CO6008 Project Topics 2023/2024

This document is a portfolio of the project topics that are being offered by academic staff this year for CO6008 Innovation Project, organised alphabetically by staff name. Please note that projects must include the undertaking of practical work of some sort using computing/IT technology. This is most frequently achieved by the creation of an artefact as the focus for covering all or part of an implementation lifecycle. Dissertations based solely on literature review activity and/or user/market surveys are not acceptable.

Action Arrange an appointment with the project supervisor of the projects that interest you during the first two weeks of the Autumn Term.

Action Complete the Project Preferences Form (download from Moodle):

- Name, email, degree course
- List the top three preferences for your project. They should each be with a **different** supervisor.
- Upload to Moodle by 5pm on Monday 9th October.

Optional if you want to propose your own project:

- Talk to your PAT or potential supervisor about your idea before 2nd October. They must confirm to you that the project is suitable and be satisfied that it will undertake practical work of some sort using computing/IT technology.
- Use the first option on the preferences form to list the project idea, making sure you state "Own Project Idea" in the title. You should still select two other projects from the portfolio.

Note that due to staff load you may be allocated a project that is not on your list. We will do our best to give you one of your preferences, however, resources permitting. It is important that your three preferences are each with a different supervisor.

Staff will have the final choice on who is selected for their projects

This Key has been used to highlight which projects are suitable for different degree courses:

CS	AC	SE	GD	Cy

CS Computer Science
AC Applied Computing
SE Software Engineering
GD Games Development
Cy Cybersecurity

Jules Barnes

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Areas of interest

- Industry 4.0 R&D - Digital Product Design for Industry
- IoT Product Design
- HCD – Human Computer Interaction
- VR & AR for use in Commercial Environments, i.e., Training in Industry
- UX – User Experience Design & Psychological Principles
- UI – User Interface Design
- Wearable Technology including Apparel
- Secure Cloud based Design & Implementation
- System Architecture
- Project Management
- Graphic Design
- Mobile Application Development

1 Design and develop a prototype (3D model or working model) for a de-centralised control panel.

CS	AC	SE	GD	Cy

This would entail a detailed design process, using UX/UI techniques and research.

The theory is to create and design, a functional MVP (Minimal Viable Product) for HCD of a main de-centralised control panel that could control any number of external machines within a factory/engineering setting and or remotely. Paying notice to the use of cloud-based technology to design and use and the security needed for that. Considerations to the use of an appropriate operating system (existing or bespoke) to handle multiple technologies with emphasis on usability and safety in the design.

Ideas that could be included in the project are extensions to the product to make it a useable workstation for technical staff to improve factory-based safety both physical, environmental and with regards to cyber security and data integrity.

Example Scenario;
A major car manufacturer has a production plant with various machine cells throughout controlling robotic arms or similar tasked an areas of building body in white cars. Each arm must be controlled by its individual control panel and safety shut off. What would be ideal is that unless a cell needed physical maintenance all the control panels and safety systems could be controlled online and offline via a de-centralised control panel, which in turn could be accessed from anywhere in case of disaster recovery and or any threat to human life.

Skills to be used: UI/UX design, 3d modelling, practical physical computing, programming. Project management techniques and industry standards to be considered throughout.

2 IoT devices and or wearable technology – Various Ideas (List below not exhaustive)

CS	AC	SE	GD	Cy

Research and definition, combined with the design, modelling and a working digital and (if possible) physical prototype for an innovative MVP (Minimal Viable Product).

To turn everyday devices or items that could be enhanced, and or a create a completely unique item or piece of wearable technology for whatever reason. i.e., topics could include, clothing, watches, products for emotional and physical wellbeing (meditation, sleep etc), music related, travel, productivity, business, lighting, fitness etc.

(Note: the idea must be unique or a unique enhancement to a product – similarities to other products more than likely could occur but there must be something completely unique or innovative)

Features to note would be to enable the device so it is mobile app controlled, therefore the design and programming of the app for hybrid devices is important. The more functionally interactive and or incorporating into the overall design makes the product more desirable for the wearer in a retail market. This could also be a product that could be incorporated into another industry product and therefore saleable business to business.

Consider the use of a Raspberry Pi or Arduino technology, sensors etc, use of Kotlin, Swift, Flutter/Dart, and hobbyist computing.

Skills to be used: UI/UX design, 3d modelling, practical physical computing, programming and for iOS or Android technology (or both). Project management techniques and industry standards to be considered throughout.

Any other projects are also considered.

Lee Beever

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Areas of Interest

- Game design and development
- Level design process and implementation
- Augmented reality games (e.g. ARKit, ARCore and ARFoundation).
- Virtual reality games/implementations
- 3D asset creation

1 Developing a single player level for X game

CS	AC	SE	GD	Cy

Main Skills Required: Design (Heavy) and Programming (Medium)
This dissertation topic aims to replicate the level designer role in a studio by asking students to develop a single player level for an existing game. Students will be required to research level design theory, plan out a level, prototype it, test/iterate and finally complete an art pass. Students will be expected to run several play test sessions throughout the process. Good problem-solving skills are required as it is also up to the student to learn the level editor and programming environment of the chosen game.
There are many games on Steam that support modded levels but not all allow for enough depth for a dissertation, therefore some recommended games are:

- Dungeon Defenders (UE3)
- Half Life: Alyx (Source 2 – requires a VR headset)
- SOMA (HPL Engine 3)
- Left 4 Dead 2 (Source)
- Dying Light (Chrome Engine 6)
- Hello Neighbour (UE4)
- Fallout 4 (Creation Kit)
- Thunder Tier One (UE4 – Campaign)
- Human: Fall Flat (Unity)

2 Developing an augmented reality game using ARKit/ARCore

CS	AC	SE	GD	Cy

Main Skills Required: Design (Medium) and Programming (Medium)
Students will develop a game that makes use of augmented reality on a smartphone using either ARKit, ARCore or ARFoundation. Augmented reality requires a new way of design thinking and making effective use of the technology is essential to developing a successful AR game. The game should be developed in Unity making use of the appropriate SDK for the desired platform or using Unity's AR Foundation

package. Students will need to provide their own device, so please ensure your device is compatible with ARKit or ARCore.

3 Developing an animated game character

CS	AC	SE	GD	Cy

Main Skills Required: 3D modeling (Heavy) and Programming (Light)
This topic requires students to research character modelling techniques and processes along with recent developments in the industry. Students will be expected to plan the character, create concept drawings, model the character (using modern techniques), rig the character and develop a set of basic animations. The character should then be implemented into either UE5 or Unity in an application that can demonstrate the different animations.
Students will need to research and develop their current modelling skills further in order to gain the skills required to develop a quality game character. The character can be of any style and can be based on an existing IP (as a new character).

4 Developing a virtual reality game for Meta Quest/Quest 2 or similar

CS	AC	SE	GD	Cy

Main Skills Required: Design (Medium) and Programming (Medium-Heavy)
This topic requires students to research virtual reality game design and usability concepts in order to develop a virtual reality game. Students are free to choose the game genre but are expected to make use of the input/output features of their HMD of choice. Students may wish to utilise the Unity XR Interaction Toolkit or code their own interactions from scratch, depending on their design or programming focus. There will also be the opportunity to integrate with my LevelEd VR software
It is recommended that students have their own VR equipment and capable PC, however, we do have several Meta Quest devices available, but these will be first come first serve and shared across the whole department.

5 Developing a networked multiplayer game in Unity

CS	AC	SE	GD	Cy

Main Skills Required: Programming (Heavy) and Design (Medium)
This dissertation topic extends and builds on top of skills developed in CO5035 by focusing on developing a networked real-time game using Unity. Students choosing to undertake this topic will develop new skills and gain an understanding of an essential topic, such as multiplayer networked games. Students choosing this topic should ensure they are comfortable working in Unity and exploring how to use 3rd party networking APIs, such as Photon or Mirror or the new Netcode for Game Objects from Unity.
Students choosing this topic are free to decide on a game genre in which to build the networking framework around. Past examples have included a first-person shooter, a turn-based RTS and a co—operative wave-based shooter.

6 Developing a new multiplayer experience for Fortnite using Unreal Editor for Fortnite (UEFN)

CS	AC	SE	GD	Cy

Main Skills Required: Programming (Medium) and Design (Medium-Heavy)
In March 2023, Epic Games launched Unreal Editor for Fortnite. This software allows developers to create truly original content for the Fortnite game, rather than using the limited built in tools. The software uses a modified version of Unreal Engine that allows developers to bring in their own custom assets, write custom code, create cutscenes, etc. and then deploy this to Fortnite for testing and ultimately, publishing. A student who takes on this topic will be required to create their own game experience using UEFN, test it online with players and finally publish the game to the platform. This topic will require students to learn the new toolset, including the new Verse programming language to succeed and so the scope of the game idea will be important to consider.

7 Personal Project Ideas

CS	AC	SE	GD	Cy

I'm also happy to discuss and support personal project ideas as long as they are within my areas of interest listed above and demonstrate a new set of skills being learnt by a student. Please discuss these with me before putting in your Project Preferences Form.

Dr Stuart Cunningham

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Areas of interest

- Affective computing
- Computer music
- Data compression
- Human-computer interaction
- Sonic interaction
- User experience

1 VR Reaction Exergame

CS	AC	SE	GD	Cy

Main Skills Required:

Game development [Unity or Unreal] (Medium-Heavy), Programming (Medium), Interface Design (Medium).

Summary

This project requires you to design, implement and test a Virtual Reality (VR) game. Essentially, in the game to be created the player is challenged to hit one of several virtual lights held within a matrix configuration (8x8 is suggested to start). The object of the game is to hit the light as fast as possible over the period of play (maybe two or three minutes). Game difficulty may be manipulated by changing the speed at which the lights turn on/off, duration of illumination, number of concurrent lights lit, and so forth. Think about the game as 3D version of the arcade game *Strike-a-Light* [Video] or the exergame system *Twall 64* [Web | Video]. Crucially, since this game is VR, you can have the lights appear all around the player as well as being able to control their depth, relative to the user, as mechanisms to manipulate game difficulty. User testing should include research to evaluate whether players found a simulated 2D version of the game different to a 3D version.

2 Navigating the Real World with Spatial Audio Cues

CS	AC	SE	GD	Cy

Main Skills Required:

Mobile app development / APIs (Medium), Sound Design (Light), User Experience (Medium).

Summary

This project will explore how sound can be used to enhance navigation software, such as Google or Apple Maps, by providing the user with auditory cues when they are wearing headphones using Head-Related

Transfer Functions (HRTFs). For example, the destination they are trying to reach could be sonified in a 360-degree space around the head of the wearer, thus indicating the direction in which the destination is. Distance from the destination might be conveyed by factors such as rate of pulsing, changing pitch, or increasing volume. The project will examine the various methods for audifying distance and direction information (and even other hazards and information) and determining which are most user friendly and effective.

Useful References

- Brewster, S. A., Wright, P. C., & Edwards, A. D. (1993). An evaluation of earcons for use in auditory human-computer interfaces. In Proceedings of the *INTERACT'93 and CHI'93 conference on Human factors in computing systems* (pp. 222-227). ACM.
- Holland, S., Morse, D. R., & Gedenryd, H. (2002). AudioGPS: Spatial audio navigation with a minimal attention interface. *Personal and Ubiquitous computing*, 6(4), 253-259.
- Strachan, S., Eslambolchilar, P., Murray-Smith, R., Hughes, S., & O'Modhrain, S. (2005). GpsTunes: controlling navigation via audio feedback. In *Proceedings of the 7th international conference on Human computer interaction with mobile devices & services* (pp. 275-278). ACM.

3 Classic Video Games as Audio Games

CS	AC	SE	GD	Cy

Main Skills Required:

Game Engine / Game development (Medium), Programming (Medium), Sound Design (Light).

Summary

Audio Games are a type of computer game that provide no visual feedback to their player. Instead, information is primarily communicated to the player using sound, music, and haptic or tactile means. In this project, you should select a classic video game (such as *Pacman*, *Space Invaders*, *Pong*, *Horace Goes Skiing*, or similar) and produce an audio game version of it. You will need to think carefully about how the sounds are designed and deployed to provide game state information, as well as entertainment, to the player. As part of the process, you are expected to perform evaluations and user testing of the game, to determine how it might be refined and how easily people are able to interact with it and, hopefully, enjoy it.

4 A User-Friendly Cricket Score Book

CS	AC	SE	GD	Cy

Main Skills Required:

Databases (Medium), Programming (Light-Medium), Web Development (Medium), interface design (Medium).

Summary

The traditional process of recording the scores during a cricket match is challenging, requiring constant attention to the match being played, knowledge of the game, umpiring signals, and various notations and symbols. To the untrained eye, the traditional score book looks intimidating and not easy to pick up. In this project, you are to create a web-based digital cricket scorebook system with an easy-to-understand interface that is designed around user need. The choice of web systems and technologies is yours, but it must be responsive and support access from a variety of devices (such as laptops, tablets, and smartphones). The idea is that the final system could be used by scorers at all levels of the game, but particularly those who are inexperienced.

5 Automatic Selection and Synthesis of HRTFs

(NOTE: Three distinct projects under this topic)

CS	AC	SE	GD	Cy

Main Skills Required (specific, depending on project):

Algorithms / Optimisation (Medium-Heavy), Programming (Medium), Image Processing / Computer Vision (Medium), Machine Learning (Medium).

Summary

The use of spatial audio via binaural reproduction (think wearing headphones whilst using a VR or AR headset or even playing a game with headphones on) is increasing rapidly. This allows the listener to hear sounds in the virtual world coming from all directions around them, just like in the real world, and is achieved with the use of Head Related Transfer Functions (HRTFs). A major challenge in creating an accurate and immersive experience is providing the user (listener) with the best spatial audio possible. This is often difficult because to be completely accurate a HRTF model would need to be created for the head of every listener. This isn't currently practical. So instead, generic HRTF models are used. But this leads to sub-optimal and often poor user experiences. However, there are already a good selection of HRTF libraries available (https://www.ece.ucdavis.edu/cipic/spatial-sound/hrtf-data/ or https://www.oeaw.ac.at/isf/das-institut/software/hrtf-database, for example), so there's plenty of data out there.

⇒ *Fast HRTF Finder:* The aim of this project is to find a way to provide a user with the optimal, or near optimal, HRTF from an existing large library. This might be done by playing the user a small number of test sounds and asking them to choose between them to identify subsets of HRTFs that might be most suitable. There is a clear trade-off between the amount of time this must take and the quality of the HRTF selected.

⇒ *Photo HRTF Finder:* The aim of this project is to allow the user to take a photo, or series of photos of their ear(s) and for these to be analysed using computer vision, before key anthropometric features are identified and these used to select the best HRTF available in the existing library. The quality of the resulting HRTF should be verified.

⇒ *Fast/Photo HRTF Synthesizer:* Either by providing the user with some simple listening tests OR by asking them to upload a photo of their ear(s), synthesise a personalised HRTF for that user based upon learnings that can be achieved from an existing dataset(s).

Useful References

- Miccini, R., & Spagnol, S. (2021). A hybrid approach to structural modeling of individualized HRTFs. In *2021 IEEE Conference on Virtual Reality and 3D User Interfaces Abstracts and Workshops (VRW)* (pp. 80-85). IEEE.
- Pelzer, R., Dinakaran, M., Brinkmann, F., Lepa, S., Grosche, P., & Weinzierl, S. (2020). Head-related transfer function recommendation based on perceptual similarities and anthropometric features. The *Journal of the Acoustical Society of America*, 148(6), 3809-3817.
- Wang, Y., Zhang, Y., Duan, Z., & Bocko, M. (2021). Global HRTF Personalization Using Anthropometric Measures. In *Audio Engineering Society Convention 150*. Audio Engineering Society.
- Miccini, R., & Spagnol, S. (2020). HRTF individualization using deep learning. In *2020 IEEE Conference on Virtual Reality and 3D User Interfaces Abstracts and Workshops (VRW)* (pp. 390-395). IEEE.

6 A General Purpose Web Scraper

CS	AC	SE	GD	Cy

Main Skills Required:

Programming (Medium-Heavy), Web Development (Medium).

Summary

The idea of this project is to allow the user to enter the URL of a web page in a simple form and for your software to visit that page and extract any specified content that the user wants from that page. For example, they may enter a web address, choose to extract the email addresses, links, and images from

the page, and for these to be returned in a specified format (for example, in a table or CSV file). There is scope to build upon this simple functionality by also allowing the user to have your system crawl the page in question, following-up any hyperlinks and extracting content from those pages too.

7 A Cross-Platform Game to demonstrate Fitts' Law

CS	AC	SE	GD	Cy

Main Skills Required:
Game Engine / Game development (Medium), Programming (Medium), statistics (Light-Medium), interface design (Medium).

Summary
Fitts' Law is used to describe and predict the way that pointing tasks are carried out in interfaces based upon the distance the user must travel to reach a target (often a button) and the target size. This is useful, for example, in providing a difficulty index or estimated amount of time it takes a user to press a button on the screen. The concept can be illustrated and testing by getting users to perform a task (essentially a mini game) where they must click on a randomly sized and positioned target multiple times, whilst the time taken for each is measured.

There are some examples of this in action available. This project involves recreating this type of game/test, but making it available on multiple platforms, thus supporting users playing the game with, for example, a mouse on a desktop or laptop computer, or using their finger on a smartphone or laptop. Ideally, this new version of the game should do some analysis of the user's performance, by examining the regression trend their data generates and plotting this comparatively against the established Fitts' Law model, to see how they correlate.

Useful References

- Fitts, P. M. (1954). The information capacity of the human motor system in controlling the amplitude of movement. *Journal of experimental psychology*, 47(6), 381.
- MacKenzie, I. S., and Buxton, W. (1992). Extending Fitts' law to two-dimensional tasks. In *Proceedings of the SIGCHI conference on Human factors in computing systems* (pp. 219-226).

8 Repertory Grid Software Development

CS	AC	SE	GD	Cy

Main Skills Required:
Programming (Heavy-Medium), Statistics (Medium-Light), Interface Design (Medium).

Summary

Repertory Grid is a technique used by psychologists and human-computer interaction researchers to understand how people perceive things in the world around them. It relies on data often elicited by semi-structured interviews or questionnaires. Essentially, it consists of multiple scales (called *constructs*) that are used by participants to rate things (called *elements*), typically by using a numbered Likert-style mechanism. These are then entered into a matrix (the Repertory Grid) where the data can be statistically analysed, primarily by ranking/ordering, correlation, and dimension reduction techniques (commonly Principal Component Analysis).

The job of this project is to develop a software system where users can enter their Repertory Grid data and be presented with the various analyses, graphs, and other information to help with their research, which they can then save and/or export. There is a very out-of-date, often unreliable, web-based version of the software here: http://webgrid.uvic.ca/ that you can try. There have been more recent attempts to develop replacement systems, but none of these offer the same level of intuitive, ease-of-use. The software to be developed in this project should be individual and easy for anyone to use. You have the option to develop the Repertory Grid system as a standalone application (in which case it must run on Mac OS and Windows) or as a web-based application.

9 Detecting Alerts in Virtual Acoustic Environments

CS	AC	SE	GD	Cy

Main Skills Required:

Game Engine / Game development (Medium), Programming (Medium).

Summary

This project requires you to design and build several virtual environments, based on common, real-world, physical spaces. For example, these might include: an office environment, a shop, a hospital ward, a train carriage, and so forth. These models should include a realistic representation of the real-world, 3-dimensional, sonic environment, considering sources of background noise (e.g., people talking, phones ringing, environmental elements) that you would encounter in these spaces as well as their acoustic properties (how reflective or reverberant the spaces are). Once built, you should recruit a group of human participants to explore and test your environment and see how well they are able to perceive a set of pre-designed audio alert sounds (provided by the supervisor) within them. There is potential for the environment to be explored by participants either using a virtual reality headset or by using headphones and a traditional display screen.

Useful References

- Cunningham, S., & McGregor, I. (2021). Evaluating Use of the Doppler Effect to Enhance Auditory Alerts. *International Journal of Human–Computer Interaction*, *37*(11), 1074-1087.

- Edworthy, J. (1994). The design and implementation of non-verbal auditory warnings. *Applied ergonomics*, *25*(4), 202-210.
- Hellier, E. J., Edworthy, J., & Dennis, I. A. N. (1993). Improving auditory warning design: Quantifying and predicting the effects of different warning parameters on perceived urgency. *Human factors*, *35*(4), 693-706.

10 Audio Forensics: Event and Object Detection

CS	AC	SE	GD	Cy

Main Skills Required:

Machine Learning (Heavy-Medium), Programming (Medium-Light).

Summary

The idea of this project is to develop a piece of software or processing pipeline that can take an audio stream as an input (probably in WAV or MP3 format) and for it to be able to identify key events of interest that take place in the stream and label them accordingly. For instance, imagine taking a recording during a lecture or lab activity at the University and for the software to be able to identify each occasion where a door was closed or when someone in the room had their phone ring or receive a message alert. Key challenges will include identifying or synthesising a suitable dataset, separating the events of interest from the background noise, and identifying suitable features and machine learning techniques to classify events accurately.

Useful References

- Babaee, E., Anuar, N. B., Abdul Wahab, A. W., Shamshirband, S., & Chronopoulos, A. T. (2017). An overview of audio event detection methods from feature extraction to classification. *Applied Artificial Intelligence*, *31*(9-10), 661-714.
- Clavel, C., Ehrette, T., & Richard, G. (2005, July). Events detection for an audio-based surveillance system. In *2005 IEEE International Conference on Multimedia and Expo* (pp. 1306-1309). IEEE.
- Portelo, J., Bugalho, M., Trancoso, I., Neto, J., Abad, A., & Serralheiro, A. (2009, April). Non-speech audio event detection. In *2009 IEEE International Conference on Acoustics, Speech and Signal Processing* (pp. 1973-1976). IEEE.

11 Fake Me a Picasso

CS	AC	SE	GD	Cy

Main Skills Required:

Machine Learning (Heavy-Medium), Programming (Medium).

Summary

Imagine being able to give a piece of software a series of images as input and asking it to synthesise one, or more, images that are similar in composition, style, colour, and so forth, as the original ones. That is the focus of this project, where it is anticipated that techniques such as Generative Adversarial Networks may be used to perform such a task. Ideally, what the user should be able to do is to provide your software with a relatively small set of 'example' pieces of artwork and for the system to produce something new, but in a similar style. The small input set will be a distinct challenge, and so you may need to consider providing some more 'general' training data to the system for it to produce variety and diversity of outputs. As such, you may want to consider looking at more intelligent systems, such as Midjourney, for additional inspiration and ideas.

Useful References

- Wang, L., Chen, W., Yang, W., Bi, F., & Yu, F. R. (2020). A state-of-the-art review on image synthesis with generative adversarial networks. IEEE Access, 8, 63514-63537.
- Xue, A. (2021). End-to-end chinese landscape painting creation using generative adversarial networks. In Proceedings of the IEEE/CVF Winter conference on applications of computer vision (pp. 3863-3871).

12 Exploring the Capabilities and Limitations of Large Language Models

CS	AC	SE	GD	Cy

Main Skills Required:

Natural Language Processing (Medium-Heavy), Python programming (Medium-Heavy), and Machine Learning (Medium-Heavy).

Summary

In recent years, large language models like GPT-3 have revolutionized the field of natural language processing, allowing machines to generate human-like text with remarkable accuracy. However, these models are not without their limitations, such as biases, ethical concerns, and lack of generalizability.

This project aims to explore the capabilities and limitations of large language models, specifically GPT-3, by conducting a series of experiments and evaluations. The project will involve the following steps:

1. Preprocessing and preparing datasets for training and testing the language model.
2. Fine-tuning GPT-3 on specific tasks such as text classification, summarization, and question answering.
3. Analyzing the generated outputs of GPT-3 to assess its accuracy, coherence, and fluency.
4. Evaluating the performance of GPT-3 on different benchmarks, such as GLUE and SuperGLUE.

5. Investigating the ethical considerations and potential biases of large language models.
6. Proposing solutions and best practices for the responsible use of these models.

The project will require proficiency in natural language processing, Python programming, and machine learning, as well as strong analytical and critical thinking skills. The outcomes of the project will help shed light on the potential of large language models and their implications for the future of natural language processing.

13 Personal Projects

CS	AC	SE	GD	Cy

Summary

I'm happy to discuss and support personal project ideas provided they match my areas of interest listed above and demonstrate a new set of skills being learnt by a student. Please arrange to chat about these with me before submitting in your Project Preferences Form.

Ralph Ferneyhough

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Areas of Interest

- Games Mechanics Programming
- Re-usable Games Components
- Procedural Generation of Game Content ("Roguelikes")
- Logic / Puzzle / Factory Games
- Boardgames

NOTE: All projects should be implemented using C++ and the Unreal Engine, as that is a critical skill to develop for the games industry.

1 Design and implement a logic / puzzle game with an editor to submit levels

CS	AC	SE	GD	Cy

Main skills required: Programming (Heavy), Unreal (Heavy), Design (Medium)

Many logic / puzzle games have relatively simple rulesets that are comparatively easy to code, but their success is then entirely dependent on the content available – i.e. how many levels or puzzles a player has to progress through, and a logical, incremental progression in difficulty.
To alleviate this, user content can provide an endless source of levels, but the creation of an in-game editor is then required, and, more importantly, one which is intuitive to use and can only be used to create puzzles which have an actual solution.
You will research, design and create a simple puzzle game, and then implement an in-game editor which the user can use to create levels for others to try and complete.

2 Create a procedural world generator

CS	AC	SE	GD	Cy

Main skills required: Programming (Heavy), Unreal (Medium), 3D modelling (Light to Medium)

Many games nowadays rely on procedural generation to provide a (near-) infinite array of levels or worlds to explore by the player – indeed it is one way "art-light" teams can produce the content expected by the user.
This challenge is to create a 3D world generator. The scope of this "world" is for negotiation – one example might be a space station generator that could be used in a space flight-sim as somewhere a player can explore in full 6 degrees of freedom. Another example could be to generate a level suitable for a survival game to take place.
The generator should aim to combine simple components into interesting shapes and layouts, and ultimately feature both a seeding system (so the best layouts can be saved and replayed) and a method to decide whether a generated level is suitably "playable" according to rules you will define for the game it is intended for.

3 Create an immersive, functional inventory and shop system in virtual or augmented reality

CS	AC	SE	GD	Cy

Main skills required: Programming (Medium to Heavy), Unreal (Heavy), Design / UI (Medium)

Many games rely on an inventory system underlying the gameplay, and supporting components such as shop interfaces to buy/sell and even craft items. The rules for these are well established for traditional 2D user interfaces, but a 3D interface in VR or AR means new considerations must be understood.

Develop a re-usable system that can be used as an off-the-shelf component by other developers which could handle this problem, working from a data set that would contain such parameters as size, weight, value, 3D model, 2D icon etc., that a third-party designer or producer could adjust and see working in the system instantly.

4 Design and implement a fully realised text system for use in a game

CS	AC	SE	GD	Cy

Main skills required: Programming (Heavy), Unreal (Medium), Design (Medium)

The job of a games mechanics programmer isn't all about the playable parts of a game – somebody has do just as essential work making sure the user experience is as usable as possible. Elements of Unity or Unreal do exist on which one can build simple text-based elements, but much more than this is needed to deliver the full-fat UX in AAA games.

You will research existing games, design a suitable framework, and deliver code which could be used as an "oven-ready" text and menu system for a game in Unity or Unreal. This can include methods for text justification, auto-splitting of lines, fitting text into a fixed size box, handling accented characters or icons within the strings (e.g. controller button icons), and handling foreign language translations seamlessly. Simple VFX such as sliding, fading, scaling or rotating text exposed to the programmer to use should be created too.

5 Create an educational game

CS	AC	SE	GD	Cy

Main skills required: Programming (Medium), Unreal (Medium), Design (Medium), 2D or 3D art (Light to Medium)

Gamification of education is a popular call, so this project will involve looking for existing games that are used to help teach some topic to people, evaluating what components are needed to make them successful, then designing and implementing your own idea. This needs to go beyond a simple quiz – the actions in the game must reflect the concept being taught.

Examples might be to teach a specific concept in physics, such as the reflection and refraction rules of light, or in chemistry the bonding of atoms into simple molecules.

6 Personal project idea

CS	AC	SE	GD	Cy

I am happy to discuss personal project ideas before you fill in the form, especially in my areas of interest, but they must include a sizeable programming component within your implementation.

Dr Nigel Houlden

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Areas of interest

- Cybersecurity
- Cyber technology
- Cyber law / ethics
- Cyber education

01) Security Data Collection, Analysis and Visualisation Projects

Knowledge Areas: Security Operations & Incident Management
Activities: Acquire, Analyse, Visualise

CS	AC	Cy

This type of project involves acquiring cyber related data. The acquisition can be from any source, for instance, websites, open-source dataset or from the log files of different devices. The next step is to sanitise the data, which involves removal of unwanted characters from the dataset. This step will transform the data in proper form removing unwanted columns or spaces etc. The next step is data analysis which involves inspecting, cleansing, transforming, and modelling data with the goal of discovering useful information, which supports decision-making. The final step is the visualization of the useful information, i.e., graphical representation of the analysed data. The final project(s) is to design how a particular security operation happens, creating a simulator to demonstrate an attack, or show how applying firewall filtering packets can be prevented from entering.

Some of the potential projects in this knowledge area are:

- Develop a web scraping intelligence gathering tool
- Investigate techniques for predicting cyber-attacks from an appropriate dataset
- Visualization of alert systems analyse trends in datasets (e.g., log files, web history, network traffic and memory dumps)
- Network mapping tools – interrogation of devices to form a 'picture' of the network.
- Create a tool for analysing and visualising email headers
- Investigating the issues of insider threat, monitor activities internally that may indicate internal threats.

02) Network Projects

Knowledge Areas: Networks, Network Security, Security Operations & Incident Management
Activities: Investigate, Design, Create, Deploy, Test, Simulate

CS	AC	Cy

Networks and Network security consists of the policies, processes and practices adopted to prevent, detect, and monitor unauthorized access, misuse, modification, or denial of a computer network and network-accessible resources and the design and implementation of networks. The projects on Network Security involve diverse activities. These include investigation of vulnerabilities in network protocols. Design of policies, processes, and practices for the detection of unauthorized access of a network. Deployment of a robust Security Incident and Event Management (SIEM) system. For just networks this is more related to simulation for training and education.

Some of the potential projects in this knowledge area are:

- Install, test and evaluate SIEM tools (e.g. OSSIM)
- Install, test and evaluate open-source vulnerability assessment tools (e.g. OpenVAS)
- Research, deploy and evaluate SNORT
- Evaluate vulnerabilities in network protocols
- Investigate wireless security vulnerabilities
- Investigate the benefits and limitations of firewalls and packet filtering
- Evaluate Intrusion Detection System (IDS) deployment
- Evaluate Intrusion Prevention System (IPS) deployment
- Evaluate vulnerabilities in IoT network assets
- Investigate, deploy, and test honeypots
- Investigate detection of unauthorised Wi-Fi networks
- Investigate vulnerabilities in home-based IoT devices

03) Educational (Simulation) Network /Cyber Projects

Knowledge Areas: Networks, Network Security, Cyber security
Activities: Investigate, Design, Create, Test, Simulate

CS	AC	Cy

This type of project involves acquiring network related data. The acquisition can be from any source, for instance, using the *show IP OSPF* command or from the log files of different devices. The next step is to sanitise the data, which involves removal of unwanted characters from the dataset. This step will transform the data in proper form removing unwanted columns or spaces etc. The next step is data analysis which involves inspecting, cleansing, transforming, and modelling data with the goal of discovering useful information, which can present a network diagram.

Some of the potential projects in this knowledge area:

- Education awareness tools – How routing works etc
- Education awareness tools – Tools to demonstrate a DDOS etc
- Visualisation maps of wireless networks for location of vulnerabilities

04) Personal Projects

CS	AC	Cy

I'm also happy to discuss and support personal project ideas as long as they are within my areas of interest listed above and demonstrate a new set of skills being learnt by a student. Please discuss these with me before putting in your Project Preferences Form.

Prof Nigel W John

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Areas of Interest

- Computer graphics algorithms
- Applications of eXtended Reality (XR)
- Medical Visualization and simulation

1 The Digital Coastline

CS	AC	SE	GD	Cy

Main Skills Required: Programming (Medium-Heavy)

This is a collaborative project between Computer Science and Biological Sciences at the University of Chester. The project aims to create an interactive intertidal immersive online environment from which the user can remotely explore interact and investigate the diverse range of species and processes common to inshore and coastal marine ecosystems. It is hoped these intertidal virtual locations will contain hotspots which could highlight important and relevant information interactively as either a body of text or a link to a short video explaining one of the many aspects we would like to convey.

Prior knowledge of Unity is useful but not essential as you can learn how to use this software as a part of the project. It involves manipulation of 3D objects and some **c#** programming. You can expect to use event handling and special rendering effects.

Useful References

- Joshi, S., Wang, Y., Sparks, E., Marufuzzaman, M., Sartain, M., & Ma, J. (2023). Marine debris awareness improvement using immersive virtual reality. *Marine Pollution Bulletin*, *186*, 114406.
- Koh, L. Y., Wu, M., Wang, X., & Yuen, K. F. (2023). Willingness to participate in virtual reality technologies: Public adoption and policy perspectives for marine conservation. *Journal of Environmental Management*, *334*, 117480.

2 Virtual Smarthouse

CS	AC	SE	GD	Cy

Main Skills Required: Design (Medium) and Programming (Medium-Heavy)

This project will be in collaboration with Hft, a national charity providing services for people with learning disabilities (https://www.hft.org.uk/). They have recently developed the "Hft Smarthouse", a web-based interface that showcases some of the assistive technologies that people may use around their home to improve their independence and quality of life, and increase their safety:

- https://www.hft.org.uk/smarthouse/

This project will create a Virtual Reality version of the smarthouse, allowing the user to learn and interact with technology in a virtual house using a VR headset and hand controllers. The student will learn how to use Unity as the main development environment, which will involve scripting in the C# programming language.

3 Using VR for Training Medical Procedures

CS	AC	SE	GD	Cy

Main Skills Required: Design (Medium) and Programming (Medium-Heavy)

Contribute to one of the current research projects that Prof John is running. This year there are two specific areas of interest:

- A tool for training students to do an eye examination – ideally with voice commands (look up/ down etc) and to include using tests such as slit-lamp and ophthalmoscope – with pathology.
- A tool for training students to do an ear examination, including the micro-suction an ear – ideally with haptics

These will be in collaboration with Aston Medical School. Prior knowledge of Unity is useful but not essential as you can learn how to use this software as a part of the project. It involves manipulation of 3D objects and some **c#** programming. You can expect to use event handling and special effects such as particle systems. Agile development will be required working in close collaboration with end users. You will have access to a Meta Quest VR headset.

4 Personal project idea

CS	AC	SE	GD	Cy

I am happy to discuss personal project that falls within my areas of interest (see above), but they must include a sizeable programming component within your implementation. Discuss further with me.

Dr Nabeel Khan

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01) *Security Data Collection, Analysis and Visualisation Projects*

Knowledge Areas: Security Operations & Incident Management

Activities: Acquire, Sanitise, Analyse, Visualise

CS	AC	SE	GD	Cy

This type of project involves acquiring cyber related data. The acquisition can be from any source, for instance, websites, open-source dataset or from the log files of different devices. The next step is to sanitise the data, which involves removal of unwanted characters from the data. This step will transform the data in proper form removing unwanted columns or spaces etc. The next step is data analysis which involves inspecting, cleansing, transforming, and modelling data with the goal of discovering useful information, which supports decision-making. The final step is the visualization of the useful information, i.e., graphical representation of the analysed data.

Some of the potential projects in this knowledge area are:

- Develop a web scraping intelligence gathering tool
- Investigate techniques for predicting cyber-attacks from an appropriate dataset
- Collate, analyse, and visualise open-source Bluetooth data
- Use machine learning to identify and analyse trends in datasets (e.g., log files, web history, network traffic and memory dumps)
- Use machine learning or other techniques to identify and analyse anomalies in device behaviour (e.g., mobile, IoT, desktops etc.).
- Extend Splunk through the API (e.g., using Python)
- Create a tool for analysing and visualising email headers

02) Network Security Projects

Knowledge Areas: Network Security, Security Operations & Incident Management

Activities: Investigate, Design, Create, Deploy, Test, Simulate

CS	AC	SE	GD	Cy

Network security consists of the policies, processes and practices adopted to prevent, detect, and monitor unauthorized access, misuse, modification, or denial of a computer network and network-accessible resources. The projects on Network Security involve diverse activities. These include investigation of vulnerabilities in network protocols. Design of policies, processes, and practices for the detection of unauthorized access of a network. Deployment of a robust Security Incident and Event Management (SIEM) system.

Some of the potential projects in this knowledge area are:

- Install, test and evaluate SIEM tools (e.g. OSSIM)
- Install, test and evaluate open-source vulnerability assessment tools (e.g. OpenVAS)
- Research, deploy and evaluate SNORT
- Research, deploy and evaluate SURICATA
- Critical analysis and comparison between SURICATA and SNORT
- Evaluate vulnerabilities in network protocols
- Simulate the efficacy of IP Masquerading
- Investigate wireless security vulnerabilities
- Investigate the benefits and limitations of firewalls and packet filtering
- Evaluate Intrusion Detection System (IDS) deployment
- Evaluate Intrusion Prevention System (IPS) deployment
- Evaluate vulnerabilities in IoT network assets
- Optimise SIEM deployment and efficacy in cloud platforms
- Investigate techniques for protecting against DDoS attacks in cloud environments
- Investigate, deploy, and test honeypots
- Investigate detection of unauthorised Wi-Fi networks
- Investigate vulnerabilities in home-based IoT devices
- Investigate secure key distribution among IoT nodes

03) Digital Forensics Activity or Investigation Projects

Knowledge Area: Forensics
Activities: Investigate, Acquire, Analyse, Create

CS	AC	SE	GD	Cy

Digital forensics is the scientific acquisition, analysis, and preservation of data contained in electronic media whose information can be used as evidence in a court of law.

Some of the potential projects in this knowledge area are:

- Create an Autopsy plugin to analyse email headers
- Create an Autopsy plugin to conduct email forensics
- Investigate tools and techniques for conducting Dropbox forensics
- Investigate tools and techniques for conducting cloud forensics
- Investigate tools and techniques for conducting website cookie forensics
- Investigate tools and techniques for conducting web browser forensics
- Investigate tools and techniques for conducting Blockchain transaction forensics
- Examine and analyse the impact of open-source antivirus software on digital evidence

- Investigate tools and techniques for conducting forensic analysis of portable and runtime operating systems
- Investigate tools and techniques for conducting IoT device forensics
- Investigate tools and techniques for conducting forensics of cloud-native artefacts
- Investigate tools and techniques for conducting Amazon Echo forensics
- Investigate tools and techniques for conducting Android smartwatch forensics
- Investigate tools and techniques for conducting ring doorbell forensics
- Investigate tools and techniques for conducting Apache Cloud Stack forensics
- Investigate tools and techniques for conducting forensic analysis of facial recognition Apps

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1 Computing in Schools Project

CS	AC	SE	GD	Cy

Innovation

The design and implementation of materials for the teaching of computing in schools, with an emphasis upon difficult concepts such as Object Orientation and the Fetch-Execute Cycle.

2 Big Data Analysis for Business

CS	AC	SE	GD	Cy

Innovation

Examine the concept of Big Data in Business, with special emphasis upon infrastructure, management and mining techniques. Use appropriate software to demonstrate how such techniques are applied.

3 Optical Character Recognition for Mobile technology

CS	AC	SE	GD	Cy

Innovation

Design a piece of software than can identify handwritten characters and symbols.

4 Newton's Laws of Motion in Games Technology

CS	AC	SE	GD	Cy

Innovation

Describe and explain how appropriate laws of physics (i.e. Newton) are applied to Games technology.

5 Cloud Computing

CS	AC	SE	GD	Cy

Innovation

Examine the advantages of cloud computing in modern business, as well as the possible problems and issues that such technology can cause. Such issues can include:

- Security and integrity
- Privacy in multi-tenancy clouds
- Virtualisation
- Data recovery and backup
- Data segregation and recovery
- Secure cloud architecture
- Cloud cryptography
- Cloud access control and key management
- Integrity assurance for data outsourcing
- Trusted computing technology
- Failure detection and prediction
- Secure data management within and across data centres
- Availability, recovery and auditing

- Secure computation outsourcing.

Andrew Muncey

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Areas of Interest

- Collection and exploitation of data from mobile and connected devices (such as wearables)
- Development of systems to automate the assessment (and/or teaching of) of programming (for example programmatically generated quizzes)
- Development of systems concerned with the internet of things (connected devices)

1 Android app to replace chords sheets for musicians

CS	AC	SE	GD	Cy

Many musicians, perhaps more so those playing contemporary popular music, often use printed sheets which contain the words and chords to music, often copied from guitar chord websites (example song here). Apps already exist to provide an on-screen version of chord sheets, with features such as automatic scrolling and transposition. A popular app for such purposes is the iOS only OnSong. The project would development the core features of such an application (catalogue of songs, ability to create set lists, displaying of chords) as an Android app. There is the potential for collaboration on this, either by making the project open source, and/or for multiple students to work on the same project. Similarly, there is scope to introduce a wide variety of extra features (such as importing file from other software).

2 Collection and analysis of error data from introductory student programming tasks (Java)

CS	AC	SE	GD	Cy

The first year Java programming module includes an assignment where students attempt to complete a number of tasks, each tested by a unit test with a number of assertions. This project would look at ways of collecting data generated by attempts to solve the problems. At its simplest, this might, for example log results of failed assertions. It could be expanded to consider exceptions thrown, compilation errors, or the potential to offer tailored feedback to the student based on repeated errors of the same type.

3 Mobile Air Quality monitoring (Android/Web)

Building on the work of previous final year students, one who has developed an Android app (using Kotlin) for mobile monitoring and logging of air quality using a portable sensor, and others who have developed systems to visualise this data using a web platform there exists the opportunity to further develop this system across two platforms.

Web application focussed project:

CS	AC	SE	GD	Cy

- Further develop (or re-develop) an existing API and web application to collect data from the mobile app, considering that data will come from multiple users
- Further develop methods for manipulating and visualising the data, in particular presentation on a map interface with controls for time/ particle type and potentially the integration of publicly available pollution data (for example by integrating with a mapping service such as Google maps)

Android focussed project:

CS	AC	SE	GD	Cy

- Develop the existing system to upload data to an API
- Develop the existing system to facilitate background operation
- Further develop on-app visualisation and manipulation of the data, for example, handling exposure over time, identification of highly polluted areas

The scope of the project is variable, therefore there is the potential for students to consider a specific aspect of the proposal and develop it to some depth, focussing, for example on just one platform, or to consider both mobile and web aspects, each to a lesser extent. It may be possible for two or possibly three students to collaborate on this project, provided each student identifies and works on discrete elements of functionality.

For more background, borrow the 2018/19 dissertation from the faculty office entitled “ParticleSense: An Air Pollution Exposure Measurement System Using Wearable Technologies” and the 20-21 dissertation entitled “Pollutribute: A web-based pollution & air quality contribution platform”.

4 Meaningful programming tasks / assignments (Java)

CS	AC	SE	GD	Cy

The primary aim of a programming task or assignment is to teach and/or assess programming skills. In reality, programming tasks, demonstrations and assignments are often contrived and lack practical context and/or social relevance, which may negatively impact on certain demographics. This project would seek to research and develop a series of programming tasks targeted for an introductory Java programming module which demonstrate social relevance and a practical context. For more background see Layman, Williams & Slaten 2007’s paper

5 Personal Project Ideas

CS	AC	SE	GD	Cy

I'm also happy to discuss and support personal project ideas as long as they are within my areas of interest listed above and demonstrate a new set of skills being learnt by a student. Please discuss these with me (via an office hour booking) before putting in your Project Preferences Form.

Dr Mike Morgan

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1 How hard can it possibly be to pack a collection of boxes (the Bin Packing Problem)?

CS	AC	SE	GD	Cy

The bin packing problem is easy to describe but notoriously difficult to solve. Given a collection of items with varying dimensions, arrange them into the smallest possible number of equally sized containers (known as bins). This has very important applications in environmental logistics. Fewer containers mean reduced fuel consumption and therefore reduced carbon emissions and available capacity is commonly underused throughout the industry. Your task is to design and implement heuristics to improve resource allocation.

2 Automation of CISCO device configuration with Python

CS	AC	SE	GD	Cy

Incremental SDN (Software Defined Networking) is becoming an increasingly important technique in network management. Whilst many small to medium enterprise networks are not yet fully programmable, it is possible to take a step in that direction by scripting the configuration of legacy (e.g. CISCO) devices. You are to investigate and implement techniques to automate the configuration of some aspect of networking (e.g. routing, access control, IPv4 to IPv6 transition).

3 Develop a simple physics engine in C++

CS	AC	SE	GD	Cy

Write a physics engine in C++. It is recommended that you keep it simple, e.g. stick to Newtonian mechanics with a bit of Hooke's law for springs/elastic.

4 Automated GUI interaction in Python

CS	AC	SE	GD	Cy

Python currently has some basic GUI automation tools (such as pyautogui) which could have their functionality enhanced in combination with image processing tools (such as opencv) for enhanced image and text recognition. Your task is to build an intuitive python library to interact with simple GUIs such as web forms on behalf of a user and test it on one or more suitable systems. The software would be intended for use in circumstances where a web system does not have an API, restful URLs or any other meaningful structure for a programmer to exploit.

5 Implement a simple games server using C++ and boost.

CS	AC	SE	GD	Cy

We all love boost. Who can deny it? How about putting it through its paces and writing a network games server (and client) with it? Any games it hosts should be relatively simple (e.g. pontoon) as the networking is intended to be the technical focus of this project.

Toyosi Oyinloye
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Areas of interest

- Software Exploitation
- Software Protection Measures
- Cyber-User Awareness for Social Engineering
- Cyber-Reconnaissance
- Cybersecurity-Data Visualisation

1 Control Flow Integrity (CFI) for Securing Vulnerable x86 Binaries

CS	AC	SE	GD	Cy

Control Flow Integrity (CFI) in protecting vulnerable programs from Control Flow Hijacks involves the use of software or hardware mechanisms to restrict (monitor) and enforce the flow of execution in a program to the intended path.

Proposal

A software-based protection to be developed, separate from the vulnerable program and inserted at compilation time or activated at runtime. The first step would be to carry out extensive software exploitation to determine the critical spots in the execution path and then generate Control Flow Graph (CFG) to use in guiding the monitoring process. Buffer and Stack overflow, UAF & DF, are vulnerabilities that attackers use in exploiting applications. Existing codes have also been used by attackers as gadgets chained together in Return Oriented Programming (ROP) attacks. An ideal protection here would consider any/all of these factors towards securing vulnerable targets. Here are possible options that could be explored in this study.

Option 1:

Write assembly code or programs in C or C++ with zero user-interaction to manage the enforcement of CFI without any further interference. Protection can be set for binaries compiled and run on X86 platform or any other CPUs.

Option 2:

Create a framework which would use either hardware or software or a combination of the two as solution in combatting CFH.

Skills required

For software-based solutions: Programming (Heavy, Assembly code, C/C++)
For hardware-based solutions: Ability to identify or build relevant/effective hardware materials (Heavy)
Software Engineering (Heavy)

2 Inter-process Communication for Execution Monitoring

CS	AC	SE	GD	Cy

Software-based protection measures can be implemented, in-line, or added at compile time, however, attacks are often executed at runtime. In-line protections could be migrated into non-vulnerable processes so that monitoring can be achieved by constantly checking of how a process is being executed, particularly in comparison with the CFG of each process. This is beyond the normal task management done by operating system. Inter-process communication (IPC) can be used to establish parallel communication between specified processes to set up a monitoring system. Possible means of IPC are through Inter-Process Signalling (IPS), In-kernel monitoring, or Hypervisor monitoring.

Proposal

Use a program, with zero user-input to monitor a suite of vulnerable programs through the mechanism of IPC. This could also be achieved in collaboration with the kernel or a hypervisor. IPS is very effective when established through shared memory. It is important to include atomic operations to prevent race conditions. **Don't create another problem while trying to solve one. Use either C or C++ to create shared memory and effectively monitor execution flow to detect errors, hijack, or deviation.

Skills required

Programming (Heavy, Assembly code, C/C++)
Software Engineering (Heavy)

3 Cyber-User Awareness System to Combat Social Engineering Attacks

CS	AC	SE	GD	Cy

In recent times, social engineering has been on the rise in the cyber-attack chain, in addition to phishing. As cyber-attack techniques continue to evolve, the user awareness system that corresponds with prevalent attacks must be deployed. This may include relevant and effective awareness training tools in form of GUIs. These includes gamification, awareness training systems, etc.

Proposal

The focus here is on Social Engineering. Designing and Implementation of Cyber-User Awareness system/tool. Consider cost effectiveness, reliability, and sustainability. Expected product from this research is Game/App.

Skills required

Social Engineering/Cyber Psychology Research (Heavy)
Design and prototyping (Heavy, involves programming)

4 OSINT/Cyber-Reconnaissance for identifying and Mitigating Attack Vectors

CS	AC	SE	GD	Cy

OSINT can be used in information gathering and then for further cyber-attack by applying other attack vectors. Organisations can apply proactive approach in securing their web-based information.

Proposal

Design an effective tool/technique for ethical Cyber reconnaissance to give organisations an advantage over attackers. Begin by identifying risky exposures of information and how attackers could use information gathered at the detriment of the target. A proper design would involve some automated information gathering and matching the information with existing attack vectors.

Option1:

Design an application to achieve the goal.

Option 2:

Create a framework that effectively simulates how OSINT can be applied to protect data/information from any of the prevalent cyber-attack vectors.

Skills required

Social Engineering/Cyber Psychology Research (Heavy)
Database management (Medium)
Design and prototyping (Heavy, involves programming)

5 Cybersecurity-Data Visualisation for Incident Response

CS	AC	SE	GD	Cy

Data visualization is relevant in cybersecurity as it provides an easy way of viewing data gathered from various sources. This could include data from activity logs, security logs, alerts, notifications, etc. When there are lots of data from various sources, they might appear as a clutter of jargons to the average user, whereas vital information is hidden in the clutter. Some clarity can reveal valuable information while further refinement can make the data/information more meaningful to investigators. According to Fry (2007) once data has been acquired, other steps to processing the data for visualisation are:

1. Parse the data
2. Filter- out unnecessary elements
3. Arrange the data statistically or mathematically
4. Use a visual model to represent the data
5. Refine the model to improve clarity
6. Make the model interactive

Proposal

Design an interactive visual tool. Obtain a relevant data set and develop it into a valuable resource for viewing the vital information, investigating possible cyber threats, or proffering solution to a security incident. This output should include a clear visual representation of the data – a dashboard where values can be compared, similarities in events can be identified, recurring patterns can be detected, new

vulnerabilities can be detected, etc. This could lead to the proffering of specific or generic solutions useful for incident response.

Skills required

Use of Data Visualisation tools (Heavy)
Programming for Data Visualisation (Heavy)
Database management (Heavy)
Design and prototyping (Heavy)

Reference

Fry, B., 2007. *Visualizing Data.* 1st ed. Sebastopol, CA: O'Reilly Media Inc.

Dr Helen Southall

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Areas of Interest

- User-centred design (e.g. Design Sprints)
- Digital heritage (using technology to research or explain historic sites and events)
- Digital STEM (using technology for training & education in science, technology, engineering & mathematics)
- Immersive experiences (AR, VR & MR) for education, training & tourism

1 Decarbonising Cheshire: Mobile app, game, or immersive experience (UCD focus)

CS	AC	SE	GD	Cy

Main Skills Required: Design (Heavy), Software Engineering (Medium); possibly also some Programming (depending on direction taken)

The Cheshire West region (including the Wirral and M56 corridor) contributes the fourth highest CO2 emissions in the country, mainly because of the large amount of energy-intensive industry in the area. Local government and industry are working on ways to drastically reduce the carbon footprint of Cheshire's industry. The goal of this dissertation project would be to research this decarbonisation project, and to propose and test digital ways of informing and involving the public about the major changes occuring locally, from large-scale infrastructure to job opportunities. Depending on the topic chosen, you may have the opportunity to work directly with council and industry contacts to research the technologies involved and application requirements, then use User Centred Design methods to design and test your prototype digital application, which could be a mobile app, a game, an AR or VR application, or some combination of these.

Further information:-
https://www.cheshire-live.co.uk/news/chester-cheshire-news/cheshire-west-council-commits-16m-17617263
https://hynet.co.uk

2 Gamification of History and Heritage Tourism (UCD / Digital Heritage focus)

CS	AC	SE	GD	Cy

Main Skills Required: Design (Heavy) and Software Engineering (Medium); possibly also some Programming (depending on direction taken)

‘Gamification’ is the use of game-based activities for more serious purposes, such as encouraging and enabling learning, e.g. in the heritage tourism industry. Historic sites such as castles, gardens, battle sites and museums are major tourist attractions, especially in historic areas such as Chester and North Wales. Site managers are always looking for ways to attract, engage, inform and entertain visitors of all ages, whether this is in person, or remotely (as has been the case recently, because of COVID19 travel restrictions). Gamified digital applications are a key area of development in the industry.

The goal of this dissertation project is to research how and where gamified heritage tourism applications are currently being used, and to choose a suitable case study location. (There are many appropriate sites in the local area.) You will have the opportunity to work directly with contacts in the heritage tourism industry when specifying and testing your prototype application. There may also be opportunities to work with staff and students from other faculties, such as Art & Design or Media. Once you have decided on an appropriate site, you will work out how a gamified digital application could help, and then use User Centred Design methods to design and test your prototype, which could be a mobile app, a game, an AR or VR application, or some combination of these.

Further information:-

Walz, S. P., & Deterding, S. (Eds.). (2015). *The Gameful World: Approaches, Issues, Applications* MIT Press.

Xu, F., Buhalis, D., & Weber, J. (2016). Serious games and the gamification of tourism. *Tourism Management, 60 (2017)*, 244-256.

https://hydro-hub.uk/about/

https://www1.chester.ac.uk/news/universities-embark-history-project-close-£100000-after-bid-success?fbclid=IwAR3Ly58sKCKpt-L-KYwNLFKJoaxXSbyTR0C6u_muceiHt6n4XeE9Gn1KtI8

Past Exemplars
A selection of recent dissertation projects pertinent to my specialist areas:

Davies, T. (2019). *The Chester Millennium Festival Trail: A User Experience Journey*.
Mullock, G. (2018). *Applying Recognised Usability Standards and User Experience Design Principles to a Console Video Game*
Lancaster, G. (2015). *Implementation of a 2D Game Engine*

Dr Richard Stocker

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Research Interests

- Formal Verification - particularly model checking
- Knowledge, Representation and Reasoning
- Agents and Multi-Agent Systems
- Human-Robot Teamwork
- Modelling Human Behaviours

Additional Areas of Interest

- Machine Learning
- Educational Tools
- Genetic Programming
- Game Theory
- Algorithms

1 Teaching Tools

CS	AC	SE	GD	Cy

Develop an application which demonstrates algorithms or tools. Such as:

- Teach simple logic circuits, e.g., AND, OR, NOT, NAND, etc. Gates
- Pathing algorithms, e.g., Dijkstra, A*, Ant Colony, etc.
- Vertex/Edge Colouring algorithms

2 Machine Learning and Genetic Algorithms (GA)

CS	AC	SE	GD	Cy

- Develop a simple emote recognition tool (not suitable for AC)
- Develop a genetic algorithm to play a simple game (not suitable for AC)
- Use a genetic algorithm to navigate a maze (not suitable for AC)
- Apply data mining techniques to build a recommendation system for a website (suitable for AC)
- Use the WEKA Machine Learning (ML) tool to analyze the performance of a variety of ML tools and select the ideal tool, and its settings, to solve a specific problem (suitable for AC)

3 Simulate Virus Infection Rates

CS	AC	SE	GD	Cy

- Design and build a simple virus simulation software that simulates the spread of infection
    - Use principles, such as BOIDS, to demonstrate the movement and interaction of people

- Create various simulations to measure the effect of social distancing, e.g., no social distancing, partial social distancing, and strict social distancing (where key workers are allowed outside)
- Programmed using Python or Java

4 Design a simple healthcare scenario in Brahms

CS	AC	SE	GD	Cy

- Design a simple healthcare scenario in Brahms and use the verification tool developed for Stocker et al. (2012) to very certain properties hold
  - You will be required to design a simple simulation for Brahms and identify certain specifications that need to hold
  - The specifications will be turned into Promela Never_Claims and used to verify the simulation using the Spin model checker

5 Build a robot simulation in Webots (https://cyberbotics.com/#cyberbotics)

CS	AC	SE	GD	Cy

- Design a simple simulation in Webots which demonstrates a robot performing a real-world problem, e.g., delivery drone, social distancing robot, search and rescue, etc. You will be required to:
  - Select or design a robot that would be suitable for this scenario
  - Decide what actions this robot will need to perform
  - Design a 3-D environment suitable for simulating the robot's actions
  - Simulate the robot performing the actions in the environment

References

Stocker, R., Dennis, L., Dixon, C., & Fisher, M. (2012, September). Verifying brahms human-robot teamwork models. In *European Workshop on Logics in Artificial Intelligence* (pp. 385-397). Springer, Berlin, Heidelberg.

Ashley Wood

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Areas of Interest

- Malware/ransomware analysis
- Digital Forensics
- Penetration Testing
- Digital Forensics
- Intrusion Detection and Prevention (IDPS)

1 Malware Analysis

CS	AC	SE	GD	Cy

In this project you would carry out detailed forensic analysis of malware samples using a mixture of dynamic and static analysis, which would then lead onto a detailed taxonomy of malware samples and breakdown of malware features. You are free to choose which malware samples you wish to analyse, although it is suggested you choose two or more variants.

2 Intrusion Detection

CS	AC	SE	GD	Cy

In this project, you would work towards building the foundations for an Intrusion Detection System (IDS) which can detect malicious/intrusive behaviour on computer systems, either by malware or a remote attacker. This could be a particular family and/or type of malware or a specific threat actor. Once you have a prototype you would be expected to the this systems ability to detect threats and to ensure this is as close to optimal as possible. This project will require a reasonable level of confidence with programming, networking and malware-analysis. Although, the choice of programming language used to implement the system will be yours.

3 Penetration Testing

CS	AC	SE	GD	Cy

In this project, you would perform penetration testing of software and systems using a virtual machine environment to ascertain and detect the presence of vulnerabilities and provide a detailed taxonomy of your findings. To further your project, you may also choose to develop a system or tool which can automate key aspects of the penetration testing process, i.e., querying a hypothetical network of systems for vulnerabilities such as open ports, vulnerable services/software etc.

In addition to the above projects, I also have flexibility to consider other projects which deviate from the suggested projects above but still align with my own research interests, please feel free to contact me at: Ashley.wood@chester.ac.uk with your proposal.

The Informatics Centre (IC)

A small number of projects may also be available that will be supervised by the Informatics Centre staff:

Matt Griffiths, matt.griffiths@chester.ac.uk

James Flower, j.flower@chester.ac.uk

Neil Hawker, neil.hawker@chester.ac.uk

Any project with the IC should be either testing a novel idea, or to meet a brief for a client that you source (providing it's suitable). It is important that you contact the IC in advance so that you can discuss your idea with them.

Particular Areas of Interest:

- Web application development
- Mobile application development
- Internet of Things
- Wearable technology
- Human-computer interaction (HCD), user experience (UX) including human-centred design (HCD), user interface design (UI) and usability.
- Design sprints