

# LIST OF STAFF PROJECTS

2020 – 2021

This document contains a list of staff proposal for final year projects.

Make a note of the project number (from the list) and explore the details of the project you like from this list. You will need to enter the selected project number in the online form of the Project Preference Selection ([here](#)).

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## Proj. # 1. **Epidemic Consensus for Blockchain**

**Project description** (max 100 words): Blockchain is an online distributed ledger (database) that is designed to build and maintain a single chain of agreed transactions that is immutable, global and distributed. In Blockchain all nodes must interact and agree seamlessly, validating blocks of transactions. Consensus in Blockchain can be achieved using Proof-of-Work or Proof-of-Stake. However, these have been shown to have critical limitations. In this project Epidemic Protocols will be adopted to develop a solution to the distributed consensus problem for Blockchain. Epidemic or Gossip-based protocols adopt a bio-inspired communication strategy which is based on a similar mathematical model of the exponential and uncontrollable spread of infectious diseases. Epidemic protocols are suitable for large and extreme scale, distributed and dynamic systems. They can be adopted to disseminate information (exponential propagation) and to aggregate information in a large and extreme-scale distributed environment using randomised communication. The project will develop and test algorithms for epidemic consensus for Blockchain.

**Keywords** (max 5 keywords): Blockchain; Epidemic Protocols; Gossip-based Protocols

**Project learning outcomes: (max 3 sentences):**

- Improving Java programming
- Learn about Blockchain
- Learn about Distributed Consensus

**Skills/knowledge/technologies used/acquired:** Blockchain; Java; Consensus

**Prerequisite for the project:** good Java programming skills

## Proj. # 2. **IoT-Wine, an IoT-based Wine Cellar Hygro-thermometer Monitor**

**Project description** (max 100 words): The hardware and software system is intended to monitor the conditions of wine cellars. Hygro-thermometer sensors are used to measure the temperature and humidity of the environments in which they are situated. Data is transmitted via a WiFi network to the server application. The application helps to collect, store, monitor and analyse the conditions of the environment in which the wines are stored. Data from the sensors are stored in a database and continuously monitored. Real time alarms based on user-defined rules, are sent by email to the user. Periodic (e.g. weekly/monthly) reports are also sent by email to the user. In the project server and client Android applications will be developed to manage data generated by multiple sensors. The sensor devices will be built using Raspberry Pi units or other hardware platforms. The system will be deployed and demonstrated with the University SCR wine cellars.

**Keywords** (max 5 keywords): IoT; Data-driven Web Application; Progressive Web App (PWA)

**Project Learning outcomes: (max 3 sentences):**

- Learn how to program a low-cost single board computer for building IoT devices
- Learn how to develop a modern complete web application using the PWA paradigm
- Improve your programming skills while developing a real-world application

**Skills/knowledge/technologies used/acquired:** IoT; programming; system integration, user interface and interaction design

**Prerequisite for the project:** good programming skills

### Proj. # 3. **Opinion Leader, fully decentralised online opinion polls**

**Project description** (max 100 words): Surveys of public opinions are typically drawn from a very small sample of the entire population. They also rely on a centralised server or service (e.g., a poll agency). Obvious issues are associated with the centralised nature of this model. Does the (small) sample size provide sufficient guarantees for extrapolating general conclusions? Will a centralised service run under a private administrative control be unbiased and objective? Would the results be available anytime and anywhere without the interference of policy makers and private interests? Decentralised mobile applications do not rely on a server or a service provider: they rely on a voluntarily/collaborative peer-to-peer model. The project will implement "Opinion Leader", a fully decentralised online application for opinion pools. Anyone can start an opinion pool or become the next opinion leader by initiating a viral poll. No one can stop or interfere with a real-time global aggregation of opinions by means of an epidemic communication protocol. A successful project will provide an implementation of an Android P2P application with a client GUI and a server-based simulator of a P2P community to demonstrate the Android application in a large-scale simulated network.

**Keywords** (max 5 keywords): keyword1; keyword2; keyword3

**Project Learning outcomes: (max 3 sentences):**

- Learning about Peer-to-Peer Computing and Communication
- Improving Java programming skills
- Learn how to develop Android applications

**Skills/knowledge/technologies used/acquired:** P2P systems, Android; Java

**Prerequisite for the project:** good Java programming skills

### Proj. # 4. **WiFi-based Location Prediction**

**Project description** (max 100 words): The Global Positioning System (GPS) is the most popular and accurate outdoor localisation system. In indoor environments, however, it often has considerable limitations. Indoor localisation can be predicted by the signal strength of WiFi access points. Many buildings are equipped with WiFi access points, whose position rarely changes and whose presence is visible to any WiFi-enabled device. The project will implement a predictive data mining algorithm within an Android application. The signal strength of WiFi access points is used to build a fingerprint of the location. The Android app is used to collect fingerprints of different environments. The collected data will be used to generate a predictive model for indoor localisation.

**Keywords** (max 5 keywords): WiFi Localisation; Android; Java

**Project Learning outcomes: (max 3 sentences):**

- Learning about WiFi technology and protocols
- Improving Java programming skills
- Learn how to develop Android applications

**Skills/knowledge/technologies used/acquired:** Android; Java; WiFi

**Prerequisite for the project:** good Java programming skills

## Proj. # 5. **Machine Learning Algorithms for the Data Science platform KNIME**

**Project description** (max 100 words): KNIME is a leading Data Science platform, which is open source and free. It includes an extensive number of algorithms for data manipulation, transformation, analytics and mining. Classification, Clustering, Regression, Association Rule Mining, Outlier Detection are the main data mining problems that machine learning can help to solve. This project will develop an implementation of some machine learning algorithm for KNIME. The algorithm will be integrated into the platform and tested. Finally, the new KNIME extension will be submitted to the community server to make it available to all KNIME practitioners.

**Keywords** (max 5 keywords): Data Science, Machine Learning, KNIME; Java; Eclipse

**Project Learning outcomes: (max 3 sentences):**

- Learning about Machine Learning and Data Science
- Improving Java programming skills and its metaprogramming framework (Reflection)
- Learn how to develop Eclipse/KNIME plugins

**Skills/knowledge/technologies used/acquired:** Eclipse; Java; KNIME

**Prerequisite for the project:** good Java programming skills

## Proj. # 6. **Big Social Data Analytics: learning from Twitter streams**

**Project description:** Algorithms and tools for Data Science, Machine Learning Data-driven applications, Big Data

**Keywords:** Data Science and Machine Learning

**Skills/knowledge/technologies used/acquired:** Eclipse; Java; KNIME

**Prerequisite for the project:** good Java programming skills

## Proj. # 7. **A web-based computer science curriculum analytical application**

**Project description** (max 100 words): This project will take a data-driven approach to analyse and manage the study curriculum which plays a key role in teaching and learning of computer science. The targeted end-users are CQSD at the university level, the department management team, lecturers, and students.

The CS curriculum comprises four interrelated features, i.e. disciplinary subjects across 3 study years, various CS module delivery methods, assessment and feedback provision, and student learning support. This project proposal seeks students who will work in a group of 3 members to develop a web-based application which is expected to perform functions to satisfy the requirements of (1) curriculum data management in a database; (2) 360 curriculum data analysis, (3) interactive data visualisation; and (4) recommendation for decision-making.

The three projects will independently conduct the development as follows:

- Project A - the requirements of curriculum data management in a database; and recommendation for decision-making
- Project B - the requirement of 360 curriculum data analysis;
- Project C – the requirement of interactive data visualisation.

In order for the three sets of resultant program to be integrated in the future, the three projects are desirable for adopting compatible platform and programming language.

**Keywords** (max 5 keywords): computer science curriculum, data/process analysis, data visualisation, statistics; web-technology

### **Project learning outcomes: (max 3 sentences):**

- To articulate problem context (e.g. CS curriculum) with the adoption of methodologies;
- To apply data-driven theories, technical knowledge/skills to develop a required program/system;
- To develop creativity and criticalness in solving problems.

### **Skills/knowledge/technologies used/acquired:**

- Essential: Programming, Excel/database technology, web technology – all projects  
Open source data visualisation tools (e.g. Tableau), statistics – Project B and C
- Desirable: KNIME, data cleansing.

**Prerequisite for the project:** None.

## Proj. # 8. **Computer Science degree project management system**

**Project description** (max 100 words): The Computer Science (CS) study programme contains the degree project which is worth of 40 credits in the final year of studies. Students undertake their project in a process through project idea accepted, a supervisor and an assessor (at later stage of the project) assigned to each project student, regular supervision carried out and progress logged, a number of formative and summative assessments attended. Such activities closely involve students, supervisors, and assessors throughout an academic year. Project management by both students and staff members need to be coordinated and monitored. This project proposal seeks students who will work in a group of 2 members to develop a web-based degree project management system which will be expected to perform functions to satisfy the requirements of (1) project data management in a database; (2) project idea and expertise matching, (3) deadline and assessments monitoring ; and (4) recommendation for decision-making. Some idea would be: Developing an application to assist users selecting a degree project; Developing an application to assist assigning experts to supervise degree projects; and Developing an application adding assessors' examination process

The two projects will independently conduct the development as follows:

- Project A - the requirements of project data management in a database and project idea and expertise matching;
- Project B - the requirement of project data management and deadline and assessment monitoring.

**Keywords** (max 5 keywords): database management; project management process, assessment management, web-technology

### **Project Learning outcomes: (max 3 sentences):**

- To articulate problem context (e.g. degree project process and management) with the adoption of methodologies;
- To master database technology, such as SQL and web-technology
- To develop creativity and criticalness in solving problems.

### **Skills/knowledge/technologies used/acquired:**

Essential: Programming, database technology, web technology – all projects

Desirable: KNIME, API technology

**Prerequisite for the project:** None.



## Proj. # 9. Interactive dashboard applications

**Project description** (max 100 words): In a sense making process, the human brain processes information to grasp the meaning of multiple data dimensions when they are displayed in charts and graphs. A number of quantitative methods are normally adopted to analyse vast amount of data and graphical tools can then be employed to present results for purposes. However, recent innovations in hardware, analytics and mobility require the analysis of data effectively and communicate results with users via statistic graphics efficiently. Projects under this theme will inquiry data visualisation concepts and principles as well as visual analytics tools, and develop interactive data visualisation methodology and device. Some ideas would be: Interactive dashboard aiding computer science curriculum analytics and visualisaiton and Driving Behaviour Prediction vs Road Safety

**Keywords** data analysis, data visualisation, 360 views

**Skills/knowledge/technologies used/acquired:**

Programming, Excel/database technologies, open source visual analytical tools (e.g. Tableau), KNIME

**Prerequisite for the project:** None.

## Proj. # 10. Data integration and analysis

**Project description** (max 100 words): Data integration (DI) is a widely adopted method in commercial world that repurpose data by transforming transactional data to a common form found in a data warehouse (DW). DWs, therefore, are central repositions of integrated data from one or more disparate data sources (e.g. transactional databases, files). DI normally support two broad practical areas: 1) online analytical processing (OLAP) creating analytical reports to support decision making, and 2) a migration, consolidation, and synchronization of transactional databases, as well as exchanging data in a business-to-business context. Projects in this theme aim to develop a prototype of data warehousing application which enables the transactional data from multiple and distributed databases to be processed in appropriate levels of summary and abstraction. The processed data (defined as informational data) will be relevant to chosen problem contexts to support the intended business purposes. This project requires adopting the data warehousing design methods (e.g. Star Schema, and data mart) as well as good database and programming skills for an implementation of a DW application.

**Keywords** data integration, ETL, data warehousing

**Skills/knowledge/technologies used/acquired:**

Programming, database technologies (e.g. Microsoft SQL Server), ETL technologies (e.g. KNIME), Star Schema

**Prerequisite for the project:** None.

### Proj. # 11. **Neural network for forecasting and pattern classification.**

**Project description** (max 100 words): Students in this project is require developing a neural network toolbox for the forecasting and pattern classification. In the real-world two tasks are crucial in the industry: (1) Forecasting such as price of stock, product demand and supply, and crude oil price. (2) Pattern classification is another dimension of classifying objects in groups is crucial in the industry such as identifying defected quality and good quality object in a product packaging line.

**Keywords** (max 5 keywords): Neural network; Backpropagation; Prediction; Classification

**Project outcomes: (max 3 sentences):**

- understanding of machine learning techniques
- understanding of real-world problems formulation
- ability to apply tools for solving problems

**Skills/knowledge/technologies used/acquired:** Java programming; Neural network;

**Prerequisite for the project:** Interest in machine learning

### Proj. # 12. **Swarm intelligence for function optimization**

**Project description** (max 100 words): Students in this project require to develop a continuous function optimization toolbox. Swarm intelligence a branch of artificial intelligence study where algorithms inspired by Swarm behaviour are used to optimize Combinatorial (discrete) and Continuous functions. Various real-world problems (e.g. best route from one point to another) are represented as either mentioned function types. Therefore, finding the best solution to a function Swarm Intelligence can be used.

**Keywords** (max 5 keywords): Swarm Intelligence; Continuous function; Discrete functions; Optimization

**Project outcomes: (max 3 sentences):**

- understanding of continuous and discrete functions
- application of swarm intelligence to function optimization
- development of a software tool

**Skills/knowledge/technologies used/acquired:** Knowledge important mathematic concept of optimization

**Prerequisite for the project:** No specific requirement, but interest in Java may be helpful

### Proj. # 13. **Signal processing of human physiological response (EEG signals)**

**Project description** (max 100 words): This project offers a student to study physiological signal of humans and understand pattern using machine learning algorithms. Student to study literature of EEG signal processing algorithms and their properties and find the best algorithm to implement and improve pattern recognition. This project uses a physiological device and human participant. The project is in collaboration with Bio-Tech department.

**Keywords** (max 5 keywords): Physiological signal processing, Machine learning, Pattern recognition

**Project Learning outcomes: (max 3 sentences):**

- understanding of machine learning algorithms
- understating of physiological signal processing
- application of techniques to apply on real-world human data

**Skills/knowledge/technologies used/acquired:** Knowledge of signal processing, collection and pre-processing data, and use of machine learning.

**Prerequisite for the project:** No specific requirement, interest in working for exiting real-world application

### Proj. # 14. **Data visualization and analysis of the Computer Science curriculum**

**Project description** (max 100 words): The university of reading Computer Science (CS) curriculum is an agglomeration of a varied nature of modules: application, theoretical learning, practical programming practices. This led to differences in the module's coursework natures; students work load balance; and assessment and feedback times. To gage on overall curriculum and efficiently manage the quality, it requires a comprehensive web-based tool. This project aims to develop a web-based tool for analysis and visualization of CS curriculum data. This can also be done in a Group.

**Keywords** (max 5 keywords): Data visualization; Data Analysis; Statistics; Web-Technology

**Project Learning outcomes: (max 3 sentences):**

- understanding of Computer Science curriculum
- understanding of data processing and data visualization techniques
- application of tools on real-world data

**Skills/knowledge/technologies used/acquired:** Knowledge of data visualization techniques, data pre-processing specific to data visualization and statistics

**Prerequisite for the project:** No specific requirement but interest in developing tool based real data and contribution toward department curriculum analysis may be helpful.

### Proj. # 15. **Chatbot - natural language processing**

**Project description** (max 100 words): Chatbot is current trend in the artificial intelligence field. Mostly as a tool for customer assistance. The idea behind chatbot is to create a system that learning from users question and provide answer to the user based on semantic analysis of the user's question. This project uses natural language processing (NLP) and machine learning (ML) techniques to build a system that can understanding users' inputs and classify them into right topics for feedback to the users.

**Keywords** (max 5 keywords): Natural language processing; Machine learning; and Chatbot

**Project Learning outcomes: (max 3 sentences):**

- understating of natural language processing
- understanding of the machine learning
- Application of the techniques for Chatbot.

**Skills/knowledge/technologies used/acquired:** Knowledge of NLP and ML

**Prerequisite for the project:** Not specific, interest in artificial intelligence.

### Proj. # 16. **Speech processing**

**Project description** (max 100 words): Speech processing an artificial intelligence technique that process human speech, music, and other sound. In this project student will try to capture sound in the university campus and town centre classify the type of sound. This project going to uses machine learning (ML) techniques to build a system that can understanding sound and classify them into right type of sound like cars, construction, lunch canteen, and supermarket. Another idea could be accent classification or language classification.

**Keywords** (max 5 keywords): Speech processing; Machine learning

**Project Learning outcomes: (max 3 sentences):**

- understating of speech processing
- understanding of the machine learning
- Application of the techniques for sound classification.

**Skills/knowledge/technologies used/acquired:** Knowledge of ML

**Prerequisite for the project:** Not specific, interest in artificial intelligence.

## Proj. # 17. Compiling to register machines

**Project description** (max 100 words): An amazing result in computation theory is that a “register machine” or “Minsky machine” with no addressable memory and just 2 unbounded integer registers and 4 primitive instructions (namely register increment, register decrement, unconditional jump and jump if zero) can compute any computable function. The goal of this project is to demonstrate this by producing a compiler that takes a program in a high-level language such as Java and produces machine code that can be executed by a register machine. The Babycino MiniJava compiler from the Compilers module could provide a starting point for this project.

**Keywords** (max 5 keywords): computation theory, compilers

**Learning outcomes: (max 3 sentences):** Students completing this project should be able to:

- describe a register machine;
- explain constructively how a register machine can compute any computable function;
- develop a compiler for a very restrictive target architecture.

**Skills/knowledge/technologies used/acquired:** Knowledge of basic computation theory will be acquired.

**Prerequisite for the project:** Java programming, Compilers and Computer Architecture.

## Proj. # 18. Lossless steganography

**Project description** (max 100 words): Steganography is the process of hiding data (the “payload”) inside other data (the “carrier”). For many file formats, there are multiple possible encodings of the same data. For example, in an image format that supports compression (such as PNG) an image may be stored compressed or uncompressed. A payload can be hidden within a carrier image by choosing which parts of the image to compress and how. The goal of this project is to develop a program that uses this method to encode/decode a payload within a suitable carrier format.

**Keywords** (max 5 keywords): steganography, binary file formats

**Learning outcomes: (max 3 sentences):** Students completing this project should be able to:

- explain the details of how some real-world binary file format encodes data;
- use bit-level operations to read and write files that conform to a binary file format specification;
- develop a program that encodes/decodes a payload within a binary carrier file format.

**Skills/knowledge/technologies used/acquired:** Knowledge of the details of some binary file format will be acquired.

**Prerequisite for the project:** Familiarity with bit-level operations (such as bitwise shifts, NOT, AND, and OR) in any programming language.

## Proj. # 19. **Silent disco app for Android**

**Project description** (max 100 words): In a conventional disco, participants dance to music played over loudspeakers. In a silent disco, participants dance to music played through headphones. The advantage of this is that the silent disco does not disturb others in the area. Silent discos usually operate using specialist FM radio headphones and short-range FM transmitters. The goal of this project is to produce a system that replicates the experience using wirelessly networked Android devices, allowing participants to join the disco using their own phones and headphones. The audio needs to be streamed efficiently and reliably and playback on all participants' devices must be synchronised.

**Keywords** (max 5 keywords): Android, audio streaming, real-time networking

**Learning outcomes: (max 3 sentences):** Students completing this project should be able to:

- design and implement UDP-based network protocols;
- explain the difficulties of reliable, real-time communication and how to overcome them;
- develop Android apps that use networking and audio playback APIs.

**Skills/knowledge/technologies used/acquired:** UDP, multicast, Android development

**Prerequisite for the project:** Some familiarity with network programming would be helpful.

## Proj. # 20. **Multiplayer networked game**

**Project description** (max 100 words): The goal of this project is to produce a networked multiplayer computer/video game. You have some freedom to choose what style of game to produce (turn-based, real-time, graphical, text-based, virtual reality, and so on), but you should focus on the networking aspect. You could consider: how potential players will find each other online and agree to start a game; how to share game state while minimising network traffic and the potential for cheating; what to do if the network connection is unreliable or intermittent; and (particularly for real-time games) how to ensure synchronisation between players' views of the game world. Some ideas would be: Multiplayer networked 2D car racing game; Multiplayer text adventure game (MUD); Multiplayer networked virtual reality table tennis game

**Keywords** (max 5 keywords): games, networking

**Learning outcomes: (max 3 sentences):** Students completing this project should be able to:

- design and implement network protocols;
- explain the difficulties of creating a networked game and how to overcome them;
- develop a multiplayer networked game.

**Skills/knowledge/technologies used/acquired:** You will probably want to use some existing networking and graphics libraries.

**Prerequisite for the project:** Some familiarity with network programming would be helpful.

## Proj. # 21. Computer solution of puzzle games

**Project description** (max 100 words): There is a wide variety of turn-based “solitaire” puzzle games. Often, these puzzles are amenable to solution by computer, either using some kind of heuristic-guided local search, or by encoding them as a constraint-satisfaction problem and using a generic external solver. The goal of this project is to produce a novel solver for such a game and evaluate its effectiveness. You might also consider the problem of how to generate interesting puzzle instances of varying difficulty. Some idea would be: Solver for “Rush Hour” block-sliding traffic puzzles; Solver and generator for Sokoban (crate pushing) puzzles; and Generator for crossword puzzles.

**Keywords** (max 5 keywords): games, constraint solvers, local search

**Learning outcomes: (max 3 sentences):** Students completing this project should be able to:

- use local search or constraint solvers to solve well-specified problems;
- evaluate empirically the effectiveness of a solution method for a problem;
- develop a computer implementation of a puzzle game.

**Skills/knowledge/technologies used/acquired:** Heuristic-based local search and/or SAT/constraint solvers.

**Prerequisite for the project:** A specific idea of a puzzle game you would like to write a solver for, and experience of solving instances of those puzzles yourself.

## Proj. # 22. Timetabling

**Project description** (max 100 words): Scheduling is a common but computationally hard problem. One example is the scheduling of lectures in the University, where many constraints must be satisfied simultaneously. Essentially, no room, student or lecturer may be allocated to more than module at any particular time. There are also some more complex constraints and some desirable but not essential “soft” constraints. The goal of this project is to produce a scheduling utility for some application (not necessarily university lectures) that makes it easy to specify constraints, solve them by computer and view candidate solutions. Some idea would be: School or university timetabling system; Sports or competition timetabling system; and Meal/diet planning system

**Keywords** (max 5 keywords): operations research, constraint solvers, local search

**Learning outcomes: (max 3 sentences):** Students completing this project should be able to:

- use local search or constraint solvers to solve scheduling problems;
- develop a user interface for specifying and viewing solutions to scheduling problems.

**Skills/knowledge/technologies used/acquired:** Heuristic-based local search and/or SAT/constraint solvers.

**Prerequisite for the project:** None beyond some programming ability.

### Proj. # 23. **Understanding performance behaviour of modern programming language on applications**

**Project description** (max 100 words): In computational science, many applications are still written in Fortran and C(+). While this typically results in performant code, the productivity of scientists dealing with such low-level programming languages is low.

In this work, we will explore the usage of various recent languages like Scala or Go regarding efficiency and single node performance. We have a short prototype code in C that can be rewritten in these languages.

**Approach:** Firstly, a measurement protocol and metrics are designed to quantify the impact of a programming language. Then, the test application (a 2D shallow water model) is implemented in one or multiple programming languages and the performance is analyzed on our testbed with various systems. Finally, the outcome is discussed with scientists from the field of climate/weather.

**Keywords** (max 5 keywords): Parallel computing, programming languages, study, climate/weather

**Learning outcomes: (max 3 sentences):**

- Understanding and analyzing of performance behavior of modern programming languages and hardware architectures
- Judging the effectiveness of programming constructs
- Applying principles from scientific computing in practice

**Skills/knowledge/technologies used/acquired:**

- Programming skills
- Understanding of performance factors in hardware and software

**Prerequisite for the project:**

- Programming skills
- Willingness to learn new programming languages

### Proj. # 24. **Monitoring Space Usage in Buildings with Data Science**

**Project description** (max 100 words): Understanding the usage of space in buildings is important to understand the performance of them and optimize the available room. For instance, one might want to understand why people prefer a certain seating space in a room, the relation between environmental conditions like CO<sub>2</sub> and room utilization and ventilation. Data science workflows can utilize this data and combine it with external data such as weather or term times to generate new knowledge about reasons behind the room utilization. This project will be embedded into a wider collaboration with the department of construction management and in a collaboration with ARM.

**Approach:** Firstly, a Raspberry PI appliance is constructed that incorporates various sensors (camera, environmental sensors) and deployed/installed into the computer room G45 and/or G56.

Then, a software is developed that computes various derived metrics (e.g., number of people, the utilized seats in the room) on the device. Finally, a data-science workflow is developed that extracts information from the captured data but also incorporates other data sources. Possibly, it could be a client/server infrastructure.



**Keywords** (max 5 keywords): Image analysis; Linux; data science.

**Project outcomes: (max 3 sentences):**

- Development of a flexible monitoring system for space utilization
- Application of data-science workflows

**Skills/knowledge/technologies used/acquired:**

**Prerequisite for the project:**

- Linux knowledge
- Understanding of the general data science workflow

### Proj. # 25. **Using NoSQL databases to store metadata**

**Project description** (max 100 words): The efficient management of metadata produced in computational science is crucial to deal with millions and billions of data products. In High-Performance Computing, a single experiment may run on 1000s of servers producing Petabytes of data products and metadata describing the meaning of this data.

The goal of this work is to develop a NoSQL solution for efficient extraction and injection of scientific metadata and make it searchable.

**Approach:** Firstly, a test environment of NoSQL databases is setup and tools to extract scientific metadata are created. Next, microbenchmarks are executed to quantify the performance behavior, and a performance model is derived for relevant use cases. Finally, the best NoSQL candidate(s) are deployed on larger scale and their performance behavior is measured and verified against the performance models. While we start on a small system, there is the opportunity to run the tests on a supercomputer!

**Keywords** (max 5 keywords): NoSQL Databases, Performance Analysis, Performance Modelling, High-Performance Computing

**Project outcomes: (max 3 sentences):**

- Understanding the domain of scientific computing
- Applying NoSQL databases to solve problems
- Understanding and analyzing of performance behavior of NoSQL solutions and hardware architectures

**Skills/knowledge/technologies used/acquired:**

- NoSQL tools like MongoDB, Apache SolR, or ElasticSearch (to be discussed which to use)

**Prerequisite for the project:**

- Knowledge of one NoSQL solution would be beneficial

## Proj. # 26. **Personalized Learning via Big-Data for C-Programming**

**Project description** (max 100 words): Personalized learning promises to aid the practitioner by prescribing suggestions of training that boosts personal strength or weaknesses. Additionally, it may predict the time for conducting a certain training or help to identify deficits. Besides these imminent benefit for student, similar techniques can be applied to assess lecture material and find missing training. We have an online platform to learn the C-Programming language (<https://oer.hps.vi4io.org>), where everyone can autonomously learn. Goal of this work is to develop a concept that harnesses big data for personalized training and to identify lecture deficits, and to deliver a prototype.

**Approach:** Firstly, a concept is designed that defines which user interaction are relevant and that can utilize machine learning techniques to predict time for exercises and prescribes tasks to cope for strength and weaknesses. Secondly, natural language processing techniques are applied to identify related topics of an exercise. Finally, a prototype system is developed, implemented, and evaluated on test data.

**Keywords** (max 5 keywords): Natural language processing, teaching, machine learning, web technologies

**Project outcomes: (max 3 sentences):**

- Designing of a data science workflow
- Understanding of personalized learning
- Extending of an existing web technology

**Skills/knowledge/technologies used/acquired:**

- C programming skills
- Development and deployment of big data workflows
- HTML, Python

**Prerequisite for the project:**

- Knowledge of the data analytics workflows

## Proj. # 27. **AI for games**

**Project description** (max 100 words): Using AI techniques such as machine learning to train an agent to play linguistic or video games. Some idea would be: Training an AI agent to play linguistic or video games.

**Keywords:** Machine Learning; Natural Language Processing

**Learning outcomes:**

- Learning both theoretical and practical advanced machine learning techniques.
- Learn how to process large dataset

**Skills/knowledge/technologies used/acquired:**

Python

**Prerequisite for the project:** None.

## Proj. # 28. **Social media analysis**

**Project description** (max 100 words): Using data mining and machine learning techniques to analysing social media. Some idea would be: Information Diffusion and Rumour Spreading over a Social media; Memotion analysis; common sense reasoning; Conversational recommender systems

**Keywords:** Recommender Systems; Machine Learning; Natural Language Processing; Chat bot

**Learning outcomes:**

- Learning both theoretical and practical advanced machine learning and natural language processing techniques.
- Learn how to process large dataset
- Learn how to develop and train a system to recommend movies to people.

**Skills/knowledge/technologies used/acquired:**

Programming language such as python

**Prerequisite for the project:** None.

## Proj. # 29. **Image analysis for disease diagnosis**

**Project description** (max 100 words): Using data mining, machine learning and image processing techniques for disease diagnosis. Some idea would be radiology image analysis for disease diagnosis.

**Keywords:** Machine Learning, image processing

**Learning outcomes:**

- Learning both theoretical and practical advanced machine learning techniques.
- Learn how to process large dataset

**Skills/knowledge/technologies used/acquired:**

Programming language such as python;

**Prerequisite for the project:** None.

### Proj. # 30. **E-Learning System**

**Project description** (max 100 words): The aim of the project is to create an e-learning system to help students learn a given topic, for instance, tree structures, computer operation or neural networks. The system may well be a web site. It should contain information for the student in a variety of forms, including potentially links to online resources, as well as opportunities for students to test their knowledge, as active learning is important. Javascript may well be used in any web page.

Note there can be multiple versions of the project, each student working on a different topic.

**Keywords** (max 5 keywords): Elearning; Active Learning;

**Project learning outcomes: (max 3 sentences):**

- A system to inform students about a topic
- A system which allows a student to determine if they understand the topic

**Skills/knowledge/technologies used/acquired:** Ability to program – can learn Javascript

**Prerequisite for the project:** Programming experience; Knowledge of relevant subject

### Proj. # 31. **DaisyWorld Simulation**

**Project description** (max 100 words): James Lovelock's Daisyworld is used to illustrate how life on a planet can influence its temperature. A simple model of it, used in Begin Robotics, is available at <http://www.personal.reading.ac.uk/~shsmchl/jsrobotstyle/demoDaisyWorldCalc.html>. The aim of this project is to develop a more advanced simulation, not necessarily on a web page, having a 3D near spherical world, with multiple species of daisies at different latitudes, which is susceptible to plagues and even animals such as foxes and rabbits. An advanced feature would be world in which the albedo of the daisies evolve.

**Keywords** (max 5 keywords): Daisyworld; Artificial Life; Evolution; Simulation.

**Project Learning outcomes: (max 3 sentences):**

- Simple Interactive Model of Daisyworld with multiple species
- 3D simulation
- Darwinian Daisyworld

**Skills/knowledge/technologies used/acquired:** programming, simulation, simulation

**Prerequisite for the project:** Programming

### Proj. # 32. **Robot Simulator**

**Project description** (max 100 words): A 3D simulation of a mobile robot moving round its environment is to be produced. This could be the ERIC Robot from Begin Robotics, in which case a model showing the rocking motion of its body is expected, or the 'Rover' in Begin Robotics, which would move around a complex terrain, etc. Suitable physics should be incorporated in the simulation, so that the robot moves realistically. The environment could be developed by the student, or the model could be incorporated in the Unity game environment. Autonomous and manual control of the robot should be available.

There can be different versions of this project, each simulating a different robot.

**Keywords** (max 5 keywords): Robotics; 3D simulation

**Project Learning outcomes: (max 3 sentences):**

- 3D model of robot moving round 3D environment
- Realistic physics incorporated

**Skills/knowledge/technologies used/acquired:** Programming, Simulation, 3D simulation, Unity

**Prerequisite for the project:** Programming, Graphical interfaces, some mathematics.

### Proj. # 33. **Cartoon Character Generator**

**Project description** (max 100 words): Sketchup is a user friendly package which easily allows 3D models of buildings for instance to be made. The aim of this project is to produce a similar user friendly system to allow a model of a cartoon character to be produced. For instance, a surface in SketchUp can be selected and pulled out – similarly part of a face could be selected and pulled out to generate a nose.

**Keywords** (max 5 keywords): 3D simulation; Graphics

**Project Learning outcomes: (max 3 sentences):**

- 3D model of robot moving round 3D environment
- Realistic physics incorporated

**Skills/knowledge/technologies used/acquired:** Programming, Simulation, 3D simulation, Unity

**Prerequisite for the project:** Programming, Graphical interfaces

### Proj. # 34. **Speaking Cartoon character**

**Project description** (max 100 words): A system is to be generated which can take in text and which produces an animated cartoon character speaking that text, with suitable movement, most important including the mouth, but ideally eyes, arms, etc. A 2D cartoon character is acceptable. Ideally the system will allow the user to define what the character looks like.

**Keywords** (max 5 keywords): Animated Cartoon Character; Text to speech.

**Project Learning outcomes: (max 3 sentences):**

- Simple cartoon character able to speak text
- User definable character
- Ability to generate a video

**Skills/knowledge/technologies used/acquired:** Programming, Text Processing, Animation

**Prerequisite for the project:** Programming, Graphics

### Proj. # 35. **ThreeD Fractals**

**Project description** (max 100 words): 2D Fractals were introduced in Part 1 and some shown in Begin Robotics : see <http://www.personal.reading.ac.uk/~shsmchlr/jscomp/demoFractal.html>. The aim of this project is to generate software to produce 3D Fractals. Associated with this will be the development of tools to render such 3D fractals, as well as other shapes – perhaps using Ray Marching.

**Keywords** (max 5 keywords): Graphics, 3D Graphics, Fractals.

**Project Learning outcomes: (max 3 sentences):**

- Resources for showing 3D scenes
- Generation and display of 3D Fractals.

**Skills/knowledge/technologies used/acquired:** Programming, Graphics

**Prerequisite for the project:** Programming

### Proj. # 36. **3D Family Tree Web Viewer**

**Project description** (max 100 words): The aim of this project is to generate a web page which will interactively show a family tree in various forms, including in three dimensions. The program should be able to read information from different data formats. Some ideas of what could be produced can be seen at [https://www.youtube.com/watch?v=WC\\_hwXF6wXQ](https://www.youtube.com/watch?v=WC_hwXF6wXQ)

**Keywords** (max 5 keywords): Interactive, Web Page.

**Project Learning outcomes: (max 3 sentences):**

- Program to read data from different formats
- Program to display family tree in 3D
- Suitable interaction.

**Skills/knowledge/technologies used/acquired:** Programming, Graphics

**Prerequisite for the project:** Programming

### Proj. # 37. **Escher inspired Virtual World**

**Project description** (max 100 words): I illustrate the different aspects of Cybernetics in an image inspired by MC Escher's Other World woodcarving <https://www.mcescher.com/gallery/back-in-holland/other-world/>. The aim of this project is to produce a 3D version of this or similar Escher carvings (see <https://www.mcescher.com/gallery/impossible-constructions/>) which can be explored by the user and the effects of changing perspective investigated. If Other worlds is chosen, then the portals could be used to illustrate aspects of computing the viewer could investigate.

**Keywords** (max 5 keywords): Interaction, Virtual Reality.

**Project Learning outcomes: (max 3 sentences):**

- 3D model based on Escher's work
- Program to interact with it suitably

**Skills/knowledge/technologies used/acquired:** Programming, Graphics

**Prerequisite for the project:** Programming

### Proj. # 38. **Password Manger**

There is a need for a systematic strengthening of capabilities for enhanced integrated cyber security and secure interoperability end-to-end through mobile applications and cloud computing services. In the context of Internet of Things (IoT) and “always-on” everything, the citizens’ self-help towards enhanced security for their multiple devices and controlling access to their data is to start with managing their password. This project investigates the password manger applications and creates a secure application that suggests and manages strong passwords for various spaces, devices and applications that a client may interact with through their everyday work and life in a hyper-connected network-centric environment.

### Proj. # 39. **Safe Travel around the City**

Incidence of crime in metropolitan areas would call for travellers and particularly young students new to a university town to be vigilant as to which areas are safest to live in and particularly walk through at night; which areas have experienced higher crime rates particularly personal assault. This project will use police crime data to map the post-codes-&-twitter-linked crime data on the city maps on an android phone as a sort of traffic light shading to show no-go zones and relatively crime free areas plus date and type of the latest crimes using appropriate graphic representations rather than text - at a glance urban safety companion.

### Proj. # 40. **Synthetic Data Generator Engine**

Proof of correctness, secure operation and process integrity validation of systems requires robust and comprehensive testing which in turn calls for design of systems for testability as well as the capability for relevant high fidelity synthetic data generation so that the system lends itself to modular and integrated testability for conformance assurance, dependability and usability. This project aims to formulate abstract data models for the target test domain and thus builds a synthetic data generator engine to characterise the properties of typical targeted input data for testing and generating such data en-mass for targeted use-cases. The quality of performance of the synthetic data generator has to be assessed e.g. in terms of the fidelity of the test data with respect to relevant syntactic, semantic and other criteria.

### Proj. # 41. **Safe Travel around the City**

Incidence of crime in metropolitan areas would call for travellers and particularly young students new to a university town to be vigilant as to which areas are safest to live in and particularly walk through at night; which areas have experienced higher crime rates particularly personal assault. This project will use police crime data to map the post-codes-&-twitter-linked crime data on the city maps on an android phone as a sort of traffic light shading to show no-go zones and relatively crime free areas plus date and type of the latest crimes using appropriate graphic representations rather than text - at a glance urban safety companion.

### Proj. # 42. **Distributed Ledger Technology (DLT)**

This would be some preliminary implementation of a use-case on Blockchain. The student is expected to examine the state-of-the art solution stacks offering blockchain implementation as a platform for development of some transactional processes in an application domain of choice; plus critical analysis of drawbacks if any with respect to indicative criteria which could be time/process/privacy/security) -

critical as relevant to the application domain and suggesting possible solutions to resolve/by-pass the problems.

### Proj. # 43. **Smart City Automatic Number Plate Recognition (ANPR) Traffic Modelling**

This project uses anonymised and/or synthesised ANPR data to carry out traffic modelling and mining for smart city management

### Proj. # 44. **Describing Supercomputer Hardware/Software using an Ontology**

**Project description** (max 100 words): We have designed a simple ontology specification language which uses simple python dictionaries to describe how numerical simulation is carried out. The project is to use these specifications to describe either the supercomputers of the top-500 or the software of some key climate models. (Any one student would do either of these, with two students, it could be done one each, or in partnership.) The project would involve some web and/or journal reading (to acquire the input data), some python programming to get information into and out of spreadsheets, and learning how to use simple tools to visualise networks of RDF triples (RDF is the "Resource Description Framework", a key component of the so-called "Semantic Web"). A stretch goal would be to consider how to serialise some of the descriptions into html using microdata.

**Keywords** (max 5 keywords): ontology, semantic web, RDF, supercomputing

**Project learning outcomes: (max 3 sentences):**

- Python programming
- Understanding key concepts involved in the semantic web
- Understanding key characteristics of supercomputing hardware/software

**Skills/knowledge/technologies used/acquired:** Software Engineering/Python/RDF

**Prerequisite for the project:** None. Previous python programming experience would be advantage but is not necessary.

### Proj. # 45. **Benchmarking Cloud Computing in the JASMIN cloud.**

**Project description** (max 100 words): The JASMIN supercomputer offers a dynamic "cluster-as-a-service" option. The exact specification of the service will change by the time this project starts, but it might be expected that it would be possible to build and deploy both SPARC and DASK clusters. The question arises as to whether these clusters will be suitable for I/O intensive workflows, so the students will involve will deploy one of these clusters (each), establish some measurement protocols, and make some performance measurements. The objective will be to make some statement about "usable compute intensity" for such clusters (i.e. defining what sort of workflows might be suitable).

**Keywords** (max 5 keywords): deployment, devops, cloud computing, workflow

**Project Learning outcomes: (max 3 sentences):**

- Devops experience with simple cluster configuration,



- Designing and carrying out performance measurements,
- Understanding how data science platforms really work.

**Skills/knowledge/technologies used/acquired:** DEVOPS: Ansible, Cloud Computing, Dask/SPARC, IOR

**Prerequisite for the project:** Undergraduate exposure to cloud computing concepts.

### Proj. # 46. **A face recognition system**

**Project description** (max 100 words): The project aims to develop a program which has the function to recognition person's identity based on the face information. It can be used for various applications, such as access control, attendance record, face-based search, etc. The following functions should be developed in the project.

- a graphic user interface;
- capture images from a camera, and save images as graphic files;
- implement face detection algorithms;
- implement face recognition algorithms;
- integrate face database;
- display recognition results showing rejection or acceptance.

**Keywords** (max 5 keywords): Computer vision; image processing; pattern classification

**Project learning outcomes: (max 3 sentences):**

- to be able to show a master-level of programming
- to be familiar with algorithms for face detection and face recognition
- to be able to implement an integrated program for face detection and recognition

**Skills/knowledge/technologies used/acquired:** programming, making use of open sources libraries, project management, knowledge of related ethical requirements

**Prerequisite for the project:** programming, image analysis is desirable.

### Proj. # 47. **Change detection based on remotely sensed image sequences**

**Project description** (max 100 words): Detecting land-cover changes can be achieved by using remotely sensed image sequences. This project aims to develop a program, which can automatically detect land-cover changes, such as green area changes, from load satellite images taken in different periods of time. Reporting the detected changes is also required in designed formats.

**Keywords** (max 5 keywords): remotely sensed images, change detection

**Project Learning outcomes: (max 3 sentences):**

- to be able to develop a user interface to load images in to the system;
- to develop algorithms for image processing and change detection;
- to be able to show the detected results in a formatted report.

**Skills/knowledge/technologies used/acquired:** programming, making use of open sources libraries, project management

**Prerequisite for the project:** programming, image analysis is desirable.

### Proj. # 48. **A real-time character recognition system**

**Project description** (max 100 words): This project explores various algorithms used in a real-time character recognition system. Information will be captured by a web camera as a video sequence. Characters in various orientations are captured by the camera through a USB port. The system should have following functions.

- capture video sequences from a web camera through a USB port;
- find the region of interest (ROI) which is an area with characters;
- segment characters in the ROI;
- recognise characters by various algorithms.

**Keywords** (max 5 keywords): character recognition, image processing

**Project Learning outcomes: (max 3 sentences):**

- to be familiar with algorithms used for image segmentation and character recognition
- to be able to implement the above algorithms by using programming languages
- to be able to develop an integrated program which can achieve the designated tasks.

**Skills/knowledge/technologies used/acquired:** programming, making use of open sources libraries, project management

**Prerequisite for the project:** programming, image analysis is desirable

### Proj. # 49. **Editing colour images**

**Project description** (max 100 words): This project is concerned with development of a software package, which has the function of editing colour images, such as remove objects or adding objects to an existing image. Based on different colour models, e.g. RGB (red, green and blue), HSI (hue, saturation, and intensity) or La\*b\*, objects in a colour image can be identified and rearranged as requested. In this project, the student requires to develop/implement image processing algorithms to achieve a designated goal.

**Keywords** (max 5 keywords): Colour spaces, image processing, algorithm development

**Project Learning outcomes: (max 3 sentences):**

- to be able to develop a user interface to load colour image files;
- to manipulate the loaded colour image by segmenting objects on the image and remove/adding objects from/to the image;
- to displace the edited image on the screen and save it in a storage system

**Skills/knowledge/technologies used/acquired:** algorithm development, image processing, programming, and project management

**Prerequisite for the project:** programming; image analysis is desirable.

### Proj. # 50. **Vision-based emotion detection**

**Project description** (max 100 words): Psychology reveals that human emotion is reflected in facial expressions and various gestures. This project aims to implement psychological findings based on visual information. It requires the establishment of relations between emotions and facial expressions or gestures. The project could start with investigating related psychological findings, then identifying visual information which would be captured by cameras, and finally developing computer vision algorithms to interpret human emotions. This application can be used as a mobile app, e.g. an Android app.

**Keywords** (max 5 keywords): emotion and facial expression, expression detection

**Project Learning outcomes: (max 3 sentences):**

- to be able to conduct research in the given area;
- to be able to analysis research results
- to develop computer vision algorithms for facial expression recognition

**Skills/knowledge/technologies used/acquired:** algorithm development, image processing, programming; knowledge of related ethical requirements, and project management

**Prerequisite for the project:** programming; skills of research and image analysis are desirable.

### Proj. # 51. **Multiple camera – based industrial inspection: document comparison**

**Project description** (max 100 words): This project aims to build an industrial inspection system, which captures images from multiple cameras and evaluates these images to make decision for “accept” or “reject”. The evaluation could use image processing techniques, such as image registration, pixel matching, etc. The system should have following functions.

- capture images from multiple cameras through controlled I/O ports, such as USB or Ethernet port;
- register each of the captured images with a reference image;
- allocate region of interest (ROI) based on pixel matching;
- evaluate words within the ROI for decision making.

**Keywords** (max 5 keywords): image registration, pixel matching

**Project Learning outcomes: (max 3 sentences):**

- to be familiar with algorithms used for image processing, such as acquisition, registration, and matching.
- to be able to implement the above techniques by using programming languages
- to be able to develop an integrated system which can achieve the designated tasks.

**Skills/knowledge/technologies used/acquired:** programming, making use of open sources libraries, project management

**Prerequisite for the project:** programming, image analysis is desirable

### Proj. # 52. **Simulator: process scheduling in an operating system**

**Project description** (max 100 words): The project could be developed as a web-based learning platform to teach students on the topic of “process scheduling” in an operating system. Multiple processes should be created to compete the CPU time. Various scheduling algorithms are implemented to schedule the processes. The simulator should have functions to calculate the average turnaround time and average waiting time based on given processes and scheduling algorithms

**Keywords** (max 5 keywords): process scheduling, operating systems, simulation

**Project Learning outcomes: (max 3 sentences):**

- to be able to implement various process scheduling algorithms
- to be able to develop an integrated web-based program with client-server communication models

**Skills/knowledge/technologies used/acquired:** process scheduling algorithms, programming; and project management

**Prerequisite for the project:** operating systems, programming.

### Proj. # 53. **Mobile phone/tablet app using onboard instrumentation to provide its location indoors**

**Project description** (max 100 words): Anyone can put their phone or tablet down and forget where it was, especially with the help of third parties such as housemates or small children. Whilst GPS equipped units can provide fairly accurate geographical fixes, these often do not work indoors. Design an app that monitors enough environmental variables (magnetic field, light levels, angle etc.) when put down to identify where it is (it is OK to have to train it to recognise a range of locations), and a secure server or peer to peer solution to make the information available to its rightful owner.

**Keywords** (max 5 keywords): location; mobile; explorative

**Learning outcomes: (max 3 sentences):**

- Accessing and using Mobile Sensors
- Utilising Triangulation to locate a device
- Persistence and information security

**Prerequisite:** None

### Proj. # 54. **3D scene natural language text renderer**

**Project description** (max 100 words): We are all at least passingly familiar with 3D graphics engines, which produce graphical output from a 3D scene. These are not user friendly for people with vision impairment, and it would be interesting to know whether an engine can be developed which produces text descriptions of a 3D scene from the view point of a character in a game. Many issues are already solved, such as line of sight and surface culling, but a natural language text description engine would also have to describe the types of objects, textures and relationships of objects to one another. In addition, in order to provide a useful output that would suit any degree of speed of play, further

attentional mechanisms would be necessary so that the most important items in the view are identified and described first.

**Keywords** (max 5 keywords): 3D; Textual; accessibility

**Learning outcomes: (max 3 sentences):**

- 3D engine pipeline
- Accessibility research

**Prerequisite:** Unity or other is advised.

### Proj. # 55. **Online text-based world/environment to support autonomous text-chat agents (bots)**

**Project description** (max 100 words): MUDs (Multi User Dungeons, or Domains) are a relatively niche field of gaming, allowing multiple players to interact within a world described by text rather than shown by graphics, and with an embedded set of rules about how things interact. Design an object-oriented MUD server which allows for message passing between in-world objects to simulate physics and other interactions. The system should enable artificial agents (bots) to interact with human players, allow for in-game editing of the environment by users with sufficient rights, and for such changes to be persistent. Objects in game should also be able to be scripted to respond to stimuli, and tools to identify bots by their behaviour would be highly desirable.

**Keywords** (max 5 keywords): Gaming; Text; AI; Agents

**Learning outcomes: (max 3 sentences):**

- Simple game development
- Benefits of text based solutions
- Benefits of focus on application interfaces

**Prerequisite:** None

### Proj. # 56. **Narrative flow analysis system**

**Project description** (max 100 words): Essays, reports and online discussions can sometimes suffer from a sudden change in topic, which creates a level of cognitive dissonance and makes it harder for the reader to understand what the writing is trying to say. By examining adjacent sections of the text and determining the topic, it should be possible to map the narrative flow within a document, and identify rapid shifts from one topic to another, highlighting any problems found. A promising method is to use forms of Latent Semantic Analysis or related bag of words approaches, such as Kohonen networks, to produce a graphical representation of the path of the topic in a concept space. Create a system which identifies the narrative flow in a number of documents from a corpus, producing a graphical representation of how the subject shifts through the document and highlighting jumps.

**Keywords** (max 5 keywords): Self-organising maps; textual; analysis; visualisation

**Learning outcomes: (max 3 sentences):**

- Self organising maps
- Linguistic analysis
- Visualisation techniques

**Prerequisite:** None

## Proj. # 57. **Behaviour (Threat/Anomaly) Detection in Wide Area Scenes**

**Project description** (max 100 words): Advances in sensor devices, communication and storage capacities make it increasingly easier to collect large amounts of multimedia material. Recorded video and/or audio is then made available in standard databases. However, the value of this recorded data can only be exploited by technologies that can selectively transform this raw data into structured knowledge with rich semantics that can be naturally understood by an end-user. Furthermore, for long-term video monitoring applications, there is an increasing need for systems with automatic human activity characterization and recognition and delivery of knowledge with semantics-rich content description. The aim of this project would be to design and implement a behaviour anomaly detection algorithm. The main application will be surveillance (threat detection involving people and the environment, e.g. critical infrastructure or land border). Images may be acquired from a variety of sources including CCTV and Unmanned Aerial Platforms (UAVs), and may be multimodal (i.e. visible and thermal images). The candidate would need to research appropriate algorithms in the literature, select one and then perform the implementation, testing and evaluation of the technique.

**Keywords** (max 5 keywords): surveillance, CCTV, behaviour recognition, anomaly detection. Performance evaluation

**Project learning outcomes: (max 3 sentences):**

- Applied understanding of computer vision
- Enhanced knowledge of performance evaluation methodology
- Enhanced programming skills

**Skills/knowledge/technologies used/acquired:** C/C++ (or agreed suitable alternative)

**Prerequisite for the project:** background in image analysis/computer vision would be beneficial, but not essential

## Proj. # 58. **Vision Based Attendance Analyser**

**Project description** (max 100 words): to develop an application to automate the task of attendance verification in a classroom scenario, using face recognition. The input to the system will be a video stream from one or more machine vision cameras (supplied). A commercial face recognition system will be used (supplied) to support the task. The project will involve development of the complete system including a GUI / dashboard for display visual analytics, with Web connectivity. The overall system will run on a miniPC to enable flexible deployment at different sites.

**Keywords** (max 5 keywords): biometrics, face recognition

**Project Learning outcomes: (max 3 sentences):**

- Applied understanding of computer vision
- Enhanced knowledge of performance evaluation methodology
- Enhanced programming skills

**Skills/knowledge/technologies used/acquired:** C/C++ (or agreed suitable alternative)

**Prerequisite for the project:** background in image analysis/computer vision would be beneficial, but not essential

## Proj. # 59. **Automatic Authentication of Specific Optical Security Features**

**Project description** (max 100 words): True Optical Machine Authentication (OMA) capability to authenticate the more complex optical security features present in travel and identity documents, such as passports and ID cards, is in its infancy. This goes well beyond the realm of features such as (2D) barcodes such as QR codes, embedded codes and PDF-417 codes which are easily produced and copied. This project will aim to develop computer vision methods that will enable automatic detection of anomalies that may be present in the physical document security features. Such innovation will take full account of design and system considerations for physical security features that are much more amenable to automated verification, and that provide better linkage with the digital domain.

**Keywords** (max 5 keywords): computer vision, border security, document verification, security

**Project Learning outcomes: (max 3 sentences):**

- Applied understanding of image analysis
- Enhanced knowledge of performance evaluation methodology
- Enhanced programming skills

**Skills/knowledge/technologies used/acquired:** C/C++ (or agreed suitable alternative)

**Prerequisite for the project:** background in image analysis would be beneficial, but not essential

## Proj. # 60. **Contactless Multimodal Biometric Fusion**

**Project description** (max 100 words): The effectiveness of predicting an individual's identity at can benefit from seeking a broad base of biometric evidence. The fusion of evidence from various biometric modalities can be performed at signal level, feature level and score level. For example, applying a sequential fusion approach until a certain level of performance is satisfied represents an acceptable trade-off between performance and practicability. This project will specifically focus on contactless biometric acquisition, including 3D face, iris and somatotype captured from subjects on-the-move and will investigate the complementarity of these modalities in a fusion scenario.

**Keywords** (max 5 keywords): biometrics, fusion, border security, security

**Project Learning outcomes: (max 3 sentences):**

- Applied understanding of biometrics, fusion
- Enhanced knowledge of performance evaluation methodology
- Enhanced programming skills

**Skills/knowledge/technologies used/acquired:** C/C++ (or agreed suitable alternative)

**Prerequisite for the project:** background in biometrics/image analysis/computer vision would be beneficial, but not essential

### Proj. # 61. **Video-Based Presentation Attack Detection**

**Project description** (max 100 words): The environment and behaviour of users during the capture process for biometric verification systems is often not controlled. In particular more sophisticated means such as using flexible silicone 3D masks or extreme makeup are opportunities to fake another identity. This project focuses on the development of video-based presentation attack detection with facial biometrics, specifically more sophisticated attacks including high quality masks, applied makeup, headgear and obscuration (e.g. partially or fully covering the face).

**Keywords** (max 5 keywords): biometrics, fusion, border security, security

**Project Learning outcomes: (max 3 sentences):**

- Applied understanding of biometrics
- Enhanced knowledge of performance evaluation methodology
- Enhanced programming skills

**Skills/knowledge/technologies used/acquired:** C/C++ (or agreed suitable alternative)

**Prerequisite for the project:** background in biometrics/image analysis/computer vision would be beneficial, but not essential

### Proj. # 62. **Smartphone-based Identification**

**Project description** (max 100 words): Smartphones are becoming increasingly sophisticated and embed many diverse and powerful sensors notably GPS, acceleration, vision (cameras), audio (microphones), as direction (compass) and light and temperature, which could be exploited to aid in identification of the owner. The project aims to research and develop a novel multimodal sensor approach to behavioural biometric identification on-the-move for smartphones; including development of a new machine learning algorithm to enable robust classification of users based on time-series multisensory data.

**Keywords** (max 5 keywords): biometrics, fusion, border security, security

**Project Learning outcomes: (max 3 sentences):**

- Applied understanding of biometrics
- Enhanced knowledge of performance evaluation methodology
- Enhanced programming skills

**Skills/knowledge/technologies used/acquired:** C/C++ (or agreed suitable alternative)

**Prerequisite for the project:** background in biometrics/image analysis/computer vision would be beneficial, but not essential



### Proj. # 63. **Handwritten signature detection from scanned documents**

**Project description** (max 100 words): Automated localization of a handwritten signature in a scanned document is useful for many banking and insurance related business activities. The project will make use of several image processing and machine learning techniques to build a demonstrator system that can recognise signatures in a stored database. The project can be organized as model training and test subtasks; For model training subtask, it involves signature data acquisition, image processing and classifier training; For model testing, the signature detection and segmentation are applied, followed by comparing it with the stored true images. The statistical analysis of results is expected for validating the project.

**Keywords** (max 5 keywords): image processing, pattern recognition, statistical analysis

**Project learning outcomes: (max 3 sentences):**

- Gain knowledge from a complete implementation of machine learning project
- Gain experience of programming (in chosen language) for a close to real product
- Enhance knowledge of several related computer science modules

**Skills/knowledge/technologies used/acquired:** image processing, matrix data handling, programming, machine learning

**Prerequisite for the project:** Linear algebra, programming, algorithms.

### Proj. # 64. **Smartphone-Based Recognition of Human Activities**

**Project description** (max 100 words): The study and modelling of human activities have attracted intense research interests due the availability of wearable sensors. This project will make use of built in sensors from smart phones, such as accelerometers, as well as machine learning algorithms for recognition of human activities. Initially the student will need to carry out literature research, modelling of the public domain data sets for classifying basic activities, e.g. using neural networks. Then practical aspects of data acquisition and experiment design will be investigated for some self-define objectives, e.g. measuring and labelling of own activities over time, classifying the resultant time series data. The statistical analysis of results is expected for validating the project.

**Keywords** (max 5 keywords): classification, sensor data, human activity

**Project learning outcomes: (max 3 sentences):**

- Gain knowledge from a complete implementation of computer simulation project
- Gain experience of programming (in chosen language) for a close to real product.
- Enhance knowledge of several related computer science modules

**Skills/knowledge/technologies used/acquired:** logic, data handling, programming, machine learning

## Proj. # 65. **Modelling and visualization of a proposed cyber-physical system demonstrator**

**Project description** (max 100 words): In a cyber-physical system, the physical-world refers to the physical objects that are needed to perform the manufacturing activities (e.g., machines, tools, sensors, physical networks etc) whereas the cyber-world refers to the computational entities that are needed to get the best from the physical objects (e.g. historical data, real-time data, information, software, data analytics, knowledge-based systems, etc) applied. From this definition, you are free to propose a project for the sake of illustrating and demonstrating the operations of a cyber-physical system. For example, you can use the game of Tower of Hanoi to demonstrate the process of smart robotics manufacturing. Other games can also be explored within the same project, e.g. modelling and control human activities in a city.

**Keywords** (max 5 keywords): recursive algorithms, cyber-physical system, mathematical modelling

**Project learning outcomes: (max 3 sentences):**

- Gain knowledge from a complete implementation of computer simulation project
- Gain experience of programming (in chosen language) for a close to real product.
- Enhance knowledge of several related computer science modules

**Skills/knowledge/technologies used/acquired:** logic, linear algebra, programming, machine learning

**Prerequisite for the project:** Linear algebra, differential equations, programming, algorithms, simulation

## Proj. # 66. **LLVM compiler Magic with Abstract Syntax Trees**

**Project description** (max 100 words): LLVM compiler Magic with Abstract Syntax Trees. The LLVM compiler is a highly modular set of tightly coupled tools that can be used to build compilers, as well as actual programming language compilers, such as Clang for C/C++. Several groups in the weather and climate community, including the UK Met Office, are developing Domain Specific Languages (DSLs) to make it easier to develop complex scientific models of the Atmosphere and Oceans. These DSLs produce ASTs which could be used directly the LLVM compiler toolchain. The approach: Examine and understand how ASTs are used by the LLVM compiler to represent code internally. Explore how ASTs are converted from one representation to another. Use the LLVM compiler technology to generate code, starting from simple ASTs, leading up to using more complex ASTs that could be generated by a DSL.

**Keywords** (max 5 keywords): LLVM; AST; DSL, compiler

**Learning outcomes: (max 3 sentences):**

- Understand ASTs in the LLVM compiler toolchain
- Process ASTs from a real application
- Understand and use intermediate representation of application code

**Skills/knowledge/technologies used/acquired:** programming skills, programming language representations, compiler technology

**Prerequisite for the project:** Programming, Compilers

### Proj. # 67. **MRI Stack**

**Project description** (max 100 words): Series of project to be developed around MRI image analysis. For example, MRI Image visualiser; MRI Image extractor (KNIME); Dementia detection via MRI analysis (traditional); Dementia detection via MRI analysis (reinforce learning).

**Keywords** (max 5 keywords): MRI, visualizer, data mining, deep learning, reinforce learning

**Skills/knowledge/technologies used/acquired:** Data Mining, Linux, Image processing, python, KNIME

**Prerequisite for the project:** None

### Proj. # 68. **Emerging IoT Networking Paradigms: Efficiency and Feasibility**

**Project description** (max 100 words): With the emerge of Internet of Things (IoT), billions of devices and humans are connected to the Internet. This significant growth in the number of connected devices rises the needs for a new development for the data processing mediums. The new network paradigms, such as fog and mist computing are seen as promising solutions for handling the large volume of securely critical and delay-sensitive data that is being produced by the IoT nodes. This project is concerned about network resource provision, efficient way of data collection and processing, distributed resources and real-time data processing. Some idea would be: Towards a seamless coordination of networking paradigms: illustration through the IoT; Achieve an optimal workload on network resources; Improving network management with Software Defined Networking.

**Keywords** (max 5 keywords): IoT, network managements, real-time processing, data processing

**Skills/knowledge/technologies used/acquired:** Students should have some basic knowledge about computer network design/architecture. Also, any tool for networks simulation or skills to use devices, such as Raspberry Pi, as a networking device.

**Prerequisite for the project:** None