Human-Centred Technologies for the Common Good

A/Prof Haifeng Shen, Human-Centred Intelligent Learning & Software Technologies Research Lab (HilstLab), Peter Faber Business School

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ABOUT HilstLab

- Based in North Sydney
- Established in 2019

- 3 academic staff
- 2 researchers
- 2 PhD students

- A*: 3
- A*/A/Q1: 14

- High Performance Computer
- Deep Learning Workstation
- 55” Wall-mounted 4K Display

- Defense Science & Technology
- Catholic Social Services
- ACU ODVCR
- Faculty of Law and Business
- $260,200

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MEET THE TEAM

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Dr Kewen Liao

Dr Maoying Qiao

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OUR APPROACH TO RESEARCH

APPLICATIONS

Assist humans in solving real-world problems

STUDIES

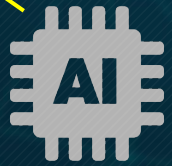
Impacts of human-centred technologies and applications

HUMAN

Centre of all technologies

SOFTWARE

Human's third hand



AI

Human's second brain

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OUR APPROACH TO RESEARCH

HUMAN
Centre of all technologies

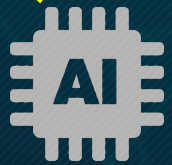
HUMAN-CENTRED SOFTWARE

- User-centred design
- UI, UX, interaction design, groupware
- Human aspects of software engineering

HUMAN-CENTRED AI

- Better AI models and algorithms
- Human-AI interactive sensemaking
- Human-AI partnership
- AI ethics, trust, security

SOFTWARE
Human's third hand



AI
Human's second brain

AI-SOFTWARE INTEGRATION

- Intelligent software
- Intelligent software engineering

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OUR RECENT PROJECTS

01 DEFENCE

02 MEDICINE & HEALTH

03 EDUCATION

04 ENVIRONMENT

05 AQUACULTURE

06 TELECOM

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DEFENSE 01

- Human-centred AI for submarine control room console operators, 2020-2021
- Visualisation as a Service for time critical decision making, 2019-2020

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Human-Centred AI for Periscope Operator

- Visually classify contacts and estimate range and course of contacts.
- High risk, time critical decision making process.
- Requires a high mental workload to achieve good performance.
- We developed a context-aware collaborative human-centred AI system to reduce cognitive load.

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Simulator

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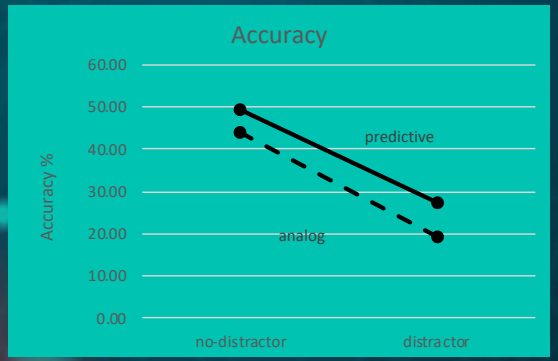
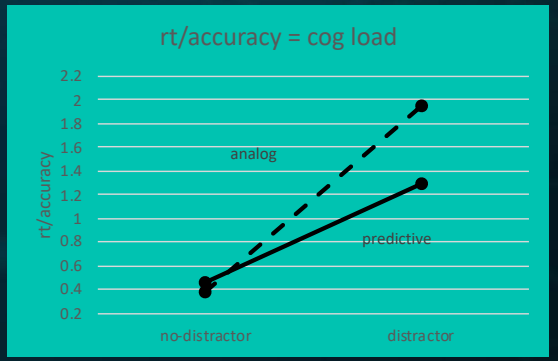
Pilot Result

- The AI-assisted system helped participants achieve both faster response times for all tasks and higher accuracy.
- In turn, measured (via eye tracker) and perceived (via survey) workload was reduced for those participants that used the AI-assisted system.





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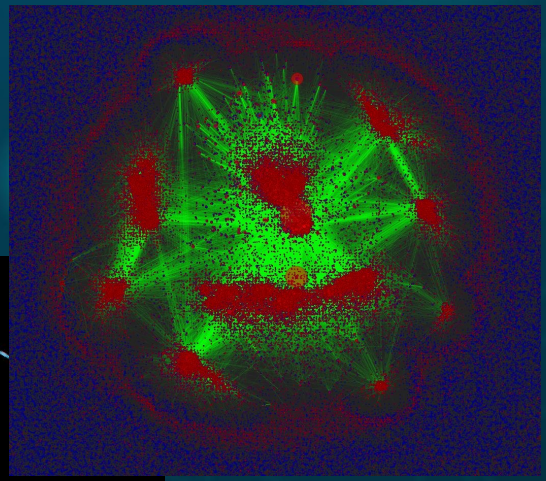
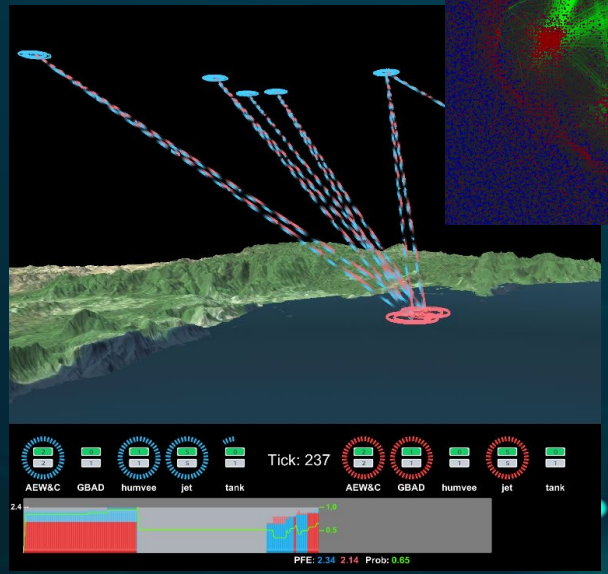
Visualisation as a Service

- High-fidelity visualisations are important for time critical decision-making.
- High-end graphic devices are not available in battlefields.
- We developed a technique for running graphics-intensive visualisations across multiple platforms.





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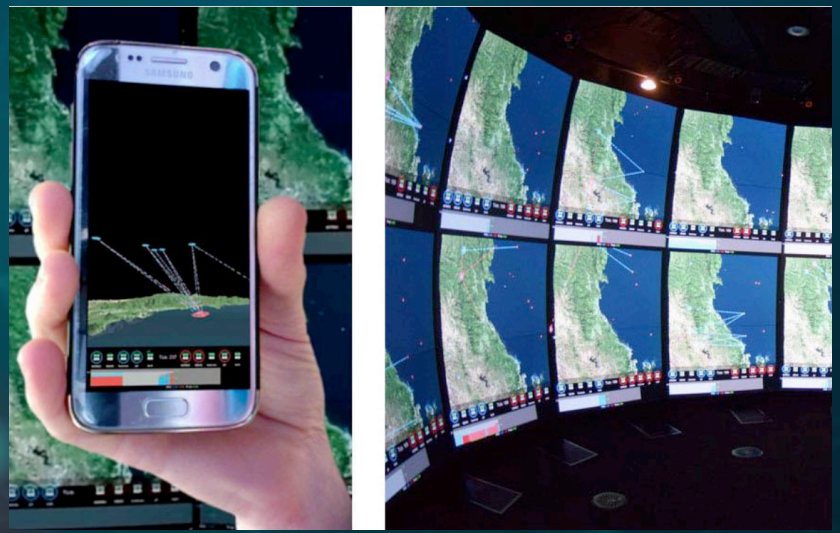
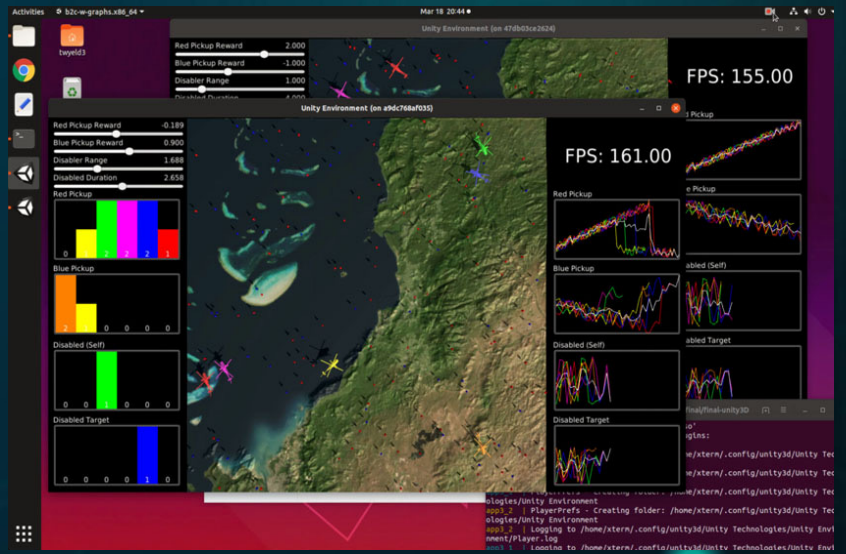
Containerisation and Virtualisation

- Visualisation applications are deployed in the cloud that provides the specific hardware and software resources required.
- Different containerised visualisation applications are custom-created to service the clients' devices.





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MEDICINE & HEALTH

02

- AI attention guidance for improved orthopaedics radiographic fracture classification, 2020 ongoing
- A smartphone-based point-of-care quantitative urinalysis device for chronic kidney disease patients, 2015-2018

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Fracture Diagnosis

- Fracture detection is a challenging task, representing up to 80% missed diagnosis in the ED.
- Mainly relies on X-ray and requires years of training and rich experience.
- Deep-learning AI has been used and performance is subject to the amount of training data.
- However facture diagnosis training data is scarce, thus requiring new technique.
- We developed an AI attention guidance technique to improve fracture detection accuracy

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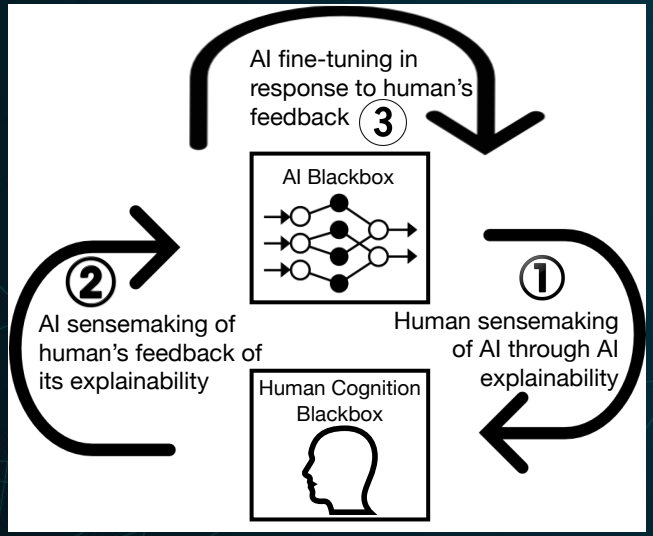
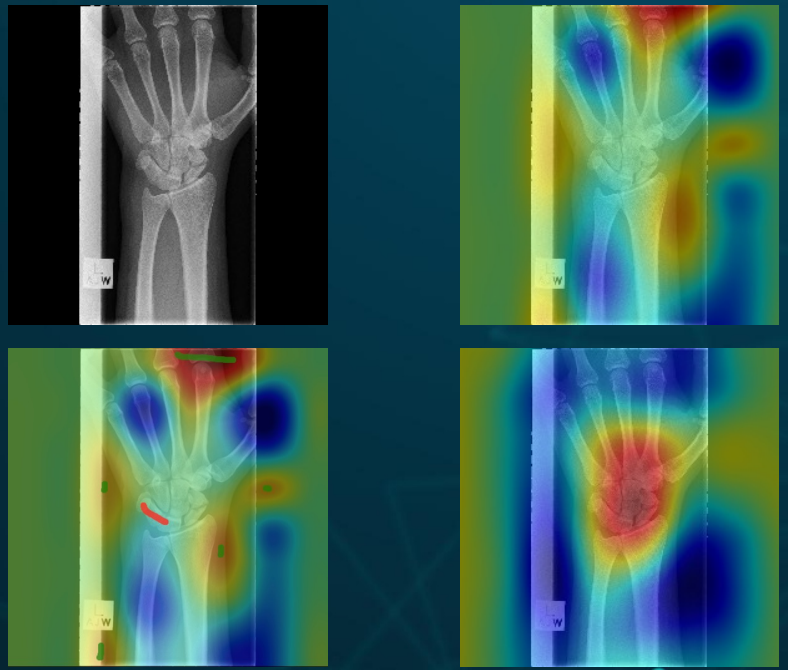
Attention Guidance through Human-AI Interactive Sensemaking





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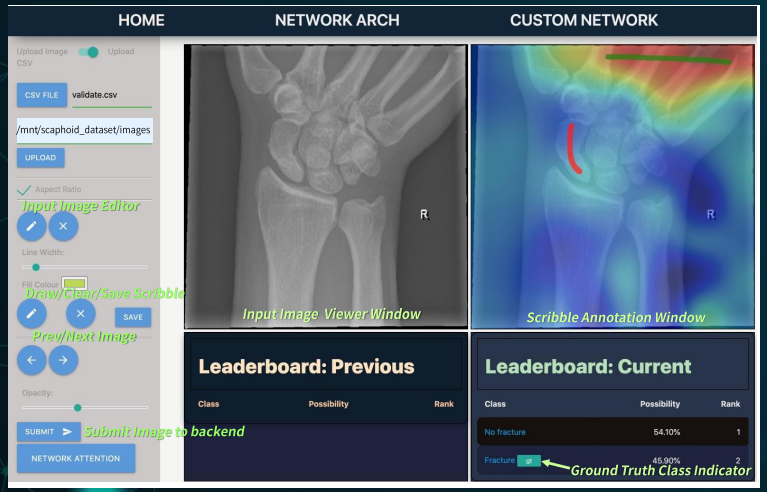
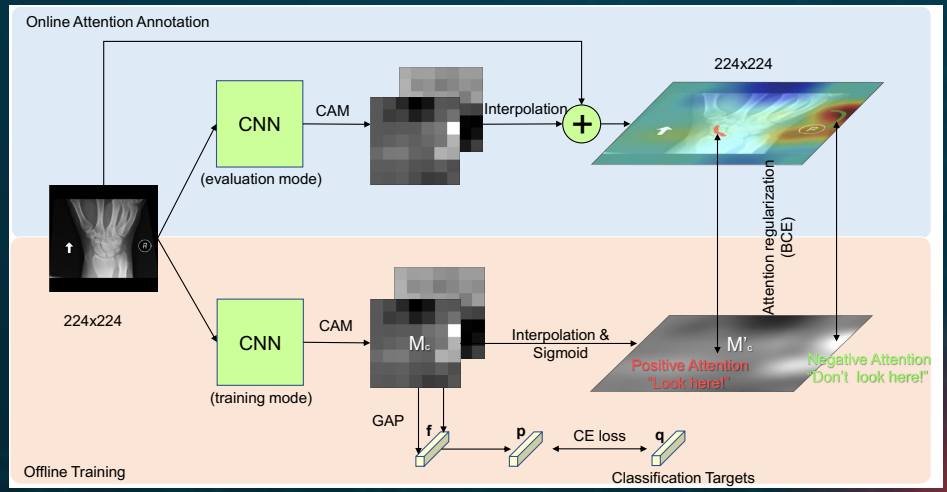
Attention Visualisation and AI Fine-Tuning

- We developed a browser-based network attention visualization tool for human-AI mutual sensemaking.
- User can upload images or a CSV file containing file paths.
- AI model fine-tunes itself to incorporate human feedback.





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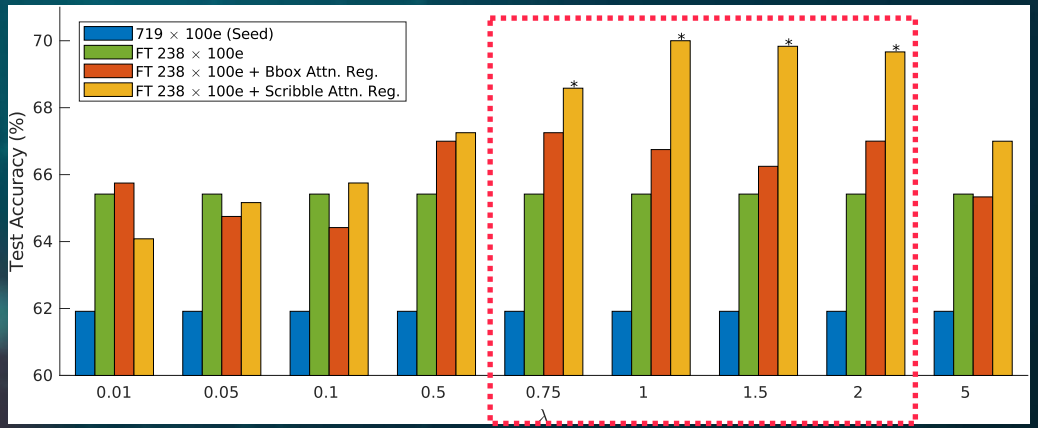
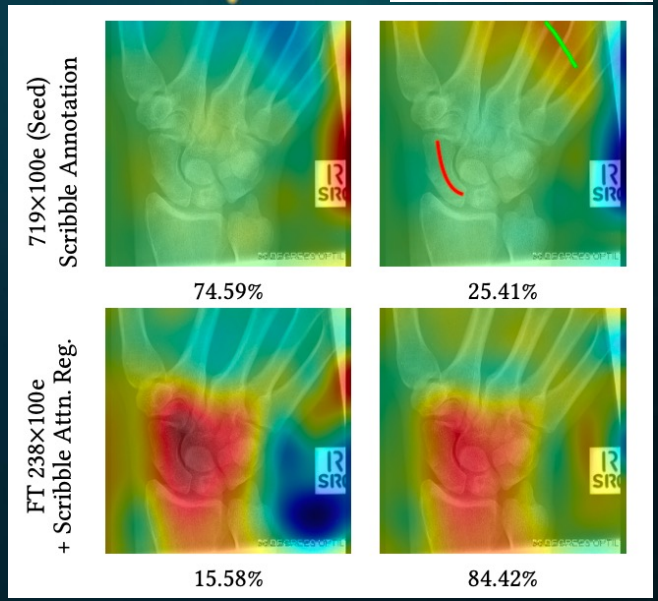
Experimental Validation

- Using a real-world scaphoid fracture dataset (1197 images from 300 patients) from Flinders Medical Centre.
- AI's performance is significantly improved after fine-tuning the AI to incorporate human's feedback.





No fracture class Fracture class

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Chronic Kidney Disease (CKD) and Urinalysis

- CKD is a major health issue worldwide (7% world population).
- Urinalysis is a standard method for the identification of people at earlier time points (HSA in urine).
- Laboratory tests require bulky machines, trained skills, and long turnaround times.
- Point-of-care (POC) dipstick-based testing is more convenient but can only provide qualitative results.
- We developed a smartphone-based POC urinalysis device for full quantitative detection using nanomaterials.

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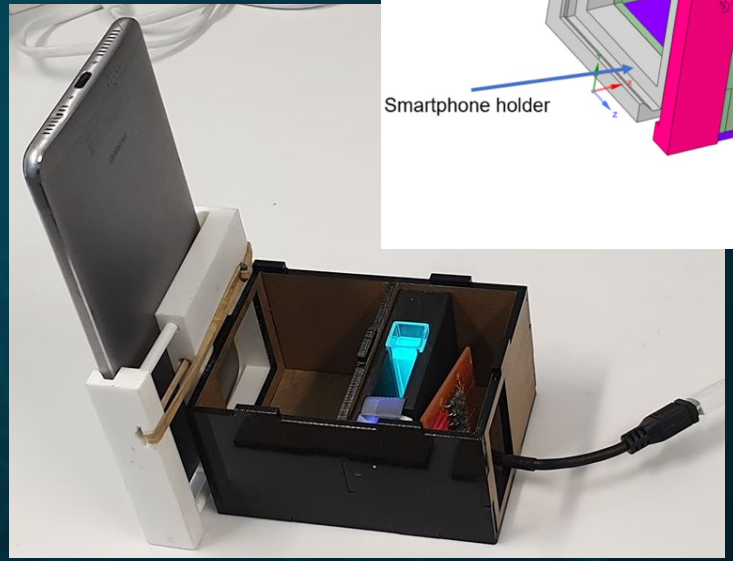
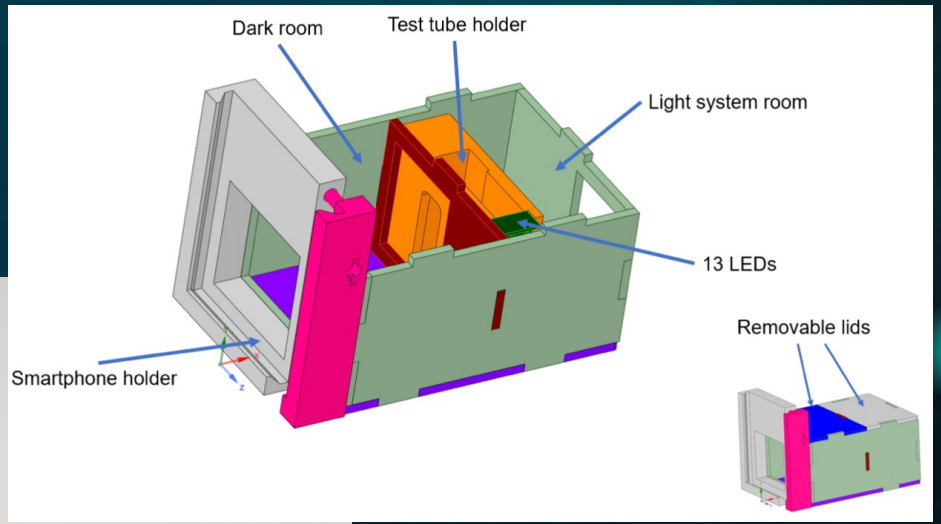
Smartphone-based POC Urinalysis Device





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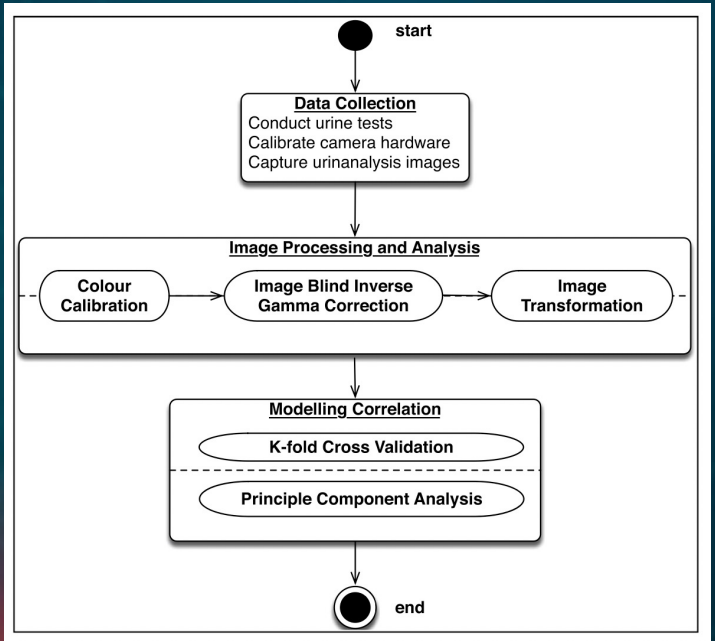
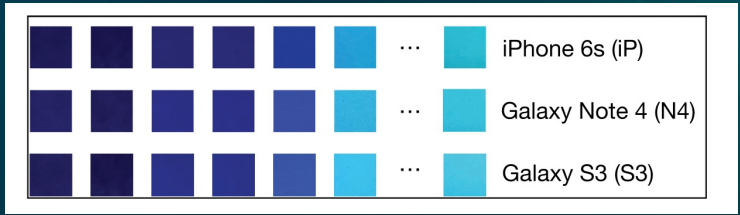
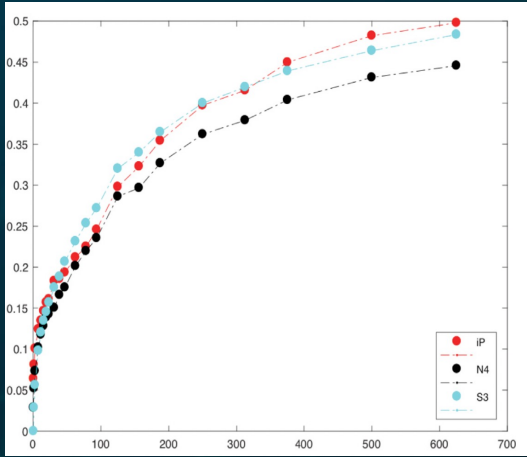
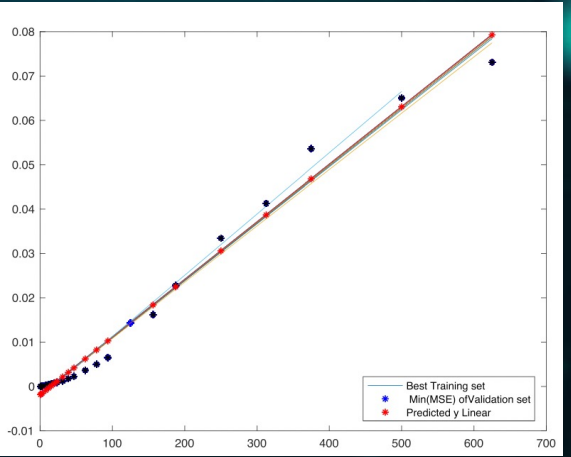
Correlation Between Urine HSA Concentration and Image Color Intensity









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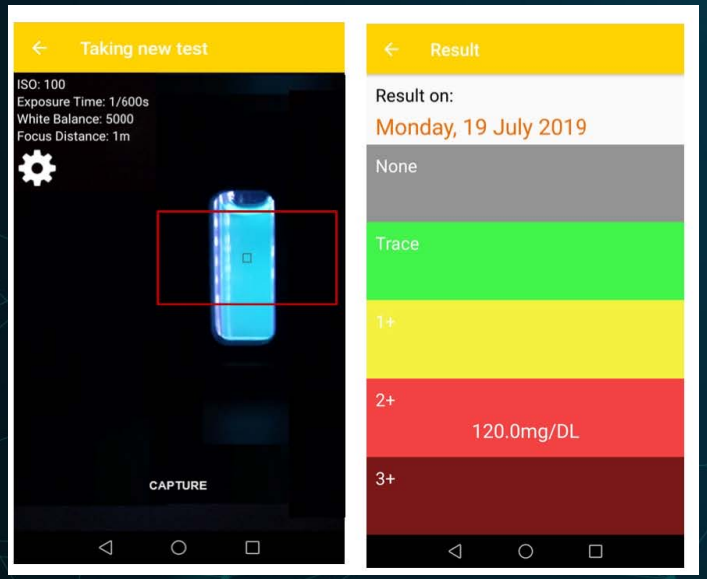
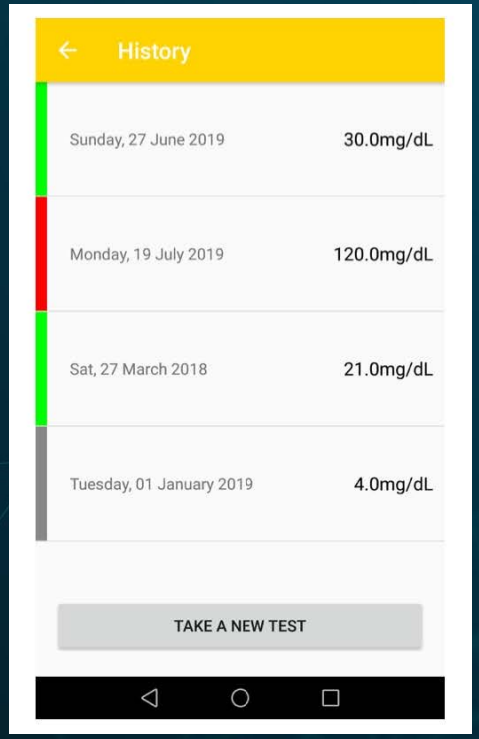
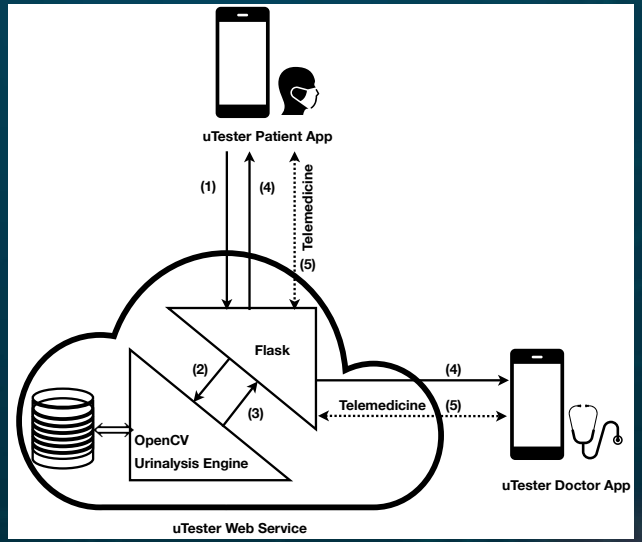
Smartphone-based POC Urinalysis Device







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EDUCATION 03

- Sentiment analysis and morale visualisation in a digital backchannel system, 2017-2019

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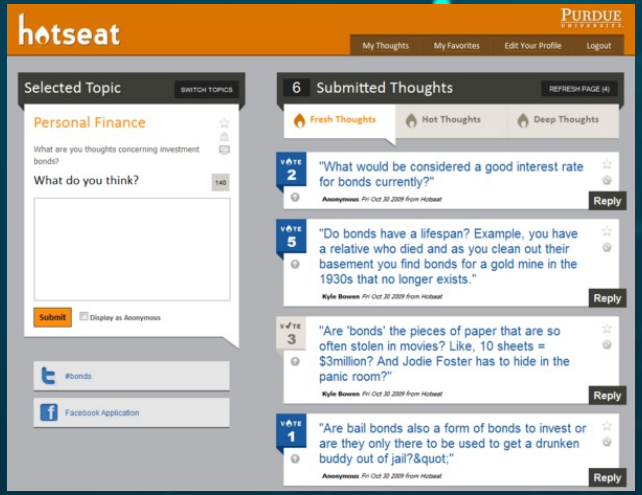
Challenge of Receiving Feedback from Audience

- Effectively connecting to a large audience is serious challenge.
- Backchannel systems are sometimes deployed to address this issue.
- They are not designed to immediately aggregate and present the audience's feedback to the presenter in a meaningful way that is easy to quickly digest.



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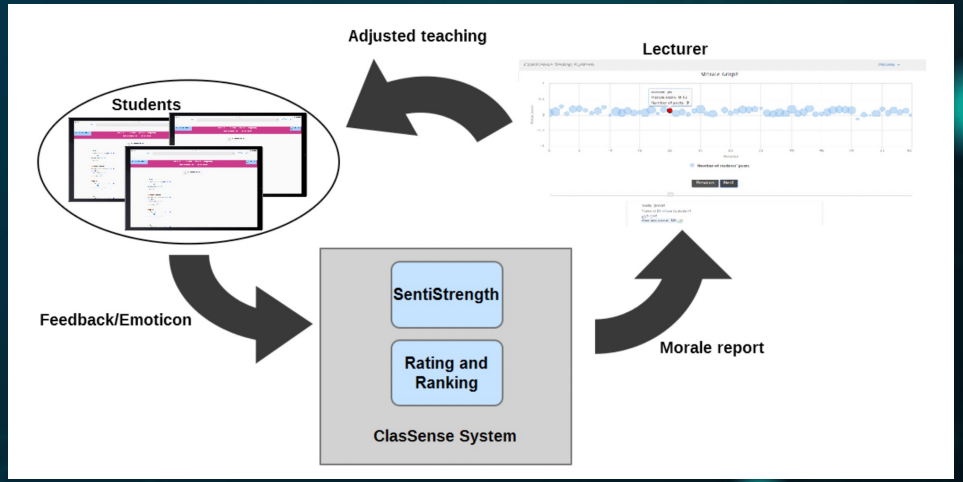
Real-time Sentiment Analysis and Morale Visualisation

- We developed a new backchannel system - ClasSense.
- Help a lecturer capture, process and respond to the large amount of students' posts effectively
- Get an overall picture of students' learning as well as their emotions and sentiments
- Trace back a summary of incidents in order to improve the lecturer's delivery and understanding of the students' comprehension level



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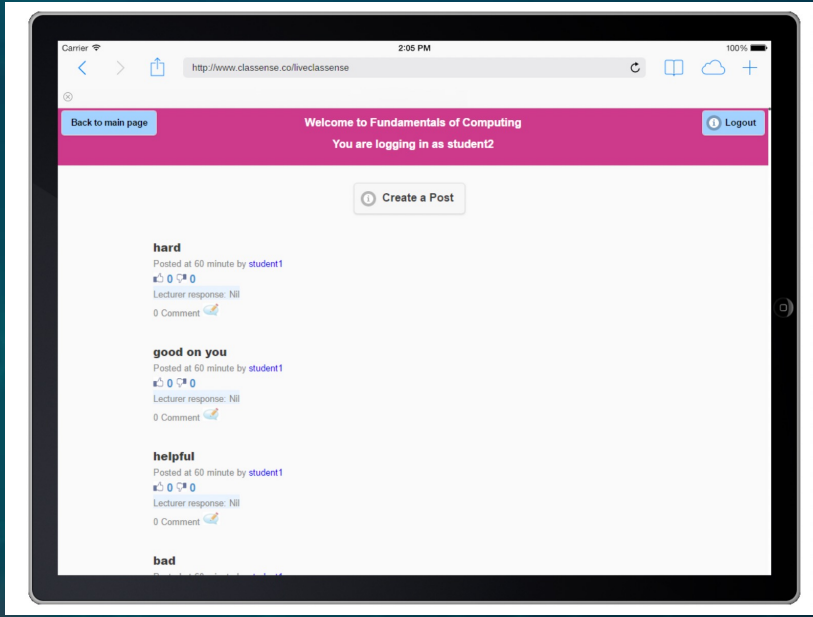
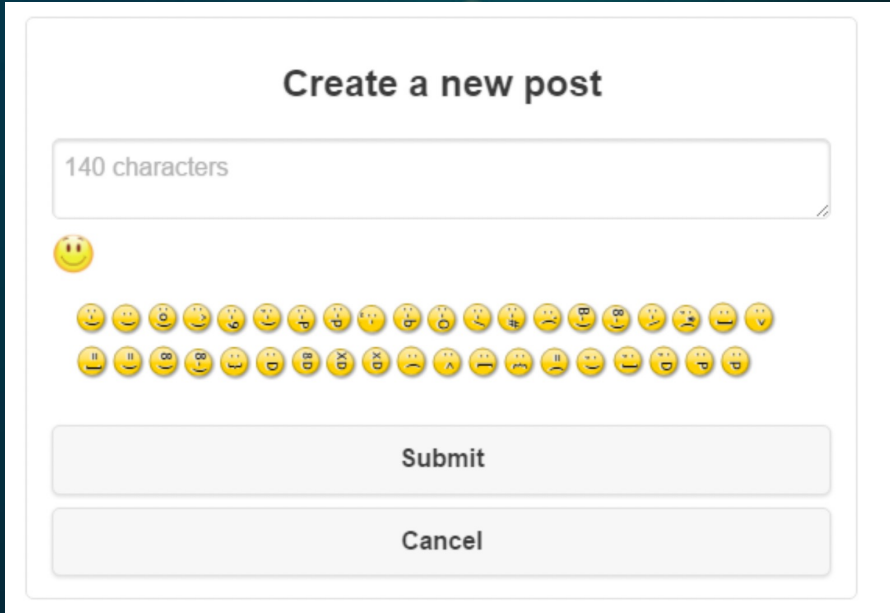
ClasSense Student Interface





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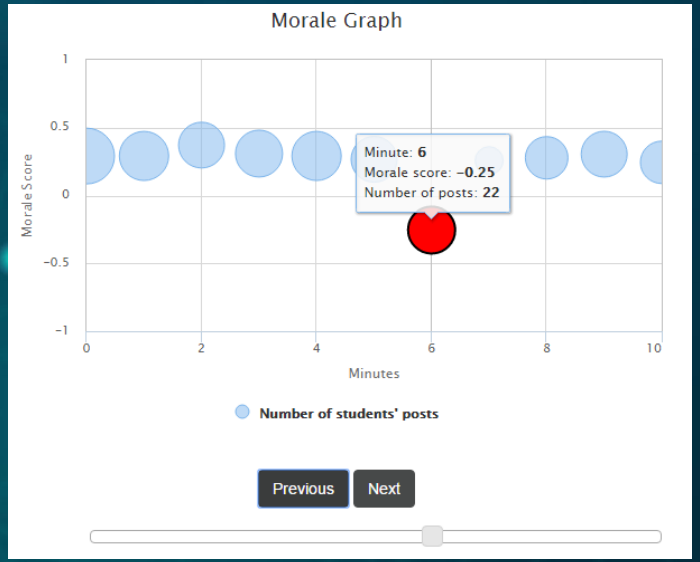
ClasSense Teacher Interface



I feel the cards were suppose to help me but I am more confused now!
Posted at 6 minute by student27
0 0
Your response:

Too much interrupting :-/ :-/
Posted at 6 minute by student37
0 0
Your response:

It's bad when someone start speaking beacause I get lost in the idea as it is difficult to hear people
Posted at 6 minute by student37
0 0
Your response:

my answer was wrong ;-) ;-) ;-) ;-) ;-) ;-)
Posted at 6 minute by student17
0 0
Your response:

example is a little difficult to follow at times
Posted at 6 minute by student5
0 0
Your response:

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Evaluation Results

- A corpus of 2,143 posts on 9 entry level Information Technology topics was collected through the ClasSense backchannel system over a period of 4 months.
- Involved 35 students and 7 lecturers.
- Lecturers accept and prefer the morale graph based user interface over conventional ones.
- Students agree that the system not only makes their feedback an important part of the class but also increases their interactions with lecturers.
- The general applicability of the tool lends itself to many other types of contexts.

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ENVIRON MENT

04

- Automated catch event detection for longline fishing, 2018 -
- Detection of fluoro- surfactants PFOA using a smartphone-based portable device, 2017-2018

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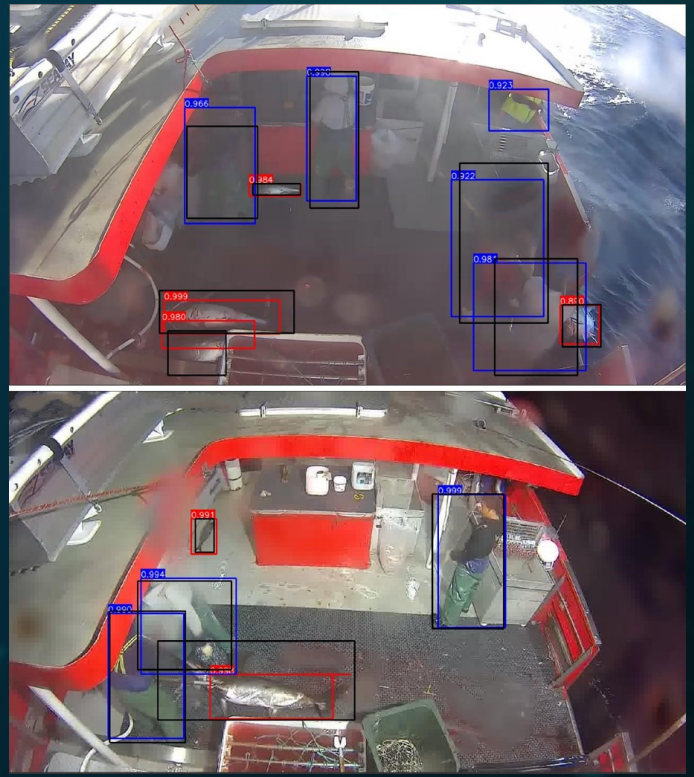
Sustainable Harvesting of Marine Resources

- Electronic Monitoring (EM) systems use on-board cameras to observe fisheries operations.
- Manually analysing the large volume of video data captured is very time-consuming.
- We developed a deep learning solution for identifying catch events automatically.



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Sustainable Harvesting of Marine Resources

Fish catch counting

Fish detection & classification

Fish trajectory via tracking

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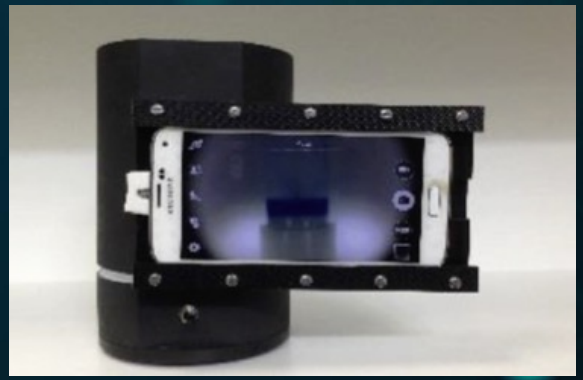
Detection of fluoro-surfactants

- Fluoro-surfactants like PFOA/PFOS/PFAS are highly toxic.
- They come from industrial and institutional cleaning solutions.
- They are currently detected globally in virtually all life forms and environments.
- Detection and analysis is time-consuming, expensive and must be carried out in professional laboratories with cumbersome instruments.
- We developed a smartphone-based portable reading kit that allows quick, accurate analysis in the lab or field.



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Detection of fluoro-surfactants

A video on using the App https://www.youtube.com/watch?v=8khPuX3r5I8

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AQUACULTURE

05

- Automated estimation of greenlip abalone mass using image analysis, 2021 -

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Automated estimation of greenlip abalone mass

- Abalone mass data is important for calculating daily feed intake, adjusting stocking density, grading, optimising use of facilities, and controlling water quality.
- Current way for measuring length and weight is time-consuming, costly, laborious and invasive.
- We are exploring an automated non-invasive way using computer vision and software technologies.

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Acquisition of Training Data for Machine Learning

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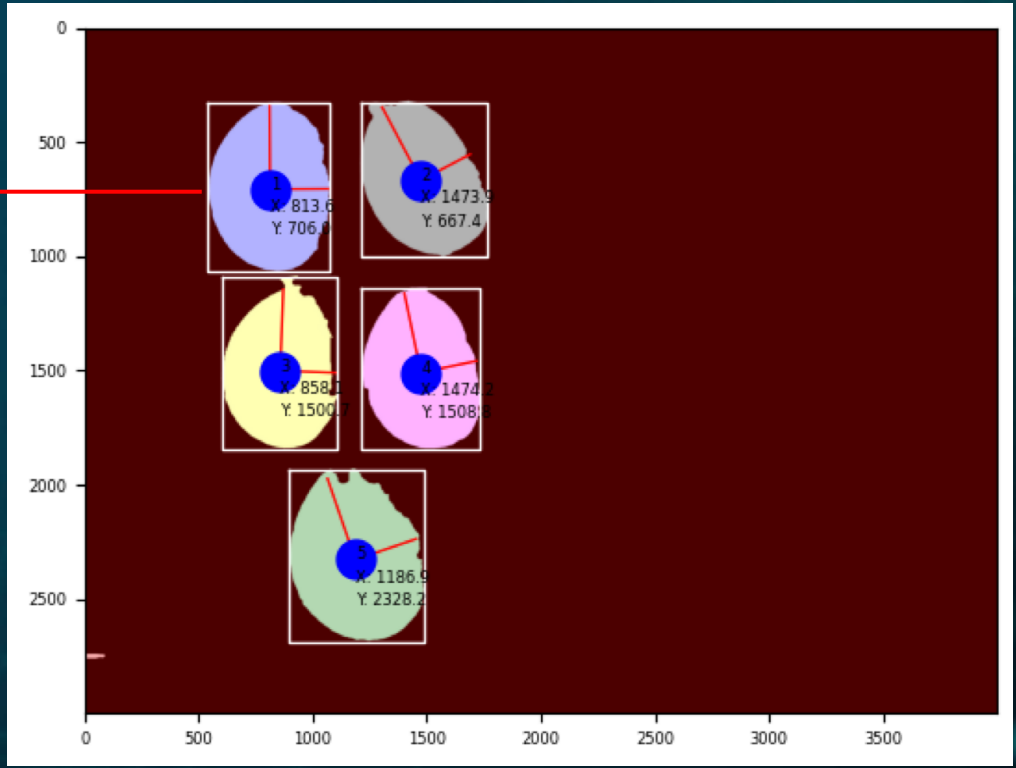
Automated Data Extraction using Computer Vision

Height, width, and area



A total of 404 clean labelled sample to use for machine learning

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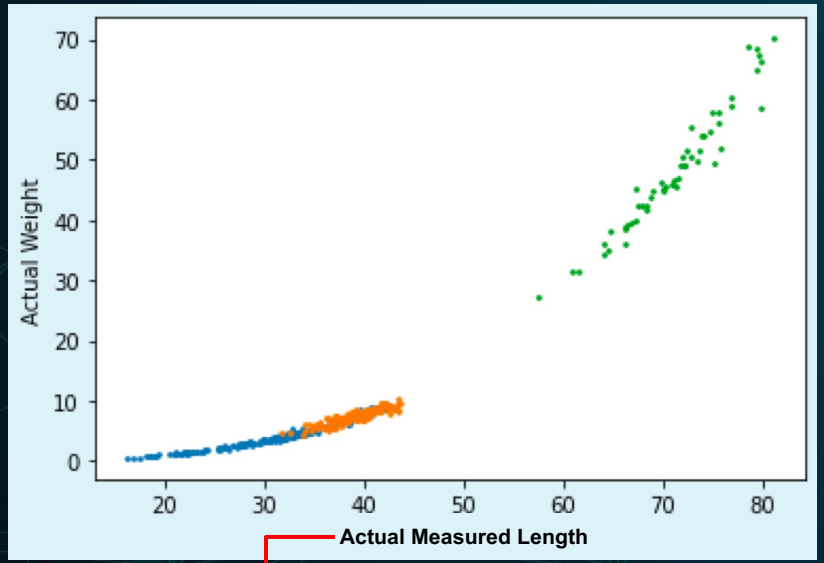
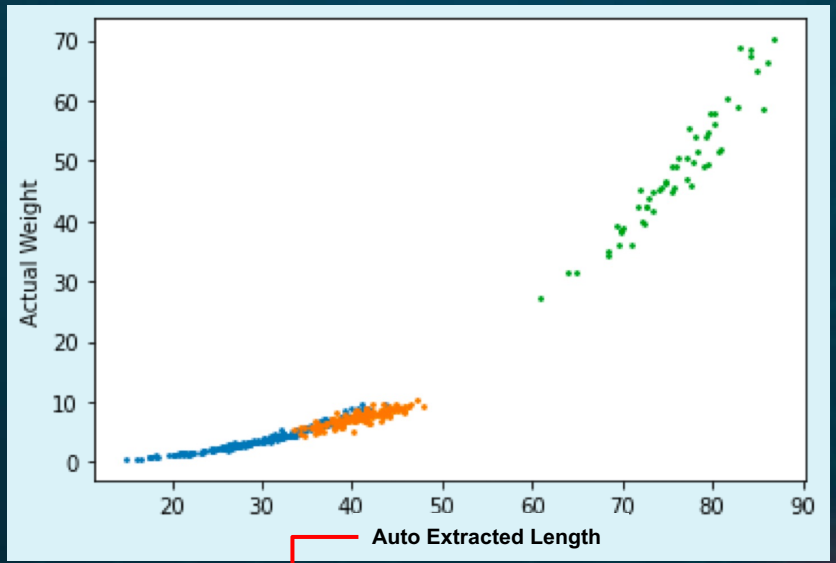
Automated ML Model Close to Ground Truth



Manually measured



Estimated using computer vision

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TELECOM 06

- Automated structural corrosion detection of telecom towers from drone images, 2018-2020

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Cost of Corrosion

- The problem of corrosion may cost Australia up to $32 billion annually.
- In most cases, inspections are conducted manually which can be slow, hazardous, expensive and inaccurate.
- We developed an AI-based automated solution utilising real-world high-resolution unaltered images captured by drones in industrial and real-world settings to identify corrosion in industrial structure such as telecommunication tower.
- Limited existing research and only for metallic surfaces.

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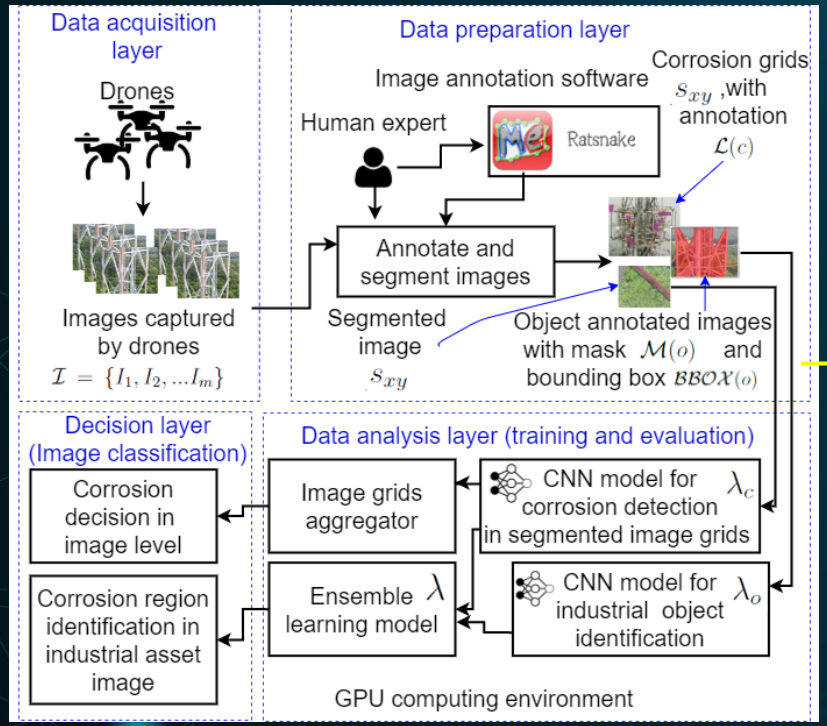
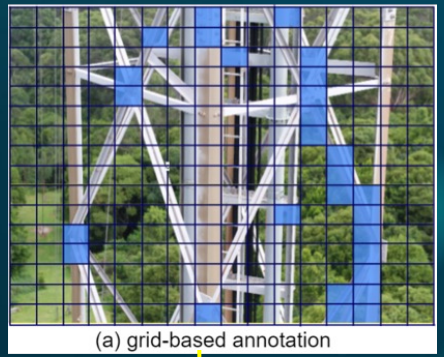
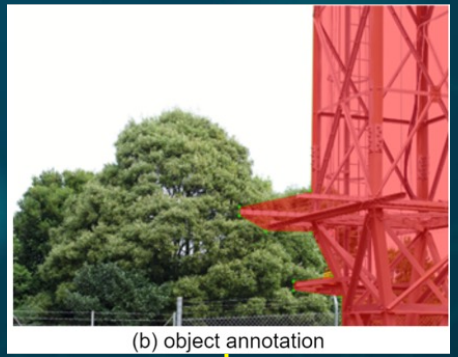
A Novel Deep Learning Ensemble Framework




(a) grid-based annotation


(b) object annotation

Compared to single model, deep learning ensemble models largely remove the false positives and increase accuracy to 93.80% (from 86.28%) with precision of 88% (from only 53.42%)

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THANKS!

Do you have any questions?

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