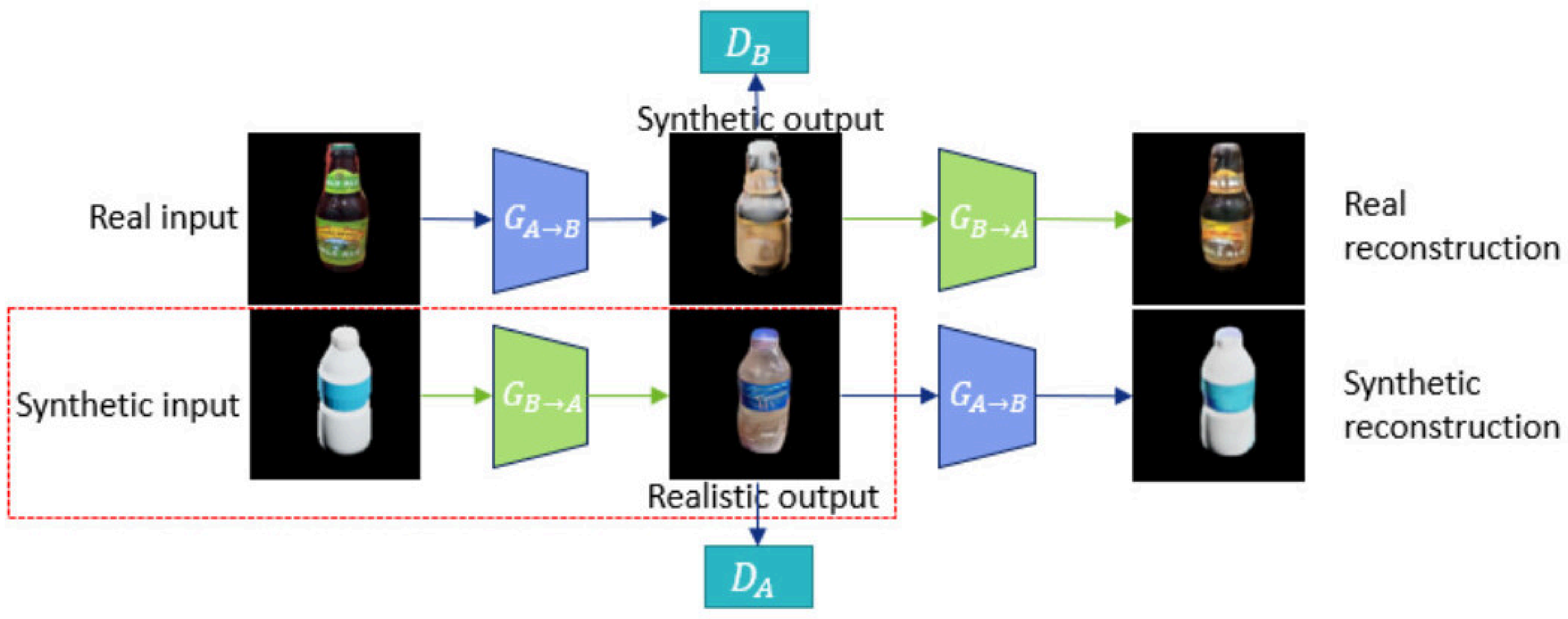


- Image-to-Image Translation:
  - Generating an image by transferring the source-image style to a target image [2,3].



Synthetic-to-Realistic Object Rendering

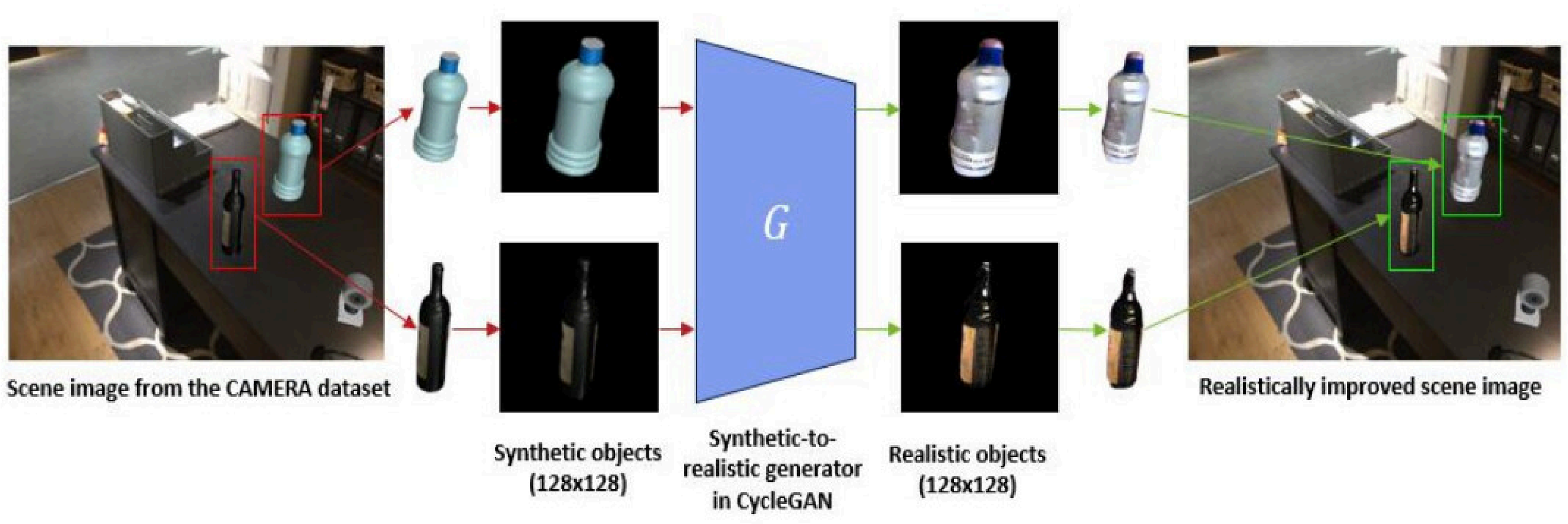
- CycleGAN for Object Rendering:
  - We use 4K real and 4K synthetic images to train a CycleGAN model for 200 epochs with a learning rate of 0.0002 and a batch size of 1.



- We set domain A as a real domain, and domain B as a synthetic domain. The generator we want is $G_{B\to A}$, applying test process on $G_{B\to A}$ to achieve synthetic-to-realistic rendering.

6D Object Pose and Size Estimation

- Normalized Object Coordinate Space (NOCS) method:
  - Estimating the 6D pose and dimensions of unseen object instances in an RGB-D image [4].
- The training dataset in NOCS is a mixed reality dataset (called **CAMERA**).
  - The domain gap exists in the CAMERA dataset
  - We train CycleGAN to render synthetic objects in the CAMERA dataset to realistic.



- Retrain the NOCS model and Make Comparison:
  - We prepare a 10K CAMERA dataset and 10K realistically rendered CAMERA++ dataset, then use them each to train a new NOCS model, evaluate them and make a comparison. (Improved on BOTTLE category)

Dataset For Training	mean Average Precision (%)							
	$3D_{IoU25}$	$3D_{IoU50}$	5° 5 cm	5° 10 cm	10° 5 cm	10° 10 cm	15° 5 cm	15° 10 cm
CAMERA 300K	84.4	76.9	9.8	10.8	24.0	24.5	34.7	36.8
CAMERA 10K	68.5	61.1	8.5	9.0	21.3	21.7	30.6	33.8
CAMERA++ 10K	71.1	63.9	8.6	9.6	22.0	22.3	32.3	35.3

References

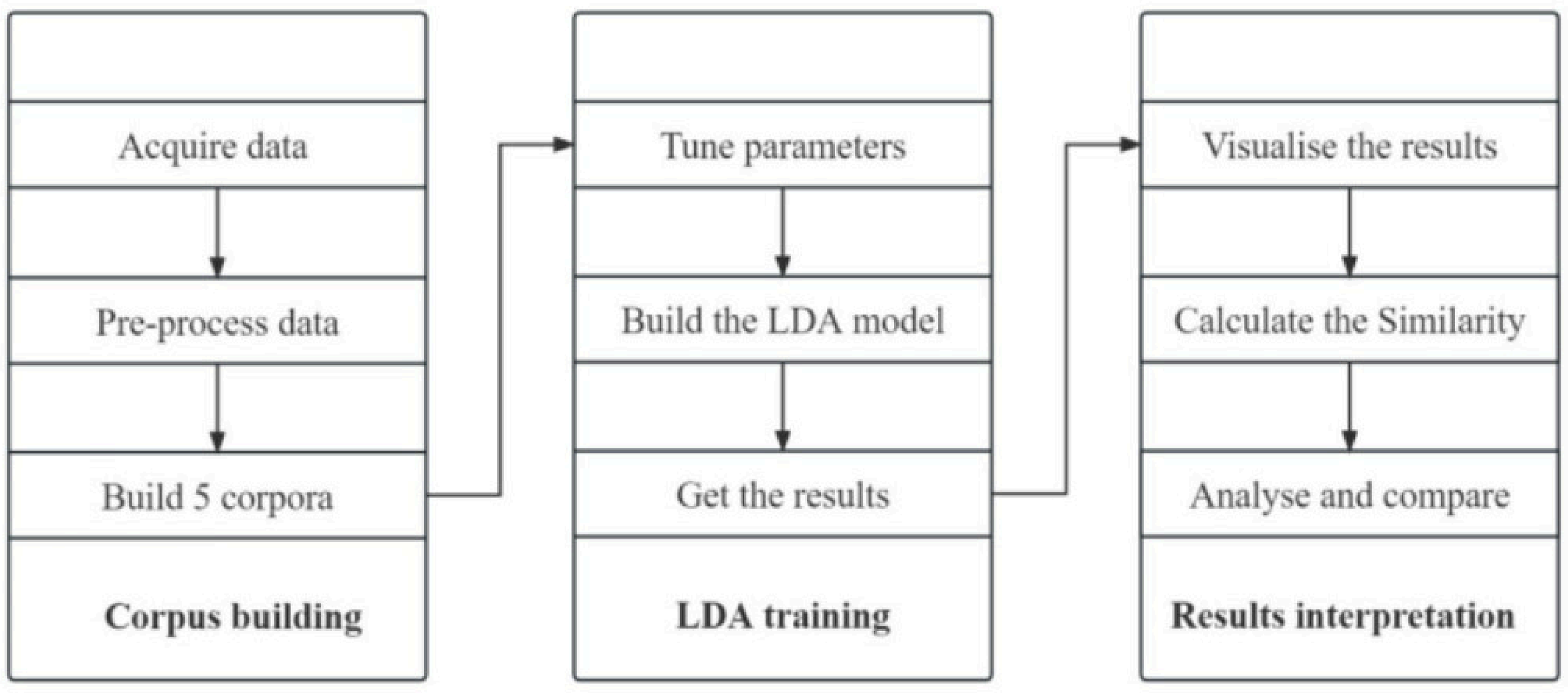
[1] I. Goodfellow et al., Generative adversarial networks, *NIPS* 2014.
[2] P. Isola et al., Image-to-image translation with cGAN, *CVPR* 2017.
[3] Zhu et al., Unpaired image-to-image translation using CycleGAN, *ICCV* 2017.
[4] He Wang et al., Normalized Object Coordinate Space for Category-Level 6D Object Pose and Size Estimation, *CVPR* 2019.

Technology Policy Text Analysis Based on Latent Dirichlet Allocation Topic Model

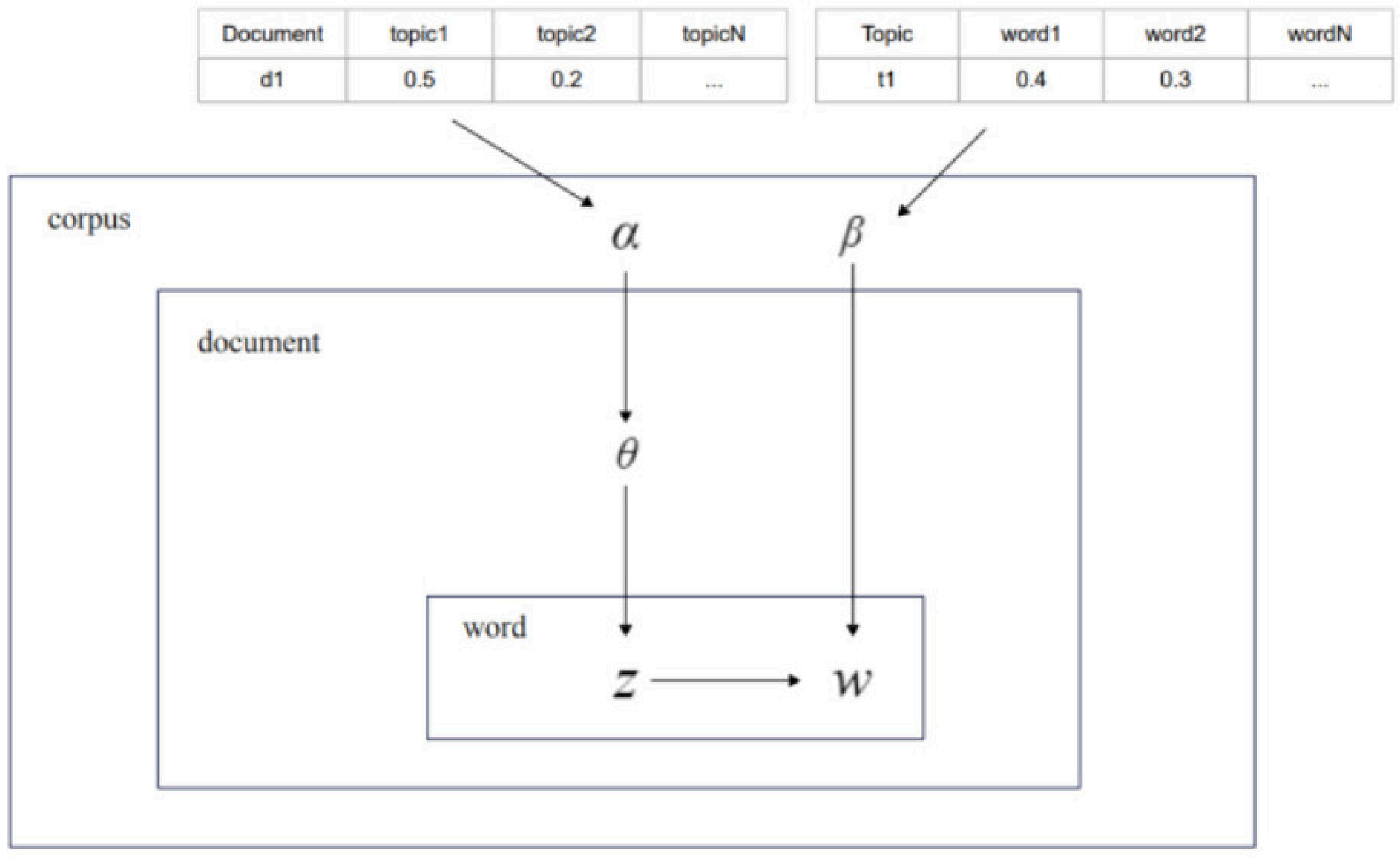
Siyuan Hu
Supervisor: Richard Clegg

Introduction

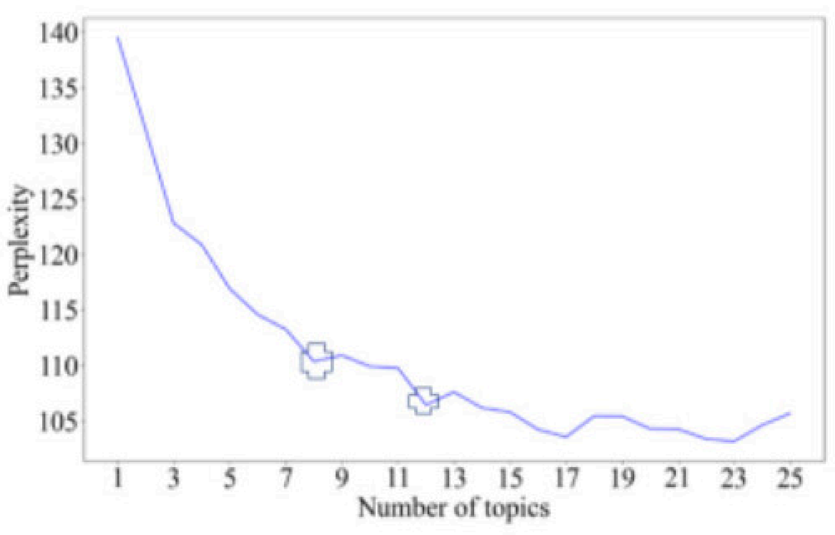
Technology policy has become increasingly significant in national security and economic development. The number of policies is surging rapidly. However, quantitative methods are underutilised. Therefore, this study uses the Latent Dirichlet Allocation Topic model to discover latent topics in different periods of technology policy in the UK and the US from 2015 to 2022.

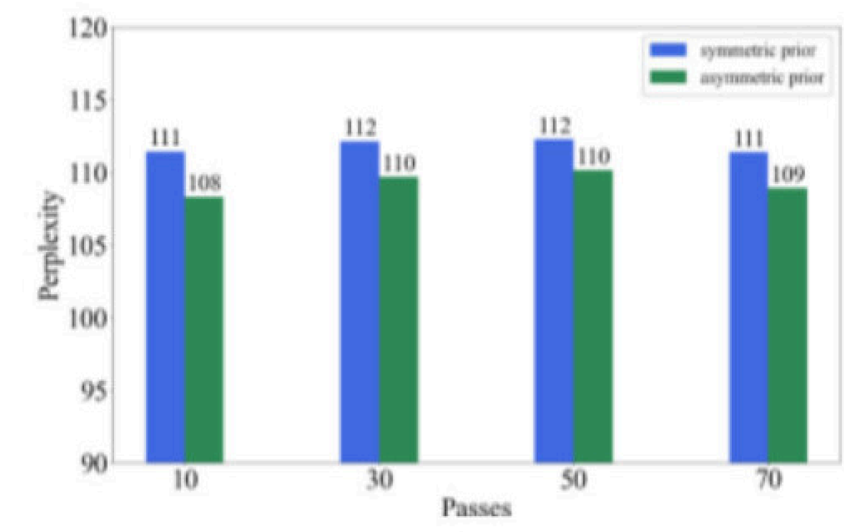


Latent Dirichlet Allocation Topic model

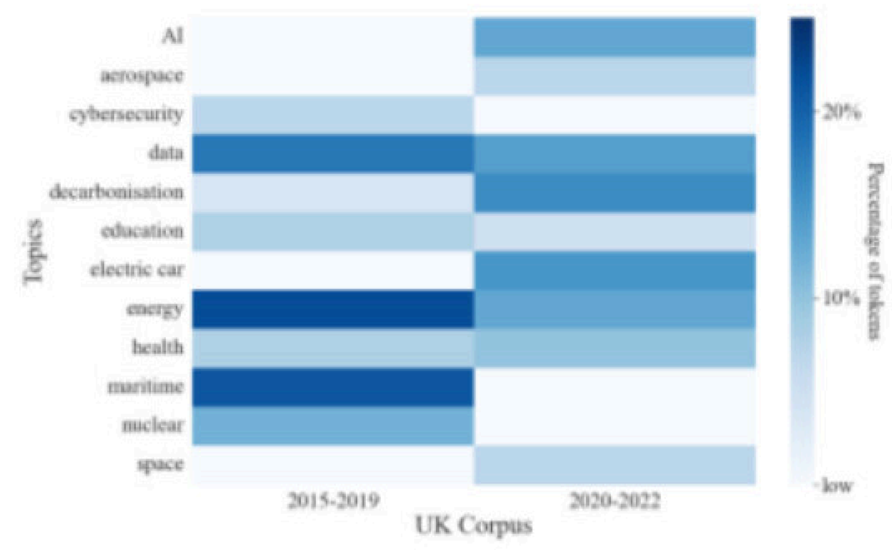


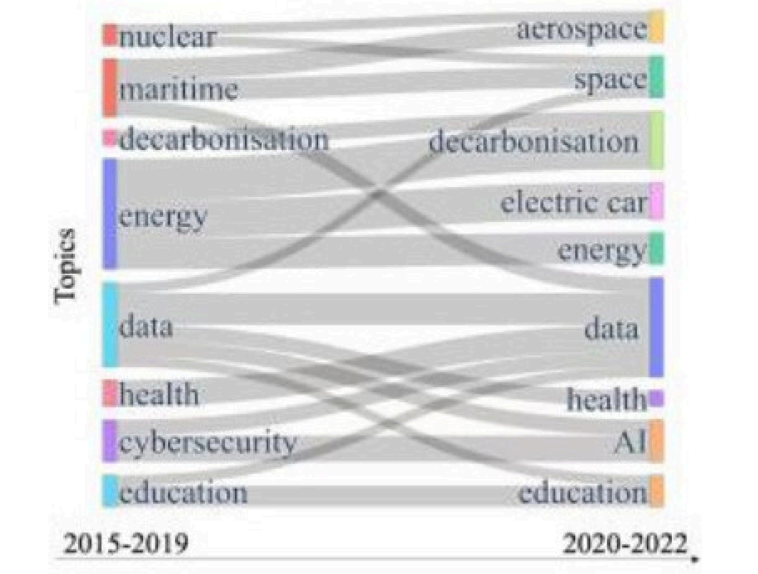
LDA model building

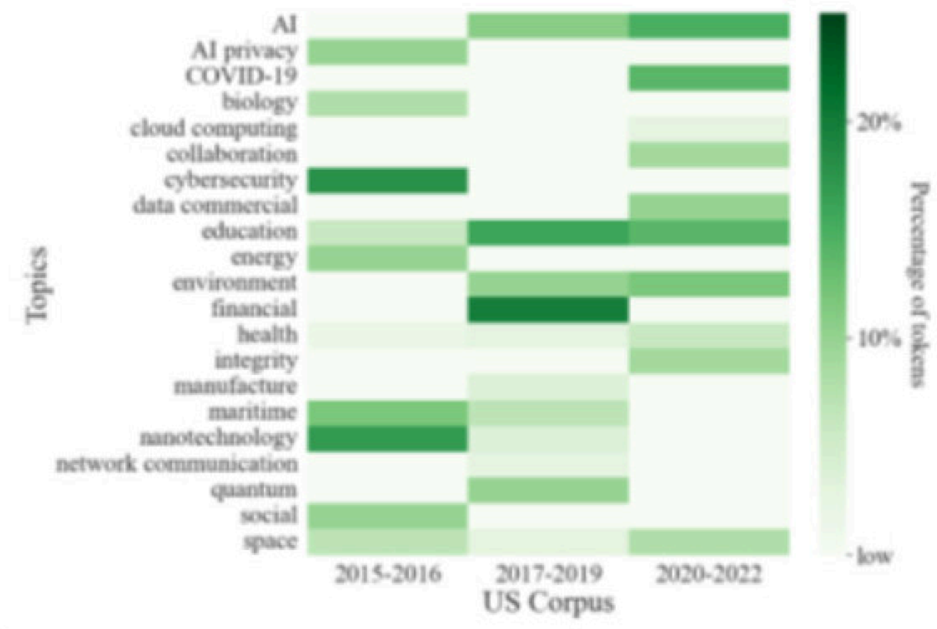


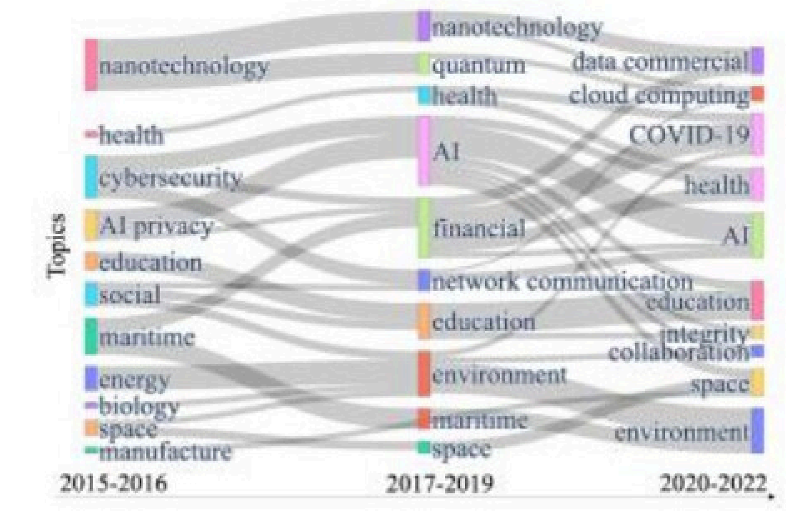


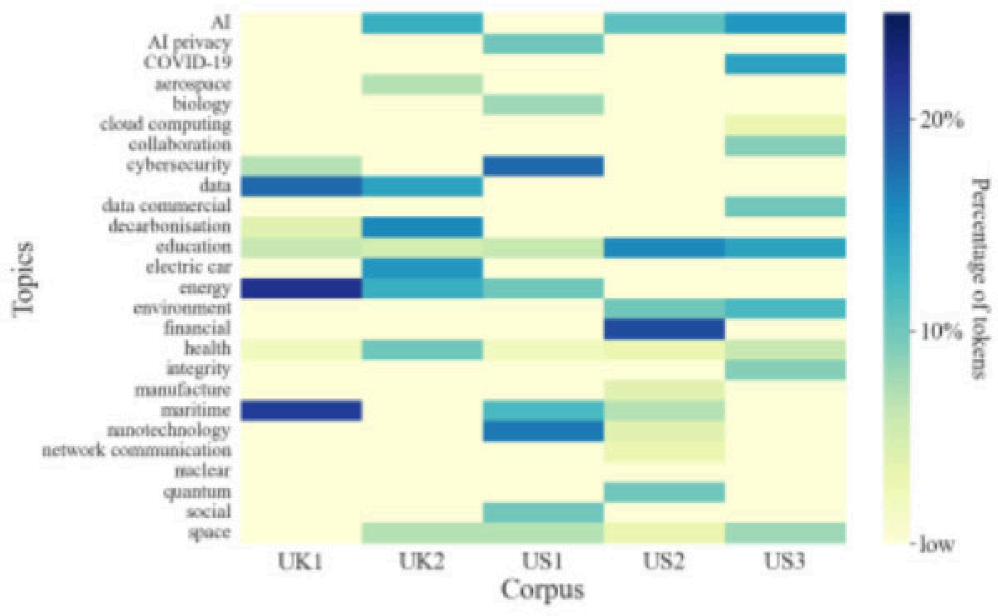
Results

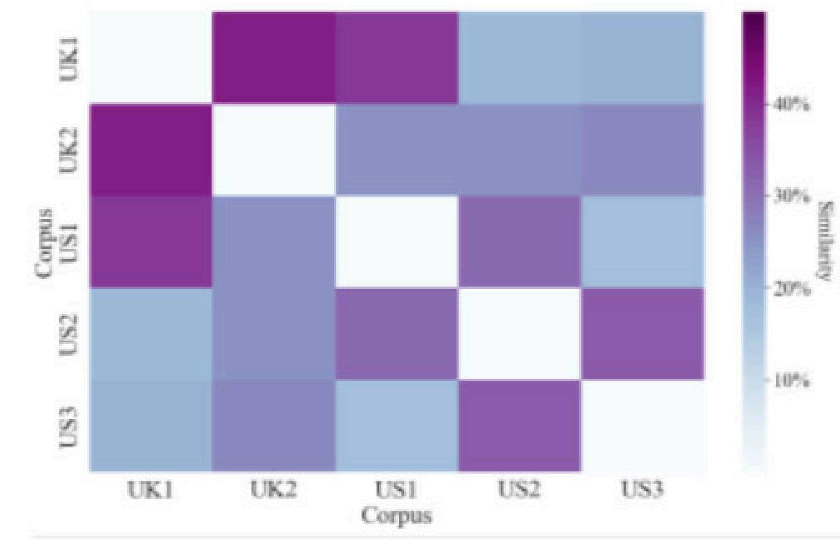












Discussion

- Topics of technology policies develop rapidly, but with continuous trends.
- Comparison between UK and US technology policy. Similarities : Highlight security issues in cyber and AI, social aspects, digital intelligent, and global collaboration. Differences: Energy (UK) or environment (US). The US highlights more on the fundamental research and COVID-19.

Conclusion

- The LDA topic model discovers topics in the UK and US technology policy from 2015 to 2022.
- Data visulisation: the heatmap compares topics in different time windows and the Sankey diagram shows the evolution of topics. The similarity diagram shows the evolution pace and comparison.
- Further research: smaller time windows, more model evaluations.

Tool for Planning and Visualising Traffic Movements

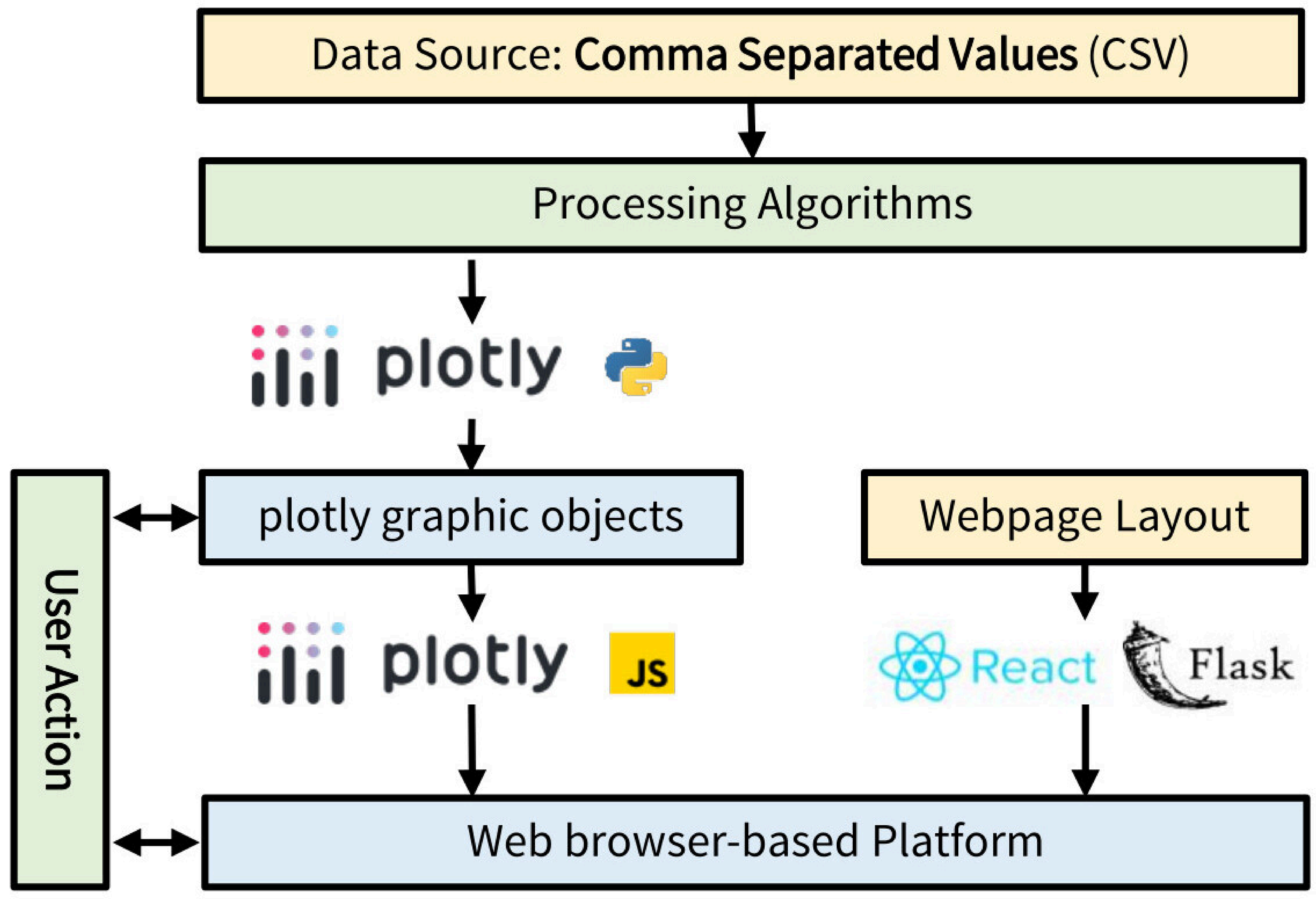
Yida Tao
Project Leader: Dr Alan Wong

Background & Objective

Blended user demand:

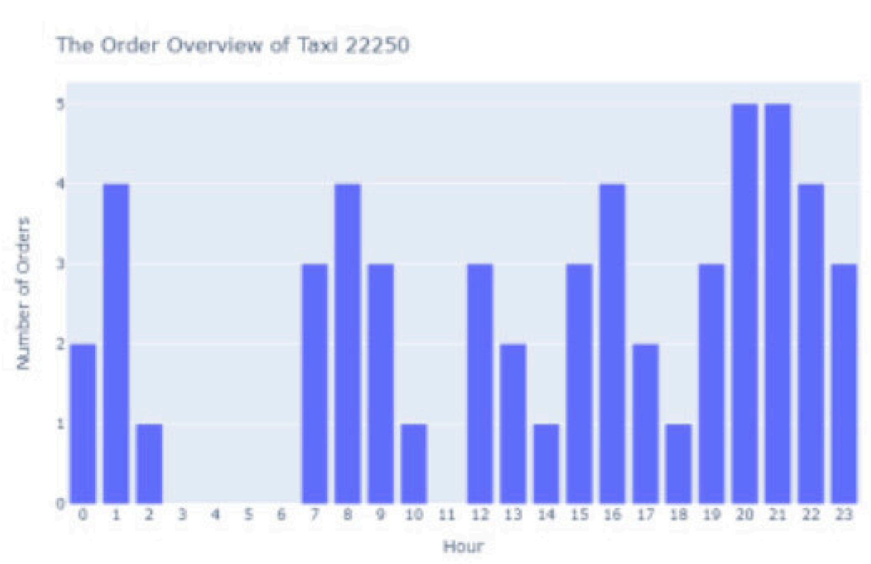
- Individual traveller: planning most efficient routes
- Traffic administrator: Analysing large scale of traffic flow data for traffic network optimisation

This project uses the traffic flow data collected by Local Authorities of Shenzhen City, China, aiming to implement an integrated and lightweight solution for analysing and visualising traffic movements, as well as assisting route planning, which is also accessible to various user groups. Multiple statistical modeling techniques and machine learning models are employed. The results are visualised in web browsers with interactivity.



Functionalities

- Taxi Operation Analysis
- Metro Station Card Analysis
- Point of Interest Discovery
- Route Planning



Order Overview of Single Taxi

Duration Overview of Single Taxi

Human-Computer Interaction

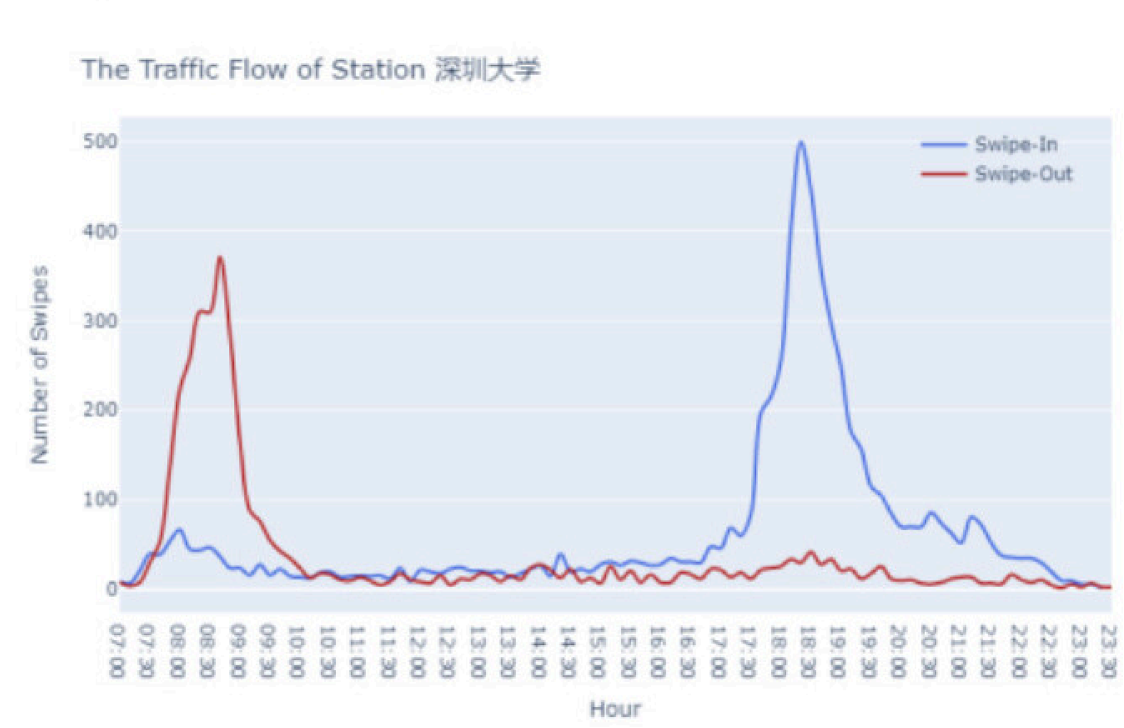
- Achieved by Callback Functions
- Supports dropdown selecting, text input and camera operation
- Mouse-hovering panel displaying detailed information of data entities

Taxi Operation Analysis

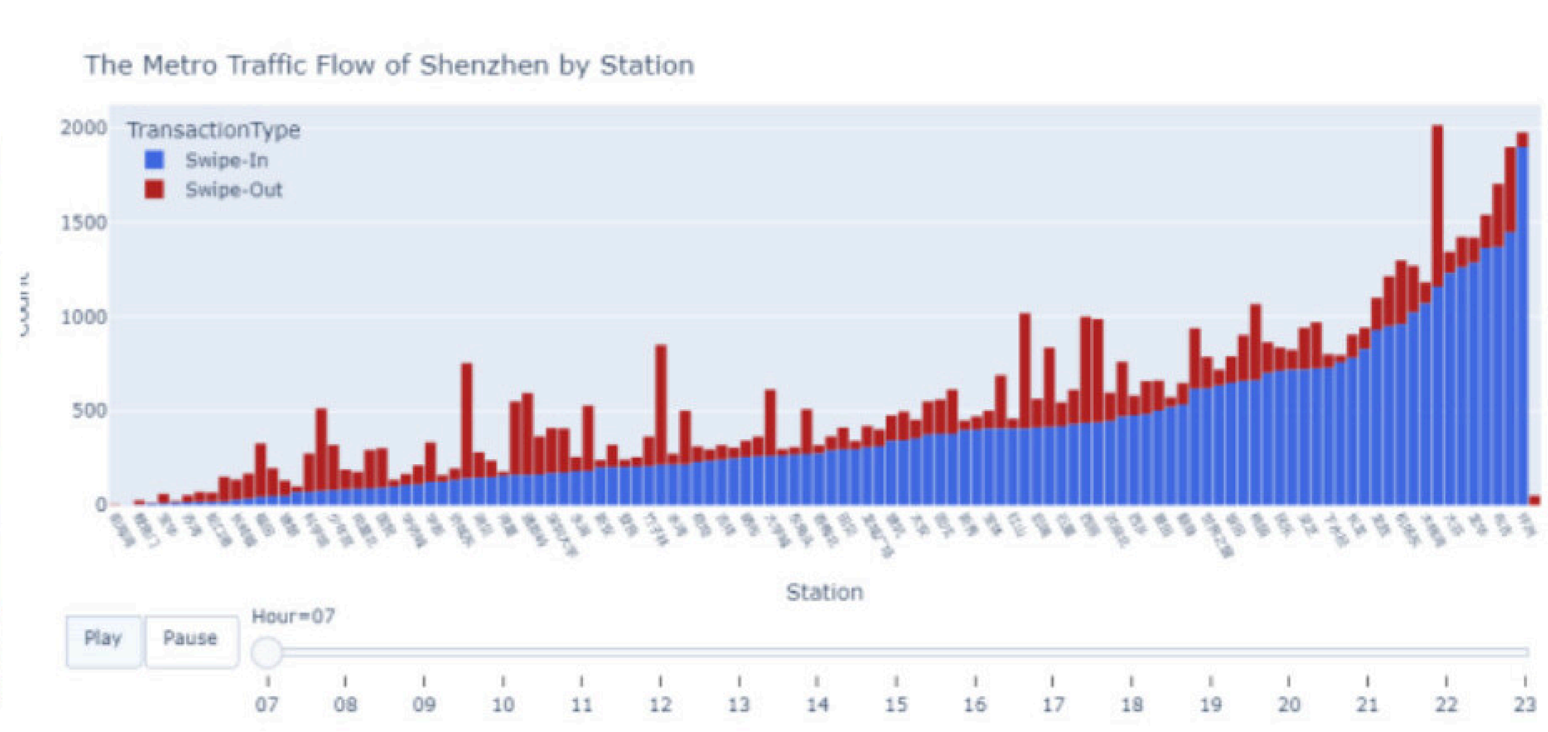
- *Origin-Destination* (OD) Extraction
- Order / Duration Overview of all taxis and selected object
- Pick-up and drop-off block
- Speed status / geospatial trace with occupation status

Metro Station Card Analysis

- Metro Traffic Flow (By station or administrative division)
- Traffic Flow of Selected Metro Station
- Sunburst of passenger flow in morning and evening peaks



Metro Traffic Flow of St. Shenzhen University



Metro Traffic Flow of Shenzhen by Station

Metro Route Planning (from St. Xiasha 下沙 to St. Buji 布吉)

Route Planning

- Enabling origins and destinations selected by user
- Supports road network and metro network
- One optimal solution based on Dijkstra routing Algorithm

Trajectory prediction mechanism in VANET for privacy protection

Honglin Li
Project Leader: Dr Yan Sun

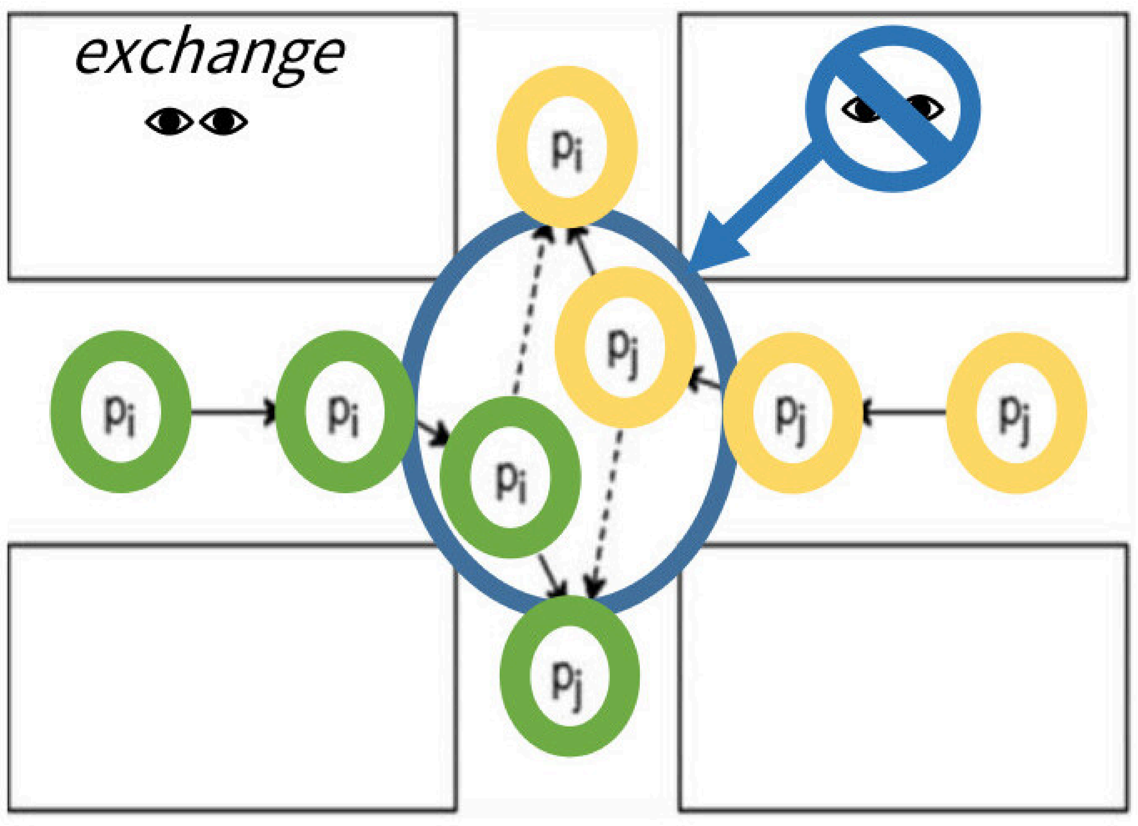
Project Objective

- Research the security threats and propose privacy protection solutions

Background

➢ Privacy protection in VANET

- Pseudonym exchange mechanism: *Vehicles exchange their VANET index with each other*
- Mix-zone mechanism: *Set a specific area to perform pseudonym exchange*



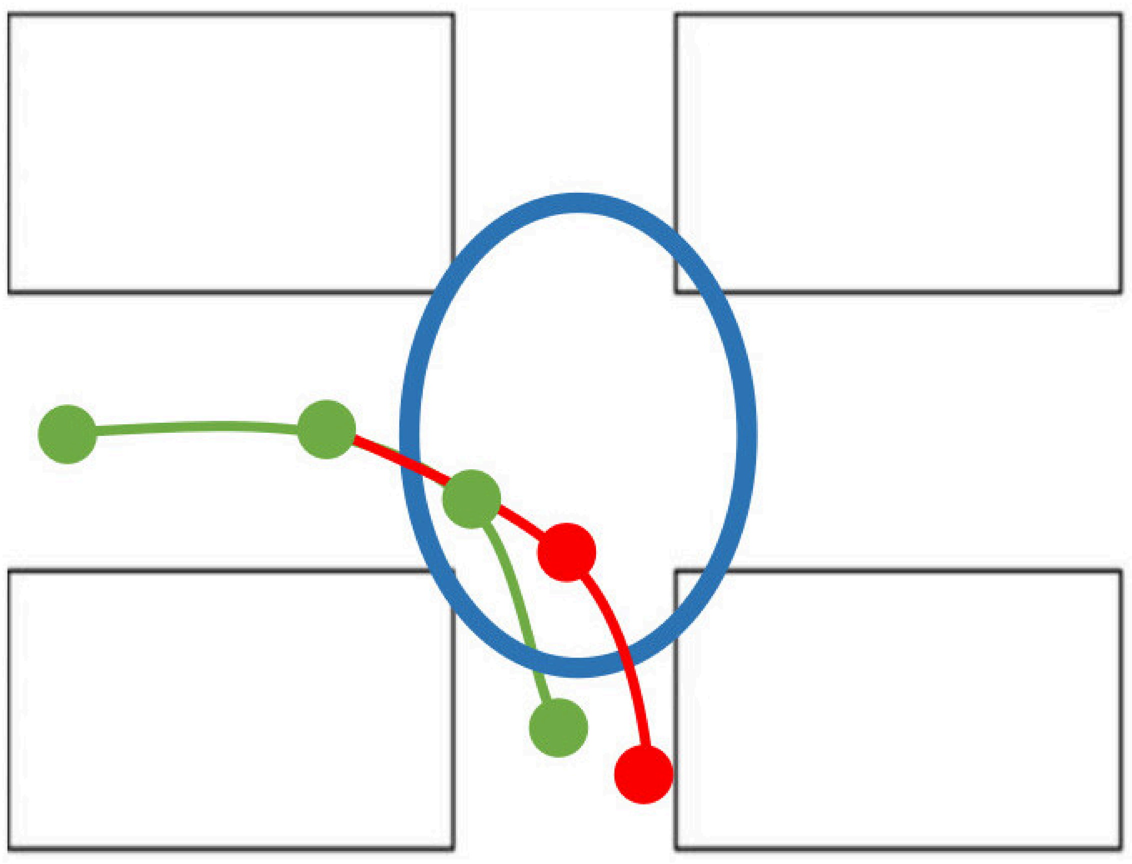
Pj & Pi: Vehicle pseudonyms   Blue circle: Mix-zone
O: Yellow car   O: Green car

Aim of privacy protection：

✓ The attacker cannot trace the vehicle trajectory in the Mix-zone

➢ Security threats

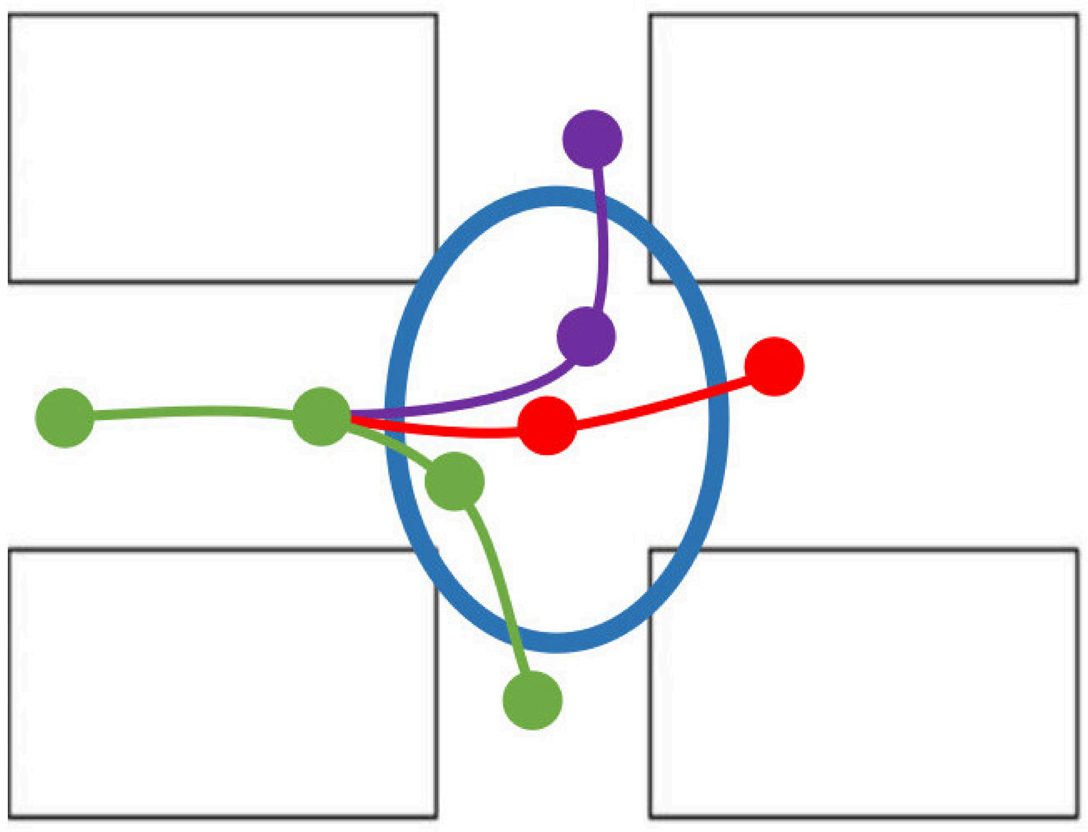
- It is possible for attackers to use advanced trajectory prediction techniques to trace trajectories in the mix-zone



• • • Real trajectory in the mix-zone
• • • Predicted trajectory in the mix-zone

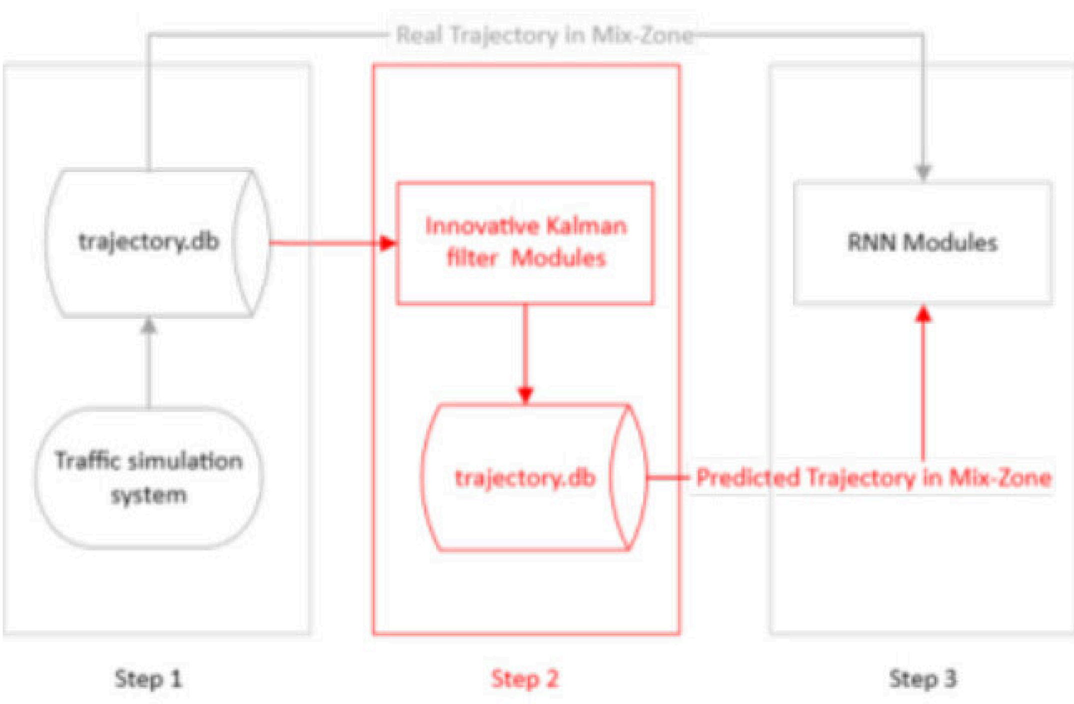
Propose Privacy protection solutions

- Develop a trajectory prediction mechanism for generating fake trajectories to deceive attackers



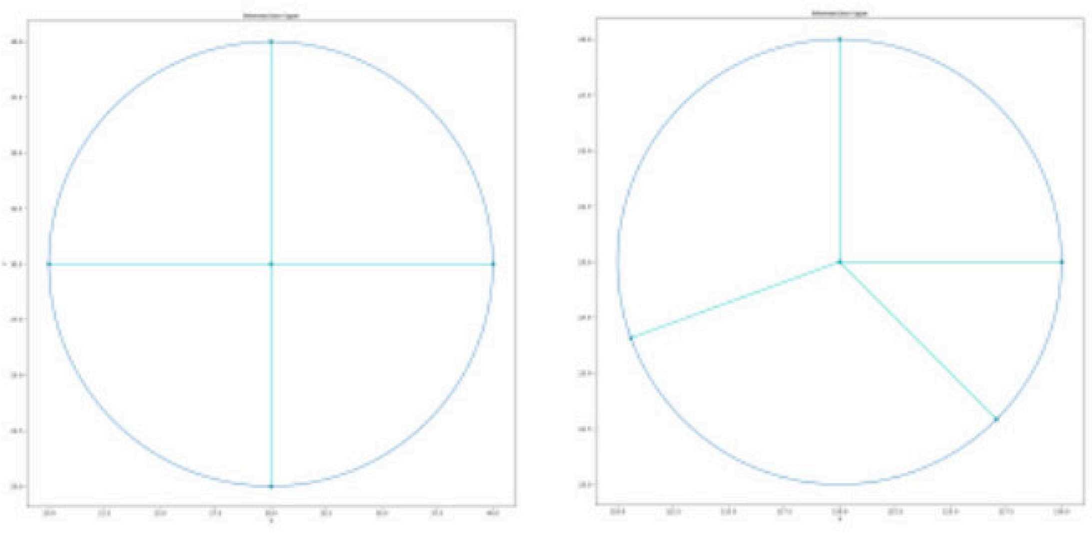
• • • Real trajectory in the mix-zone
• • • Predicted trajectory in the mix-zone
• • • Fake trajectories in the mix-zone

➢ Solution Structure



✓ Outcome 1: Traffic Simulation system

- The simulation system generates simulated data according to different intersections and vehicles
- The data is stored in the supporting database

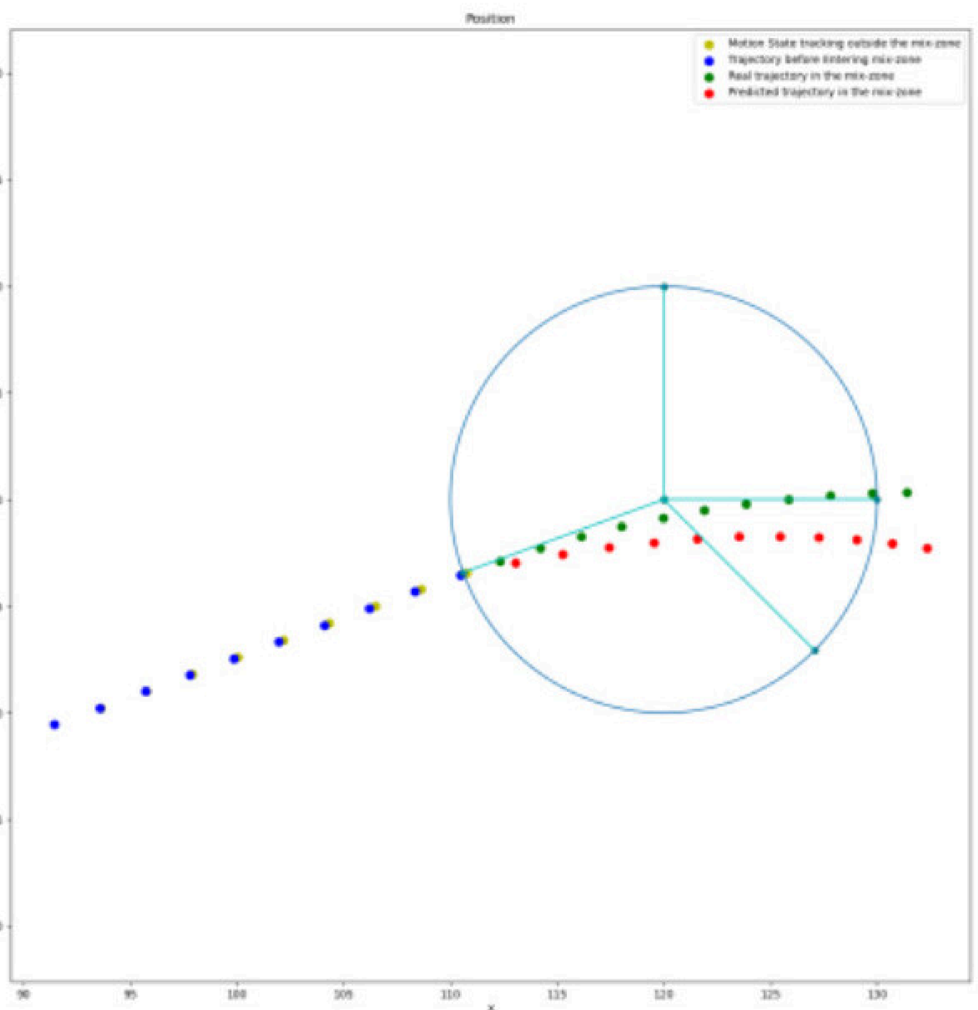


- Different kinds of intersections

✓ Outcome 2: Innovative Kalman Filter Algorithm

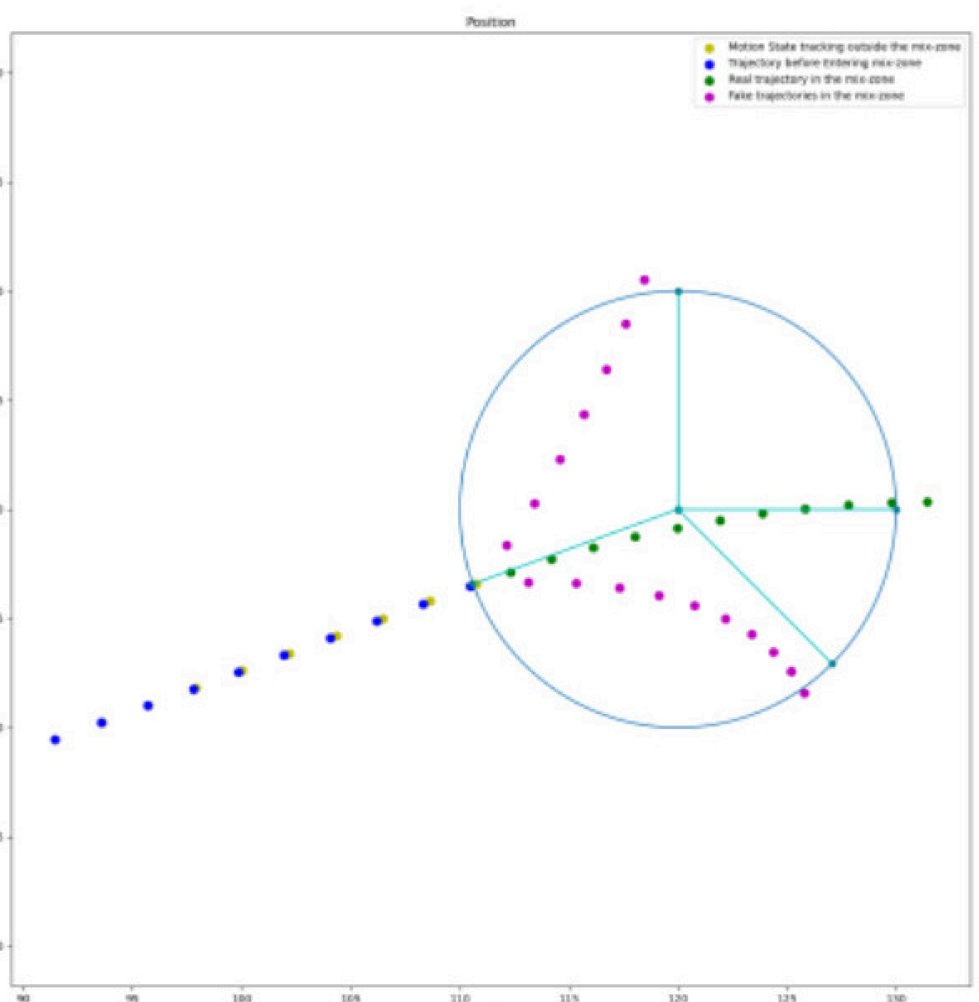
• • • Vehicle trajectory prediction

In Mix-zone, the red predicted trajectory is very close to the green real trajectory. And exit the Mix-zone from the same intersection.



• • • Fake trajectory generation

In Mix-zone, the algorithm generates two purple fake trajectories, which leave the Mix-zone from other two intersections.



• • • Motion State tracking outside the mix-zone
• • • Trajectory before Entering mix-zone
• • • Real trajectory in the mix-zone

✓ Outcome 3: RNN Optimization

- Goals: make the predicted trajectory closer to the real trajectory
- Input: real trajectory & predicted trajectory (two time series)