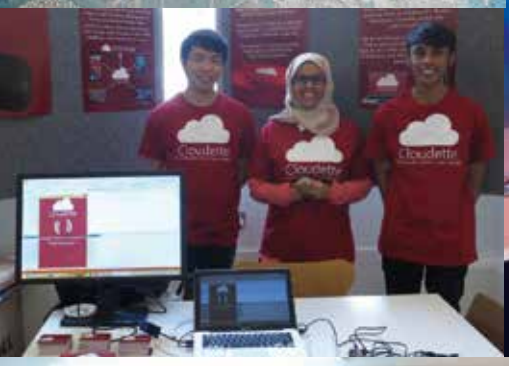
COMPUTER SCIENCE

UCL

Student Showcase 2019

INDUSTRY EXCHANGE NETWORK IXN

Book of Abstracts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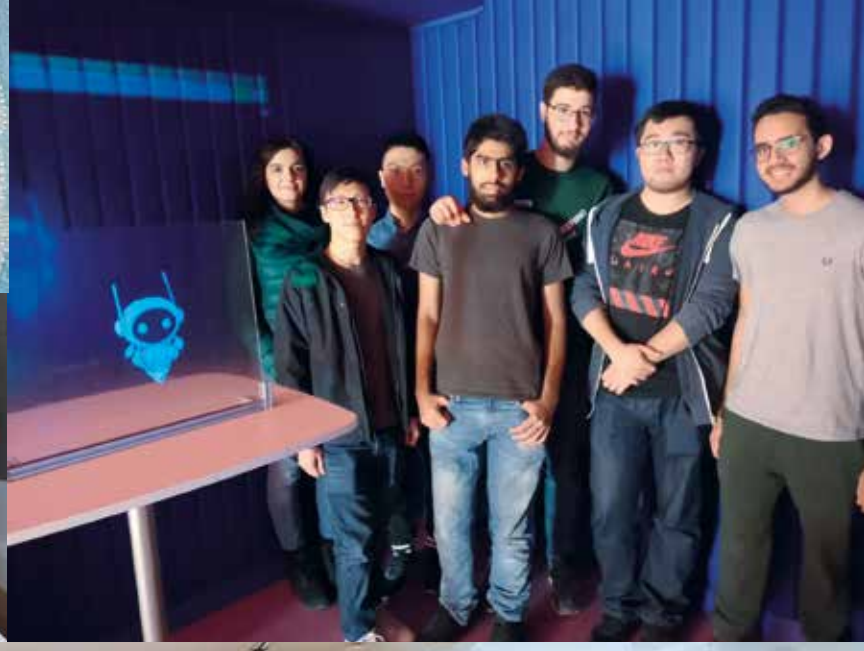


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Contents

Student Modules: COMP0016 Systems Engineering, COMP0067 Design, COMP0102 Software Abstractions and Systems Integration, COMP0029 Individual Project for Year 3 BSc, and COMP0138 Individual Project for Year 4 MEng

Educational Programme developed by: UCL Industry Exchange Network & UCL Engineering

Editors: Dr Dean Mohamedally, Dr Graham Roberts, Vajeeha Farooq, Adam Peace, Terry Williams Graça Carvalho and Dr Caroyln Phelan

UCL ENGINEERING
Change the world

UCL Computer Science
Student Showcase Presentations 2019

Tuesday 23rd April 2019

Registration Desk at UCL Roberts Building Entrance (08.30–16.00).

Partner meeting/work space (available 08.30–15.30): UCL Roberts Building, Lecture Theatre 421, 4th Floor.

Morning Sessions 09.00–11.00

Healthcare part 1 with GOSH DRIVE – Session 1

Primary Examiner:
Dr Dean Mohamedally
Room: UCL Roberts Building 106, First Floor
Time: 09.00–11.00

Each team has 6 minutes to present, with up to 2 minutes Q and A from the audience.

Running Order	Team No.	Title
1	1	Synthetic Healthcare Data Generator with PEACH GAN Processor
2	2	SMART on FHIR Modules
3	3	Healthcare IoT eVitals
4	4	NTTData SOTA/Jibo as a Robotic Patient
5	5	Healthcare Sensor Fusion
6	6	Computer Vision for Medical Instrument Detection
7	36	NTTData Augmented Reality Simulations for GOSH patients
8	7	HoloLens support for Clinical Education
9	8	Accesibility Technology for GOSH Sight and Sound Hospital
10	15	PEACH Big Data Engine 2019 with HaMpton Pregnancy Analysis
11	32	Exploration of 3D clinical models navigation with Sopra Steria
12	19	GOSH DRIVE HoloRepository 2019

Tech Disruptors – Session 2

Primary Examiner:
Dr Graham Roberts
Room: UCL Roberts Building 508, 5th Floor
Time: 09.00–11.00

Each team has 6 minutes to present, with up to 2 minutes Q and A from the audience.

Running Order	Team No.	Title
1	26	Evolv VirtualRehab Hands: Fine Motor Rehabilitation Games
2	29	Avalon: A Financial Data Image Recognition System
3	30	A crowdfunding investment portfolio management system
4	31	3D Depth Capture for Dance Review with Arthur Murray Studios
5	33	Kazendi HoloHand
6	37	DeafPlus Speech2Sign
7	38	DeafPlus Auto-Speech2Subtitles for Internet Radio
8	42	Addin365 ChatBot for onboarding Office365 users
9	43	UCL Micropalaeontology – Machine Learning of Foram Images
10	44	UNESCO Policy Registration Engine System
11	45	Asset Investment Platform powered by Sentiment Analysis
12	46	A Rehabilitation chatbot for educating offenders for MegaNexus

Lunch Networking and Project Posters

Primary Guest Lead:
Graça Carvalho
Location: North Cloisters, Wilkins Building

11.00–14.00 Project Posters at North Cloisters
Overviews of student projects on display.

11.30–13.30 Lunch
An opportunity to get lunch and speak to students about their work.

Media interviews
Showcase Filming Contact: Yonita Carter

Afternoon Sessions 14.00–16.00

Healthcare part 2 with the NHS – Session 3

Primary Examiner:
Dr Dean Mohamedally
Room: UCL Roberts Building 106, First Floor
Time: 14.00–16.00

Each team has 6 minutes to present, with up to 2 minutes Q and A from the audience.

Running Order	Team No.	Title
1	9	NHSD Wellbeing Score Analyser
2	10	NHSD 111 Optimiser tools
3	11	NHSD Interpreting Black Box Algorithms
4	12	NHS AI PlayGround – an AI testing platform for the NHS
5	13	Trakka Medical Blood Glucose Monitor App for Pregnancy
6	14	Trakka Medical Hypertension Monitoring Service for Pregnancy
7	18	FHIR FLI Version 2.0 for consumer IoT health data integration
8	20	NHSD DepthVisor for Surgical Depth Video Capture
9	21	Immersive Health Mixed Reality Sports Training
10	22	Immersive Health PEACH VR cycling gamification for rehabilitation
11	27	Code4Health OpenEHR Data Explorer

Industry R&D – Session 4

Primary Examiner:
Dr Graham Roberts
Room: UCL Roberts Building 508, 5th Floor
Time: 14.00–16.00

Each team has 6 minutes to present, with up to 2 minutes Q and A from the audience.

Running Order	Team No.	Title
1	23	Ocado Image Stitch Up
2	24	Ocado NLP for Product Review Analysis
3	25	Ocado 3D Object Recogntion for Shopping Automation
4	17	EDVS – Emergency Detection System for Vocal Signals in Care Homes
5	16	ARM IoT Fall Detection
6	34	NTTData Medical Augmented Reality Use Cases
7	35	NTTData Augmented Vehicle Experiences
8	28	Camden Council ML for ASB detection
9	39	Microsoft Accessible AI with Cortana
10	40	Mixed Reality for Remote “Audiolisation” using Soundscape
11	41	Microsoft MLAcademy – an ML Education Platform

Syllabus of the Future Session for IXN Partners

16.00–17.00

Chairs: Dr Dean Mohamedally and Dr Graham Roberts
Room: UCL Roberts Building 421 Lecture Theatre

An opportunity for current collaborators to discuss future projects. An opportunity for potential collaborators to find out more about working together.

IXN Innovation Mixer

17:00-18:30

Chairs: Dr Carolyn Phelan and Graça Carvalho
Room: UCL Roberts Building 422

Now that you have seen IXN, come and learn about IXN Innovation. For IXN partners, IXN guests and UCL Staff.

Welcome to UCL Computer Science Student Showcase 2019!

The student project work you will see in today's showcase reflects how computer systems touch every element of our daily lives. Studying Computer Science has developed not only the students' analytical thinking, but also their ability to collaborate and work together to creatively tackle the most challenging of problems.

As a department, we are proud of our strong focus on solving real-world problems, and the scale at which we do them. Introducing our students to partners as early as possible is a core principle of our teaching agenda. This not only raises motivation – it also accelerates learning and makes theoretical concepts applicable. Our students' project work is the product of a successful combination of partner-facing work and the world-class teaching of our dedicated academic staff.

Student projects are facilitated by the Department's unique UCL Industry Exchange Network (UCL IXN), which partners students with partners to work on projects both internally within UCL and externally, with local businesses, charities and healthcare providers. This academic year has provided a number of exciting new developments for the UCL IXN. We have launched two new sub-programmes of activities, our IXN Innovation programme for advanced Masters students and our IXN for the NHS programme in collaboration with Microsoft, NHS Digital and Apperta Foundation.

Our Academic Staff that works with our Teaching and Learning Team, Technical Support Group, Professional Services Team, Finance Managers and our new Strategic Alliances Team have all worked tirelessly to support problem-based learning at scale with our students on their projects and have pioneered innumerable new opportunities for them.

I would also, of course, like to thank the students themselves. They have shown a great capacity for innovation, resilience and collaboration as with every year – please take every opportunity you can to ask them questions about their experience and take advantage of their new thirst for knowledge and understanding!

With best wishes,
Professor John Shawe-Taylor
Head of Department

The UCL Industry Exchange Network – UCL IXN

"There are enough problems in the world to solve, big and small... and students must publish their work to be seen."

UCL Computer Science is a global leader in experimental computer science research, concerned with real-world data and observations about computer and software systems, and their use. This orientation directly feeds and shapes our teaching curriculum, across our two main undergraduate teaching programmes (BSc & MEng Computer Science) and across many of our Master's programmes. We have adopted a problem-based teaching and learning approach, training students to be able to address real world challenges with methodological rigour. There are two key ways by which we deliver this to students: (1) the UCL Industry Exchange Network (UCL IXN), and (2) academic research training. Both of these work in a teaching framework that exposes students to societal, entrepreneurial and commercial challenges and gives them the opportunity to engage, right from their first year, in real-world software engineering projects.

Students work under the joint supervision of a named technical mentor from the company, and a UCL academic supervisor. In so doing, fundamental transferable skills of teamwork, professional standards, ethics and communication are fully integrated within our taught programmes.

Created in 2011 as a partnership between UCL CS and Microsoft UK, the UCL IXN has evolved and grown over the years: in the last two years (2016/17 and 2017/18), our cohort of about 450 undergraduates and postgraduates have been working in teams with about 110+ industrial partners,

ranging from large firms (e.g., Microsoft, IBM, Google, ARM, NTTData, ATOS), to public sector / government (e.g., UNESCO, UNICEF, local government such as Camden and Kent Councils), healthcare (e.g., NHS Digital, UCL Hospital, Great Ormond Street Hospital), charities (e.g., OpenEyes Foundation, Look Ahead Care and Support), and SMEs (Net-a-Porter, Meganexus, BrainFocus).

Industry partners suggest projects capable of running strictly to term-times, while we continuously review our student population skills and interest areas in order to match students with the right projects. Undergraduate group projects are allocated to students based on tracking their motivation, grades, and criteria such as their prior experience. Master's and final year undergraduate individual projects are also matched on similar criteria, with students able to select a specific project from the range available. Every year the UCL IXN culminates in a student showcase event in April, where all students present their work to an audience of over 150 industrial partners and academic staff.

About the UCL IXN Innovation Programme

Our MSc programmes have a rich history of industry engagement, both within the project and the teaching spheres. Since 2018 the projects have been combined and expanded under the IXN Innovation banner and today our specialist MSc programmes offer students the opportunity to do a three month summer research project with an industry partner.

The breadth of the MSc programmes covered by IXN Innovation gives our partners unprecedented access to around 500 students with a variety of specialist skills, supported by over 70 academic staff and their research teams. We have designed this scheme to be a natural progression for existing IXN partners who would like the opportunity to explore their research and innovation ideas in the greater depth that a three month full-time engagement with postgraduate students allows. We also welcome partners who wish to connect with us solely at the IXN Innovation level.

In order to scale up the IXN Innovation programme to support these large numbers of students, we have set up several new structures. This allows us to offer our partners additional benefits such as dedicated assistance in scoping the work and targeted matching of students to projects, as well as opportunities to engage with students and staff throughout the year through events such as Tech Talks and guest lectures. Dr Carolyn Phelan is Director for IXN Innovation.

Introducing the Strategic Alliances Team

As the scale of the IXN in our teaching has been growing, the department's own visibility for industry in research areas has also made tremendous leaps. From the AI Centre and the Robotics Centre launch at UCL East, to doctoral training centres, major initiatives in the Department of Computer Science are reliant on strong partnerships with industry. In 2018 the department created a new partnerships management group called the Strategic Alliances Team (SAT) to reinforce relationships with industry. Graca Carvalho is Director of the group, and oversees a number of high visibility activities across UCL Computer Science. Our two Strategic Partnerships Managers, Wei Chen & Marie Purcell will support the IXN programmes across different specialisations to facilitate the collection of new ideas for projects and support the administrative efforts of facilitating the programmes.

To contact the Strategic Alliances Team please email:
cs.strategicalliancesteam@ucl.ac.uk

The IXN for the NHS Programme

It is in our mandate that at least a fifth of all student projects should be charitable or in healthcare, for the good of humanity. Since 2013 we have worked hard to develop our reach and skills in pairing clinicians with Computer Science students to solve real-world problems in UK healthcare. We have worked extensively with all the major London hospitals and many groups across the UK that have small to very large problems to explore with our students.

As of January 2019, UCL, NHS Digital, Code4Health, Microsoft, NTTData and others have now built an open source national software engineering programme for Interoperability, Efficiency and Innovation (IEI) projects in the NHS, as reported in the Government's TOPOL Review.

The programme extends the IXN through technology providers like Microsoft to partner up with leading universities to co-build useful, scalable, and applied solutions in a safe test environment with no financial, or technical risk for the NHS. This partnership of commerce, academia, and industry is the perfect place to drive IEI development. Further the final intellectual property (IP) on this programme is kept in open source format at Code4Health's Apperta Foundation, for the NHS to use at no cost. This will lead to many more projects and allow students to generate visibility and publications from the work they have done.

"Via the IXN I have been able to get access to a focused and capable student population to produce clinically led proof of concepts that solve real needs and improves lives. As a consequence, I am able to provide proof of concepts quickly to clinicians that have no commercial risks and little technical risks. This allows one to help clinicians to be innovative within the boundaries of their technical and operational pathways."

Joseph Connor of NHS Digital

The newly formed IXN for the NHS is the first teaching sub-group collaboration within the IXN framework to support open-source based UK healthcare systems engineering across all disciplines of Computer Science, with access to all undergraduate and master's level IXN supported courses and students. This collaboration has been initiated by members of NHS Digital and its primary backing by Microsoft UK and NTT Data. It looks to pair clinicians from across the country with computer science students based on topics of study within their degree programmes. The IXN for the NHS programme facilitates the largest educational domain of Fast Healthcare Interoperability Resources (FHIR) teaching in the world.

The Apperta Foundation and Code4Health oversee the legal requirements and framework for clinicians to join, and for the code repositories to be managed in Open Source. In 2018 UCL Computer Science ran 86 projects for the NHS supported by clinicians and NHS staff around the UK. The programme has been referenced in the Topol Review for UK Government as a recommended activity for enhancing the state of the art in healthcare technology. The programme is paired with mentors from the Royal College of General Practitioners as its independent body for clinical outcomes in projects selection.

It is our intention to begin populating and maintaining a full range of UK healthcare projects for computer science students across the UK, giving the opportunity to work with NHS clinicians, researchers, and developers in supporting UK healthcare.

Introducing GOSH DRIVE

Through collaborative projects with the Great Ormond St Hospital (GOSH) Digital Research, Informatics and Virtual Environment (DRIVE) centre based in Russell Square, London, the UCL IXN programme matches undergraduate UCL computer science students to 'real-world' projects at Great Ormond Street Hospital, based on a portfolio of potential projects previously developed with clinical staff at the hospital. Each project is allocated an academic supervisor for technical supervision, a clinical/GOSH supervisor as a 'partner' lead, along with additional support from industry / corporate partners as appropriate.

Potential projects are categorised according to their main area of CS development (for example mobile application development, machine learning, human-computer interaction and design, VR, etc.) and project type (training and education, systems integration, patient experience, clinical support etc). Student teams are matched by the IXN programme according to their areas of CS interest and / or expertise. All projects are approved by the DRIVE board to ensure that they align with the overall DRIVE strategy and each project is evaluated when completed.

How do UCL IXN Partnerships work?

For companies, charities, government and healthcare

It is key to convey to all potential partners that they should follow the IXN "rule of 4" to make the process work effectively:

- Must have a technical mentor for the students (not just subject matter experts but actual technology). This can be a partnership, e.g., Microsoft supporting Camden's projects and a multitude of companies supporting NHS projects.
- Must come with accessible and ready to use data. The data must be anonymised/ sampled and authorised for students to work on, at UCL, without data protection concerns.
- Must be able to adhere to academic timelines (such as our call for projects deadlines), commit to weekly calls or in-person meetings with the students, and review the students progress.
- Must attend final events such as presentations and of course, the code handover and assist the teaching team with providing feedback on the project outcome.

Following the principle that at least on fifth of all projects must be either charitable or healthcare related, making the results fully open is important. In the case of the NHS projects, the partners have always been happy to open source the results including code back to the community for further development. The majority of projects in machine learning and AI systems are also moving to open source because of the rate of change in the area. Many technology companies may have their own specific open source licenses, which we can work with. To note, however, that a project is closed source, it makes it more difficult to make the work more visible and for follow-on projects to be run. Whatever the project the results will be assessed for marks, and there cannot be restrictions on what a student can submit for assessment.

Schedules for Incoming Student Project Proposals

All term-time IXN projects are prototypes and not expected as final ready to deliver production ready software.

IXN Innovation / MSc Programmes:

- MSc student projects run from late May to early September.
- All MSc projects require initial project titles-only to be sent to UCL Computer Science by early February for Course Directors to review, and for project promotion material be generated and distributed for selection by the students by mid-February. Paragraph briefings for reviewed projects will then be needed by early-March.
- IXN Undergraduate Students: (first-year, second-year teams, third-year research group projects, and fourth year final projects)

Undergraduate classes have projects throughout the academic year depending on the year of study:

- The deadline for second-year Systems Engineering team projects to be arranged is mid-May, ready for starting in October.
- The initial ideas for individual BSc/MEng final year projects are requested as titles-only by mid-February with paragraph briefings by early-June for starting in October.

This year's topics include the following:

- Machine Learning and AI
- Data Science
- Information Security
- Computer Vision
- Cloud Tooling and Software Engineering Methods
- Mobile, Wearable and Cloud Apps
- Big data/Hadoop
- Protocols and legacy systems
- Visualisations of Data
- Blockchain in Industry
- Systems integration
- Privacy Systems
- Software optimisation and testing
- Holographics, VR and AR
- Gaming and Simulators
- Graphics and Image Processing
- Interactive Education
- IoT and Edge Computing

IXN Project Abstracts

The following abstracts outline the projects carried out by second year undergraduate and MSc Computer Science students during the current academic year.

IXN for the NHS and Healthcare Projects

Synthetic Healthcare Data Generator with PEACH GAN Processor

Authors: Ali Zia, Dylan Vekaria, Sifang Du
Partners: Prof Neil Sebire, Ben Margetts
Partner Organisation: GOSH DRIVE
Technologies Used: Python 3.6, TensorFlow, Python Pandas, Keras, TensorFlow, Python QT5, NumPy, Python Autocorrect
Abstract: The use of real healthcare data is limited by security and GDPR. Synthetic data is a preferable substitute for real data, but it is not readily available. Hence, our project involves the development of a tool which can be used to both process unstructured EHR data so that it can be learnable by ML models in TensorFlow and also a synthetic data generator that uses real anonymised data to produce representative numerical synthetic data. Our solution uses the GANs machine learning architecture to do so. The goal of this project is to justify that unstructured EHR data can be manipulated in such a way that it can be learnable by a Generative Machine Learning Model. We have also developed a functional Generative Model to go alongside this.

A library of modular SMART on FHIR JavaScript functions

Authors: Ralf Yap, Qinyi Tang, Ziyang Dong
Partners: Prof Neil Sebire, Gemma Molyneux, John Booth
Partner Organisation: GOSH DRIVE
Technologies Used: React, Django, SQLite, Azure, SMART on FHIR JS Client
Abstract: FHIR is a standard for exchanging electronic healthcare data and records between medical institutions and applications. It is a common framework that makes it easier to read, write, and transfer medical data, such as patient information, medication and conditions, in a secure yet convenient way. SMART is a platform that builds upon the FHIR specification and provides developers with a set of APIs to create applications on top of FHIR. We aim to help individual doctors, small teams of developers or large medical organisations, who may not be too familiar with FHIR, to discover the capabilities of SMART APIs and build applications for this next generation of digital healthcare. We have produced a web application that contains a library of modular and runnable SMART functions and code snippets, written in JavaScript, that a developer can use and implement in their application.

IoT Healthcare Monitoring Package (eVitals) clients

Authors: Ho Jiahui, Goh Xin Deik, Adamos Hadjivasiliou
Partners: Prof Neil Sebire, Dr Gemma Molyneux
Partner Organisation: GOSH DRIVE
Technologies Used: Android (Java), Web App (Node.js + jQuery), Raspberry Pi (Node.js), Azure IoT Hub, Azure Time Series Insights, MySQL
Abstract: The Great Ormond Street Hospital commissioned our project. The main focus of our project is to create a prototype of a system where a wearable device (we used a smartwatch since it is highly accessible) is attached to the discharged patient. In addition to collecting health data from the wearable itself, it also collects data about the environment using separate sensors. These combined data allow for more meaningful analyses. For example, when a patient has a seizure, the doctor can look at the info of the environment at that time and possibly determine the cause of the seizure (i.e., high light & humidity).

SOTA/Jibo as a patient

Authors: Phu Sakulwongtana, Cao Khanh Nguyen, Klajdi Lamce
Partners: Gemma Molyneux, Dr Neil Sebire
Partner Organisation: GOSH DRIVE
Technologies Used: React, Python, TensorFlow, Docker, DialogFlow
Abstract: When training medical personnel, one of the most important goals is for them to have the ability to interact and communicate with patients to understand their condition. However, an approach consisting exclusively of training with real patients has some restrictions including the availability of both parties and ethical issues. Here, we present an extensible platform for people in the medical profession to practice basic interaction with patients whereby we replace real patients with a chat-bot. The users will be able to interact with a bot to complete a certain goal. In this case, the goal is to diagnose the disease which the bot might have. We employ a powerful differential diagnostic tool, called Isabel, to act as the guidance system for users to measure their performance empirically. Furthermore, we explore the design of the chatbot and propose a mix between a state-of-the-art neural-network architecture with a rule-based system, powered by DialogFlow.

Healthcare Sensor Fusion

Authors: Nikolay Bortsov, Alexandros Frangos, Ahmed Adeeb Fawzy
Partners: Prof Neil Sebire, Ms Gemma Molyneux, Mrs Sue Conner
Partner Organisation: GOSH DRIVE
Technologies Used: Python, React, Django, Raspberry Pi, Azure Virtual Machine, Django REST Framework
Abstract: The problem we were trying to solve was the identification of the normal state for a room using a variety of sensors. We have set up the sensors with a Raspberry Pi microcomputer that communicates with our backend using an API. The data from the sensors are then displayed on the dashboard where medical staff can control the Raspberry Pi sensor hubs and record medical procedures. The data from the sensors are also used in a variety of algorithms that calculate the optimal condition the room should be operated in. In the case that a room's conditions are not ideal, a flag is shown on the dashboard. We hope that with this technology, issues from external factors can be found and prevented earlier to improve the success rate of medical procedures.

Computer Vision for Medical Instrument Detection

Authors: Benedict Chan, Shirin Harandi
Partner: Prof Neil Sebire
Partner Organisation: GOSH DRIVE
Technologies Used: Python, TensorFlow, TensorBoard, Google Object Detection API, node.js, Electron, Azure,
Abstract: With recent advances in Computer Vision, current technologies can identify vast numbers of objects in a wide variety of scenarios. By utilising such technologies, we attempted to train machines to detect and identify different medical instruments used in clinical environments. We wanted to create a system that monitors medical instruments being used in operating theatres. The system will be able to correctly identify and display the different instruments that are present in the operation tray, thus allowing all staff to gain a clearer overview of the operation at any given time. By gathering this data, complete operation summaries and timelines can be produced. All of these real-world data can be analysed and shared with all medical personnel to learn and improve their skills. We hope our system will open up avenues for object detection in the medical field and allow the field to advance further.

HoloLens To Support Clinical Teaching and Training

Authors: Petros Xenofontos, Elena Aleksieva, Amy Jeffcoate
Partner: Prof Neil Sebire
Partner Organisation: GOSH DRIVE
Technologies Used: C#, HoloLens, HoloToolkit, Windows Mixed Reality
Abstract: Currently junior doctors, while taking a ward round with a senior doctor, often encounter medical terminology (diseases, drugs, etc.) which they are unfamiliar with. Using the Microsoft HoloLens, we created an application which offers real-time medical entity extraction as the senior doctor speaks and provides immediate information such as explanation and diagrams directly in front of the Junior doctors' eyes. The information is presented using the best practices of Mixed Reality

(MR) following the guidelines of development for HoloLens by Microsoft. Furthermore, junior doctors can manipulate the data as if they were physical objects. As an example, the doctor could virtually pin a word onto the door of a patient's room so they can remember details about their disease. The data generated by each session are then saved and can be later retrieved for further analysis. Finally, users can use voice commands to view common medical utilities such as CT scans or graphs/charts.

Developing Technology for Accessibility in the GOSH Sound & Sight Hospital

Authors: Harry Thomas, Sidak Pasricha, Xingyu Liu
Partners: Prof Neil Sebire, Mrs Sue Conner, Ms Gemma Molyneaux
Partner Organisation: GOSH DRIVE
Technologies Used: Java, Android, Meridian SDK
Abstract: Our project is to produce a mobile method of indoor navigation for patients of the Great Ormond Street Sound and Sight Hospital. We hope to improve safety and patient independence within the hospital by allowing users to navigate without the aid of parents or staff. The system will allow users with hearing and sight impairments to select a destination using an Android phone application and receive turn by turn directions through the use of haptic feedback. In our deployment, we will be using the NTT Data supplied Buru-Navi to provide haptic feedback to the user. However, we have designed the system to allow for alternative output devices to be used.

An Automatic System for Gathering and Visualizing Patient Readiness to Get Well

Authors: Zurab Murvanidze, Azizan Wazir, Nanxi Zhang
Partner: Joseph Connor
Partner Organisation: NHS Digital
Technologies Used: Java, Node.js, Android, Python, ML.NET, Tensorflow, Azure, MySQL, C#
Abstract: The NHS Wellbeing App tracks a user's phone usage statistics to determine if they are recovering from a medical procedure following an approved NHS framework – the 5 Ways to Wellbeing. The app tracks users' pedometer data (number of steps taken), social media and other telecommunication apps usage to generate a wellbeing score which is indicative of how closely the user is following the NHS framework. All predictions are made locally, and thus the user is in control of who can access their data. The scores collected can be shared with a trusted individual, such as a GP, for them to understand the user's condition better. There is also an option to share the randomised data to a nationwide database anonymously. The project includes a web application framework which visualises this data on a map to be used by the NHS to improve their services.

Optimising 111 call handling experiences for call handlers, using machine learning

Authors: Gun Woo Park, Mohammed Chouman, Ziying Cheng
Partner: Joseph Connor
Partner Organisation: NHS Digital
Technologies Used: Python, Pytest, IBM Watson, Microsoft Azure Cognitive Services, Google Cloud Platform, Java, Apple Script, HTML, JavaScript
Abstract: This project consists of a toolkit which can help emergency phone line operators to optimise their call handling practices for the NHS 111 and 999 services. This is achieved by solving three problems: call quality analysis, queuing optimisation and an automated care advice system using various natural language processing techniques from Azure Cognitive Services, IBM Watson, Google Cloud Platform and some machine learning techniques. The call quality analysis evaluates the call as well as providing a monologue analysis. The queuing optimisation automatically rearranges a call queue based on the needs of the caller, and the automated care advice system provides an automated way of providing care advice that is repeated frequently. The outcome of the project is an application that runs on all desktop platforms.

BlackBox Insight – Cloud Enabled Black Box Model Interpreter

Authors: Ayushmaan Seth, Yi Zhong
Partner: Joseph Connor
Partner Organisation: NHS Digital
Technologies Used: Python, Flask, Azure VM, Docker, Nginx
Abstract: The project aims to be able to interpret and explain, in lay terms, the various black-box algorithms and artificially intelligent models used in different streams but especially in healthcare, where the slightest of miscalculations can cause a catastrophe. The desired outcome of the project was to be able to explain why a decision was taken, what could have happened if the inputs

were different, how close the inputs were to have a different decision made and to be able to audit the model and make it suitable for real-world applications. Our solution was designing a web-app integrated with TensorBoard, Google's What If tool for explaining machine learning models as well as combining research projects such as LIME to perform a comprehensive analysis.
This will be helpful especially to the NHS since after the enforcement of GDPR it is necessary to explain the reasoning behind the output of a model.

NHS CareAI PlayGround – AI Testing Platform

Authors: Haixiang Sun, Wei Tan, Zixuan Wang
Partner: Joseph Connor
Partner Organisation: NHS Digital
Technologies Used: Python, Django, JupyterHub, Azure Kubernetes Service
Abstract: The project aims to provide a secure and comprehensive web platform for NHS clinicians to post challenges which are solvable by AI. The developers can work on the challenges on the platform itself and after that submit their solutions. Solutions will be evaluated by the clinician and ranked according to the accuracy of each solution. The platform is a Django-based web app which is then further split into smaller Django applications (e.g., challenges, solutions, users, etc.) which handle different areas of the app. The on-site coding environment is provided for using JupyterHub, and Azure Kubernetes Service is used to manage the hub itself. Additionally, the platform has additional features such as a tutorial page and a discussion page for developers to interact.

Trakka Medical Blood Glucose Monitor App for Pregnancy

Authors: Yifan Liu, Zhizhe Xu, Yomna Ghannam
Partner: Asma Khalil
Partner Organisation: Trakka Medical
Technologies Used: Xamarin, Azure
Abstract: Pregnant women with a high concentration of protein in urine, hypertension, or diabetes are advised to frequently visit the hospital for testing to monitor for development of any complications which can cause anxiety for patients and have significant cost implications.
Our project aims to mitigate the financial burden and time consumption of this process by extending the Hampton app to allow patients to record and monitor blood glucose and urine dipstick results through a mobile app while displaying these values to doctors through a web app for their evaluation. The app uses image processing to analyse urine dipstick results through pictures and includes a chatbot to allow users to discuss their results.
It also alerts patients and doctors to abnormal results and advises patients to consult their doctor if the need arises. Overall our app is intended to make this common but complex process efficient, cost-effective, and stress-free for both patients and doctors alike.

An IoT-enabled cross-platform application for glucose and blood pressure monitoring for pregnant women

Authors: Yanke Zhang, Yusi Zhou, Sonia Shah
Partner: Asma Khalil
Partner Organisation: GOSH; Trakka medical
Technologies Used: Ionic, Angular, TypeScript, HTML
Abstract: Pregnant women and doctors are continually trying to battle pre-eclampsia development by the continuous monitoring of blood pressure and glucose levels. Over time it has proved difficult for patients to come in daily solely for this purpose. The development of our cross-platform application provides a new care pathway that gives the patient flexibility and comfort to measure these readings on their own and be notified when readings present a potential risk. The application collects measurement readings from their respective measuring devices via Bluetooth and uploads them to a cloud database for monitoring by doctors, without any cables and manual input. Patients are reminded to take readings and are shown the results of the readings obtained. This has been achieved through Ionic frameworks and firebase cloud technologies.

Case study: Microsoft Smart Hospital with Azure Sphere

Introduction

This project has been introduced by Microsoft in order to address some common hospital challenges such as using inefficient strategies to organise tasks with potential for automation, by implementing a system that is able to track patients and staff within the hospital, manage and allocate the beds and lastly identify the forthcoming choke point in hospital units. Smart Hospital with Azure Sphere addresses these challenges by providing an Allocation and Tracking System.

Students: Aisha Aldosery, Georgiana Birjovanu, Martin Cabello, Bogdan Ionita, Pius Jude, Desislava Koleva, Fraser savage, Sijin Sun, Sihan Yu
Partner: Microsoft (Adrian Boyd, Paul Thomas, Kelly Limonte, Steve Hodges, Geoff Hughes)
Supervised by: Dean Mohamedally, Emmanuel Letier

Proposed Solution

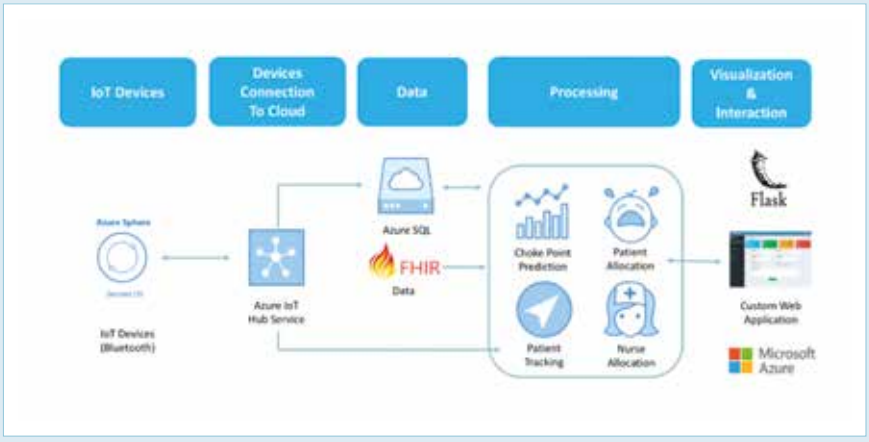
The system was built based on the FHIR standard, GDPR regulations and IoT devices with hardware embedded security suitable for healthcare, through the experimental use of Microsoft's Azure Sphere. The implemented system allows the most suitable beds to be allocated patients, schedule nurses' shifts and predict saturation of room capacity based on real-time patient tracking. The system not only meets its initial objectives but can also be built upon, to service tracking of staff or hospital resources.

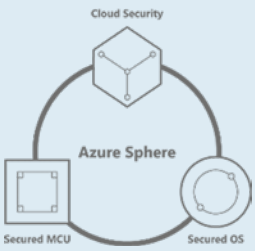
Architecture

In order to build a first prototype system incorporating IoT machine intelligence and a scalable architecture, we had to identify the physical sensors and interpret the messages between system components. Therefore, Azure cloud services are utilized to handle the flow of information from the hardware devices, store these data in a database and act as a server to host the final processing of data along with the user interface displayed by the web program.

Azure Sphere

There are concerns for security when it comes to information technology systems for healthcare and even more when IoT devices are involved. In this context, using the Azure Sphere coupled with the Azure eco-system and FHIR server simplifies implementation decisions by having cloud authentication built into its design.



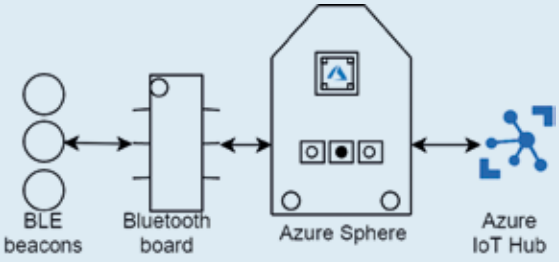


FHIR (Fast Healthcare Interoperability Resources)

FHIR provides a standardised data format for exchanging electronic patient health records in NHS. The implementation of a HAPI FHIR server was used, which is an open source software stack that supports FHIR version 3. For this project, it was deployed as a web service on Azure Cloud where other systems can fetch patient records as a JSON file through API calls to the FHIR server endpoint. The consistent data format from FHIR supports interoperability and makes it easier to share information between systems. Although the FHIR server is not a security protocol and doesn't define specific security functionalities, the HAPI FHIR server implementation can be made secure through OAuth 2.0. This ensures that users who attempt to use the server are properly authenticated.

Initial PoC Testing

A specific testbed is conducted on the system to measure system performance, connectivity and scalability by simulating a number of IoT devices. According to the obtained results, the system is able to handle 100 connected devices which send approximately 20 messages per second to the IoT Hub with no bottleneck observed. Moreover, 20 bracelets were simulated to be detected by only one node. This was limited due to the maximum number of Bluetooth beacons a test phone environment could emulate.



Conclusions

The IoT setup has been tested by initial prototyping with Raspberry Pi devices leading to development of a proof of concept with Azure Sphere technology from Microsoft. Several apps and the core FHIR integrated architecture have been constructed using HAPI FHIR from Microsoft with Azure services manage flow of data and application spaces. This project reports a first working Proof of Concept for a healthcare use case, with Azure Sphere combined with FHIR capabilities as a solution for secure communication from hardware to software in an experimental clinical hospital setting.

The open source code is available via the Apperta Foundation.

Supported by

Microsoft

PEACH Big Data Engine 2019 for HaMpton Pregnancy Data

Authors: Wiryawan Mehanda, Max Bertfield, Selena Li
Partner: Prof. Asma Khalil, Prof. Neil Sebire
Partner Organisation: Trakka Medical, GOSH DRIVE
Technologies Used: Apache Spark, Azure Cosmos DB, Kubernetes, Python, Django, JavaScript, chart.js
Abstract: Pre-eclampsia is a leading cause of stillbirths among pregnancies, whose early detection is an ongoing challenge in the field of Maternal-Fetal Medicine. In the past year, Prof. Asma Khalil's HaMpton Medical app has collected blood pressure data from hundreds of pregnancy patients with the hope of applying Machine Learning to develop predictive models which can lead to breakthroughs in the early detection of pre-eclampsia. This project acts as a first step to this ultimate goal by developing a scalable data engine to house HaMpton's growing dataset to be used by medical and data professionals alike. We have developed intuitive APIs allowing future researchers to interact with the data with ease. These include tools which process HaMpton data for machine-learning-readiness and generate interactive visualisation features for use by medical professionals and a Kubernetes cluster running the Apache Spark platform to allow future data scientists to efficiently analyse HaMpton dataset stored on Azure Cosmos DB.

ARM IoT Fall Detection

Authors: Martynas Janonis, Jiaxin Lin, Jaroavs Maksimovssl
Partner: James Goodacre
Partner Organisation: Arm
Technologies Used: Python, TensorFlow, Keras, Cuda
Abstract: A lot of hospital beds are occupied by older people, who are extremely susceptible to injuries caused by falls. Observational studies in hospitals reported fall rates from 1.3 to 8.9 falls per 1000 occupied bed days. Thus far, solutions include having patients wear devices with gyroscopes and accelerometers, but they are clunky and uncomfortable to wear. Our solution solves this problem by using a neural network to detect falls from a video captured by a small camera on an embedded device. We use a state-of-the-art neural network architecture (T3D) and employ transfer learning to speed up the learning process as well as pruning to decrease inference time. Considering that with the T3D architecture we can achieve 61.1% accuracy on the HMDB51 dataset, we expect great results on our data set as well.

EDVS – Emergency Detection System for Vocal Signals in Care Homes

Authors: Shoaib Omar, Longxi Yin, Kimia Pirouzkia
Partners: Mr James Goodacre, Mr Mike Pallister, Mr Alan Fish
Partner Organisation: ARM; NHS Digital
Technologies Used: Raspberry Pi, node.js, express.js, mongoose, MongoDB, Python, multiprocessing, RNNoise, pocketsphinx
Abstract: "Preventing tragedies in healthcare." Being in a clinical setting is a scary experience for most people, especially if one is alone. EDVS is a system that is designed to give people peace of mind while minimising the impact on their privacy. Its main objective is to alert staff when people are in distress so that they don't go unnoticed in times of need. We went with an edge device based solution that employs "nodes", which passively listen for specific keywords, and upon detecting them will send an alert to staff along with the relevant audio snippet and their location information.

FHIR FLI 2.0

Authors: Mostafa Ibrahim, Zhengxian Fan, Jiahao Wang
Partner: Alexandru Matei
Partner Organisation:
Technologies Used: Node JS, React JS, Redux JS, MongoDB, Express JS
Abstract: FHIR FLI Version 2.0 is an FHiR-based platform for managing fitness and lifestyle data. FHiR is am open-source standard describing data formats and elements for exchanging electronic health records. The user can input their data from the Fitbit smart-watch, then their data can be stored anonymously on our decentralised servers. The user will then be able to view visualisations and statistical graphs of their data on his dashboard. Moreover, they can associate their account with a company if needed, and add health goals such as losing weight.

GOSH Drive HoloRepository v2.0 2019

Authors: Rod Matveev, Jeff Cai, Lovepreet Singh
Partners: Dr Shabnam Parkar, Prof Neil Sebire, Dr Dean Mohamedally
Partner Organisation: St George's Hospital
Technologies Used: React, HoloJS, Java EE, Unity, Azure, Hololens
Abstract: The project aims to improve the process of surgical planning and the accuracy of surgical procedures. Surgeons and other medical staff are provided with a live render of an organ viewed in a Hololens. This is superimposed over their working environment. This will be achieved with an implementation of the GOSH DRIVE HoloRepository which features a patient database and 3D model conversion pipeline enabling patient scans to be beamed to a Hololens. Patient data can be retrieved quickly and easily using patient tags and filters. The database will securely store patient data using the FHIR specification on Azure and allow data to be accessed from a variety of hospitals and end users in different medical fields.

NHS DepthVisor Surgery Camera System for GOSH and St Georges

Authors: Kyla Aguillo, Venet Kukran, Kailun Shen
Partner: Dr Shabnam Parkar
Partner Organisation: NHS, St George's Hospital, GOSH DRIVE
Technologies Used: HTML, CSS, JS, C#, web-socket
Abstract: Often, it is the case that medical students are unable to find sufficient resources from which they can learn the intricacies of surgery, without having to struggle to find a surgery which they can watch in person. To better facilitate the learning of trainee surgeons, we are developing a web application which can then be used to store and easily access the surgical video. The footage captured, using the Microsoft Kinect, will also be reconstructed to deliver immersive, 3D views of surgery, to produce the best possible learning resource for students. Various features will also be implemented to make the video finding and watching process as streamlined and intuitive as possible, to produce a platform which can help develop medical students into the best surgeons they can be.

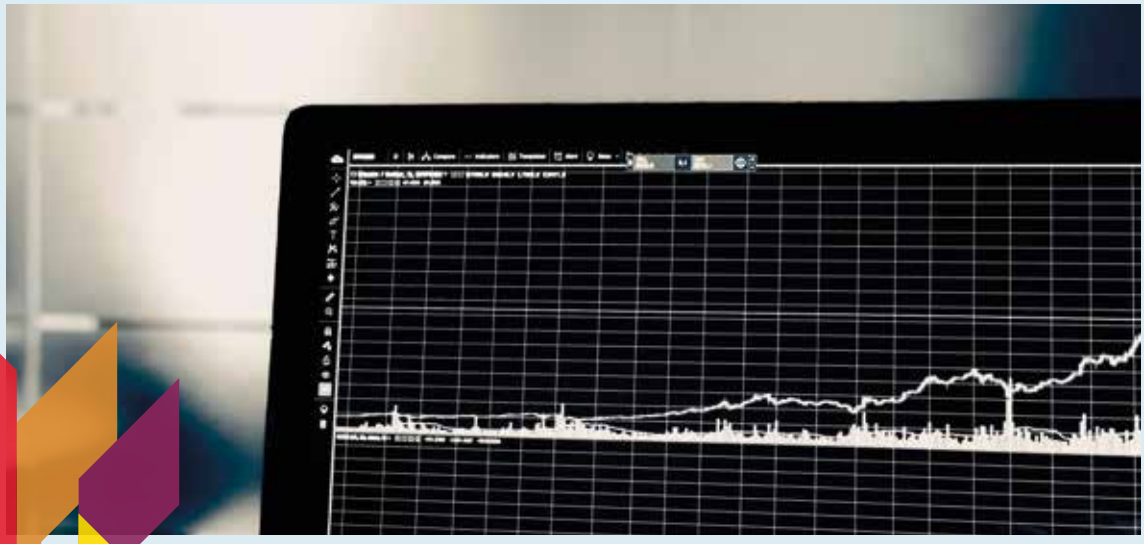
Virtual Reality Sports Trainer App

Authors: Granit Mullahasani Dula, Fehed Wasti, Yifan Yao
Partner: Mr Amin Naj
Partner Organisation: Immersive Health
Technologies Used: Unity, Microsoft Hololens, Kinect v2 C#, NUnit, NSubstitute
Abstract: Our project requires that we support the user with the ability to train for a particular sport without being too dependent on where they are or the tools they need. Our solution to this is a virtual reality application that allows the user to train in a gamified style (currently boxing is supported as an example) in a virtual environment. We expect that the application in its current form can help to not only train users in any place they wish but also further develop ideas on how to potentially advance training methods for sports and improve on them.

openEHR Clinical Knowledge Explorer

Authors: Leo McArdle, Christian Martin Rios, Daniel Kyung Hwan Min
Partner: Dr Ian McNicoll
Partner Organisation: NHS Digital
Technologies Used: Electron, HTML, JavaScript, CSS, (React)
Abstract: Clinical data is usually distributed in different repositories called CDR (Clinical Data Repositories). openEHR is an open standard that allows clinicians to develop technical models of clinical information requirements that can be rapidly deployed to vendor-neutral datastores to underpin the data storage/querying requirement of a new breed of clinical/patient-facing applications. In this world, the developer interacts with the data storage layer via logical models/querying and does not interact directly with the underlying physical database. openEHR is now being adopted globally by commercial vendors and healthcare institutions. Some CDR vendors provide additional tooling that allows developers to browse the data repositories and build queries easily. Although there are some open-source CDR available, they do not currently have any equivalent tools. The tooling will be warmly welcomed by the openEHR community and likely to find immediate utility in those international projects that are making use of open-source CDR.

Case study: NHS NLP Query Visualisation Tool



Introduction

Data representation is key when maximising the value of information. While a table of data is easy to generate, it requires the user to spend time studying the data to detect patterns and this effort increases with the size of the data. NHSDigital (NHSD) currently faces a data representation issue with respect to a Natural Language Query (NLQ) system that accepts English language queries to NHSD data. We propose a rule based system that generates up to 4-dimensional graphs. Visualisations are plotted with Chart.Js, an open-source Javascript tool to minimise latency, allow interactiveness and maintain accessibility and quality.

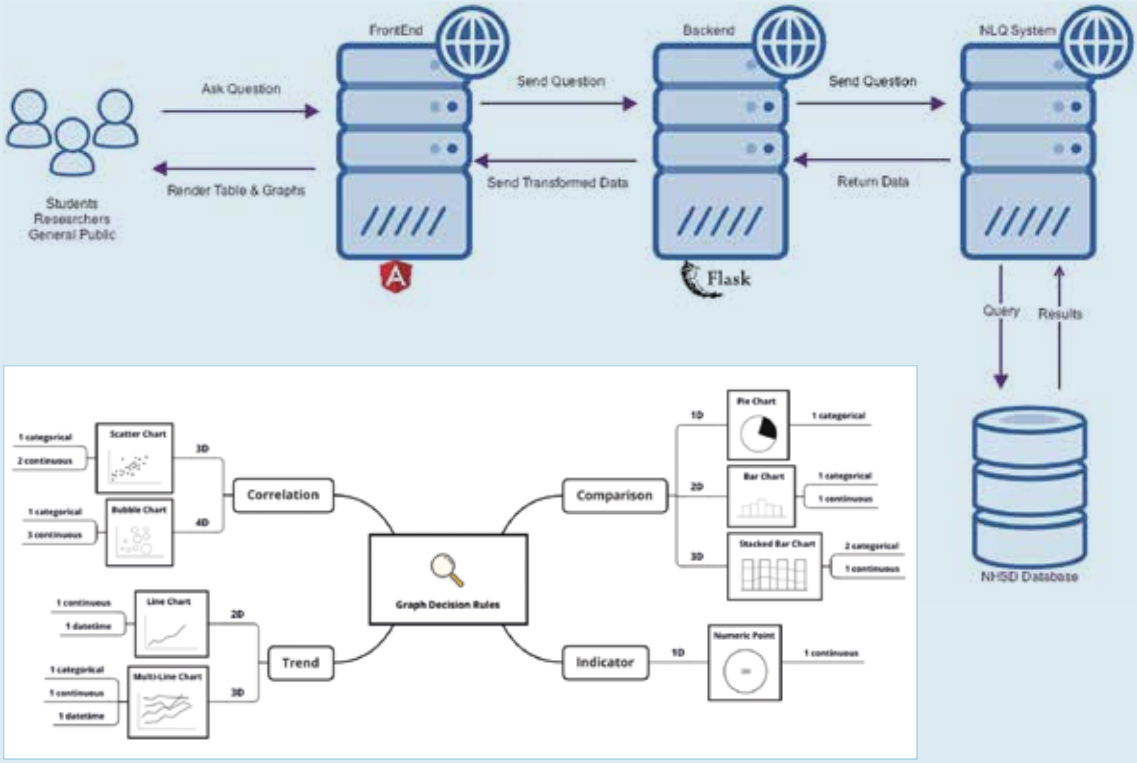
Students: ADEGBUYI Adebusola, HAN Tao, PURSIAINEN Viivi, SONG Chen, ZHANG Yuanxi, ZHOU Jing
Partner: NHSDigital, Joseph Connor
Supervised by: Dean Mohamedally & Emmanuel Letier

Architecture

The primary goal of this project is to allow an open and easy access to NHSD data by the general public, this could range from researchers, healthcare professionals to members of parliament. Questions received from users are forwarded to the NLQ system which in turn queries the NHSD database. The visualisation system then learns patterns and trends from the aggregated data produced by the NLQ system to decide the best graphical models suitable for presenting this data to the user.

Approach

To offer the user a comprehensive overview of the data, the generation of graphs was divided into four main categories. Correlation measures how continuous values correlate with one another, comparison shows the difference in values between categories and trends show how a value changes over some time period. Finally a numeric point was added to give the total of any continuous attribute.[1]



Current System

This system visualises healthcare data into 9 types of charts including bar chart, stacked bar chart, grouped bar chart, line chart, area chart, multi-line chart, pie chart, bubble chart and indicator. It receives queries typed by users or selected from the frequently asked question list, and displays related table and recommended charts accordingly. Also charts with the same dimension can be switched at runtime. Additional functionalities include support for downloading the table as editable CSV files and charts as PDF files, a feedback window to capture users' opinions and an option to interact with the table in full-screen mode.

Evaluation

Our research proposes rules for generating visualisations for up to 4-dimensional data, in line with findings that show 5 dimensions as the optimal number for visualisation[2]. These rules are then evaluated based on the usefulness of the graphs produced and the coverage of the dataset, while the overall system was evaluated based on its latency and its degree of accessibility.

Future work

This project can be further improved by supporting increasing types of charts to display, implementing more interactive functionalities for users, perfecting current structures and codes, reducing the execution time for every query and scaling.

References

[1] https://www.sapanalytics.cloud/resources-chart-type-guide/

[2] https://www.inetsoft.com/blog/multidimensional-charting-many-dimensions-many

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Exploration of 3D clinical models manipulation

Authors: Samuel Bouilloud, Yue Wu, Chris Obasi
Partner: Ben Park
Partner Organisation: Sopra Steria
Technologies Used: Microsoft HoloLens, Leap Motion, Buru-Navi, Unity
Abstract: This project, in collaboration with Sopra Steria and Great Ormond Street Hospital, is about creating a way for surgeons at GOSH to be able to simulate operations. The goal here is to increase the security and efficiency of medical interventions. Also, medical students could also use it as a tool to learn and test their skills and knowledge. We have integrated the Microsoft HoloLens with Leap Motion (a hand-tracking device) and the Buru-Navi (a device which guides the user with haptic feedback) to manipulate 3D organ objects in Mixed Reality. With this integration, we have allowed users to naturally manipulate different 3D models and made them able to place markers, find them using the Buru-Navi or even strip layers of the objects. Also, full documentation is available, including a tutorial and a training mode.

VirtualRehab Hands: Fine Motor Rehabilitation Games

Authors: Weixi Zhang, Yun Fang, Carlton Ji
Partner: David Fried
Partner Organisation: Evolv
Technologies Used: Unity C#
Abstract: A stroke is the leading cause of adult disabilities and affects around 100,000 people each year in the UK alone. VirtualRehab Hands is a software suite that addresses and enables the practice of fine motor skills in the hand area. Our project pertains to the Exergames module which utilises the Leap Motion Controller to produce games that have a focus in making repetitive exercises more engaging for the user. We implemented this in the form of an endless runner style game, using Unity and C#. By creating a fun, interactive and engaging Exergame, we expect an increase in player enjoyability, the length of time before being bored and most importantly, the effectiveness of hand rehabilitation.

GOSH Rare Disease Repository

Authors: David Elston, Georgi Krastev, Max von Borch
Partners: Daiana Bassi, Prof Neil Sebire
Partner Organisation: GOSH DRIVE
Technologies Used: Python, Django, PostgreSQL, Azure
Abstract: A rare disease is one that affects fewer than five in 10,000 people. Because they only appear rarely and research on them is limited, and it is hard for doctors to identify them due to the lack of precedence. 75% of rare diseases affect children, and 30% of patients will die before their fifth birthday. To improve that situation, Great Ormond Street Hospital opened the world's first centre for research into rare diseases in children in 2015. Our project aims to build on that research to create a comprehensive educational platform that allows trainee doctors to view anonymised clinical observations of patients with rare diseases. The platform will improve their knowledge and training experience and prepare them better to identify and recognise rare diseases in their future careers.

Kazendi HoloHand – Exploring the research mode on the HoloLens to paint in AR

Authors: Farid El-Aouadi, Cyrus Horban, Sehej Sethi
Partner: Maximilian Doelle
Partner Organisation: Kazendi
Technologies Used: Python, OpenCV, Unity, C#
Abstract: HoloHand is a mixed reality project using Microsoft HoloLens. We will be using the new Research Mode made available to the public in recent months to make breakthroughs in live hand tracking using the HoloLens. We have delivered an application which walks the users through the hand segmentation process, allowing them to use finger gestures to paint in augmented reality.

Web Application To Allocate UCL Medical Students to GPs

Authors: Steven Lord, Sergi Bray
Partner: Kristina Narvet
Partner Organisation: UCL
Technologies Used: Python, Django, Bootstrap, jquery, pandas
Abstract: The partner (the Teaching Administrator Group Lead in Primary Care Medical Education) and her team currently have a process for allocating medical students to GPs that is inefficient and could be highly optimised by an interactive database system. The solution would be a web application which allows the administrative team to store, view, and edit data related to the student-GP allocation task. This would be a system that analyses and filters the data such that the administrative team can undertake their various tasks far more efficiently. We have delivered a functional application ready for thorough user testing.

NTT Data Medical AR Object Recognition

Authors:
Partners: Praveen Selvaraj, Tom Winstanley
Partner Organisation: NTT Data
Technologies Used: android studio, java
Abstract: There is a lack of hands-free technology in the health sector. To combat this issue, NTT Data has created a hands-free prototype that uses machine learning and augmented reality to provide instructions to the user. While wearing Epson smart glasses, our machine learning algorithm will identify key medical objects and pull up instructions on how to use them. The user will be able to choose which instructions to view by taking advantage of the voice-control option, allowing them to work on the machinery while viewing the instructions.

NTTData Augmented Reality Simulations for GOSH patients

Authors: Yin Long Ho, Haonan Zhang, Chirag Hedge
Partners: Tom Winstanley, Hiroki Inagaki, Neil Sebire, Nadia Aziz
Partner Organisation: NTT Data
Technologies Used: Unity, C#, WebGL
Abstract: The project aims to help reassure young patients before they have an operation. Children are more often afraid of the unknown. Hence our solution is made to help children familiarise themselves with the medical environment beforehand. Our project consists of two parts: a web application where users can customise augmented reality (AR) rooms and a mobile application where the patients can enter an AR portal and then explore the rooms above while interacting with objects. Both applications are designed to be easy to use for anyone, regardless of their technical background. While our applications are made in mind of the healthcare sector, our completed project is a generic design that can be built upon in the future, in various industries and sectors, such as for training new staff and leisure activities.

PLANET

Authors: Julian-Ferdinand Vögele, Michal Lis, Chia-Ping Chang
Partner: Frederique Liegeois
Partner Organisation: GOSH DRIVE
Technologies Used: Ionic, Typescript, HTML, CSS, SQL, Azure, Google Speech API, Python (Flask), JavaScript
Abstract: As with adults, children with brain disorders frequently show language difficulties such as struggling to find the right words when they speak or having difficulty understanding spoken instructions. Such symptoms can be the first sign that brain disease is about to emerge, that a treatment is not working or that they may be exposed to special social conditions such as violence. At the same time, there is an unmet need for an easy-to-use tool that quickly identifies the type and severity of language disorders while relating it to the brain. The project aims to develop a prototype app able to measure three out of the five most common language deficits observed in children: fluency, naming, and understanding. In tasks related to fluency, the children will be asked to perform word association in a given topic. In tasks related to naming, the children will be asked to name an object as quickly as possible. In tasks related to understanding, different kinds of situations will be visually depicted, and the children will then be asked questions that require logical reasons.

Looked after Children Health Plan

Authors: Christopher Pettinga, Nilayraj Patel, Anthony Williams
Partner: Marc Rice
Partner Organisation: NHS
Technologies Used: Python, Flask, jQuery, MySQL
Abstract: A platform that gives Nurses the ability to quickly and easily conduct questionnaires during annual health reviews of children in care. Children and Nurses can work together to set specific goals, the progress of which can be tracked using the platform at later dates. Powerful customisation options allow for the exclusion of specific information and anonymisation when exporting questionnaire data and sharing it with particular individuals.

A GOSH visitor management Ionic application and admin web application for office events

Authors: Ben Smith, Chao Ding
Partners: Gemma Molyneux, Prof Neil Sebire, Daiana Bassi
Partner Organisation: GOSH DRIVE
Technologies Used: HTML, CSS, JavaScript, Ionic, node.js, Express, Azure
Abstract: The purpose of this visitor management system is to allow the partner to digitise visitor and event data so that visitors can more easily sign in and out of the doctor's office and it can be accessed or modified more efficiently by members of staff during office events and day-to-day office hours. Our solution involves two main components. The first is an Ionic hybrid application that can be downloaded onto mobile devices, specifically tablets, to allow visitors to sign in and out of the building. The second is a web dashboard that the partner can use to monitor current visitors, access the data of upcoming and past events, upload/export data and check who has evacuated the building in an emergency. Both of these components interface with a MySQL database hosted on Azure, using node.js as the middleware.

A mobile and web app to submit and manage Pre-Operative Assessment Clinic Surveys

Authors: Jonathan Choi, Nishchal Sen, Sheng-Wen Huang
Partners: Mr David Chalkley, Ms Sarah Debard
Partner Organisation: Taunton and Somerset NHS Foundation Trust
Technologies Used: Angular JS, Ionic, Node.js, MySQL, TypeScript, SCSS, Bootstrap, Azure
Abstract: The Pre-Operative Assessment Clinic (POAC) Working Group is looking to utilise a digital platform to screen patients before their operation to identify those that are more complex and who may need a POAC appointment/multi-disciplinary team (MDT) involvement. We have built a mobile application for use by patients to complete their screening survey and provide feedback. We have also built a website for use by the POAC team to manage questions, view results and feedback, and manage users. This will reduce the time taken for the assessment from the current 45 minutes to less than 10 minutes. Patient and NHS staff time will be saved.

Spasticity Trigger Recorder

Authors: Sean Nicholson, Samuel Sanders, Yiming Liu
Partner: Sarah Massey
Partner Organisation: UCL
Technologies Used: Ionic, Python, Azure
Abstract: An application to record triggers for patients with neurological injuries. Helping the user and observer better understand the cause of the patient's triggers, and perhaps minimise these triggers in the future

Mobile TTA Tracker

Authors: Joe Savidge, Lee Simmonds, Haow Jern Tee
Partners: Sandie Wills, Sue Bracey
Partner Organisation: NHS Plymouth
Technologies Used: Ionic 4
Abstract: The process from dispensing To Take Away (TTA) medications to them being received by patients is not currently tracked. Any issues that can interrupt this flow may cause inefficiencies within the system, such as a bag being misplaced. To increase efficiency, the Mobile TTA Tracker app is designed to track this process through barcode scanning. A barcode is attached to every bag as well as the dispensing and collection points, to be scanned at each step of the workflow. When the app is deployed, it will be integrated into NHS Plymouth's management software (SALUS) to create a fully integrated tracking system, that will eventually be used by other hospitals around the country.

Critical Appraisal of Economic Analysis

Authors: Charles Smith, Francesco Stefani and Matthis Peltier
Partner: Dr Hassan Haghparast-Bidgoli
Partner Organisation: UCL Institute for Global Health
Technologies Used: Ruby on Rails, React Native
Abstract: Charta is a web and mobile application that aims to facilitate the appraisal of health research papers. Our partner, Dr Haghparast-Bidgoli has envisioned an app that would enable him to invite his students and other scholars to provide feedback on academic papers and gather their responses immediately. This new process would prevent the hassle of having to send forms to each reviewer individually before then computing their responses within an excel file once the forms are returned. Our team of three developers have the opportunity to build the Charta app (Latin for "paper", "papyrus" or "writing") as a university project as part of our Design module.

PEACH VR Rehab with Cycling Gamification

Authors: Tiernan Watson, Bruce Lu, Jason Lin
Partner: Sheena Visram
Partner Organisation: NHS
Technologies Used: Gear VR, VirZOOM Bike, Unity, Android
Abstract: Cyclists can struggle to find the correct terrain and weather to train in. Some may find it hard to summon motivation, or simply find the time to travel. Our project uses an exercise bike and a virtual reality headset to immerse users in their chosen environment and helps them train by recording statistics such as distance cycled. This also improves adherence to exercise, and users report having more fun.

Informed Consent App

Authors: Azariah Kusi-Yeboah, Ross Murray, Dan Ward
Partners: Daiana Bassi, Gemma Molyneux
Partner Organisation: GOSH DRIVE
Technologies Used: Ionic, PHP, MySQL, HTML, CSS, Javascript
Abstract: Our design project is centred on building a platform which end users can manipulate to provide consent to participate in clinical research. The partner, Great Ormond Street Hospital, is continuously involved in clinical research studies. As such they are legally required to provide information to prospective study participants regarding the study and are also required to obtain participant consent before allowing participants to take part in studies. The current process involves the creation of word documents describing the study and detailing other important information. These documents are printed out and given to prospective participants and are manually filed away on signed return. We aim to automate this process by creating a website that allows creators and authors of studies to quickly create studies and build the required forms online. The forms are then stored on a database and are retrievable, by a mobile device such as an iPad, by authorised health professionals. This way, the form can be sent electronically to the participants' email address, and upon provision of consent, the signed document can be stored to a database – readily retrievable when required.

Case study: GOSH Speedy Recovery: A Role-Based, Health Platform with SMART on FHIR

Consumers are increasingly utilising digital applications in the context of healthcare. However, many Health IT systems are built upon deprecated data standards, creating the need for better interoperability between systems and stakeholders. We applied the FHIR data standard and the SMART on FHIR specification to solve a real-world problem and created a web-based application to facilitate the day-to-day tasks of the main stakeholders at Great Ormond Street Hospital for Children. Paediatric patients, their parents, and healthcare providers have very different requirements. Accordingly, our application architecture adjusts its properties and functionalities to each role while also supporting portability between different healthcare systems.

Authors: Niels Boecker, Joshua Zeltser, Fabiha Ahmed, Fanbo Meng, Chong Yang, Ying Huang, Kawai Wong
Partner: Great Ormond Street Hospital for Children (London)
Supervisors: Dean Mohamedally, Marios Isaakidis, Emmanuel Letier

Background

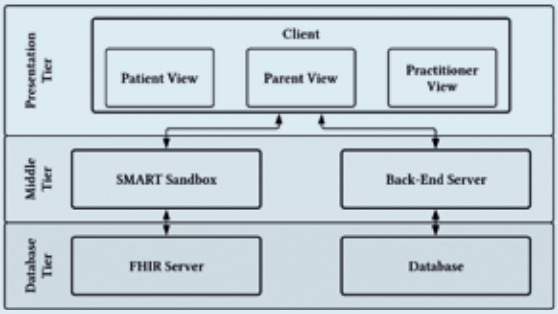
The technological developments in healthcare have substantially changed the Health IT (HIT) landscape. Consumers increasingly make use of digital applications for healthcare purposes[1], and the effective integration of technology is becoming a crucial factor for a hospital's success[2]. However, many clinical systems are built upon outdated, flawed data exchange standards[3]. The recently proposed FHIR (Fast Healthcare Interoperability Resources) standard alongside the SMART on FHIR specification promise improved interoperability through a secure, RESTful data exchange architecture[4].

Objective

We set out to implement a web-based HIT application providing different interfaces to satisfy the heterogeneous requirements of three different stakeholders of Great Ormond Street Children's Hospital (GOSH): Paediatric patients, their parents and healthcare providers. Upon user authentication, Speedy Recovery (SR) displays appropriate amounts of data retrieved from FHIR in a role-specific interface design. The features comprise an overview of patient conditions, an appointment calendar and a messaging service.

Methodology and Tools

The project was developed in an agile setting of bi-weekly sprints, in which the main functionality was iteratively expanded. The client application was built using React, and the back-end using Node.js. Key build procedures, including code style adherence checks and automated formatting, were automated early on. To provide continuous integration and deployment, respective build and release



pipelines were installed on Azure DevOps. Extensive testing was carried out using Jest, Enzyme, and Mocha, and successful test-suite execution made a condition for a passing build.

System Architecture and Integration

SR implements a traditional three-tier architecture with presentation, middle and database tiers, as this design facilitates separation of responsibilities and dependency management. The separate components exclusively communicate through asynchronous HTTP messages.

Components and Interactions

The client is comprised of a single page web-application (SPA) running in the end-users' browsers. It interacts with the public SMART on FHIR sandbox, which offers access to synthetic patient data as well as an abstraction of the actual EHR (Electronic Health Record) system into which a HIT application will be embedded in production. Additionally, we enrich the data with additional clinical data stored on a proprietary server and accessed through a separate back-end.

Strategies and Patterns

To solve the individual challenges imposed by this project, the design choices were made with the following key aspects in mind:

- Modularity and extensibility: SR's modular package structure reflects the architectural design while also ensuring separation of concerns, decoupling of components, independent testability and extensibility.
- Interoperability and portability: By dynamically discovering the capability of external components and using appropriate adapters, SR supports different clinical settings and versions of the FHIR standard.
- Adaptability: Using the adapter and abstract factory patterns combined with dependency
- injection, SR adjusts to different environments and user roles.
- Resilience and graceful degradation: To ensure errors or outages of external components do not lead to internal failures, exhaustive error-handling is carried out, ensuring that the system stays responsive.

The open source code is available via the Apperta Foundation.

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Great Ormond Street Hospital for Children
NHS Foundation Trust

A mobile app to allow sufferers of nephrotic syndrome track their condition

Authors: Tom Archer, Wing Ping Tsang, Hugh Gray
Partner: Dr Daljit Hothi
Partner Organisation: Great Ormond Street Hospital
Technologies Used: Ionic, Angular, SQLite3
Abstract: Our mission is to create a mobile app to help children with nephrotic syndrome cope with their disease by replacing the current method of tracking their condition, a paper notebook, with something more engaging. Hopefully, this should make children more proactive in recording the state of their condition. Our secondary objective is to make it easier to analyse a patient's conditions. Currently, a patient will bring in their notebook for the doctor to analyse. However, these notebooks are often misplaced, and the fact it is filled in with whatever pen the patient has at the time means that there is no uniformity in the presentation of the data. This means it is impossible at a glance to get an overview of the patient's condition. Having all data stored digitally means we can present the information in an easy to understand way (using colour and pictures)!

GOSH Drive Device Management System

Authors: Poyzan Taneli, Cecilia Pretus, Wilfrid Berry
Partners: Daiana Bassi, Gemma Molyneux
Partner Organisation: GOSH DRIVE
Technologies Used: Ionic, PHP
Abstract: Samsung donated physical devices to GOSH Drive, which includes smartwatches, cameras, tablets and VR headsets. UCL students borrow these devices for certain periods (on average three months) to utilise in their projects. Currently, DRIVE staff track these devices using a manual Excel sheet. The main problem we addressed was that the admins want to know which device is checked-out by whom at a given time. We developed a mobile app and a website to manage the check-in and check-out process of these devices.

Staff activity tracker smartphone application and web page to support GOSH clinical trials, staff

Authors: Darren Ko, Jacob Currant
Partner: Great Ormond Street Hospital Clinical Research Facility
Partner Organisation: NHS
Technologies Used: Ionic, Django, MySQL, Angular
Abstract: GOSH Clinical Trial employees currently employ outdated, basic Excel spreadsheets to log and analyse staff activity data over designated time intervals. The current system suffers from inaccurate data collection and low user satisfaction stemming from repetitive and inefficient logging processes. Users of the current system are constrained to PC desktop-reliant data input. The project improves and streamlines the process by moving data collection to mobile devices, supporting both Android and iOS. Erroneous user input is greatly reduced, and activity logging is made more efficient as minimal user interaction is required to input data. Simultaneously, the project improves support of management staff workflows, with data handling and analytics output delivered via a companion web page for administrators' and business managers' ease of use.

Mobile app and associated web client for symptom tracking

Authors: Samin Ahbab, Shan Pandya, Yusuf Sohoye
Partner: Dr Richard Shaw
Partner Organisation: The University of Liverpool Cancer Research Centre
Technologies Used: Node.js, Angular, Azure, Ionic, Javascript, MySQL
Abstract: A mobile client for patients on a clinical trial. The app prompts users to complete regular surveys monitoring their symptoms. The web client provides admin functionality for hospital staff to add patients and input their survey responses if necessary. The web client also displays data visitation tools to monitor symptoms. Additionally, the project contains safety netting functionality to flag patients displaying high pain ratings.

Weight Management Triage Tool

Authors: Damian Harateh, Wentian Fang, Demilson Fayika
Partner: Marie Little
Partner Organisation: Taunton Somerset NHS Foundation Trust
Technologies Used: Ionic, Node.JS, MySQL, HTML, CSS, JavaScript
Abstract: The main project goal is to develop an application, which will allow the Taunton and Somerset NHS Foundation Trust to triage patients to appropriate specialists, thus cutting down on waiting time and improving the experience of the patients under care. This would be done through a comprehensive questionnaire in the application, from which data will be used to direct the patients to the appropriate specialist(s). On top of that, patients will be able to track their weight and other factors, such as 'Hba1c, fluid, mood'. Consequently, this increased amount of easily accessible data by the WM ('Weight Management') team will contribute to the ease with which the patients' progress can be monitored. Apart from the mobile application developed in Ionic 4, the Taunton and Somerset NHS Foundation Trust will be managing the application using an admin website developed in HTML, CSS and JavaScript, from which new patients can be added, and the data submitted by patients can be reviewed.

ARM Analysis of Real-Time AI Sensor Data for Human Movement Patterns

Authors: Wenjie Boon, Nikolaos Bafatakis, Gazi Oznacar, Hend Almalik, Jin Zhang, Changdi Zheng, Yumo Han
Partner: Mike Pallister
Partner Organisation: ARM
Technologies Used: Python, Keras, Django, Azure DevOps
Abstract: In a public space like a hospital, there are large numbers of people entering, leaving and generally moving around daily. Concerns about security, congestion and the need to analyse human behaviour mean that there is value to seamlessly track and understand the movement of people within a given area. We are working with ARM to extend their proprietary facial recognition cameras to implement a web application that uses this information to visualise human movement in the building. With this, users will be able to tell how crowded a place is, investigate historical movements and predict where people may go next.

Case study: Improving Verbal Communication Using IBM's Watson and Node-RED

Abstract

Not all people are capable of verbal communication. These individuals may not be born with verbal abilities, or suffer from brain damage, mental health issues, or a variety of other speech impairments. The current solutions available (text-to-speech, visual charts, etc.) can help, but are slow. We are working with IBM to develop a Progressive Web-App (PWA) which will use IBM's Node-RED flow to improve communication for users. Instead of typing a full sentence, users can type or select a keyword and sentences are generated for them. The Node-RED flow creates sentences from relevant social networks such as tweets (from Twitter) which are filtered by IBM's Watson for content and tone.

Authors: Norah Abanumay, Babatunde Adeola, Yiming Fan, Ryan Finlayson, Xiaofeng Fu, Kristen Hayzelden, Assia Moujdi
Partner: John McNamara, IBM
Supervised by: Dean Mohamedally & Emmanuel Letier

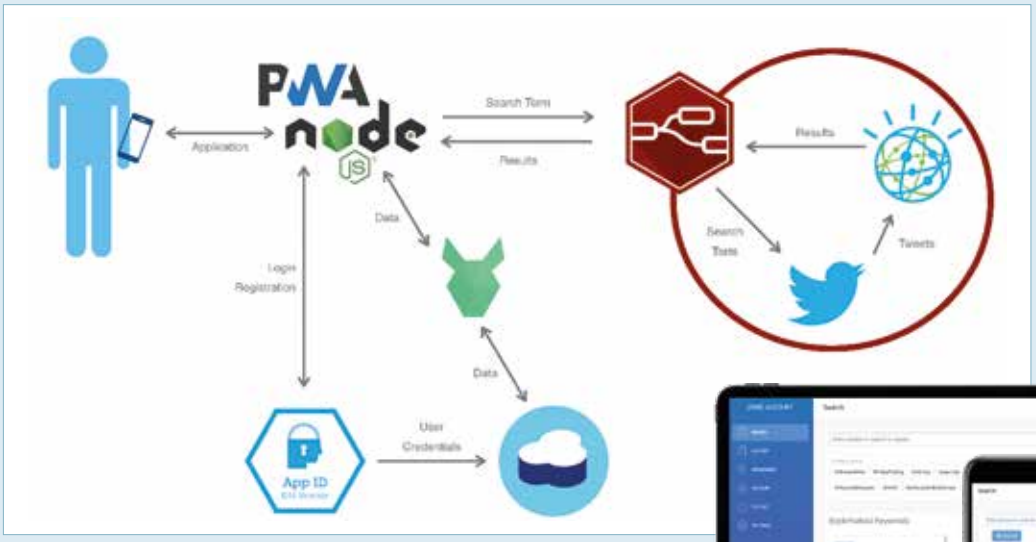
Our Application

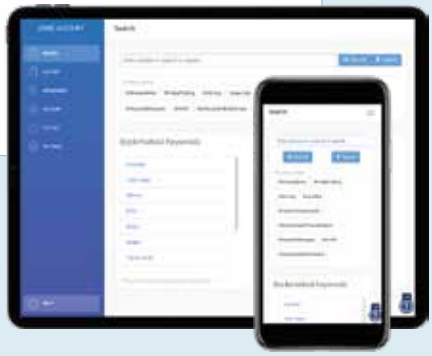
The Problem

The current technologies for those who are communicationally challenged have drawbacks. For example, text-to-speech tools require users to type out the full sentence which can be tedious and slow.

Our Solution

Theoretically, most opinions on a popular topic are already expressed online. Therefore, we decided to turn content online into sentences for our users to improve their communication speed. Our solution is a PWA that will provide a user with sentences based on a keyword search. The sentences are made by using Node-RED to filter content from Twitter. Watson then analyzes these results for tone. Users will also have access to bookmarks and their search history. We took care to ensure the application is user friendly, has standard accessibility features, and has partial offline functionality.





Implementation

The predominant tools upon which our system is built are Node.js and Node-RED. Node.js provides a myriad of features, namely the offline functionality. Node-RED is a flow tool that connects our application, Twitter, and Watson.

The application is a Progressive Web App using Node.js, EJS, HTML5, CSS, Bootstrap, and JavaScript. Our user registration is handled using IBM's AppID and data in the application is stored with PouchDB and IBM's Cloudant. Our Node-RED flow uses Twitter and Watson's Tone-Analyzer. We also use open source API's. Firstly, UserWay, an accessibility widget for web applications that allows for typical accessibility features (increased contrast, desaturation, etc.). Secondly, a text-to-speech API, Responsive Voice.

We are using the Jest framework for unit testing. For performance testing we are using Selenium.

Outcomes

The Node-RED flow is currently single threaded as a first generation prototype meaning that it will process and filter tweets one at a time. The current filtering process would ideally like to filter more for URLs, emojis, expletives, etc which will require refactoring for multi-threaded approaches.

The second outcome is that subsequent iterations will be designed in collaboration with the Ace Centre, a specialised charity that make custom communication tools for the disabled, with regards to a user centric study.

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Image Stitch Up

Authors: Vanessa Lin, Yida Zhou, Yiyun Lu
Partners: Richard Watkins, Benjamin Thomas
Partner Organisation: Ocado Technology
Technologies Used: Keras, Python, Tensorflow
Abstract: Ocado's 10x Team has achieved highly accurate results in image recognition for its products. The current model trains on and recognises product images taken from inside warehouse settings, with accuracy to the point of overfitting. They are interested in exploring techniques to generalise the product recognition pipeline so that it can be trained on internally generated data to recognise Ocado products in various real-world, everyday settings. Our proposed solution is to explore various techniques to develop and analyse results in a new deep learning model: data augmentation through generating training data from 3D models, comparisons of different neural network architectures, and fine-tuning training parameters.

Ocado Review Analysis

Authors: Krzysztof Kozinski, Walter Wu, Rui Chen
Partners: Andre Jonasson, Joseph Zammit
Partner Organisation: Ocado
Technologies Used: Python, Scikit-Learn, Jupyter Notebook, TensorFlow
Abstract: Reviews are essential for any company's growth, but some may not be very useful, and as the number increases they can be hard to manage. Hence, we worked with Ocado Machine Learning team to look into various Natural Language Processing (NLP) techniques and Machine Learning models that can be used to analyse the review text and predict its rating and helpfulness. The research material we produced will help Ocado team handle similar problems easier, e.g. developing a program that identifies unhelpful reviews or reviews that are tagged with wrong ratings. Such a program is crucial for managing reviews automatically and can improve the website's quality significantly.

Ocado 3D Object Recognition for Shopping Automation

Authors: Chi Cheong Tony Siu, Hou Li, Yacoub Ahmed
Partners: Richard Watkins, Ben Thomas
Partner Organisation: Ocado
Technologies Used: Python, Keras, Tensorflow, Yolo, OpenCV
Abstract: In recent years, there has been an increasing interest in the checkout-free automated store, especially online retailers. Our team intends to explore this idea with our partner Ocado and build a prototype only use computer visions and machine learning. This prototype uses multiple cameras to capture videos of different locations of a store and perform object detection and stock counting in a scene. By this, we mean that the system can track where grocery products are in the store and count the numbers of different products in that location. Currently, automated stores integrate sensors and computer visions. From this project, we hope to build a system without the need for sensors in automated store.

Camden CCTV with AI/ML

Authors: Andreas Papavasiliou, Shiko Azuma, Shun Shao
Partner: Richard Bond
Partner Organisation: Camden Council
Technologies Used: OpenPose, OpenCV, TensorFlow
Abstract: The area of Camden is well known for its high levels of criminal activity. The project assigned to our team is related to the CCTV monitoring of the whole Camden Borough. Our partner is the Camden Council, and they have asked us to develop a software that will use AI (Artificial Intelligence) as well as ML (Machine Learning) to monitor all their CCTV to notice any anti-social behaviour captured by the cameras. Our solution is to build a web application that will use a combination of Image, Face and Object recognition to train the neural network and make it smarter and more accurate over time.

3D Depth Capture for Dance Review with Arthur Murray Studios

Authors: Nikhil Kunde, Minjae Kang, Sadhbha Odufuwa-Bolger
Partner: Adrian Persad
Partner Organisation: Arthur Murray Studios, Microsoft UK
Technologies Used: Unity, Kinect, node.js, Azure
Abstract: Judging dance competitions is an arduous process, with professionals having to travel across the globe to view and give their verdict. Furthermore, even esteemed judges can occasionally have poor technical judgement, leading to inaccurate scores. We propose an online platform upon which judges can review and score user-uploaded dance routines, thereby saving precious time. The routines can either be from a desktop application using the Kinect sensor or a regular video recording. Furthermore, the collation of 3D data paves the way for a machine learning implementation, which would remove the need for human judging entirely. In addition, this technology has the ability to extend into other applications such as sports technique and crime detection.

Crowdfunding aggregation platform

Authors: Medi-Remi Hashim, Dhir Patel, Chris Choi
Partners: Dr Farzin Rejaifar, Amin Najafi
Partner Organisation: Algoraise
Technologies Used: node.js, express, SQLite, TensorFlow
Abstract: We were tasked with creating a crowdfunding aggregation platform that would allow investors to easily search and filter through up and coming startups in need of funding. Using search criteria such as country of origin, currency and keywords investors can find the perfect investment for their risk appetite, which they can then add to a portfolio. We decided to create this platform using node.js, specifically using the express web server framework. Data on potential investments is obtained using several platforms' APIs, which are converted from JSON to rows in a SQL database. Recommended investments are generated using machine learning powered by TensorFlow running in a separate microservice. We expect to implement further features such as automatic tagging of projects from text descriptions obtained from the API of the project's crowdfunding service.

Avalon: A Financial Data Image Recognition System

Authors: Tobias Edwards, Anjana Ratnayake, Pooja Sridhar
Partner: Amin Najafi
Partner Organisation: Algoraise
Technologies Used: Python, TensorFlow, Django, HTML/CSS, JavaScript, Highcharts JS, Matplotlib, pandas, Selenium, pytest
Abstract: There is a necessity to find an easier way to research and predict financial markets. Our solution utilises open-source neural networks and image recognition techniques to research large amounts of financial data for stock market analysis. To achieve this, we convert and aggregate raw financial data into 10-minute candlestick images before clustering the images based on similar patterns. Binary classification of the images through TensorFlow – an open-source machine learning technology – then predicts whether the stock value will increase or decrease. Our results are displayed on an online platform where authorised users can upload and store CSV files of their financial data for analysis, as well as visualise and interact with 3D clusters of their data. Training our neural network will give rise to software that can accurately predict financial markets, thus changing how investment strategies are implemented.

Augmented Driving: An AR-enabled virtual tourist guide

Authors: Vikash Panjiyar, David Pourquery, Alex Forey
Partners: Joe Trainor, Tom Winstanley
Partner Organisation: NTT Data
Technologies Used: Ruby on Rails; JavaScript; Unity and Blender; APIs: MapBox, Yelp, Twilio
Abstract: Faced with the death of high streets and dwindling retail, our partner NTT DATA, hopes to tap into the large market of drivers unfamiliar with the local area. Our project aims to be the perfect guide for drivers: showing them an augmented view of all buildings nearby, highlighting points of interests. The thin-film device on which the software runs, paired with completely voice-enabled controls ensures that the driver does not get distracted from the road while being able to discover features and attractions around them. The device uses AR and 3D models to encourage interactivity; including features to aid

navigation, search by price range, as well as the ability to directly communicate with businesses. This would promote shopping on the high street and drive commerce within the local community.

Enabling Accessible Communication Between British Sign Language Users and English Speakers

Authors: Nithin Anand, Noor Soni, Rija Rizvi
Partner: Gary Williams
Partner Organisation: DeafPLUS
Technologies Used: Python, Java (Android), AzureVM
Abstract: We present a proof concept to demonstrate the possibility of simple communication between British Sign Language (BSL) users and English speakers. An Android application; it uses built-in libraries to generate text from speech samples. Then, using a virtual machine hosted in the cloud, a corresponding video of BSL is generated then sent back to the device. To provide context and a possible use case for the application, the vocabulary is tailored towards navigating a hospital. To demonstrate the cross-platform nature of the application, we are also presenting a version of the app for smart glasses. Key to the ethos of the project is to make it as accessible as possible, and this port is part of that proof of concept.

DeafRadio – auto-generated subtitles for radio on Android

Authors: Roxana Tugulea, Zak Morgan, Mahdi Nasrollahi
Partner: Gary Williams
Partner Organisation: Deaf PLUS
Technologies Used: Java, Android, Google Speech services
Abstract: Radio by nature of its form is inaccessible to the deaf community. This presents a problem, as it still forms an important part of people's lives today. Our solution to this is an Android application which automatically generates subtitles for radio stations. This allows this form of media to be consumed by individuals with a hearing impairment. A key part of our solution is ensuring our representation of this media is accurate and contains all the information of the original, such as who is speaking. We do this through different colours of text, similar to a solution proven effective by BBC's IPlayer.

An investigation into the use of intelligent interactive features for blind users on a mobile Soundscape Simulator platform

Authors: Karolina Koupanou, Terry Williams, Yuxuan Li
Partner: Jarnail Chudge
Partner Organisation: Microsoft
Technologies Used: Ionic, Typescript, API, Cognitive Services, LUIS (Language Understanding), Node.js, HTML, CSS
Abstract: Our project involved building a Soundscape simulator platform in which the user can interact with a built-in intelligent chatbot which can provide suggestions and information about the local environment via voice. We also included Cortana and Maps to improve the information content available for the blind and visually impaired users. We researched and implemented various subtle improvements to the user experience from the perspective of a visually impaired Soundscape application user but also kept in mind that users with normal vision could also benefit from using the application.

Microsoft Soundscape – Mixed Reality for Remote "Audiolisation"

Partner: Jarnail Chudge
Partner Organisation: Microsoft Corporation
Technologies Used: Unity Engine, C#, MapBox SDK, Microsoft Azure Cognitive Services, Bing Maps API
Abstract: The visually impaired often face difficulties navigating and interacting with their surroundings. Microsoft Soundscape is a research project that explores the use of innovative audio-based technology to enable people, particularly those with blindness or low vision, to build a richer awareness of their surroundings, thus becoming more confident and empowered to interact with the real world. Soundscape provides information about users surroundings via binaural audio. It navigates its user around by providing information about points of interest as the user passes by them and uses 3D audio imaging to help create a complete picture of users' surroundings. Our team worked on a feature that builds on Soundscape, allowing users to explore any location remotely via a Soundscape-like experience. Much like how Google Street View allows users to see the surroundings of different places on the map, our project allows Soundscape

users to explore any location across the world using 3D sound & graphics combination. This allows the visually impaired to explore these places without leaving home and gain confidence when navigating new environments.

mlAcademy – An interactive educational platform for high-school students, specialising in machine learning

Authors: Adam Peace, Samuil Stoychev, Sotirios Vavaroutas
Partner: Justin Garrett
Partner Organisation: Microsoft
Technologies Used: React, Tensorflow+Keras, Pandas, Django, Azure Pipelines, Jest, SQL
Abstract: Machine Learning is quickly becoming one of the most popular fields in Computer Science. The problem is the first formal introduction to machine learning is only at the 2nd or 3rd year of some courses at University. Currently, there are hundreds of approachable courses in Javascript, C and HTML, but none related to Machine Learning. mlAcademy is a skinnable, interactive educational platform, aimed at secondary school students, specialising in Machine Learning. We have created a tuition platform to provide students with a fundamental understanding of many different aspects of Machine Learning, including Gradient descent, Linear Regression and Neural Networks, at an attainable level and in a way that is interactive and fun.

Personal on-boarding coach

Authors: Chung Ho Ryan, Ahmed El Herazy, Luming JI
Partner: Wes Hackett
Partner Organisation: Addin 365
Technologies Used: C#, Azure Bot Service, Power BI, Microsoft bot builder SDK
Abstract: Office 365 provides users with Office applications and cloud services. It aims to improve workers' communication and productivity. As it is still a relatively new service, companies might find their employees not utilising the tool properly even though it can aid their work and increase efficiency. The solution is to build a bot to help users adapt from their old ways of using emails to using Office 365 – On-boarding them. The bot should be able to ease the onboarding progress by providing resources and guidance in dialogues to users. The bot should also track their onboarding progress so the company would also know about the onboarding progress of their employees.

Foraminifera-Tagger: Smart Digitization and Deep Learning System for Climate Change Analysis

Authors: Zong You Chua, WenWen Zheng, SeungHoi Kim
Partners: Bridget Wade, Gabriel Brostow
Partner Organisation:
Technologies Used: Pytorch, OpenCV, Django, Travis CI, MySQL, Azure Blob
Abstract:
Problem: The manual (human) categorisation of foraminifera is very time-consuming. A large majority of a researcher's time is spent doing this when it can be spent on doing more productive things.
Solution: Utilising modern machine vision techniques and large convolutional neural networks, we will systematically implement transfer learning to automate the categorisation of foraminifera.
Results: We hope to achieve a sufficient degree of accuracy in our models such that we can effectively categorise 17 species of foraminifera. Hopefully, this will lessen the time researchers spend on categorising foraminifera.

UNESCO Policy Registration System

Authors: Ksenia Pavlina, Simon Fattal, Zhuang Zhang
Partners: Catherine Holloway, Jaco Du Toit, Gideon Mwaura
Partner Organisation: UNESCO
Technologies Used: Django, Python, HTML, CSS, JavaScript, Bootstrap
Abstract: For UNESCO's Policy Registration System, our problem statement was to improve the accessibility of government and non-government policies for Ugandan citizens with disabilities, as well as allow these citizens to voice their own opinions on the policies proposed. To solve this, we built a policy engine for generating web applications which allow for governments and NGOs to update the users with the latest and most relevant information about their policies. In this instance, Users can browse through a catalogue of policies, as well as provide direct and detailed feedback about specific policies of their interest. Visually impaired users can interact with the website using voice commands with minimal use of their keyboard. Finally, organisations can view analytics feedback through dynamic charts.

We hope that through this work, we will increase the engagement between Ugandan citizens and respective organisations.

Asset Investment Platform powered by Sentiment Analysis

Authors: Yiota Krashia, Hiru Ranasinghe, Rudraksh Shankaran
Partner: Philip Treleaven
Technologies Used: Python, MongoDB, node.js, AzureVM, Selenium
Abstract: This project involves the creation of an Asset Investment Platform that will be used by investors to decide whether to invest in a particular commodity. The commodity market is very complex and price volatile, which is affected by some factors such as economic and political events. The main aim of this platform is to capture, clean and store data about commodities such as coffee, gold and oil in a database, and use these data to analyse pricing influences. Accordingly, Sentiment Analysis is conducted on online news articles and social media to extract their sentiment using Natural Language Processing and Deep Learning. Therefore, this project will investigate how news and social media influence the price of commodities by revealing the trends and movements in the commodity market, hence facilitate investors in making better investment decisions.

Rehabilitation Chabot

Authors: Andrea Belahouane, Bo Xi Isaac Lee
Partner: Dan Brown
Partner Organisation: Meganexus
Technologies Used: AzureML, SQL, REST, Microsoft Bot Framework
Abstract: The prison system is failing to rehabilitate prisoners. It is estimated that roughly 70% of offenders re-offend upon completion of their sentences, and is resulting in overcrowded prisons. This is expected to come from a variety of factors, with a predominant one being that the rehabilitation system is not fit for purpose. The Rehabilitation Chatbot, which interfaces with MegaNexus' Virtual Campus – an educational platform app contributes to the rehabilitation journey by providing interactive assessments which are spoken to the user, App navigation using voices, texts and buttons, help on FAQs or merely someone to talk with so that they can improve their English.

Dissertation Project Management System

Authors: Akash Bhattacharya, Sia Agarwal, Oliver Waterman
Partner Organisation: UCL
Technologies Used: Node.JS, MySQL, JS/jQuery, HTML5/CSS3
Abstract: A web application that aims to provide a smooth experience for all users involved in the creation, choice, grading and other interactions with Final Year Dissertation Projects.

Numberfit Teacher Support App

Authors: Lile Cao, Lei Peng
Partners: Ms.Ashley Highmore, Dr Fraca Santamaria Estibaliz
Partner Organisation: Numberfit Limited
Technologies Used: Ionic, node.js
Abstract: Numberfit is developing a platform to run physically active Maths sessions in primary schools. The objective of this project is to develop an APP for a tablet which will be the interface to allow the teacher to communicate with the system. Also, researchers from the UCL Institute of Education will perform some observations. An interface to help this research would be added to the APP as an additional feature. To store and retrieve the data in the database, a node.js API needs to be developed.

Financial Fabric's Datahub

Authors: Zhiyuan Cheng, Frank Gatheru, Yufei Hao, Roushan Lan, Linhui Lu, Yifan Wu, Xinrun Yang, Xiaokun Yu
Partner: Paul Stirpe
Partner Organisation: Financial Fabric
Technologies Used: C#, Visual Studio, Azure Cosmos, Azure Function Apps, Azure Stream Analytics, PowerBI, Trill
Abstract: Financial Fabric is a New York-based company that works in the finance industry, concerning themselves with sourcing, storage, organisation, processing, visualisation and access of financial data for their clients who include fund managers, investors, data scientists, brokers, banks and application developers. We built a solution that adopted a lambda architecture to fulfil the need to source, organise, store and visualise historical as well as real-time financial data from the Investors Exchange(IEX).

IXN Project Management System

Authors: Mingya Zhou, Peter McGrath, Xuesong Yu
Partner: Industry Exchange Network
Partner Organisation: UCL
Technologies Used: HTML, CSS, Javascript, node.js, MySQL
Abstract: Our project aims to produce a project management system for UCL IXN projects. Currently, the project admin Dr Fu can only contact the IXN partners via email. Therefore, all the project proposals and feedback are stored in emails and are difficult to keep track of. We will develop a web app project management system that serves three types of users: project admins (Dr.Fu), project partners and the students. Admin can view the project proposals and approve or decline them. They can also assign students to specific projects. Partners can propose new projects and keep track of the progress of their ongoing projects. Students can upload reports and code for their IXN projects. We hope to deliver a system that efficiently assists the users in managing their projects and improves communication between all the parties involved.

Final Year Projects Overview

All final year undergraduate students on all three of our programmes, BSc Computer Science, MEng Computer Science, and MEng Mathematical Computation, take a final year individual project. The projects run from October to April, roughly seven months, and represent one quarter of the final year mark and effort.

These projects allow time for a finalist to investigate a challenging problem in depth and develop a plausible solution. A typical project will involve researching and understanding the problem area, identifying and comparing potential solutions, building one or more prototypes, and evaluating the results. Each student has a project supervisor, who is a member of academic staff, and regular tutorials in order to get support and feedback along the way.

Students have a wide choice of subject areas they can work on, from across the whole range of departmental research areas. Alternatively, a student may have their own idea for a project, or work in collaboration with an external person or organisation via IXN or via personal contacts.

The results of the project work are written up in a substantial project report, which is submitted for assessment. The following section lists the project title and abstract for many of the projects, giving an overview of the wide range of projects worked on and the level of challenge that many represent.

The prize for the best final year project after final assessment is completed is sponsored by IBM. We would be happy to hear from other organisations that would like to sponsor prizes for our classes.

Finalists' Projects Abstracts

Natural Language understanding system for extracting and understanding textual information from the web

Author: Matt Policane
UCL Supervisor: Anthony Hunter
Technologies: Python, NLTK, Spacy, Scikit-learn
Abstract: The world wide web contains millions of articles each of which contains useful information. For example, Wikipedia contains over 5.8 million articles ranging across numerous different topics. If a human was asked the question, "What is the capital of France?" they could easily find its answer as it would most likely be included in more than one of the articles. However, a machine would find the task harder due to the unstructured nature of the articles, and so they would need to be converted into some structured form. This structure can come in the form of a Knowledge Graph which contains a series of nodes representing entities and edges representing relationships between them. This project aims to build such graphs by extracting relevant information from different Wikipedia articles on the web. These graphs can then be used in the development of numerous applications, most notably intelligent assistants and question-answering systems.

Information Extraction in Randomised Clinical Trials

Author: Vu Ngoc Dung Luong
UCL Supervisor: Anthony Hunter
Technologies: Python, NLTK, GENIA Tagger, Pug, UMLS
Abstract: Randomised clinical trials (RCT) are used as the main source of data in evidence-based medicine (EBM) for clinicians as well as researchers to obtain high quality, up-to-date information for diagnoses and treatments. However, key information is extracted from RCTs through a manual, labour-intensive process. We aim to create an automated system to extract on the fine-grained level, the key six data: the patient group, the outcome measure, the intervention and control treatments, and their respective results; to produce an evidence table. Our system leverages the structure of modern RCT abstracts to build a set of features to train a classifier (SVM or decision tree), then for inference, we made predictions ranking and pattern matching criteria. The result shows that our system is feasible for RCTs aimed at a single disease (glaucoma), extending to a different illness is done by simply modifying parameters.

Multi-Step Reasoning for Question and Answering on Structured Data

Author: William Lam
UCL Supervisor: Anthony Hunter
Technologies: Python, NLTK, scikit-learn
Abstract: The project is about creating a question and answering system for movie reviews. These include questions such as 'What is the rating for Inception?'. The system would also be able to handle questions that require information from multiple rows such as 'Should I watch Moana or Frozen?' and answer with the appropriate response.

Investigating Granger Causality using the InterDyne Simulator

Author: George Hassan-Coring
UCL Supervisor: Chris Clack
Technologies: Haskell R
Abstract: Due to the evolution of computing power over the last 50 years, researchers are now able to model huge, complex systems that arise in the real world using simulation software. These models may contain hundreds or even thousands of agents, so my project aims to help make these results easier to understand and comprehend. Using the concept of multivariate Granger Causality, I have designed a program to identify causal links between agents in the InterDyne simulator and present the results.

3D reconstruction for vision in robotic surgery

Author: Timur Kuzhagaliyev
UCL Supervisor: Danail Stoyanov
Technologies: Python, Matlab
Abstract: Despite a large number of data sets available for computer vision (CV) applications in general, finding appropriate data sets for CV in robotic surgery can be a challenging task. We aim to fill that gap by designing a data collection pipeline using the da Vinci surgical robot and computed tomography scanners. Once the pipeline is complete, we will use the collected data to generate photo-realistic 3D surfaces of various organs, enabling further synthesis of training data for 3D reconstruction and stereo vision algorithms.

Malware Classification using Normalized Compression Distance

Author: Tom Ayoola
UCL Supervisor: David Clark
Technologies: Cuckoo Sandbox, Intel Pin, Python, C++, C
Abstract: This project investigates the usefulness of the normalised compression distance (NCD) for malware classification. NCD, an information theoretic similarity measure, is applied to various abstractions of malware including binaries, execution traces and system calls to distinguish between malware families. The project aims to find an abstract representation of malware that captures family-specific behaviours such that the intra-family NCD values are lower than the inter-family NCD value. As this would allow for a machine learning classifier to determine which family a malware file belongs to based on the NCD values calculated against a set of known families.

Venture Capital Recommendation Engine

Author: Raja Upadhyay
UCL Supervisor: Denise Gorse
Technologies: Python, Selenium, SQLite
Abstract: The project involved building a Venture Capital (VC) Recommendation Engine using supervised learning techniques. The main aim was to develop a model that would augment the human assessment of the likelihood of 'success' for a given early-stage startup. A complete Machine Learning pipeline has been established that ingests data regarding early-stage startups from various relevant websites, processes the data before training and deploying the model. The output of the pipeline involves recommending certain startups that require special attention.

Cryptocurrency Market Forecasting using LSTM Neural Networks on Limit Order Book Data

Author: Andrei Maxim
UCL Supervisor: Denise Gorse
Technologies: Python Tensorflow Keras
Abstract: LSTM networks have proven to be the state of the art choice for time-series prediction and analysis. Although research has been done on their exploitation over the Foreign and Stock exchanges, little attention has been given to less efficient markets such as Cryptocurrencies. The main novelty of this project's approach is the use of high-frequency Order Book data as input features fed to the neural network for providing a more accurate spatial representation of the movements within the market. This eventually translates to a better performance in pattern recognition when it comes to predicting the price movements.

A comparative survey of recommender systems

UCL Supervisor: Dmitry Adamskiy
Technologies: Python, Pandas, Scikit-learn,
Abstract: The project aims to identify best techniques, practices and algorithms in recommender systems. The challenge is set by WSDM 2018 Music Recommendation Challenge, which aims to predict the probability of a user re-listening to a song in a certain time frame after a first observable listening event. The project has a heavy focus on problem exploration to properly utilise machine learning techniques, such as data exploration, feature engineering, model selection and evaluation and model blending. As for evaluation, the competition uses the area under the ROC curve. This metric is used for comparison against the top scorers.

Toychain: Formally Verified Blockchain Consensus

Author: George Pîrlea
UCL Supervisor: Earl Barr
Technologies: Coq, OCaml
Abstract: We present the first formalisation of a blockchain-based distributed consensus protocol with a proof of its consistency mechanised in an interactive proof assistant. In this work, we focus on global system safety properties and prove a form of eventual consistency. Our development includes a reference implementation of the block forest data structure and provably-correct message handlers for the protocol logic. The development is parametric with implementations of several security primitives, such as hash-functions, a notion of a proof object, a Validator Acceptance Function, and a Fork Choice Rule. We precisely characterise the assumptions, made about these components for proving the global system consensus, and discuss their adequacy. Finally, we instantiate Toychain with a SHA256-based proof-of-work scheme and extract a proven-correct OCaml implementation of a blockchain consensus protocol. All our results are formalised in the Coq interactive theorem prover.

Data-driven analysis of wine consumption through Vivino

UCL Supervisor: Emiliano De Cristofaro
Technologies: Python
Abstract: This project is about doing a wine recommendation system with the database from Vivino application. This wine recommendation system is trying to recommend the regional style of wines rather than a specific wine. I applied the collaborative filtering to predict the ratings that users might give to regional styles they have not tried before. Besides, I have tried to cluster wines into several classes with the latent factor model. The result of this model is quite good.

Predicting the outcome of chess games based on historical data

Author: Stefan Manole
UCL Supervisor: Fabio Caccioli, Giacomo Livan
Technologies: Python
Abstract: This project aims to predict the outcome of chess games using historical data about the players. The first part of the project presents a comparison between the results obtained using several machine learning techniques such as multinomial logistic regression, random forest, LightGBM or XGBoost. Moreover, the project focuses on implementing new ways of calculating the chess Elo rating. The efficiency of these approaches is tested using the models mentioned above.

Analysing Statistical and Machine Learning Forecasting for Financial Stock Prediction

Author: Keshav Aggarwal
UCL Supervisor: Fabio Caccioli, Simone Righi
Technologies: Python
Abstract: Despite their raising prominence Machine Learning approaches have not yet reached the level of maturity of statistical methodologies. Scant evidence is available about their relative performance as a standard forecasting model especially in the field of financial forecasting for the Stock Market. This project takes up this task to analyse the working and application of “State of the Art” Machine and Statistical Learning techniques in the context of forecasting financial data about the Stock Market. This project compares their performance, their computational efficiency and whether standard machine learning approaches can be improved with the application of sliding window approach to the conventional methods.

Comparison between Machine Learning and Statistical models in FX prediction

Author: Sidharth Sikka
UCL Supervisor: Fabio Caccioli, Simone Righi
Technologies: Python, Selenium, sqlite3
Abstract: The Efficient Market Hypothesis states that prices reflect all available information; hence, making ‘beating’ the market an almost impossible task. Many researchers have approached this in the past with the help of stochastic modelling gaining results no better than random. However, with the

increase in computational power machine learning (ML) has proved to be outperforming stochastic processes in modelling of time series data in certain cases. Hence, raising the question of their ability against stochastic models in financial markets. In this paper, we propose to implement our ML and statistical models to predict the classification of whether the price will be higher or not given its past prices. Models implemented in this paper consist of Multi-Layer Perceptron neural network, Classification and Regression Trees, Gaussian Process, AutoRegressive Integrated Moving Average and Theta models. We expect the ML models to be no better than random but be a lot more computationally expensive.

Lab Ticketing System: A web-based application for managing student help requests in labs

Author: Conner Lukes
UCL Supervisor: Ghita Kouadri Mostefaoui
Technologies: Django, Bootstrap, Bokeh, Selenium, LocustIO
Abstract: Module administrators often have a lack of knowledge of what is happening in their module lab sessions. This project aims to implement a lab ticketing system, to give module administrators a clear idea and a real-time view of what's happening during lab sessions. The system is a web-based application, which monitors students' requests for support during lab sessions.

Impactful Relationships: The Social Network of Academics on Twitter

Author: Desislava Koleva
UCL Supervisor: Giacomo Livan, Fabio Caccioli
Technologies: Twitter API, Python, Gephi, Twython, SQLite, SQLAlchemy, Simplejson
Abstract: The rising presence and activity of academics on social media platforms such as Twitter enable the exploring of their social interactions and contribute to academic success in general. This project presents an in-depth investigation of this social network of academics on Twitter. It does this by monitoring the activity on the platform during some conferences in the area of Computer Science, obtaining and visualising networks of the relationships and interactions between conference goers, and providing insights into the connectedness of these networks with the use of different measures of degree, clustering and centrality. Thisvwould allow future analysis to be done to find out if these relationships develop over time and if they may lead to potential collaborations, as well as determine whether and how the presence, activity and interactions between academics on the platform influence their success, recognition and academic impact overall.

An investigation into the application of Blockchain in Multidisciplinary team meetings in NHS (GOSH)

Author: Shubham Bakshi
UCL Supervisor: Graham Roberts
Technologies: Python, Ethereum, Truffle suite, node.js, Ionic
Abstract: Multidisciplinary team meetings (MDT) are a way for hospitals (such as GOSH) to make decisions on what treatment or diagnosis patients experience; as such these meetings can have serious consequences for patients and recording them is necessary, for auditing. But, trusting a central party to store all information is dangerous and makes it difficult to support the idea of non-repudiation. We investigate an approach using Blockchain and smart contracts to store these meeting data in a way that is transparent and can be audited in the future. The result is a proof of concept of the system, and an evaluation of its practicality.

Advanced multi-type search system for the Aula platform

Author: Martí Serra Vivancos
UCL Supervisor: Graham Roberts
Technologies: NodeJS, ReactJS, Elasticsearch, AWS
Abstract: Aula is a communication platform for higher education that replaces emails and learning management systems with a digital campus designed to encourage student interaction and engagement. The project aims to design and implement a complete search system for Aula that can surface all content (posts, comments, direct messages, etc.) generated by students and educators in an intuitive and fast way. The final solution is divided into three main subcomponents: search indexer, search API and search UI. The first two are built on top of Elasticsearch, whose speed and features allow for great user experience. The search API can return accurate search-as-you-type results in under 200ms. Finally, the system has been developed with production deployment in mind,

including accounting for failures in the indexing process that might lead to an inconsistent state between the main database and Elasticsearch.

AI vs human bridge game platform

Author: Danchen Lou
UCL Supervisor: Jun Wang
Technologies: Python
Abstract: Prof. Wang and his team are developing a bridge game AI. This project involves building a platform that allows humans to play against an AI server.

sdcrisk: A Python tool to measure the disclosure risk in de-identified health data sets

Author: Carlota Ortega Vega
UCL Supervisor: Graham Roberts
Technologies: Python
Abstract: Great Ormond Street Hospital's digital unit, GOSH DRIVE, wants to share their patient data so that it can be used for research purposes. However, before publishing these data, measures must be taken to ensure that the identities of these patients are protected. For this purpose, GOSH DRIVE uses Aridhia's AnalytiXagility tool, which de-identifies the data sets based on a set of rules. My solution, sdcrisk, is a command line interface Python tool that analyses the de-identified data sets to be published and calculates different risk metrics, enabling users to evaluate the risk of disclosure. The tool can be used as a checking tool before publishing data to decide if further de-identification needs to be carried out on the data set. Potentially, the tool could be used as part of the Statistical Disclosure Control process across a range of industries.

Spatio-temporal models for 3D human pose estimation

Author: Wanyue Zhang
UCL Supervisor: Iason Kokkinos
Technologies: Pytorch
Abstract: Estimating human poses from videos is a challenging task because poses might be inconsistent across frames. In this work, we extend from the current deep learning system to predict 3D meshes from a single frame. Subsequently, temporal smoothing is applied across the video sequence. To compute the loss, a differentiable neural renderer is incorporated to project 3D predictions into depth images, which are then compared to the ground-truth depth from CMU Panoptic Dataset.

Code to Test Traceability

Author: Raymond Tan
UCL Supervisor: Jens Krinke
Technologies: Java
Abstract: Code-to-test traceability establishes links between code and the tests testing the code. Establishing such links is not straight forward, and multiple approaches have been developed. This project will have to establish such links by tracing a program while it is being tested.

Clone Search for Python 3

Author: Wayne Tsui
UCL Supervisor: Jens Krinke
Technologies: Java, ANTLR, Maven, JUnit
Abstract: Siamese is a scalable code clone search system powered by Elasticsearch with code clone detection approaches, including code normalisation, n-grams and query reduction technique. It can efficiently search for clones of Type-1 to Type-3/ Type-4 source code. My project is to implement an extension of this system to perform clone search for Python 3 and evaluate its accuracy and performance. Siamese can do clone search at either a method-level or file-level. For each specific language search implementation, we would require a normaliser mode, normaliser, tokeniser and parser. The current implementation uses JavaParser as the parsing library. However, this is specific only to Java and developers will be unable to extend this system for other languages in a modular way. A more generalised approach is followed by using ANTLR4, which provides grammars for many popular programming languages.

News Reading Style Modelling

Author: Ronglong KE
UCL Supervisor: John Dowell
Technologies: Python, Azure MySQL Database, Scikit-learn
Abstract: This is a user modelling project, where it aims to model mobile news readers' reading style. To be more specific, the user modelling system predicts users' reading style by processing raw data. In this project, I was provided with more than 200k rows of raw data regarding mobile news

readers' interactions with a News application. By cleaning and aggregating raw data, I visualised users' reading behaviour into graphs for better observations. By observation, I extracted the users' raw data into five factors that can describe the reading style. I then reduce these 5-D datasets into two dimensions dataset by PCA. Subsequently, I applied unsupervised machine learning algorithm to cluster users into four groups. Each group represents a type of reading style, and then we train the modelling system to predict user into one of these four groups by labelling each user and applying a supervised machine learning algorithm.

The value generated by sponsored advertisements on Amazon.

Author: Darius Grigore Pop
UCL Supervisor: Jun Wang
Technologies: Python, Google Cloud Platform, Amazon Web Services, Natural Language Processing library in Python, Github, BeautifulSoup, Multi-Threading
Abstract: The goal of my project is to analyse how much value is brought by sponsored advertisements on Amazon. The work is based on research papers and projects currently being developed by the partner. For the first part of the project, traditional statistical methods are used to analyse relevant information on the products displayed on Amazon. The analysis will be run on aspects such as category as well as bestsellers. To construct this information, web crawling libraries developed in Python will be used. The second part of the project involves more engaging techniques, such as Machine Learning and natural language processing. The user will be able to use a website which I develop to obtain relevant information to their desires, by typing keywords on the website. If the work achieves the target quality bar, it is expected that the company will use my work in their future projects and a research paper will be published, based on it.

Integrating reinforcement learning rewards for semantically meaningful representations from pixels

Author: Pranav Nashikkar
UCL Supervisor: Jun Wang
Technologies: TensorFlow, OpenAI Gym, Python, NumPy
Abstract: High-quality knowledge representation is a problem at the forefront of deep and reinforcement learning research. Unsupervised methods can generate rich representations driven without human intervention but cannot be contextually specialised. This dissertation demonstrates the success of a combined unsupervised learning approach of perceptual grouping from pixels with deep reinforcement learning, by integrating environmental reward through backpropagation. High data efficiency convergence, as well as stronger overall task performance, is achieved, and this mechanism allows the unsupervised representation generator to become a converter of raw pixels into high-level objects. These perceptually grouped objects capture not only environment dynamics, but also instil a deeper contextual 'meaning' as to the nature of an object. Not only does this allow for semantic interpretability emerging from only environmental rewards, but it also opens up future avenues to build richer, more meaningful, yet emergent representations driven purely by the task at hand.

AGED: Analysis of Gene Expression in Dementia

Author: Mihai Ionut Deaconu
UCL Supervisor: Kevin Bryson
Technologies: Python, R, Selenium
Abstract: Despite decades of intensive research, medical science is yet to find a cure for brain diseases that lead to dementia. Enhancing clinicians' involvement in dementia studies could potentially improve the quality of research conducted in this area, and enable a smoother transition and application of research results. Nonetheless, clinicians' lack of expertise in data analysis could potentially complicate such collaborations. The central idea of this project is to create a web application that can be used by clinicians and disease experts to integrate Machine Learning methods of gene expression datasets and visualise their results and performance. The project is driven by the analysis of neurodegenerative disease

datasets from the Mayo Clinic, that involve a comparison of RNA-seq data from Alzheimer's Disease, Progressive Supranuclear Palsy, and elderly controls from two different regions of the brain: temporal cortex and cerebellum.

TaskRabbit Cost Influencing Factor Analysis

Author: Javier Pascual
UCL Supervisor: Licia Capra, Giacomo Livan
Technologies: Python, Selenium, SQLite
Abstract: The past few years have seen important growth in the online freelance market through platforms which connect clients and taskers with relative ease. One such platform is TaskRabbit. We collect demographic and social data for cities in the U.S, along with data from within TaskRabbit with the aim of performing both descriptive and predictive analysis. By building regression models on a selection of services, we examine the feasibility of predicting the price offered by taskers in certain areas, through factors like ethnicity, age and median income. Results show good adjusted R2 values overall, especially when combining factors from within the platform and the U.S census. Descriptive analysis of the variables also shows interesting correlations, for instance, between the vehicle ownership and median prices offered by taskers.

Dense Semantic SLAM

Author: Xiaohan Shen
UCL Supervisor: Lourdes Agapito
Technologies: Python, C++
Abstract: This project takes InfiniTAM as a base system fused with Mask-RCNN which would be applied to RGB images for object detection, such that each object in the 3D reconstruction could carry a semantic label by projecting detected objects onto the 3D scene. And also, I aim to eliminate the dynamic part to avoid confusing the system and get the correct camera poses and accurate reconstruction.

Implementation and evaluation of a large displacement optical flow algorithm

Author: Vivian Grannell
UCL Supervisor: Marta Betcke, Nargiza Djurabekova
Technologies: MATLAB
Abstract: "Large Displacement Optical Flow Computation Without Warping", 2009, Frank Steinbrücker et al., was published as part of the IEEE 12th International Conference on Computer Vision. It describes a novel approach to determining "optical flow" over larger distances without distortion in a sequence of images (and determining the movement of objects visible). Despite this, the final implementation is not freely available. The software has been written using MATLAB to perform the steps of the described algorithm, and its behaviour in practice is evaluated in comparison to other pre-existing optical flow algorithms.

Designing an attachable device to aid the mobility of people with visual impairments.

Author: Arjun Khurana
UCL Supervisor: Nic Marquardt, Catherine Holloway
Technologies: Java, Arduino
Abstract: The project targets mobility aiding devices for people with visual impairments. Individual, special-purpose devices and equipment can be very expensive, and almost always very specific to a certain type of visual impairment. Having a multi-purpose attachable device can help save money, allow for much greater flexibility and improve comfort for the visually impaired as they would not have to buy different variations of similarly functioning support devices. The proposed solution is a physical device which measures and obtains information about a user's location and orientation to determine which direction/point-of-interest the user is facing. The device will be made to ensure it can be attached to a walking stick and a guide dog handler, with the ability to send the data captured to a mobile phone app, which would then process this information as necessary. The supporting mobile app has already been developed with Microsoft's Soundscape technology.

Defending against Adversarial Attacks on CNNs

Author: David Al Mjali
UCL Supervisor: Niloy Mitra
Technologies: Python, Pytorch, Jupyter, Numpy, PIL, Matplotlib
Abstract: Recently, neural networks are susceptible to attacks that allow an adversary to craft images that mislead the network and pose a significant security threat. Our project is to defend against these attacks by distinguishing between adversarial and normal inputs and training a separate classifier for adversarial inputs to build up robustness against the specially crafted images. The project will deliver an implementation of multiple attacks on the MNIST dataset, the architectures of the models, as well as the trained models' weights.

The efficiency of Uber Drivers' Movement in Between Rides

Author: Redacted
UCL Supervisor: Paolo Barucca
Technologies: Python, Pandas
Abstract: Should a driver operating in ride-sharing services such as Uber and Lyft stay stationary or move about actively to look for passengers in between rides? The problem at hand is to find out the best and most efficient driver behaviour that will yield the most number of rides, thus maximising the drivers' profits. A large dataset of Uber pickups in New York City (NYC) will be analysed, which leads to developing models to simulate different drivers' behaviours. The results will be significant to help understand and improve urban mobility in busy cities.

A Gamified Antimicrobial Stewardship Decision Support App

Author: Georgiana Birjovanu
UCL Supervisor: Patty Kostkova
Technologies: Ionic, Node.js (MongoDB)
Abstract: Infectious diseases remain one of the most common causes of death in lower-middle-income countries, where infection prevention can be achieved by implementing better practices and controls when prescribing antibiotics. However, antibiotics contribute to the worldwide growing antimicrobial resistance when these are not properly administered. The 'Gamified Antimicrobial Stewardship Decision Support App' aims to investigate how mobile technology can help to reduce the prescription of surgical antibiotic prophylaxis in a real-world hospital setting by giving real-time feedback to clinicians. In the mobile app, the real-time feedback given to surgeons is based on current health guidelines and takes into consideration patient data, such as allergies, patient risk level, specific procedure and antibiotic type and duration. Moreover, gamification elements are implemented to encourage user behaviour change, so that doctor's prescribing decisions don't contribute to the worrying rise in antimicrobial resistance. The app is now being tested with surgeons in three hospital settings in Nigeria to evaluate its effectiveness.

Portfolio management using the Fama & French model with ambiguity in Carbon Risk

Author: Shivam Shah
UCL Supervisor: Philip Treleaven
Technologies: Python
Abstract: The main objective of this research is to propose an improvement to the existing Fama-French Asset Pricing Model by incorporating new but necessary variables representing ambiguity in Carbon Risk, and thus providing better insights to the associated risk for firms.

Behaviour inference through extraction of attitudes and intentions using chatbot

Author: Reemma Muthal Puredath
UCL Supervisor: Philip Treleaven
Technologies: Python, Django
Abstract: The project represents an intersection of behavioural analysis and software engineering to produce a novel method of collecting and identifying Theory of Planned Behaviour (TPB) variables. The chatbot is a conversational agent responsible for engaging users and prompting them when necessary to gather information about entities related to the food and shopping domain. The second challenge faced is the knowledge representation of the data, and this has been overcome through designing and implementing a structure that holds the attributes associated with each of these three TPB variables for each entity explored. The prime motivation is to be able to identify a user's behaviour through classifying their

attitudes, intentions and actions. In this project, the focus is placed more on designing the chatbot so that it can extract this information with a particular focus on intentions and attitudes as a base predictor for the model.

AI-based System for Automating Financial Regulation

Author: Andrei Margeloiu
UCL Supervisor: Philip Treleaven
Technologies: Java, Spring Boot, Angular, JUnit4
Abstract: This project investigates the application of Artificial Intelligence (AI) technology, especially Expert Systems, to automate financial regulation, with specific reference to the registration workflow of a financial company with a regulatory authority. This research presents a solution for modelling financial regulation and encoding the registration process into a machine-executable format. The research outcome is an Intelligent Regulatory Advisor system that uses AI to help firms complete the registration forms with a regulator.

Enabling FHIR-based Machine Learning

Author: Kiran Gopinathan
UCL Supervisor: Philip Treleaven
Technologies: Tensorflow, Python, FHIR
Abstract: This dissertation provides a methodological study into the application of Machine Learning algorithms over the Fast Healthcare Interoperability Resources (FHIR) format with a specific focus on the comparison of Deep Learning approaches against classical Machine Learning methods on the task of insurance claims prediction. This research was conducted in collaboration with the Aetna Insurance company, allowing the validation of the proposed system within a real-world industrial context. The FHIR format has recently seen widespread adoption by healthcare services. This popularity has to lead to the establishment of a large corpus of healthcare data in a FHIR schema, providing ample potential for the application of Machine Learning. However, as FHIR data enforces no single semantic encoding of attributes, it often requires extensive pre-processing before use with classical Machine Learning algorithms, which typically cannot handle learning over unharmonised data. Recent research has suggested a novel way to circumvent this cost - by applying Deep Learning methods, which have no such restrictions, directly over the raw FHIR data but this approach has so far only been tested under high-fidelity clinical environments. This study aims to extend the current research by providing a quantitative comparison of standard Deep Learning methods against other classical Machine Learning approaches on the task of insurance claims prediction to evaluate whether Machine Learning over FHIR is feasible outside of clinical data sets. An implementation of a general framework for FHIR-based Machine learning is presented, and its efficacy with a variety of machine learning algorithms on standard insurance claims tasks is demonstrated. The major contributions of this dissertation are the design and implementation of an open-source platform for applying Machine Learning over FHIR data. The project also extends the current literature by investigating how prior work on Machine Learning over on medical FHIR data sets can be applied to low-fidelity insurance claims data.

Circuit-breaking machine learning systems: performance and biases analysis

Author: Yll Kelani
UCL Supervisor: Philip Treleaven
Technologies: Python, Jupyter, Scikit-learn
Abstract: This dissertation analyses the impact of a circuit breaker machine learning system in various case studies. The circuit breaker paradigm is designed to detect when a system isn't working as intended and then interrupt it or carry out another designated function. The use of machine learning has elevated many fields and so naturally appears as a useful inclusion in this paradigm. Its purpose is to detect when an algorithm isn't behaving correctly. We investigate and use different anomaly and outlier detection techniques across multiple case studies and assess their suitability. This is important as many software systems are relied on to work as expected, at all times. This can cause large issues especially in sensitive environments such as for trading systems in the financial market. We test the techniques used to detect the abnormal behaviour of software to demonstrate their reliable performance across different domains.

Automatically batching neural networks by creating an SPMD extension for Julia

Author: Marco Concetto Rudilosso
UCL Supervisor: Pontus Lars Erik Saito Stenetorp
Technologies: Julia
Abstract: Writing code for deep learning models has been made easier by the emergence of specialised frameworks which can automatically compute gradients. One of the issues that these don't seem to solve fully is how to make it easier for people to run their models on batches of inputs in parallel. This project aims to solve that, by extending the Julia language to support SPMD, which will allow users to write their models in a non-batched fashion and run them on batches thanks this extension.

Student Household Management System

Author: Iustin Targovet
UCL Supervisor: Rae Harbird
Technologies: Node.js, Jasmine, Azure/GCP
Abstract: A major issue right now is how students fail to properly organise their chores, shopping list or notes about things going on in the house. I decided that a service providing some organisation for these students would be very useful. My project consists of designing, implementing, testing and deploying an API that will make these tasks easy to implement in any household. The three features that mark the outline of the project are:
1. A virtual fridge where students can post notes for all the others to see
2. A Common shopping list that users will be able to check and get notifications from regularly when some product is missing from the house or when something has been bought
3. A chore timetable that also implements a reward system to encourage doing the chores that are assigned to you.

Modal Logic Theorem Provers and Validity Rates

Author: Sergio Hernández Gutiérrez
UCL Supervisor: Robin Hirsch
Technologies: Java, Python
Abstract: This project has been focussed on the development of a theorem prover for various modal logic systems, as well as on a study on the tendencies of the validity rate of propositional and modal formulae as the size of such formulae increases. The theorem prover has been designed and implemented in Java for modal logics K, T, B, D, L and 4, as well as for any valid combination of such frame conditions. It has been thoroughly tested for correctness, completeness and termination. Using the prover and a random formula generator also developed during the project, data on the validity rate of formulae has been gathered for a wide range of sizes and different sets of connectives and systems.

Dimension Estimation for Fractals in 3D Space

Author: Sijin Sun
UCL Supervisor: Robin Hirsch
Technologies: Python
Abstract: Fractals are modern concepts introduced to denote chaotic geometric shapes with non-integer dimension. The standard approach of box-counting is widely utilised for fractal dimension estimation of 2D pictures. Despite its potential, box counting is less implemented for dimension calculation of 3D real-world objects and higher dimensional mathematical formulae. In this project, we introduce a python program to estimate the fractal dimension from 3D models and complex formula. Our box-counting method is the first one to give an estimated result of three to the open question in Fractal Geometry: What is the Fractal Dimension of the Mandelbulb?

Genetic algorithms and theoretical foundations in Cluster Editing

Author: Miron Zelina
UCL Supervisor: Robin Hirsch
Technologies: IBM ILOG CPLEX, C++
Abstract: Cluster editing is a subproblem within graph clustering, which has always been an important task across many disciplines. This project investigates the effectiveness of genetic algorithms at the task and also serves as a review of the literature and theory around the subject.

A New Worker Satisfaction Framework for the Generalised Assignment Problem

Author: Ibrahim Emara
UCL Supervisor: Robin Hirsch
Technologies: Java, Watchmaker Framework
Abstract: The Generalised Assignment Problem (GAP) is an optimisation problem which aims to find the best possible assignment of tasks to workers. Unfortunately, the traditional problem definition of the

GAP is only suitable in models where the agent has no choice but to accept the proposed task allocation as it does not take the notion of worker satisfaction into account. In the modern age, there are various task-allocation models where consideration needs to be given towards worker satisfaction. For example, in the context of online task-based crowd-sourcing, it is the case that workers only accept a task if they find it more desirable than the other tasks available. This paper will introduce a new version of the GAP which takes these issues into account and will produce a Genetic Algorithm aimed at solving this new version of the problem.

UCL Attendance Tracker

UCL Supervisor: Sarah Sanders
Technologies: Python, Flask, Azure, Docker, Android, MySQL, Selenium
Abstract: This project aims to create improvements to the current registration system provided at University College London (UCL). Teachers are required to take a register of all students in each lecture with the main method being through physical signatures. Such methods can be time-consuming and often lead to unreliable results. Furthermore, useful analysis can be taken of this data and relayed to all parties for insights on progression, health and efficiency. This is completed with the use of multiple modern technologies for an automated system of the entire registration process. The end users of students, teachers and admins have access to a comprehensive report of all their data. As a result, the downtime of taking registers in lessons is minimised while gaining useful data beneficiaries for all of UCL.

Examination of Local Interpretable Model Agnostic Explanations (LIME) of a Recurrent Neural Network on Natural Language Inference Classification Tasks

Author: Noa Luthi
UCL Supervisor: Sebastian Riedel
Technologies: LIME, Python
Abstract: The complex nature of Deep Learning algorithms create opaque classification models whose predictions are difficult to interpret. This raises concerns about these models' transparency which as a result are known to be described as "black boxes". I will be looking to understand the predictions of a Recurrent Neural Network using two Natural Language Inference (NLI) data sets. I am producing and analysing human interpretable and faithful explanation of the NLI tasks using the LIME tool – Local Interpretable Model Agnostic Explanations. I will be assessing and establishing the reliability of the model, which was previously found to produce highly accurate results in several NLI classification tasks on various datasets. Finally, the explanations and their analyses are used to identify drawbacks in the model and evaluating LIME's effectiveness.

Automatic Student Register by Matching Mobile Photos

Author: Alex Hale
UCL Supervisor: Shi Zhou
Technologies: Python, Dlib, AzureML
Abstract: Existing attendance monitoring solutions are inaccurate and prone to manipulation, with the increasing use of attendance monitoring at universities an alternative is needed. This project investigates the use of face recognition for generating attendance sheets from photos of lectures, in particular, the use of mobile phones to provide a cheap and simple implementation by not requiring additional dedicated hardware. The project will deliver a reference implementation of such a system as well as survey face recognition and best practice, with a particular focus on the use of mobile phone images.

Human Detection in Aerial Frames

Author: Cosmin Vladianu
UCL Supervisor: Simon Julier
Technologies: Python, Tensorflow, Keras, Jupyter Notebook
Abstract: Drones have the potential of being the ideal tools for reconnaissance and rescue missions, however, to utilise them to their full potential, we need to understand the impact of the environment and behaviour of the drone on the performance of object classifiers. My project analyses how these factors affect the accuracy of a popular Convolutional Neural Network, Retinanet, and proposes techniques which improve the precision of human detection in aerial frames, while trying to minimise the detection of other objects.

Hololens Hand Tracking

Author: David Stepanov
UCL Supervisor: Simon Julier
Technologies: Hololens, Unity, Vuforia, OpenCV, Python, Socket.IO
Abstract: Augmented reality and Hololens have a wide range of applications in the industry. It's essential that the user's hands are not obscured by holograms. A system for detecting and masking hands in an augmented reality environment on the Hololens is proposed. The system detects the user's hands using OpenCV using a webcam connected to a PC. The hands' coordinates are transformed to the perspective of the Hololens, then transferred to the Hololens via a WebSocket connection and finally rendered in the Hololens virtual environment to mask them. Two calibration mechanisms using Vuforia and OpenCV are explored. The whole end-to-end system is tested and evaluated.

Improved user guidance and tracking in AR Apps

Author: Brian Gunawan
UCL Supervisor: Simon Julier
Technologies: ARKit, Swift
Abstract: Positional guidance for users towards a point of interest in AR applications is not well developed and often requires real-world feedback. We aim to explore persistent maps in augmented reality applications and evaluate new ways to express the positional information of points of interests relative to the user and guide them towards them intuitively.

Who participates in the sharing economy?

Author: Vlad Popa
UCL Supervisor: Simone Righi
Technologies: Python, Scrappy, Pandas, clustering algorithms etc.
Abstract: Airbnb is growing in importance over the last years, and an analysis of the actors in this industry is of significant relevance. Our project focusses on gathering the data of the properties from London, extracting features from the available information and interpreting these results. The final goal is to gather information about the participants in the sharing economy and identify common features and clustering similarities.

Determinants of Real-estate Price in Budapest

Author: Tianshan Li
UCL Supervisor: Simone Righi
Technologies: Python
Abstract: This project aims to identify the main determinants of residential and commercial real-estate price in Budapest using information about properties currently available for rent or purchase on publicly available websites.

SDN Topology Discovery and Vulnerabilities

Author: Ryan Collins
UCL Supervisor: Stefano Vissicchio
Technologies: Python, Rust, Mininet, Ryu, NetworkX
Abstract: The problem this project concerns, is what information can be discerned about a software-defined network when different traffic engineering techniques are deployed. The methods employed to tackle this issue involve continuous monitoring of traffic and different ways of saturating the bottleneck links. The results achieved while not completely replicable in a real-life scenario, show us some of the extents of what can be done.

intelligent Active Intrusion Management (iAIM)

Author: Dragos Andrei Popa
UCL Supervisor: Steve Hailes
Technologies: MATLAB, Simulink
Abstract: As the world relies more and more on the stability of industrial plants that produce energy, water cleaning, transport and so on, attacks on such plants are becoming more of a threat of severe disruption than ever. Thus, the iAIM project is analysing the behaviour and outcome of industrial plants during different types of simulated attacks, improving detection mechanisms of security breaches.

Adding Global Illumination to Foveated Rendering using Reflective Shadow Maps

Author: Linas Beresna
UCL Supervisor: Tobias Ritschel
Technologies: glsl, Plexus, openGL
Abstract: Foveated rendering is a new field where only parts of a viewpoint need detail, the surrounding area is not focused by the eyes, and thus extra computation there is wasted. A fast and effective way of computing global illumination is needed for a scene, with a focus on real-time accuracy on where there is a focus. Reflective shadow maps add global illumination and are transferable to foveation. The aim is to add indirect lighting that has more detail in the fovea and therefore less workload in the peripherals, while still being accurate.

Developing sparse probabilistic models from real data using complex networks

Author: Ioan-Daniel Savu
UCL Supervisor: Tomaso Aste
Technologies: Python
Abstract: The current work extends a cutting-edge, score-based algorithm for estimating the structure of Markov Random Fields from noisy data: the Maximally Filtered Clique Forest (MFCF). It explores the chordal graphs resulting from MFCF using various gain functions and introduces an element of innovation - the first non-linear gain function. Moreover, a heuristic is proposed which improves the accuracy of all the gain functions under certain conditions.

Using Facial Recognition to Monitor Attendance

Author: Sam Pham
UCL Supervisor: Yun Fu
Technologies: Node.js, OpenCV, Microsoft FaceAPI, Angular, Android
Abstract: We aim to create a system with a native Android app and a web app working in tandem to be able to take attendance via facial recognition with the potential to replace the current paper method. We have explored machine learning techniques for facial recognition and compared the performance, by benchmarking, of different facial recognition algorithms and APIs to create a reliable and fast automatic attendance checking system.

What's Next for the IXN?

Our term-time project programme is growing to have a national reach with the IXN for the NHS, with a goal to work with universities across the UK that are looking to engage with us in the coming year.

We are especially pleased to be building upon student project relations with our top US university colleagues at Harvard, Stanford and Berkeley Universities in the coming year. We also have a long-standing relationship with NII Tokyo in Japan, with groups of students taking it in turns each year to visit London or Tokyo.

At UCL we will continue the yearly fine-tuning of our teaching processes. We look forward to the IXN Innovation sessions over the summer period and the insights in preparing for a larger cohort of highly capable Computer Science students to get access to what they want to study most. Most importantly is continuing to enable students to publish their findings, small and large, and to be a part of contributing to society.

If you are visiting us for our Student Showcase, and you are looking for potential internship students to assist you on projects outside of term time, please get do in touch with the Strategic Alliances Team at **cs.strategicalliancesteam@ucl.ac.uk**

Special Thanks

To all our amazing students and staff, those who support the students every day, internally and externally. For all the partners cited in this book, all of the families and friends who look after the students and staff in this book, the book is dedicated to you for giving our students the opportunity to reach out and change the world.

As the leading sponsor for our undergraduate IXN programme, thank you to Microsoft for the outstanding support given to our students and to IXN.

We would also like to thank all of our partners for supporting IXN and providing such interesting projects.

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