--- Enda Barrett ---

Code EB1
Elastic Load Balancing using Machine Learning
Scaling applications in virtualised environments in response to changes in demand from a distributed user base is a challenging problem. When hosted in public IaaS clouds such as Amazon's EC2 platform, interference from neighbouring and co-located Virtual Machines (VMs) sharing the same physical host can result in unpredictable behaviour and performance. The goal of this project is to develop suitable techniques using machine learning to optimally scale these applications to meet defined Service Level Agreements (SLAs).

Code: EB2
Classifying application types
Deploying applications and services on public Infrastructure as a Service (IaaS) clouds is challenging given the variety of virtual machine configurations and types available across all the IaaS providers. In order to optimally deploy one's apps and services one needs to rigourously test a number of deployment configurations, observe specific KPIs and devise a deployment configuration. This generally requires extensive domain knowledge and testing. This project investigates employing classification techniques from machine learning to determine the type of application being deployed such as whether it is CPU, memory or disk intensive. It then automatically builds a deployment configuration based on the output.

Code: EB3
OpenCV with a UAV (Drone)
OpenCV (Open-Computer Vision) provides a variety of image processing algorithms which when combined with a live camera feed on a drone, enable additional functionality, such as follow me, corner/edge detection and object recognition. The goal of this project is to analyse the FPV feed from a UAV and process it in real time using OpenCV to create functionality such as object recognition, edge detection or to follow/track a moving object in flight.

Code: EB4
Security UAV (Drone)
This project involves setting up specific GPS way points around a premises which forms a security perimeter patrolled by a drone. The drone will wake up at regular intervals and perform a sweep of the premises. It will take a recording of the area under its supervision and allow it to be viewed through a web application. The drone should be capable of establishing a norm around specific objects of interest and notifying the user if something is missing.

Code: EB5
Augmented Reality Game
The success of Pokemon Go this year has shown the potential for Augmented Reality gaming. This project involves creating a multiplayer game for a mobile device. The game will use the phone's GPS sensor to determine the location of the players in the game. The student may choose the genre of game they wish to develop.

--- Attracta Brennan ---

Code: AB1
Dementia Assistance
The number of people living with dementia worldwide is currently estimated at 47.5 million and is projected to increase to 75.6 million by 2030. The number of cases of dementia are estimated to more than triple by 2050. This project requires you to explore how technology can be used to help people suffering from Dementia and/or their families

Code: AB2
Co-ordination and Fitness Tracker
This project requires you to create a cheap and accessible gaming solution which will benefit and/or track an older person's co-ordination and overall fitness.

Code: AB3
Ageing Data analysis
"You're never too old to play Nintendo Wii-Fit – because it helps keep older people on their feet, claim researchers. Those prone to falling have most to gain from the popular computer game console, which simulates sports such as tennis, bowling and boxing. A study shows it benefits those too frail to take part in conventional physiotherapy because they are not strong or fit enough" (Daily Mail, 2014). Your project is to come up with a cheap and accessible gaming solution which will benefit an older person's co-ordination and overall fitness.

Code: AB4
Where to??
When visiting a new place, parents are always interested in finding things of interest for children/young adults with which to engage (e.g. Boda Borg, Forest Park, playgrounds etc.). Some such activities are both weather and age related. Develop a system that takes account of current location, travel mode, price, age of children, weather, ratings etc. and makes recommendations.

--- Michael Schukat ---

Code: MS1
Management App for Juvenile Athletics
This project aims to develop a system (Android app and / or web based) to support coaches of juvenile athletes to monitor, analyse, compare and evaluate an athlete's performance in various track and field events (i.e. long jump, 600m, hurdles, etc.) throughout the training season. Possible features (non-exhaustive) could include:
- Simple data / performance logging
- Trend analysis of athletes' performance throughout the year
- Generation and validation of training plans based on set performance goals
- Comparison of athletes' key performance data for squad selection

The tools will be developed in collaboration with a local athletics club.

Code: MS2
A Network Intrusion Detection System for wireless Sensor Networks
Network Intrusion detection systems (NIDS) like Snort are an integral part of cyber defense. Such systems monitor IP traffic on a given network and raise an alarm if some suspicious activity (like DoS attacks, packet injection etc.) are detected. In this project you will research and prototype NIDS for sensor networks. Your system will be either based on BACnet (a network protocol used by the building management system in the new engineering building) or will be based on a sensor wireless sensor network protocol stack (802.15.4, ZigBee or 6LoWPAN). The overall goal of your project is to detect cyber-attacks on such infrastructure.

Code: MS3
Java-based Public Key Infrastructure
Public key cryptography enables users to securely communicate on an insecure public network, and reliably verify the identity of a user via digital signatures, which are typically stored in digital certificates.
A public key infrastructure (PKI) is a system for the creation, storage, and distribution of digital certificates. The PKI creates digital certificates which map public keys to entities, securely stores these certificates in a central repository and revokes them if needed.
This project aims to design and implement a "Micro-PKI" based on Java technology (e.g. the Java Security API) that covers all aspects of certificate management including certificate revocation and OCSP.

Code: MS4
MQTT on embedded systems
MQTT (formerly Message Queue Telemetry Transport) is a publish-subscribe based "light weight" messaging protocol for use on top of the TCP/IP protocol. It is designed for connections with remote locations where a "small code footprint" is required and/or network bandwidth is limited. The Publish-Subscribe messaging pattern requires a message broker. The broker is responsible for distributing messages to interested clients based on the topic of a message.
This project aims to develop a reference implementation/deployment of MQTT on a sensor network consisting of networked embedded Linux systems (like the Raspberry Pi or the BeagleBone Black).

Code: MS5
A SIEM (security information and event management) system for M2M
SIEM technology provides real-time analysis of security alerts generated by network hardware and applications. It can also used to log security data and generate reports for compliance purposes.
In this project you will prototype and deploy a SIEM for Machine-2-Machine networks. This project will build on open-source tools (like OSIM and Snort).

--- Owen Molloy ---

Code: OM1
MOOC Development
Using the outputs from the EU project ResponSeable, assist in developing a multi-lingual MOOC in the Ocean Literacy, using the knowledge created by a number of teams on topics such as Microsplastics, Invasive Species, Marine Renewable Energy. You will use a tool such as the Google Open Online Education Course Builder (https://www.google.com/edu/openonline/index.html) to develop a multilingual online course.

Code: OM2
Version Control Visualisation
Querying and Displaying Knowledge from a Graph Database. Working with a PhD student here, help develop a querying and graph visualisation tool for the OrientDB graph database. The database is being used in an EU project (http://www.responseable.eu/), and will contain a large amount of information which needs to be queried and displayed in an engaging way. You will use browser-based technologies (e.g. js, jquery, d3.js, HTML5, CSS, ajax, REST) to develop an interactive, intelligent user interface for exploring the knowledge in the graph database, both visually and using queries.

Code: OM3
Simulation and Visualisation of Student Movements
The university's ever-expanding student population explodes onto the corridors every hour at the same time, and must vie for space as they beat a path to the next lecture. This project will use a simulation system such as DESMO-J or AnyLogic to simulate and visualise these movements. This system will allow us to experiment with ideas such as traffic lanes, variable lecture times, lecture theatre location etc.. It may involve the use of specialise libraries for visualisation of the simulation outputs.

Code: OM4
Traffic Crowd Monitoring
Develop an iPhone or Android based app which users would switch on at the start of their journey / commute. The app will record the location and speed of the user (i.e. their car), and report it back to a central server application. The central server application will identify bottleknecks where traffic is slowing down / at standstill. It will provide web services which return live information on traffic conditions at locations for which it has data. App or website developers can then use this information to create interactive maps showing traffic conditions and where the other users are (or show the number of users at a location, which indicates the reliability of the data).

Code: OM5
Virtual Concierge
The goal is to develop an integrated system for managing hotel guest requests for various hotel services such as restaurant bookings, dry-cleaning, booking spa treatments etc.. Guests would ideally download the app on arrival at the hotel. Each request must be logged and assigned to the appropriate member of staff. The progress of each request must be trackable from start until completion both by the guest in question and by management. While simple in concept, this could grow into quite a sophisticated workflow management system. Ideally a central server would manage requests and interact with apps on the mobile devices of both guests and staff.

--- Enda Howley ---

Code: EH1
Development of advanced Reinforcement Learning Methods.
Reinforcement Learning is an approach that allows an agent to learn optimal actions over time from receiving rewards for what are considered good choices and punishments for bad choices. This project will examine various mechanisms whereby this technique can be extended and applied to a range of problems.

Code: EH2
Development of a Tool for Modelling of Transportation Networks
Transport simulation is becoming an increasingly important analysis technique in traffic engineering and urban planning. Realistic simulations require detailed models of transportation networks, and the purpose of this project is to develop a tool for modelling and editing transportation networks. The networks produced using this tool may then be used for simulations. The proposed tool will GUI based, and will allow visual editing of the networks, as well as having its own project file format that will allow users to save their work for future editing. Importing data from a variety of common GIS sources and file formats (e.g. AutoCAD, Ordnance Survey, OpenStreetMaps) will allow users to develop models quickly, which can then be fine-tuned in the editor. A layer-based approach will be adopted to represent different types of transportation links (e.g. national routes, regional routes, bus lanes, rail links, cycleways and pedestrian routes), and allow flexibility when selecting which information is to be edited or exported. The finished tool will allow users to export completed networks in a variety of formats suitable for use in common traffic simulation packages.

Code: EH3
A Study of population health through social network analysis
The speed of epidemics is directly linked to a number of key factors, which include the virus infectivity and the connectivity of the infected species. This project involves a study of various forms of social networks and various parameters which influence the spread of a virus in a population. The project involves the simulation of agent populations and their behaviour under certain experimental scenarios.

Code: EH4
Multi-Agent approaches to managing resources on the Cloud
Determining how better manage cloud services raises a range of significant challenges. Some of these involve limited access to resources at certain peak times, or the arbitrary pricing plans of cloud providers. With these in mind, it is possible to put in place hybrid cloud mediators, which can determine stable and low cost cloud service plans from a range of providers. There is increasing need for cloud services, which can support highly flexible and adaptive requirements and this is now a key challenge for the Cloud Computing Industry. This project will involve the development of a multi-agent simulator, which reflects these challenges and offers insights into the complex world of cloud services.

Code: EH5
Body Composition Assistance App
Body composition has become a highly scientific process in recent time through both tracking activity levels and controlling nutrition levels. Calories In vs Calories Out are only one particular dimension of this. So to develop more complex and accurate mechanisms for assisting people achieve this we aim to design a smartphone app that will assist users in making smarter choices with both their workout and nutrition choices throughout the day so they can work towards a particular goal over a period of time. Aspects that might be explored in this project could include, logging and tracking activity levels with suggestions as to how the user can meet their goals on a given day. Logging and tracking nutrition information so the user can meet their macro-nutrient targets for a particular period.

Code: EH6
Complex Topologies in PSOs
A Study of neighbourhood topologies in PSOs Particle Swarm Optimization has been shown to be a highly effective computational method that optimizes a problem by iteratively trying to improve a solution with regard to a given measure of quality. It has been shown that through alternative topologies or neighbourhoods significant improvements can be achieved in the performance of the PSO. Therefore in this project a number of alternative approaches will be examined and evaluated using various problems. Possible improvements will also be explored.

Code: EH7

A Study agent interactions in a game theoretic environment.

Through a number of intuitive games a range of quite complex social behaviours can be studied that include cooperation and coordination. This project will examine a number of these games using a simulation of an agent environment. It is intended to explore the effects of certain social interactions on the resulting game dynamics.

Code: EH8

Percentage Body Fat Tracking App

BMI has long been the single most popular mechanism for easily tracking obesity in the general population, however this technique has become very outdated and unsuited to providing any meaningful information. Percentage Body Fat is a much more accurate mechanism but notoriously difficult to ascertain an accurate reading unless a dexa scan is completed. Therefore mechanisms such as skin fold calipers are usually used however these can be quite subjective. In order to aid more accurate tracking and recording of this data, we propose an app that will use a range of data inputs that include multi-location skinfold measurements. Using this data we can apply statistical methods to determine an overall trend in the data which can then be saved and shared as necessary.

--- Seamus Hill ---

Code: SH1
Evolutionary algorithms (EAs) often have a tendency to converge on local optima, rather than locating the global optimum. Premature convergence is caused by structural features of EAs, such as selection pressure and a high gene flow between members of a population. As diversity within the population decreases the population becomes homogenous and the ability to escape local optima becomes increasingly difficult. This project examines the main methods of maintaining population diversity used by various EAs and empirically analyses their performance over various landscapes comparing the impact of both representation and the problem domain on the search.

Code: SH2
Evolutionary Algorithms and the Zen Puzzle Garden.
The Zen Puzzle Garden (ZPG) is a one-player puzzle game which involves a Buddhist monk raking a sand garden. The puzzle is inspired by Japanese garden design, which contain a region of sand or pebbles raked into a pattern. ZPG is an example of a transport puzzle, which are logistical puzzles that often represent real-life transport problems. This project involves examining the use of a variety of Evolutionary Algorithms (EAs) in solving the ZPG and then comparing the results obtained to those of other heuristic approaches used to solve the ZPG.

Code: SH3
Evolutionary Algorithms and the Hawk-Dove Game
"Hawk-Dove" describes a situation where individuals compete for a shared resource and can choose to either conciliation or conflict. The hawk-dove game involves two players (birds) competing over a resource, which is indivisible. Each player can choose between two opposing strategies, either a threat displays (Dove), or attacking each other (Hawk). The outcomes of the strategies are as follows:

- Should both players choose the Hawk strategy, they must fight until one is injured and the other is declared winner.
- If one player chooses Hawk, then this player defeats the Dove player.
- And should both players choose to play Dove, there is a tie, and each player receives a payoff lower than the profit of a hawk defeating a dove.

This project proposes to develop a simulator for the Hawk Dove game, which incorporates an Evolutionary Algorithm for strategy selection.

Code: SH4
Tragedy of the Commons Game
Description: The Tragedy of the commons is a dilemma arising from a situation in which multiple individuals, acting independently and rationally consulting their own self-interest, will ultimately deplete a shared limited resource, even when it is clear that it is not in anyone's long term interest for this to happen. This project proposes to develop a "game" based on the Tragedy of the Commons which incorporates an evolutionary algorithm.

--- Des Chambers ---

Code: DC1
Emulate RAID based storage mechanism across multiple cloud storage services
RAID (redundant array of independent disks) is a data storage virtualization technology that combines multiple physical drive components into a single logical unit for the purposes of data redundancy, performance improvement, or both. There are different RAID levels that provide varying degrees of redundancy and performance. The idea of this project is to implement a prototype mechanism that implements RAID level 5 storage across multiple cloud based storage services. Normally RAID 5 consists of block-level striping with distributed parity where the parity information is distributed among the drives. It requires that all drives but one be present to operate. Upon failure of a single drive, subsequent reads can be calculated from the distributed parity such that no data is lost. RAID 5 requires at least three disks, however, the goal in the project is to replace the physical disks with cloud based storage. The overall result would be that your data would be replicated but not all stored on any one cloud based service giving inherent benefits in security and redundancy. The project would require research on the most suitable cloud services to use and then the implementation of a prototype network file service or virtual drive that allows a user to store and access their data transparently.

Code: DC2
IPv4 and IPv6 Routing and Usage Analysis on Mikrotik Routers
The goal of the project is to research and design a system that analyses the allocation and usage of both IPv4 and IPv6 address blocks within a network of Mikrotik routers. The idea is to use the Mikrotik API to access the OSPF routing table and static DHCP allocations on a network of routers. From this information the subnetting and usage of an address block can be analysed and presented. The system can also show what IP address blocks are still available for allocation within a network. A test network will be built using the GNS3 open source network simulator which provides a graphical user interface to design and configure virtual networks consisting of devices such as switches, routers and interconnects. The system can be extended to present graphical information about a network of routers.

Code: DC3
Intrusion Detection Analysis of Netflow Data
Netflow is a feature available on network routers that provides the ability to collect information about IP network traffic as it enters or exits an interface. By analyzing the data provided by Netflow, a network administrator can determine things such as the source and destination of traffic, class of service, and the causes of congestion. The primary goal of the project is to research and implement mechanisms to provide analysis of the collected netflow data to implement intrusion detection or classification of online behavior for individual IP addresses. The first challenge will be to develop a netflow data collection and monitoring system that filters, aggregates and saves netflow data into a suitable structure for analysis. The project can use and augment existing netflow data collection and analysis tools e.g. nfdump to help collect and filter the raw dataset.

Code: DC4
Antenna Alignment Augmented Reality Video Application (Smartphone or Drone derived Video)
The goal is to develop a novel smartphone application that uses augmented reality techniques to help with the alignment of highly directional microwave dish antennas. High speed fixed wireless point to point links use very high gain and directional dish type antennas that have often have a very narrow beamwidth so precise alignment in both the horizontal and vertical planes can be very difficult, especially when working at height on a telecoms tower or rooftop. The application would be used to provide visual clues to help engineers with the initial alignment of the antenna as well as information on the expected signal strength based on the distance and power budget calculations. The video source could be the camera on a mobile phone or video being streamed live from a GPS enabled drone.

Code: DC5
Personal Security Smartphone Application
The goal of this project is to design and develop an application that utilises the unique capabilities of smartphone devices. The application in this case will be used to aid personal security for vulnerable adults and children. The application could use various mechanisms to help with this including active periodic check-ins from the device itself, remote monitoring of device location, and detecting lack of movement or movement outside certain boundaries depending on the requirements of individuals being monitored. The full implementation and testing is then undertaken using the development environment for the particular platform. The application could run solely on the phone itself or it may be enhanced with backend server and management capabilities. For the purposes of this project the most likely platform to be used is the Android and the programming language in this case is Java.

--- Conn Mulvihill ---

Code: CM1
There are many ancient scripts that have never (to date) been successfully deciphered - sometime there is just not enough information, perhaps the matter under discussion is unclear, perhaps there is no bilingual text available, no handy place or personal identifiers, or it is perhaps unclear if you are dealing with a logographic, syllabic, or alphabetic system. This project would attempt to look at a small set of (highly constrained) short texts (ancient, modern or of your own devising) and develop software to essentially infer what they mean - without prior knowledge of the script in question.

Code: CM2
This project would consider abstract games - especially those suitable for two players. The idea would be to characterise the tactics that occur in these games and conduct some experiments in order to explore this (for example, looking at detailed tactics in a particular game or a comparison of tactics across games or characterising tactics via the type or family of the game in question – things like blocking, capture, connection, pattern, position, territory). Possible two-player abstract games that might be considered would include (but are not limited to): Hex, Hnefetafl, Rithmomachy. Reference: Neto and Silva, Mathematical Games, Abstract Games, Dover 2013

Code: CM3
This project would consider abstract games - suitable for three players. The idea would be to characterise the tactics that occur in these games and conduct some experiments in order to explore this. Possible themes to explore would include the 'tall poppy effect' - where players try to pull a leader back, the 'kingmaker effect' – where a player rounds on another perhaps handing victory to the third and the 'revenge effect' - where a player opts to inflict damage on whoever put him/her in that position. All of these come under the heading of the Petty Diplomacy Problem. Possible three-player abstract games would include variants of two-player games and things like porus torus. Augmented rule sets could be developed in the course of the project to address Petty Diplomacy. Reference: Neto and Silva, Mathematical Games, Abstract Games, Dover 2013

Code: CM4
This project would be concerned with exploring the emerging world of computer forensics (see http://www.forensicfocus.com/ for examples of work in the area). The main aim would be to provide an intelligent assistant that would help people find computer forensic software that would be useful to them. The assistant would look have knowledge of free tools like for example http://www.gfi.com/blog/top-20-free-digital-forensic-investigation-tools-for-sysadmins/ and some knowledge of commercial tools (some here: http://www.forensicfocus.com/software) and within the context of regulatory and legislative boundaries provide suitable advice in connection. This would be an overview tool; it would not replace courseware in detailed workshops run by providers of particular technologies.

Code: CM5
This project would be concerned with exploring the emerging world of computer forensics (see http://www.forensicfocus.com/ for examples of work in the area). In particular, the focus would be on developing grammars for file parsing. An example of the kind of environment that uses such grammars may be found here: https://www.synalysis.net/tutorial-decode-a-png-file.html (though you are not restricted to this one of course). The idea would be within the context of regulatory and legislative boundaries to supply a tool (grammars alone drawing on something like the above example tool, or your own front-end and grammars) that would help with file parsing.

--- David O'Sullivan ---

Code: DOS1
Learning Management Systems
Evaluate a number of learning management systems. Survey teachers and learners on usage. Develop user requirements for optimum LMS. Interest in content management systems required.

Code: DOS2
Picture Translator
Develop concept for a universal translation app for smart phones based exclusively on icons and pictures (no words). Strong interest in user experience design required.

Code: DOS3
Personal Assistant
Evaluate personal 'todo' list managers and their usage. Develop user requirements for novel kind of digital assistant suitable for students.

Code: DOS4
Emotion Tracker
Develop a smart phone app for tracking moods and assisting mood enhancement. Survey students on mood tracking and develop prototype app that will enhance moods and hence productivity among students population.

Code: DOS5
Innovation Manager
Study innovation process and idea management systems and tools. Develop definitions and prototype for an idea management system to be used within organisations such as Students Union.

Code: DOS6
Personality Test
Develop personality test and decision support app for smart phone. Define requirements and develop prototype app. User testing and validation among student population.

--- Sam Redfern ---

Code: SR1
Procedural (random) map generation in computer games
This project will investigate the techniques used for procedural map generation in computer games, and will develop a random map making tool. The map could be 2D or 3D, could use a game engine if desired, and could use the student's own artwork or open-source artwork. The project would involve investigation of various techniques (Perlin noise, cellular automata, Voronoi maps etc.). The requirement is to be able to specify various parameters, a random seed, and generate a map which can then be scrolled around to view. There is no requirement for any functioning gameplay. E.g. see http://pcg.wikidot.com/category-pcg-algorithms

Code: SR2
Team-Based Pathfinding in strategic computer games.
Although pathfinding is a well understood problem in computer games, the automatic production of interesting, believable and challenging pathfinding behaviours for teams of AI agents has received little academic interest. This project will evaluate team-based AI in general, and develop+evaluate team-based pathfinding solution(s).

Code: SR3
Tactical Pathfinding with visibility+threat analysis
This project will build on the well-known algorithms for pathfinding in computer games, by assessing and building on approaches that take visibility, threat, and tactical value into account.

Code: SR4
Development of a Turn-Based 2D Strategy Wargame
The goal of this project will be to develop a well-written and well-structured turn-based strategy wargame, with the intention of using it as a testbed for future work and research into games AI. The current project is not required to develop any significant AI – rather, the requirement is to develop a piece of software that is robustly designed for future enhancements. I will provide detailed discussion and advice during the design phase. It should be possible to use open-source game graphics for this work, e.g. see The Battle for Wesnoth, or OpenGameArt.org

Code: SR5
Car Racing AI
This project will work with the open-source car racing simulator TORCS (https://sourceforge.net/projects/torcs/), which is used as a testbed for car racing AI. Existing AI drivers will be analysed (e.g. built-in ones and those that performed well in TORCS competitions), and novel AI drivers will be developed. The student's own AI solutions will be tested in races against other AI drivers.

Code: SR6
Automatic Jigsaw Solver
This project will research and develop digital image processing / pattern recognition software to automatically solve jigsaw puzzles. Advice will be given on appropriate image processing SDKs and potential approaches.

Other ideas
I am generally happy to supervise student-specified projects in the areas of computer games, graphics, AI, online collaboration, and digital image processing.

--- Finlay Smith ---

Code: FS1
Multilingual website.
Create a website that can be set to display information in a variety of websites - a single click should change the entire content from one language to another. In addition some translation tool should be made developed - this could be initially a simple "word for word" translation though a richer translation tool could also be developed.

Code: FS2
Using Genetic Algorithms in Scheduling
This project will look at the use of Genetic Algorithms in scheduling timetables for lectures and exams. There will be 2 aspects to the project, firstly starting a schedule from scratch - this approach will be given a list of venues/ facilities two lists - one compulsory and one desirable - the system should then try to find the a schedule that satisfies all of the compulsory elements and as many of the desirable one as possible. The second aspect would be to look at amending an existing schedule - say adding a new module to a timetable - this would use similar techniques, but with the added constraint of making as few changes as possible.

Code: FS3
Qualitative reasoning
Implement a qualiatative reasoning system that can be used to model a range of dynamic systems. The system should be developed in Prolog or Clips for which guidance will be given.

Code: FS4
Evolving gaming strategies
This project would aim to evolve gaming strategies for an automatic player in a game. The player should be able to learn a strategy based upon experience and be able to change this strategy in reaction to opponents changing theirs.

Code: FS5
Programming tool
Develop a programming tool to help beginners with programming, the tool should help them build the required constructs and be able to be incrementally augmented as the cover new topics - so the tool will only help them with what they have covered.

Code: FS6
Calculation accuracy
Investigate the accuracy of calculations. Errors can occur from many sources, including measurement tolerance and rounding error. This project should investigate the effect of these errors in calculations. One way of doing this would be to create a new numeric class that incorporates both value and margin of error.

--- Karen Young ---

Code: KY1
Mobile Application Development: Personal Development: Cognition / Personality / Language Learning
The challenges of meeting human interaction needs on mobile devices are well documented. Successful mobile applications often promise user benefits (developing or testing some motor / cognitive skillset) with little user overhead in an engaging environment. This project will require the student(s) to choose a domain from the above listed developmental areas and identify an appropriate problem within the domain and satisfy the users' goals as engagingly as possible (user engagement, successful task completion) in the final mobile system. The system can be developed as a mobile application (Phonegap, Android or iOS development), or as a mobile web system. Following identification of the application, requirements and design details will be elaborated prior to implementation of a prototype and evaluation of same.

Code: KY2
Educational Game
The goal of this project is the fun and engaging delivery of educational content in a risk-free environment: educational game. The student(s) will specify, analyse, design, implement and evaluate an educational (e.g. maths / science / music / language learning) game on a device and platform of choice (mobile / tablet / PC; can be web or standalone). Students will review and evaluate various game development technologies as well as potentially web development technologies before selecting the most appropriate environment for developing their game. Specific topics could incorporate children's language learning, storytelling, mathematical or scientific concept development, or adult literacy or language learning or music learning.

Code: KY3
Music Interaction Application
The investigation of audio based interaction between computers and people is a developing area of interaction research. This project will explore the area of music interaction and identify a suitable prototype system for development. For example the prototype may incorporate adaptive user interaction by recording / monitoring user activity with the application or more generally on their device (using other music applications) and modifying playlists or suggesting other music or could modify the audio mix to suit a user's preference. Another possibility would be to explore the best means of organising and managing music data and sharing recommendations on the mobile phone: a music social application.

Code: KY4
Improving user experience of navigational (mapping) applications
Map-based system interfaces could greatly improve user experience by supporting multiple modes of input – especially speech and gesture, e.g. touch. This multimodal interaction approach can offer a number of advantages over traditional interfaces in terms of wayfinding or mapreading allowing for a more natural and user-friendly use experience. This approach also provides redundancy to accommodate different people in different circumstances: speaking while driving, or touching or keypad interaction in noisy environments etc.
One potential application area that could be explored in this project is that of tour guide (of a building, a campus, a town). The student(s) will specify, analyse, design, implement and evaluate a navigational or tour guide application on a device and platform of choice.

Code: KY5
Museum / Gallery "Experience" System / Application
This project will explore opportunities for exploiting new technologies that can enhance the visitor's experience of a museum or gallery. It will involve conducting a critical review and evaluation of technologies currently employed in museums, and proposing a prototype system extending or integrating these technologies (e.g. could implement an augmented reality component using Vuforia). The student(s) will analyse, design, implement and evaluate a prototype system for either a real or virtual museum or gallery exhibit. This project will be require an understanding of the principles of inclusive design as well as strong interaction design skills.

--- Michael Madden ---

Note: I am happy to discuss other project ideas in the broad areas of machine learning and data mining. The ones below are linked to our ongoing research. For information and publications related to our ongoing research, see http://datamining.it.nuigalway.ie and contact me at michael.madden@nuigalway.ie

Code: MM1
Discrete Simulation of Irish Elections
The Irish general election process is complex by international standards, with a single transferrable vote and multi-seat constituencies with differing numbers of seats. As such, it poses an interesting challenge for simulation. Some of our past research in probabilistic data mining could be adapted for this application.
The goal of this project is to develop a software model for simulating Irish general elections, using a discrete simulation approach, where the simulation models individual voters or voter cohorts in individual constituencies, and includes behaviours such distributing votes when a candidate is elected or eliminated. The system should also be able to use polling data as an input. A final step could be to combine this simulation with our recent work on probabilistic inference, to evaluate the range of possible outcomes from elections, based on polling data.

Code: MM2
A Bot to Fix Code Bugs
The idea of this project is to develop a bot that interacts with a code repository such as GitHub, and pulls down programs and analyses them to find lines that must be bugs. It would then push a change, along with a helpful message. It may also keep track of the bug changes via a twitter account and/or a web page.
This program will use pattern matching to identify bugs. It is essential that it avoids false positives, as it would ruin its credibility if it sets out to fix a bug and introduces one instead.
Part of the work will involve collecting a good set of candidate bugs in more than one programming language. Here is an example to begin (Java):
int f = (int) Math.random() * 100; // Error: cast is higher priority than multiply

Code: MM3
Accurate Health and Activity Recognition
There is a good range of wearable sensors available for platforms such as the Raspberry Pi, e.g. https://www.cooking-hacks.com/documentation/tutorials/ehealth-biometric-sensor-platform-arduino-raspberry-pi-medical
In addition, wearables such as Android smart watches, the FitBit and the Microsoft Band may have APIs that can be used to stream data. At the same time, low-cost ARM based processors, such as found in smart phones and the Raspberry Pi, are interesting alternatives to desktop computers. We have been working to develop develop data mining and machine learning techniques that can operate effectively on such small devices. Separately, we have been working on activity monitoring. The combination of these sensing and computing platforms provides a new and interesting opportunity for real-time health and activity monitoring.
The goal of this project will be to develop an application using wearable sensors and a portable computing platform to monitor the wearer's activities of daily living or to address a specific health monitoring application to be decided agreed between student and supervisor.
There are two possible approaches that could be explored: (1) algorithms that have low computational requirements, and so can be implemented directly on such processors; (2) approaches in which data mining models are built on a more powerful computer and then deployed to a small processor. For example, it may be computationally expensive to inductively learn a Bayesian network or Decision Tree from data, but the resulting network/tree can be represented as a small piece of code.

Code: MM4
Robotics and Reinforcement Learning
Reinforcement Learning is a form of machine learning in which agents learn by interacting with an environment, initially operating at random but getting positive or negative reinforcements when they perform actions correctly or incorrectly. The goal of this project will be to conduct research and development on Reinforcement Learning and use it to control a physical robot. In recent work, we have developed a robot to play Connect-4 and one to navigate mazes while being chased by an adversary (this is based on Theseus and the Minotaur maze puzzles). There is scope to extend either of those projects or tackle new ones.

Code: MM5

Web-Based Timetable Entry, Validation and Display

In the IT Discipline at present, we use a spreadsheet to enter timetabling information on one tab, and this is then formatted on separate tabs of the spreadsheet in timetables organized by student cohort and by venue. Tabs are saved as PDF to be posted online. In the current timetable system, the spreadsheet operates as a crude database. There is some error-checking to catch duplicate entries, but it could benefit from more error-checking. In addition, it would benefit from being able to compute timetables by lecturer, and to be able to automatically account for issues such as modules being taken by multiple student groups, modules having multiple lecturers, and labs being scheduled in multiple simultaneous venues. It would also be good if it had a native web interface for both data entry and display, backed up with a facility to import/export details for the person editing timetables and a facility to generate PDF timetables for users. The goal of this project is to redesign the timetabling system as a web app, with different permissions and different facilities for different user groups such as the public, students, lecturers and administrators.

Code: MM6

Intelligent Extraction of Reminders from Outlook Emails

We receive email messages daily informing us of meetings and other appointments, and we have to transcribe these manually into our calendar software. The objective of this project is to develop utility that can 'read' email messages that are about meetings/appointments, extract relevant details such as the time, location, duration and description. It must then create a reminder with the appropriate details. An interesting challenge is to parse the natural language of email messages in order to be able to correctly generate date/time representations for phrases like "tomorrow at eleven" or "next Tuesday". Outlook has a built-in facility to find "suggested meetings" but it does not handle these well. Microsoft Outlook 2013 and later supports third-party add-on apps, which could provide a useful framework for the implementation.

Code: MM7

Analysing Steamships to Understand 19th Century Trade

In the 19th century, goods were moved from country to country using steamships, and detailed records were kept of the ships and their cargo. However, a key task is to match up steamships, as records were sometimes inaccurate, and ships were renamed occasionally. This is a collaboration with Dr Aidan Kane of the School of Economics in NUI Galway, whose research includes economic history. Aidan and collaborators have developed a database of British and Irish steamships in the first half of the 19th century. They have put together a set of about 25,000 observations on these ships, drawn from a variety of sources, including parliamentary papers, newspaper reports, listings provided in specialist works of maritime economic history. A typical observation has information like the ship name, date of built, its tonnage, where it was built, but there can be other data on technical dimensions. A key task, before they can do economic analysis on all this, is match up observations — basically asking 'is that the same ship as this?' This can be tricky, as ships change names, names are inconsistently recorded, and there is variation in how technical characteristics are recorded/regulated. Some work has been done by hand, and the challenge of this project is to approach it more algorithmically and transparently, using clustering, Bayesian testing, and/or other machine learning methods.

We will build on previous work in the Machine Learning & Data Mining Research Group in which we developed methods for record linking, in the context of identifying individuals who appear in the censuses of 1901 and 1911, even though they may have moved or have had other details changed.

--- Colm O'Riordan ---

My research interests include information retrieval, evolutionary computation, evolutionary game theory, games, graph theory, artificial life and agent theory. I am happy to discuss project ideas that you may have in any of the above domains. Some further details of previous and current work including projects and publications are available from my webpage on the departmental website. Should you be interested in any of these domains, a short list of proposed projects are listed below.

Code: COR1
Design and evaluation of a suitable weighting scheme for agraph based representation of content
The performance of most information retrieval systems is based on the quality of the underlying weighting scheme. These schemes attempt to attach weights to terms that are good at describing the content of a document. There have been a number of recent studies into the formal 'correctness' of weighting schemes by adopting an axiomatic framework to which these weighting schemes should conform. These weighting schemes have adopted a simple 'bag of words' approach to model information. This project will explore a more expressive and rich representation. The project will explore the usefulness of a number of weighting schemes informed by previously specified axioms. This project will involve research, design, implementation and evaluation of results.
Domains: Information retrieval; graph theory

Code: COR2
Evolution of Graphs
In many domains (mathematics, computer science, social science), we need to build or generate graphs that exhibit certain properties or adhere to certain constraints. This project will explore a technique that incorporates evolutionary computation and graph re-writing rules. Both real world graphs and automatically generated graphs exhibit a range of properties that may be of interest. Previous work has shown the power of coupling graph re-writing rules with evolutionary computation to automatically generate a range of graphs exhibiting various properties. This project will entail further developing and exploring the idea to generate graphs that exhibit features of interest.
Domains: graph theory; algorithms; graph comparison algorithms

Code: COR3
Spatial Evolutionary Game Theory
Game theory involves the analysis and study of strategic interactions. In evolutionary game theory, the focus is on successively breeding populations of agents to play games. The project will continue some current work in the domain of evolutionary game theory. The project will explore the emergence of cooperation among self-interest agents where both the agent strategies and the spatial structures are subject to change.

Code: COR4
Partner selection in evolutionary computation
Evolutionary computation (e.g. genetic algorithms, genetic programming) is a field of artificial intelligence in which generations of solutions are evolved over successive generations in the hope of breeding or finding good solutions to problems. One of the key operators in these algorithms is recombination (or crossover) where the genetic material of two parent solutions is combined to create new offspring. Typically the parents are selected based on their ability to solve a particular problem and solutions are paired in a random manner. This project will, using a set of benchmarks, explore the usefulness of using more informed partner selection mirroring approaches that have been identified and analysed in several species.

Code: COR5
Artificial Life/Multi Agent Systems: simulation and analysis of collective behaviours
Artificial Life and Multi agent systems are often used to simulate certain aspects of natural systems (cooperation, competition, coordination, communication). This project involves the design and development of an abstract model to study certain forms of coordination in artificial life systems. A number of scenarios will be explored resulting in an analysis of the dynamics of the system.

--- Jim Duggan ---

Code: JD1
Contact detector app.
The goal of this research project is use near-field and GPS communications to gather contact data from the population. Based on the proximity of phones, contacts can be inferred, and represented as a dynamic social network over time.

Code: JD2
Predicting the spread of seasonal influenza using a network-based approach.
The goal of this project is to build a network model of influenza spread in R, so that policies can be tested to mitigate its transmission. .

Code: JD3
Resource Allocation Optimiser for Pandemic Response
The aim of this project is to design software (using genetic algorithms) that will optimally allocate scarce resources to population cohorts in order to reduce the burden of disease on the overall population.

--- Matthias Nickles ---

Code: MN1
Contextualized web browsing
Modern web browsers are able to predict surf targets, and various web annotation tools augment the presentation of web pages with a second layer of information (e.g., notes, ratings or discussions about content on that page). However, no efficient and general approach to the automated discovery of context information exists yet. Such context information includes (but is not restricted to) background knowledge (e.g., from Wikipedia or online databases), information about provenance, history and follow-ups of information on the respective page (e.g., news articles). In this student project, a framework for the automated or semi-automated (interactive) discovery and presentation of context information using state-of-the-art machine learning / data mining and linked data technologies should be developed and implemented, leveraging existing approaches in information retrieval.

Code: MN2
Textual and graphical notations for Predictive State Representations
A certain category of stochastic models has been proposed which represents the state of a dynamic system in terms of predictions of future observations. It has been claimed that such so-called Predictive State Representations (PSR) are at least as expressive but more concise and in certain cases easier to learn from data compared with traditional models of dynamic systems, such as Hidden Markov Models (HMM) and Partially Observable Markov Decision Processes (POMDP).
In this project a basic framework for the textual (JSON-based) and graphical representation of one variant of PSRs (Relational PSRs) shall be created.
Requirement: good programming skills

Code: MN3
Visualization of inconsistencies in knowledge bases on the (Semantic) Web
Inconsistent knowledge bases are traditionally considered useless, because in classical logic from a contradiction follows everything ("ex falso quodlibet" principle). However, in many realistic scenarios this verdict is too strong, in particular in the context of the (Semantic) Web. Inconsistencies are often unpreventable (especially if contributions to the knowledge base stem from multiple or unreliable information sources), and the discovery and analysis of inconsistencies can provide valuable meta-knowledge for the reconciliation of the knowledge base. Consequentially, several approaches to the analysis of or reasoning in the presence of inconsistencies have been proposed, including various para-consistent logics and inconsistency measures. Domains which are particularly prone to contradictory information are the (Semantic) Web, which means that ways to deal with inconsistencies are becoming more and more important for real-world applications. In this project existing approaches to the quantification of inconsistencies in knowledge bases shall be examined, and a software tool shall be developed which implements one of these existing approaches prototypically, in order to allow for the visualization (i.e., identification, measurement, and/or graphical representation) of inconsistent knowledge bases. A similar project which focuses on formal ontologies instead of general knowledge bases would also be possible. Requirement: basic knowledge of logic (e.g., basic Prolog).

Code: MN4
Answer Set Programming tools on the Java Virtual Machine
Answer Set Programming (ASP) is an approach to Logic Programming which is syntactically similar to Prolog. Most ASP tools are written in C/C++, and using them with other programming languages is rather cumbersome and slow. In this project, a certain existing ASP solver should be extended with an interface or a Domain Specific Language which allows ASP programs to be directly embedded into software programmed in Java or other Java Virtual Machine-languages, such as Scala or Clojure. Requires good programming skills. Pre-existing ASP knowledge is not required.

Code: MN5
Aggregation of contradictory beliefs using SPARQL
SPARQL is a standardized query language for RDF-encoded knowledge on the Semantic Web. SPARQL already proved to be useful in real-world applications. But although SPARQL tools are able to gather data from multiple sources, they are typically not well suited for the weighted aggregation of knowledge from multiple contradictory information sources. Several approaches to tackle this issue have been proposed, such as belief fusion (based on the Dempster-Shafer theory of evidence) and provenance-aware data aggregation. In this project a software tool shall be developed which extends the functionality of some given implementation of SPARQL so that it captures both the provenance of information and their inferred probability. For this project, basic existing knowledge about the Semantic Web or Linked Data on the Web is recommended (e.g., about RDF) but not strictly required.

Code: MN6

A chatbot based on rules and/or machine learning

The purpose of this project is to create a chatbot which is able to perform certain services for its users (e.g., providing information or scheduling events) and to interact with users in an adaptive and context-aware way using simple English sentences. There are various possible technical approaches to this project: e.g., the chatbot could be based on a set of flexible rules or a suitable machine learning approach (such as reinforcement learning), or a combination of these.

Requirements: good programming skills (in, e.g., Java, Scala, C++ or Python). Interest in Artificial Intelligence.

--- Hugh Melvin ---

See http://pel.it.nuigalway.ie for more details of the research group on campus.
See www.taaccs.org and http://www.cost-across.nl/ also for further background on the first 2 projects.
The first is a US-based interest group, with NUIG involvement that is broadly looking at the role of timing. The 2nd is an EU project that we are involved in.

Code: HM1
Time-aware Gaming – level the playing field for everyone
Gamers are all too familiar with the impact of poor network bandwidth on gaming experience. This project will investigate the use of precise time to better manage the Gaming Anywhere Cloud MMOG platform http://gaminganywhere.org/ Having access to precise time gives the Gaming Anywhere controller much better information on which to base techniques such as lag compensation. This project will firstly look at how Gaming Anywhere is implemented and will then examine ways to use precision timing to improve the performance. It will build on previous work by MSc student Xiaojie Wu and 4th Yr BSc CS&IT student Adam Long.

Code: HM2
WebRTC - VoIP Application Development
We are all familiar with using VoIP technologies such as Skype, Viber, WhatsApp etc etc ..but have you thought about how they work and what causes the often common Quality of Experience (QoE) problems? WebRTC is another RealTime Communications application that is free, open source, and enables web browsers with RTC capabilities via simple Javascript APIs. It is being driven by Google along with Firefox and others. See www.webrtc.org for details. In this project you will build on the existing VoIP application within webrtc to implement better Quality of Experience features such as improved jitter buffer management. You will get to fully understand how VoIP applications work and get to implement your own modifications (C++). You will work closely with Yusuf Cinar, PhD candidate within the PEL research group.

Code: HM3
Using the Open Internet of Things (IoT) platform NodeRed to harness NUI Galway Building Mgt. Systems Data
Collaborative project with Dr. Marcus Keane NUI Galway, and Karl Byrne (Optimised Energy Controls)
One of the key challenges for IoT is making use of the huge volumes of data being generated by sensors and devices. This project will investigate the use of IBM's IoT platform NodeRed http://nodered.org/ to help capture, store and visualise various sources of Building Management System Data across the University , along with other contextual information streams eg. twitter to better manage the BMS. This work will be done in collaboration with Dr. Marcus Keane, Civil Eng and BMS expert Karl Byrne.

Code: HM4
Health and Safety Logging App
Health and safety is of paramount importance in the day-to-day running of a busy research laboratory. In particular, interdisciplinary research such as biomaterials development requires extensive expertise in chemistry and biology, research areas associated with significant and diversified health and safety challenges. Critically, the use of hazardous chemicals within an experiment requires an experimental risk assessment to be performed. The laboratory is continuously trying to ensure that these are performed for all experiments, but most especially experiments involving mixing of chemicals The Proposed project will be conducted with research staff and scientific officers at CURAM's laboratories, Bioscience Research Building and will focus on the development of an online matrix system to aid in tracking, evaluating and verifying on-going health and safety practices within the building. Specifically, the student will develop an interactive health and safety logging app that will allow a user to input the systems, and chemical being employed in a particular experiment and which will return a risk assessment statement, detailing the risks and protocols associated with that experiment and provide information and instructions on the control measures required to manage that risk, if the control measures are not sufficient to manage the risk, then additional information may be required in the form of a new risk assessment. The development of an integrated health and safety risk assessment web app is the key deliverable.

-- Josephine Griffith ---

Code: JG1
Exploring and Visualising factors affecting mood through social media and sentiment analysis
Many generic factors affect people's mood – the day of the week, the weather, sporting events, political events, etc. Some work in sentiment analysis has considered "mood factors" and used sentiment analysis techniques (specifically machine learning techniques) to extract public mood in online social media. This project should develop an approach to model and visualise sentiment based on one or more chosen mood factors. Steps include extraction of data from a suitable online social media source such as Twitter; extracting sentiment from this data and visualising the data.

Code: JG2
Targeted Online Social Media Recommendation
This project will consider user recommendation in online social networks. Existing approaches use standard graph and recommendation techniques to model the similarity between users and allow for user recommendation. This project will build a system to extend these approaches by investigating additional factors which affect user similarity such as user's degree of interaction with each other and their responses to targeted content.

Code: JG3
Sentiment Analysis and Sarcasm Detection in Twitter Conversations
Many sentiment analysis approaches applied to Twitter data consider individual tweets. Such approaches generally try to infer whether a tweet has a positive or negative sentiment or opinion. Such individual tweets lack the context of a pre-existing conversation or set of related tweets. Thus the task of sentiment analysis, or of inferring higher levels of sentiment, such as sarcasm, are more difficult. Indeed, typically not enough evidence is available given only one tweet to correctly label a tweet with respect to sentiment and therefore this presents a particularly difficult task for any automated approaches. This project will build a graph to represent Twitter conversations and use this graph to test approaches to detect sentiment and potentially, sarcasm.

--- Conor Hayes ---

Code: CH1
Smart Open Street Map of NUI Galway
Many people find the geography of NUI Galway difficult to negotiate. Finding buildings, PC suites or lecture theatres is a challenge. The NUIG online map is out of date and not up to the task. The project will create an up-to-date crowd-sourced map of NUIG using open source information such as Open Street Map.
Functionality as follows:

- users can update landmarks directly on the map
- users can upload photographs that indicate a location
- users can upload directions and warnings - "this is not easy to find" but take a right just before the Bank of Ireland and go through the double doors…"

Searchers can type in a key word: E.g. "smokeys". The map will zoom to the location, provide a user generated photo, user directions (and suggest a route for the user - this part will require quite a bit of research).
What is required:

- good programming skills
- ability/desire to build web/mobile apps
- interest in human-computer interfaces
- data analysis and reasoning

Code: CH2
Crowd sourced Atlas of Living Ireland
This project is designed to create an app and web site that allows users to upload records of observations of flora and fauna, recording the uploader date, time and location. This is an example of what is sometimes known as citizen science - non-experts contributing data that helps the overall understanding of topics of scientific interest. In this case, bio-diversity in Ireland. The backend of the system stores the data, and allows it to be queried and displayed in a variety of different ways. It should have a mapping component (e.g. using Open Street Map) that allows for the visualisation of the distribution and density of submitted observation. Please see http://www.als.scot/ for some ideas
What is required:

- good programming skills
- ability/desire to build web/mobile apps
- interest in human-computer interfaces
- databases and data analysis
- visualisation

Code: CH3
Analysis and visualisation of Galway's extended communities
In 2010, an intern at Facebook, Paul Butler, created a visualisation of Facebook users in such a way that it outlined the most populous regions of the world - excluding those areas of the world that don't use Facebook (e.g. China). This project takes this idea as an inspiration. The context is as follows - Galway has recently been awarded the European city of Culture for 2020. We would like to try visualise the communities around the world with which Galwegian social media users have contacts. Using some of the techniques described by Paul Butler on Twitter data the goal is to visually represent the Galway and its extended communities throughout the globe. Of course, this technique will be generalisable to any city or community in the world and it would be preferable if you design a system that can be used to generate analytics and visualisation for any city or region.

Challenges: limited data capture from Twitter, data analysis on friends and followers, NLP/Text-mining analysis on content to infer location, visualisation of friendships on a map

Sources of data: Twitter and/or social media sources from which location is given or inferred.

Outcomes: The goal would be to develop a visualisation similar to the one developed below, but focusing on the extended communities of a particular city or region. This will be of use to groups such as Galway 2020 organisers and possibly business, but also sociologists seeking to understand human migration patterns.

What is required:

- good programming skills/ willingness to learn a language such as R
- ability/desire to build web/mobile apps
- interest in human-computer interfaces
- databases and data analysis
- visualisation

--- Frank Glavin ---

The projects below are related to my ongoing research interest in the application of artificial intelligence algorithms to computer games in order to create more interesting and adaptive opponents for human players. I am also open to discussing other related project ideas in the broad areas of machine learning and data mining. My research publications can be found here: https://www.researchgate.net/profile/Frank_Glavin2/contributions

Code: FG1
Intelligent Non-player Characters in First Person Shooter Games
The first-person shooter (FPS) genre of computer games has existed for over twenty years and involves a human player taking control of a character, or avatar, in a 3D world and engaging in combat with other players, both human and computer-controlled. Human players require many hours of practice in order to become familiar with the game controls, maps and to build up quick reflexes for accuracy. Replicating such human behaviour in computer-controlled bots is a difficult task considering that they do not have physical controllers and must read the game circumstances from the system as opposed to basing their decision-making on audio/visual stimuli and physical reflexes. Pogamut 3 [http://pogamut.cuni.cz/main/tiki-index.php] is an open-source platform toolkit that can be used for creating virtual agents in the 3D game environment of Unreal Tournament 2004. A research project could be undertaken which involves developing artificial intelligence approaches to address some interesting FPS tasks including, but not limited to:

- Natural and adaptive navigation
- Item acquisition and prioritisation
- Opponent evasion and strategic use of map geometry
- High-level behaviours for mode-specific team strategies (domination, capture the flag etc.)
- Learned proficiency for different categories of weapons
- Short-term memory for opponents and "hot spot" location determination

Code:FG2
Real-time Computer Game Skill Matching for Human Opponents
Dynamic Game Balancing (DGB) involves adjusting parameters, scenarios, and behaviours in real-time computer games, based on the current opponent's ability, in order to avoid them becoming bored with the game. When the computer-controlled opposition is too strong, human players can become frustrated with the gameplay. Likewise, opponents that are too weak result in predictable games in which human players do not feel challenged. This project would involve the design and development of a web game or phone app which incorporates DGB into the game logic in an effort to closely match the current opponent's skill level. A game development platform such as Unity could be used to create the initial prototype game. The project would suit students that have an interest in game design and development as well as the application of AI techniques.

Code: FG3
Humanlike NPCs and the BotPrize Competition
The BotPrize competition has been running since 2008 and the purpose of the competition is to see if computer controlled bots can fool expert judges into believing that they are human players in the FPS game Unreal Tournament 2004. This competition essentially acts as a Turing Test for bots. The rules of the competition change from year to year and recently one of the guns in the game has been edited with the sole purpose of tagging opponents as either human or bots. This is known as first person assessment and is combined with a third person assessment, in which judges view video clips, in order to determine the overall humanness ratio. The goal of this project would be to design and develop a UT2004 bot that incorporates different AI techniques in an effort to create humanlike behaviour. There is a lot of interesting research based on this competition with plenty of potential to extend techniques or develop new approaches. Further information about this competition can be found on: www.botprize.com

Code: FG4
Annual Computer Poker Competition Agent
This project would involve the design and development of an AI agent in the context of a poker game.
The competition, which is described here: http://www.computerpokercompetition.org/ , states its objectives as follows:
"*Poker brings many new and interesting problems that are not faced in checkers, chess, Go, or backgammon. It is not only random, there is hidden information, and a desire to maximize your winnings. Handling the hidden information is a problem that is on the edge of artificial intelligence: for instance, in video games, often the bots cheat, i.e. they are given perfect information about the world. Understanding how AI can tackle these problems is key to the next stage of AI, not only in video games, but in real-world scenarios, such as in business and the military.*

At its heart, the Annual Computer Poker Competition aims to benefit artificial intelligence by promoting, aiding, and evaluating research in the challenging problems presented by the wide variety of poker games. By having an annual competition, we hope to provide ongoing encouragement to improve existing methods and develop new ideas and algorithms for tackling even more challenging variants of poker."

Code: FG5
Project based on other existing Research Competitions
There are several other interesting competitions and testbeds that could be used to form the basis of a research project. Some examples are as follows:

- RoboCup Competitions: http://www.robocup2016.org/en/
- Angry Birds AI Competition: https://aibirds.org/
- Student StarCraft AI Tournament: http://sscaitournament.com/
- Simulated Car Racing Championship: http://cs.adelaide.edu.au/~optlog/SCR2015/index.html
- General Video Game AI Competition: http://www.gvgai.net/