

Title

Developing a Mobile App to Foster Healthier Behaviour Among Stroke Patients:
Drawing from Fogg's Model-Inspired Persuasive Technology.

Advisor

Adetunji Adeniran

Project Description

Health and wellbeing are closely intertwined with healthy behaviours. As the internet and mobile devices become more ubiquitous, the popularity of mobile applications to aid users in making healthier choices is on the rise. The vast amount of data generated by mobile technology holds tremendous potential to promote health behaviours both on an individual and population-wide scale, but this potential remains largely untapped or underutilized. The main objective of this project is to design and develop a mobile application dedicated to fostering healthier behaviours among stroke patients. This initiative is inspired by the Fogg Model's persuasive approach. To achieve this goal, the project will address the following sub-objectives:

1. To explore the health promotion theories, to determine potentially approach and information content that can prompt and persuade patients to actions towards the recommended behaviour that improves their health.
2. To explore effective design of a system that can provide the healthy behaviour prompt to user (stroke survivors), applying Fogg's model inspired persuasive technology.

This project will largely be research based and a preliminary object-oriented design of the intended application which will involve the following steps:

1. Conducting a comprehensive review of the literature on risk factors and recommended health behaviours for stroke survivors, as well as persuasive technology in the context of health promotion theories and Fogg's model of behaviour change.
2. Developing a study to gather requirements, with a focus on health professionals who specialise in treating stroke patients, such as nurses and doctors.
3. Obtaining ethical approval for your study, and then conduct it using a design that maximises the number of participants and facilitates access to the target respondent.
4. Analysing the data from your study to determine the initial scope, information content, and framework for the design of the mobile application.
5. Creating an initial object-oriented design and developing a prototype of the mobile application to promote healthier behaviour in stroke patients, integrating Fogg's model of behaviour modification.
6. Obtaining another ethics approval to conduct a preliminary test of the prototype system, with a focus on evaluating the efficacy of Fogg's model in the design and implementation of the application's interface.
7. Analysing the test results and providing recommendations for further enhancements to the application

Technologies

Use the technology platform that meets the design's requirements for functionality, user interface, data processing, and communication. Popular backend implementation languages include Python, Node.js (JavaScript), Ruby, and Java, as well as their respective web frameworks Flask, Express, Ruby on Rails, and Spring. Additionally, use HTML/CSS/JavaScript or popular frameworks like React, Vue.js,

or Angular for structured and efficient frontend development. For Native Mobile App development, consider Swift for iOS and Kotlin or Java for Android, or use Cross-platform development frameworks such as React Native, Flutter, or Xamarin. Consider cloud services such as Amazon Web Services, Microsoft Azure, and Google Cloud Platform for hosting your application and storing data securely. You can also employ a database management framework tailored to the complexity of your data relationships.

Skills the student will develop and any prerequisites

Web Development, API usage, research study design, user testing.

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Proposed Topic:

Developing a Gamified Maths Learning App for Elementary and Secondary School Pupils: Improving Students Engagement with EdTech and Thus Their Learning.

Advisor

Adetunji Adeniran

Project Description

Gamification refers to the application of game-design elements or mechanisms to non-game contexts in order to encourage the desired behaviours. Although theoretically promising, empirical studies on the effectiveness of gamification in educational practices have presented results that are inconsistent (Luo, 2022).

Despite research and application of gamification strategies in the development of existing maths EdTech, children prefer playing recreational games to completing gamified computer-based homework. A review of 44 articles on the efficacy of gamification in education, suggests that the gamification components, game elements, and gamification mechanisms should be reconsidered and refined. Reconsidering and redefining game-like elements, such as having goals, visualisation, immediate feedback, adaptation, challenge, competition, reward, and fun failure, and incorporating this element to foster a gaming-like feel while students' complete computer-based maths tasks can increase student engagement with maths EdTech (Liu, 2021).

JB Fogg developed the Fogg's model, an output of his research into persuasive technology. Fogg's model explains the factors that generate a particular behaviour, such as the factors that allure children to play their recreational computer games far more than they would engage in computer-based mathematics learning activities. This project aims to investigate gamification elements and mechanisms in light of Fogg's model, to better understand the features that captivate children in playing recreational video games, and to integrate similar features into computer-based maths learning activities to improve students' engagement and context-based learning. The objective will be investigated by addressing the following sub-goals:

1. Investigate the persuasive elements within computer games that captivate children and create a strong attachment to the gaming experience.
2. Explore the possibilities of integrating these captivating elements into the design of a maths learning app, with the ultimate goal of enhancing students' engagement and interest in maths learning activities.

This project will largely be research based and a preliminary prototype of a maths learning app which will involve the following steps:

1. Conducting a comprehensive review of the existing literature and online articles related to video game addiction and Gamification in Education. Identify and classify the game-feel components and mechanisms that contribute to children's attraction to video games.
2. Analysing the findings from the literature review in the context of Fogg's model of behaviour, which encompasses motivation, ability, and triggers, to understand the underlying factors that drive children's engagement with video games (Zhou et. al., 2023).

3. Developing a structured framework based on the insights gained from the analysis (Objective 2) to effectively incorporate game elements and mechanisms into the design of a maths learning app. This framework will aim to enhance students' engagement and interest in mathematics learning activities via the application.
4. Creating a preliminary design and prototype for a gamified mathematics learning app, incorporating the framework developed in Objective 3. The prototype will serve as the initial basis for iterative testing, evaluation, re-design, and retesting, following an agile design approach.
5. Designing initial evaluation study to test the impact of the incorporated gamification framework, element and mechanism, on students' engagement with the maths learning app.
 - a. Identifying participant schools (primary or secondary, depending on the content of your prototype maths learning application).
 - b. Securing the required collaboration agreements and approval, which may involve obtaining parental consent for children's participation in the study.
 - c. Obtaining institution's ethics approval for the study.
6. Analysing the data gathered from the evaluation study to draw conclusions and provide preliminary evidence of the enhancement (or lack thereof) of student engagement with the gamified mathematics learning application.
7. Presenting the research findings and recommendations, including suggestions for the next phase of development of the maths learning app.
 - a. Identifying any areas requiring additional research in future work on improving and/or refining the math learning app.

Technologies

Use the technology platform that meets the design's requirements for functionality, user interface, data processing, and communication. Popular backend implementation languages include Python, Node.js (JavaScript), Ruby, and Java, as well as their respective web frameworks Flask, Express, Ruby on Rails, and Spring. Additionally, use HTML/CSS/JavaScript or popular frameworks like React, Vue.js, or Angular for structured and efficient frontend development. For Native Mobile App development, consider Swift for iOS and Kotlin or Java for Android, or use Cross-platform development frameworks such as React Native, Flutter, or Xamarin. Consider cloud services such as Amazon Web Services, Microsoft Azure, and Google Cloud Platform for hosting your application and storing data securely. You can also employ a database management framework tailored to the complexity of your data relationships.

Skills the student will develop and any prerequisites

Web Development, API usage, research study design, user testing.

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Proposed Topic:**Developing A GPT-Powered Intelligent Interactive Math Tutoring System (IIMTS)****Advisor**

Adetunji Adeniran

Project Description

Existing research demonstrates that personalised learning has the potential to improve maths performance among elementary and secondary education students (Schaldenbrand et al., 2021). Harnessing students' mistakes as valuable learning opportunities to promote both conceptual and procedural comprehension is an effective strategy for personalising instruction for each student (Hu and Hodge, 2021; Lepper et al., 2013, pp. 79-81). A study reveals that expert teachers refrain from providing direct responses to student errors. Instead, the teachers employ an indirect approach by subtly indicating the presence of a problem in the student's solution and encourage them to reevaluate their approach. The teachers were seen asking leading questions with the goal to guide the students to the location of their errors, and support them to solve the learning task successfully, boosting their self-efficacy in the learning context (Lepper et al., 2013, pp. 79-81). This approach of responding to student errors can more easily be exploited in one-on-one tutoring settings. However, it is costly to provide every pupil with personalised human tutoring whenever they require it (Dai et al., 2023). There exists a development opportunity with the power of AI, such as the GPT-based language model, which not only can converse in a learning interaction like humans (Firat, 2023), but can also tackle novel and difficult learning tasks across subjects. AI may not replace the function of a teacher (Ausat, 2023), but AI can be utilised to provide a human-like tutoring approach in areas where it has been deemed effective, expanding students' access to personalised learning, particularly in elementary and secondary school maths learning (Chine et al., 2022).

This project aims to investigate and develop a GPT-powered, intelligent, interactive maths tutoring system (IIMTS) that responds to students' errors in a learning task by guiding them to self-discover the error, successfully complete the task, and boost their self-efficacy. Similar examples of leading questions observed to be asked by expert-tutors in their approach to "reacting to students' errors" (Lepper et al., 2013, pp. 79-81) are provided in the Appendix by means of a ChatGPT prompt. This project's output, IIMTS, will detect when students make errors in computer-based maths learning activities, ask them guiding questions in an interactive manner, and prompt them to reevaluate their solution in a way that not only guides them to successfully complete the task but also teaches them from the error-resolving interaction. Achieving this project goal will be explored by addressing the following sub-goals:

1. Investigation, Analysis, and Design:
 - a. Investigate and analyse existing models and architectures that are pertinent to the project's aims.
 - b. Determine, adapt, and modify the most suitable models and architectures to develop a workable design for the GPT-API powered Intelligent, Interactive, Maths Tutor.
2. Prototype Implementation and Testing:
 - a. Develop a prototype based on the refined architecture.

- b. Conduct comprehensive testing to assess the effectiveness of the AI Maths Tutor compared to a Human Tutor.
- c. Focus particularly on the AI's capacity to respond to student errors and foster their learning process.

This project will focus primarily on research, and development of a prototype of IIMTS, which will involve the following steps:

1. Conducting a comprehensive review of the existing relevant literature and exploring documentation of the GPT-API. Determine adaptable architecture, framework, or technological know-how that will be applicable for achieving the project's objectives.
2. Analysing the findings of the literature review, rationalising applicable concept and technologies, and identifying new or adaptable existing architecture for the proposed IIMTS.
3. Developing the preliminary design for proposed IIMTS.
4. Implementing a prototype of the designed IIMTS. The prototype serves as the initial basis for iterative testing, evaluation, redesign, and retesting consistent with an agile design methodology.
5. Designing an initial evaluation study to determine the efficacy of the IIMTS with Emphasis on student satisfaction in the support it provides and comparison to human tutoring.
6. Identifying participant schools (either elementary or secondary, depending on the content of your maths learning tasks incorporated in the IIMTS prototype).
7. Seeking and obtaining the necessary collaboration agreements and approvals, which may entail obtaining parental consent for children's participation in the study.
8. Obtaining institutional ethics approval for your study.
9. Analysing the data obtained from the evaluation study in order to draw conclusions and provide preliminary evidence of the effectiveness (or lack thereof) of the personalised learning intervention envisaged from the IIMTS.
10. Present the research and development findings and recommendations, as well as suggestions for the next phase of development of the GPT-Powered Intelligent Interactive Maths Tutoring System.
11. Identifying any areas requiring additional research in future work aimed at enhancing and/or refining the human-like tutoring support by the GPT-Powered Intelligent Interactive Maths Tutoring System.

Technologies

Understanding technological know-how of integrating GPT-API in software development. Use the technology platform that meets the design's requirements for functionality, user interface, data processing, and communication. Popular backend implementation languages include Python, Node.js (JavaScript), Ruby, and Java, as well as their respective web frameworks Flask, Express, Ruby on Rails, and Spring. Additionally, use HTML/CSS/JavaScript or popular frameworks like React, Vue.js, or Angular for structured and efficient frontend development. For Native Mobile App development, consider Swift for iOS and Kotlin or Java for Android, or use Cross-platform development frameworks such as React Native, Flutter, or Xamarin. Consider cloud services such

as Amazon Web Services, Microsoft Azure, and Google Cloud Platform for hosting your application and storing data securely. You can also employ a database management framework tailored to the complexity of your data relationships.

Skills the student will develop and any prerequisites

Web Development, API usage, research study design, user testing.

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Appendix: Sample exploring with ChatGPT

TU

Question: $x + y = 5$; $2x + y = 7$; Student Solution: $(x+y) - (2x+y) = 5-7$; $-x = 2$; $x = -2$; $-2+y=5$; $-2+y+2 = 5+2$; $y = 7$. How can you ask leading questions to make the student realize their mistake and correct themselves.

ChatGPT

It's great to see your approach! Let's walk through your steps and address some points:

Step 1: You subtracted the second equation from the first, which is a good start. However, let's double-check the signs and values of the terms after subtraction. When you subtract $(2x + y)$ from $(x + y)$, how should the terms on the right side of the equation be combined? Can you review the subtraction and the resulting expression?

Step 2: You proceeded with isolating x by dividing $-x = 2$. However, remember that when we divide both sides of an equation by a negative value, the direction of the inequality changes. What should the correct sign be on the right side of the equation after division? Could you re-evaluate this step?

Step 3: Moving on, you substituted the value of x into the first equation to solve for y . However, let's recheck the arithmetic when simplifying $-2 + y = 5$. How should the equation be simplified correctly?

Step 4: Lastly, you worked to solve for y , but there seems to be a small error when adding 2 to both sides. Could you adjust the arithmetic and re-evaluate the final result for y ?

Now, let's revisit these steps and make sure our calculations are aligned to achieve the correct values for both x and y .

TU

Can you make this prompting simpler to understand

ChatGPT

Absolutely, let's break it down step by step in a simpler way:

Step 1: You subtracted the second equation from the first, but let's focus on the terms after subtraction. When you subtract $(2x + y)$ from $(x + y)$, what do you get? Please show the simplified equation after the subtraction.

Step 2: You divided both sides by -1 to solve for x , which is good. But remember, when we divide by a negative number, the direction of the inequality changes. Could you correct the sign on the right side of the equation after division?

Step 3: When you substituted x into the first equation, you got $-2 + y = 5$. Let's double-check the math when adding 2 to both sides. What is the correct result of this addition?

Step 4: Lastly, you solved for y , but there seems to be a small mistake when adding 2 to both sides. Could you show the correct calculation for finding the value of y ?

Let's go through these steps again, ensuring we have the correct signs and calculations, to find the accurate values of both x and y .

Development of a conversation tool for people with intellectual and cognitive impairments and communication difficulties

Advisors Prof J L Arnott in collaboration with Speech & Language Therapist(s)

Project description

Adults with autism, cerebral palsy and intellectual disabilities may have difficulties with communication as a consequence of their disorder. They may have little or no speech and be unable to understand and remember information and so have great difficulty in taking part in everyday conversations important in developing social relationships. These adults often need augmentative or alternative forms of communication (AAC) using technology to help them express themselves.

This project would build on previous work which developed a prototype voice output conversation aid (VOCA) on a Smartphone. The VOCA was developed to include speech acts and address the challenging skills of initiating, developing and finishing a conversation. The system was designed to ensure that the user could always experience success in the interactions they would have.

The work requires further development and this project would investigate how a user could easily engage in conversations about key topics of interest. The software development would involve enabling a user to access photographs or symbols (visual supports) related to topics of conversation that they enjoyed which are stored in their system. The photographs/symbols could be designed and programmed to enable a user to initiate or maintain a conversation about a topic of their choice. For example, a user could directly select areas of the photograph/symbol which would access pre-stored information about the topic in a form that would allow them to take part in and develop a conversation with a listener. This would assist users, who had not previously been able to initiate or maintain successful conversations, to develop and sustain their interactions with conversation partners.

The project will have input from the speech and language therapy profession to guide the development, implementation and evaluation of the system and, if prevailing conditions allow, appraisal with people with intellectual and developmental impairments. Training and support to carry out evaluations would be provided as well as advice on the requirements of the system being developed.

Skills the student will develop

Knowledge of diversity and accessibility matters, including augmentative and alternative communication (AAC). System development and evaluation for special populations.
Experience of User Interface Design and Programming.

Industrial/Social Relevance

Development of software/apps for health and care settings and users with special requirements. Collaboration on development with professionals from other disciplines.

Making health information documents easier to understand and recall for people with intellectual and cognitive impairments

Advisors Prof J L Arnott in collaboration with Speech & Language Therapist(s)

Project description

Many people who have intellectual and cognitive impairments have communication difficulties that mean they are unable to understand or express themselves. They may also be unable to read and write. This group of people have difficulty in accessing health promotion information which includes advice on how to keep well and safe, as well as information about life-saving screening assessments; hence many people with intellectual and cognitive impairment do not access health services and support that would keep them well. This population has far poorer health outcomes than the general population.

One way of helping people to access health services is by making health information more accessible to them. This requires the language to be simplified and supported with images (symbols or photographs) to enable people who cannot read to understand and recall the messages provided. Accessible health information has been shown to be beneficial if the reader is supported by another person who helps to clarify the information, repeat it and check that the person understands. However, this is time consuming for staff and carers and reduces a person's independence. Having information that is accessible and usable for the person with impairments, without need for assistance or intervention from other people, could help improve health outcomes for these individuals.

Health information leaflets for people with cognitive impairments are currently produced by Speech and Language Therapists from existing publicly available health information. This project would investigate how technological means might be used to provide people with cognitive and intellectual impairments with an interactive means to engage with the health information and so better understand it.

In this project adapted health information leaflets (already provided) will be taken and a technological system developed which would allow a person with a cognitive and intellectual impairment to access them such that the information could be presented, repeated and clarified without the help of a carer. The system would also provide an engaging means to check that the person has understood the information. The HCI aspects of how the information would be accessed by people with intellectual impairments would also need careful consideration.

The project will have input from the speech and language therapy profession to guide the development, implementation and evaluation of the system and, if prevailing conditions allow, appraisal with people with intellectual and developmental impairments. Training and support to carry out evaluations can be provided as well as advice on the requirements of the system being developed.

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Skills the student will develop

Knowledge of diversity and accessibility matters, including augmentative and alternative communication (AAC). System development for special populations. Experience of User Interface Design and Programming.

Industrial/Social Relevance

Experience of application development. Development of software/apps for health and care settings and users with special requirements. Collaboration on technology development with professional(s) from other disciplines.

Computer-based support for language screening assessment of people with communication impairments and intellectual disabilities

Advisors Prof J L Arnott in collaboration with Speech & Language Therapist(s)

Project description

Speech and Language Therapists carry out screening assessments to identify the language level of persons (clients) with communication impairments and intellectual disabilities. Currently this assessment is presented as a paper-based activity which does not make use of technology; clients are presented with photographs and symbols to match with each other, or objects to manipulate. The assessment can be cumbersome to use and relies on scores being recorded via visible assessment sheets which can increase a client's anxiety about their score and so cause more mistakes to occur in the assessment.

An alternative approach is to make the assessment computer-based, which would enable the client to carry out assessment tasks given to them by a Speech & Language Therapist and to manipulate symbols and objects on the display while following instructions. This would allow therapists to assess the client's language level and record their progress unobtrusively while encouraging their participation and enjoyment.

This project proposes to progress investigation on computer-based language assessment. Previous work has investigated interaction with and manipulation of on-screen photographs and symbols for this client group, including 3-dimensional representation and manipulation. Further development of interaction options would allow extension of the range of language assessment available for the therapist to use. Client progress could be recorded automatically and unobtrusively by the system, which would be realised as a desktop or laptop application.

The project will have input from the speech and language therapy profession to guide the development, implementation and evaluation of the system and, if prevailing conditions allow, appraisal with people with intellectual and developmental impairments. Training and support to carry out evaluations could be provided as well as advice on the requirements of the system being developed.

Skills the student will develop

Knowledge of diversity and accessibility matters, including augmentative and alternative communication (AAC). System development for special populations. Experience of User Interface Design and Programming.

Industrial/Social Relevance

Experience of application development. Development of software/apps for health and care settings and users with special requirements. Collaboration on technology development with professional(s) from other disciplines.

Title

Enhancing Angiogram image contrast

Advisor

Dr Pardis Biglarbeigi

Project Description

Many real-life images, such as medical images, remote sensing images, and electron microscopy images suffer from poor image quality and contrast. Therefore, image contrast enhancement is a fundamental application in image processing, which entails methods that increases the dynamic range of an image. Histogram equalisation (HE) is a classical method in image contrast enhancement; however, it has been shown that considering the histogram of the whole image cannot be effective in increasing the contrast. As an example, in images where preserving the brightness is required, application of HE will cause the mean brightness of the image to have a middle-grey level, regardless of the overall brightness mean of the original image [1].

In this study, the student will develop a new image contrast enhancement algorithm to increase the contrast of series of medical images. For this purpose, student will work with a couple of videos containing multiple angiogram frames obtained from a post stent operation. The contrast enhancement should be done in a way that allows easy segmentation of the coronary artery [Fig 1].

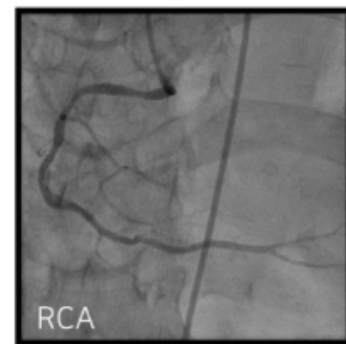


Fig 1. Coronary artery angiogram image [2]

Skills the students will develop and any prerequisites

This project requires coding skills and understanding of image processing libraries. Students will learn about image processing techniques of during the course of research.

Industrial Relevance

Image processing techniques have had vital effects in different technologies and fields of work such as biomedical engineering, electronic engineering, remote sensing, GIS, and food industry*. Image processing can improve the quality of images for human interpretation. It, also, extracts information from the images for machine interpretation.

References:

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* An example can be found [Industrial Image Processing in the Food Industry](#)

Title

Characterisation of seizure event transition point in EEG

Advisor

Dr Pardis Biglarbeigi

Project Description

Electrical activity of the brain is measured by electroencephalogram (EEG) with the help of small sensors attached to the scalp. It is understood that any sudden and uncontrolled change in electrical activity of brain is a seizure. Seizures can cause sudden movements, changes in behaviour, or even changes in consciousness. Patients undergoing repeated seizures in short period of time are considered epileptic.

EEG bio-signals are the main source of detecting seizure. Seizures appear as increase in the frequency, or appearance of rapid continuous spikes in the EEG. Time-frequency analysis as well as time-frequency ridges of the EEG signals have shown to be powerful tools in detecting these changes [1, 2, 3].

Commonly, in EEG analysis, 30 seconds of data are considered to be one epoch and the analysis is done for one or multiple epochs. However, there is a lack of research in understanding the transition of EEGs at the starting point of the seizure. Therefore, characterisation of the ridges at the transition point may add to the understanding of seizure events.

In this study, the student will develop a framework to characterise the transition point from normal to seizure state of EEG. This characterisation is done by understanding the time-series statistical significance of the time-domain ridges in a big dataset.

Skills the students will develop and any prerequisites

This project requires mathematical and statistical understanding and coding skills. Students will learn about signal processing techniques of developing time-frequency images during the course of research.

Industrial Relevance

Understanding of statistics is important in any field of work, more specifically statistics in health care have vital role in understanding risk factors, impact on policy changes, and assessing quality of healthcare. Signal processing, also, has huge application in different fields of work such as biomedical engineering, electronic engineering, audio engineering, speech processing, seismology, and financial signals.

References:

- [1] Arts, L.P. and van den Broek, E.L., 2022. The fast continuous wavelet transformation (fCWT) for real-time, high-quality, noise-resistant time–frequency analysis. *Nature Computational Science*, 2(1), pp.47-58.
- [2] Madhale Jadav, G., Lerga, J. and Štajduhar, I., 2020. Adaptive filtering and analysis of EEG signals in the time-frequency domain based on the local entropy. *EURASIP Journal on Advances in Signal Processing*, 2020(1), pp.1-18.
- [3] Khan, N.A., Ali, S. and Choi, K., 2021. An instantaneous frequency and group delay-based feature for classifying EEG signals. *Biomedical Signal Processing and Control*, 67, p.102562.

Title

Enhancing Language Model Accuracy using Vector Search Techniques

Advisor

Andy Cobley

Project description

(NOTE, this description was written by ChatGPT and check for accuracy).

The "Enhancing Language Model Accuracy using Vector Search Techniques" project aims to explore and implement vector search methodologies to improve the accuracy and efficiency of Large Language Models (LLMs). With the rapid advancement of natural language processing, LLMs have become essential tools for various applications like text generation, translation, and question answering. However, these models still face challenges in terms of generating coherent and contextually accurate responses.

This student project will focus on leveraging vector search techniques to enhance LLMs' performance. Vector search involves representing text data as high-dimensional vectors in a semantic space, where similar vectors correspond to semantically related content. By integrating vector search into the language model's architecture, the project aims to achieve the following objectives:

1. **Contextual Enhancement:** Implement mechanisms that use vector search to find and incorporate relevant contextual information from a large text corpus. This will enable the model to produce responses that are not only syntactically correct but also contextually appropriate.
2. **Error Correction:** Develop vector-based error correction techniques that can identify and rectify inaccuracies or inconsistencies in the model's generated output. This can contribute to more reliable and accurate responses.
3. **Efficiency Improvement:** Investigate how vector search can optimize the inference process of the language model, potentially leading to faster response times while maintaining or improving accuracy.
4. **Semantic Coherence:** Experiment with techniques that leverage vector search to generate text that maintains a coherent semantic flow, reducing instances of abrupt topic shifts or disjointed language.
5. **Domain Adaptation:** Explore how vector search can aid in domain adaptation by enabling the language model to better understand and generate content specific to certain topics or industries.

The project will involve stages of research, experimentation, implementation, and evaluation. Students will need to study existing vector search algorithms, understand their applicability to language processing, and then integrate them into the chosen language model architecture. Evaluation will be based on quantitative measures of accuracy, coherence, and efficiency, as well as qualitative assessment by human judges.

By the end of the project, the students should have developed a prototype that demonstrates the benefits of integrating vector search techniques into a Large Language Model, showcasing improvements in response quality, accuracy, and contextual relevance. This project will not only contribute to advancing natural language processing techniques but also provide students with practical experience in working with cutting-edge technologies in the field.

Skills the student will develop and any prerequisites

If the student project involves using Cassandra DB as the vector search database, the students will have the opportunity to develop a wide range of skills, including:

1. ****Database Management:**** Students will gain hands-on experience in setting up, configuring, and managing a distributed NoSQL database like Cassandra. This includes understanding data modeling, schema design, and managing data replication and consistency.

2. **Data Modeling:** Designing the database schema to efficiently store and retrieve high-dimensional vectors requires a deep understanding of data modeling principles. Students will learn how to represent vector data in Cassandra's column-oriented structure effectively.
3. **Query Language:** Working with Cassandra involves using CQL (Cassandra Query Language) to interact with the database. Students will learn to write complex queries to perform vector searches efficiently and retrieve relevant results.
4. **Distributed Systems:** Cassandra is a distributed database that operates on a cluster of nodes. Students will learn about distributed system concepts like data partitioning, replication, and fault tolerance, which are crucial in maintaining the database's performance and reliability.
5. **Performance Optimization:** Optimizing the performance of Cassandra for vector search involves understanding indexing strategies, query optimization, and data distribution. Students will learn techniques to improve query response times and overall database performance.

Overall, using Cassandra DB for vector search in the student project will offer a holistic learning experience that encompasses database management, distributed systems, data modeling, query optimization, and practical integration with machine learning models. These skills are highly relevant in today's technology landscape and can prepare students for roles in data engineering, backend development, and data science.

Industrial Relevance

The project of implementing vector search using Cassandra DB to improve Large Language Model (LLM) accuracy holds significant industrial relevance in several key areas:

1. **Natural Language Processing (NLP) Advancements:** Natural language processing is a rapidly growing field with applications in chatbots, virtual assistants, sentiment analysis, content recommendation, and more. Enhancing the accuracy of LLMs through vector search can greatly improve the quality of generated responses and make NLP applications more reliable and contextually relevant.
2. **Customer Support and Chatbots:** Many industries rely on chatbots and virtual assistants to provide customer support and answer queries. Implementing vector search can help these systems better understand user intent and context, leading to more accurate and helpful responses.
3. **Content Recommendation and Personalization:** Content recommendation engines use NLP to suggest relevant articles, videos, or products to users. Improved LLM accuracy can enhance the precision of these recommendations, leading to better user engagement and satisfaction.
4. **E-commerce and Search Engines:** In e-commerce, accurate search results and product descriptions are essential. By leveraging vector search, e-commerce platforms can offer more relevant search results and product information, enhancing the overall user experience.
5. **Healthcare and Biomedical Applications:** In the healthcare domain, accurate communication is crucial. LLMs can assist in generating medical reports, patient communication, and research. Vector search can help improve the precision and relevance of medical information generated by these models.

Title**Raspberry Pi Pico Oscilloscope****Advisor**

Andy Cobley

Project Title: Raspberry Pi Pico Oscilloscope with LCD Display

Project Description:

(Note, this project description was written by ChatGPT and checked for accuracy by Andy Cobley)

The "Raspberry Pi Pico Oscilloscope with LCD Display" project aims to create a portable and affordable oscilloscope using a Raspberry Pi Pico microcontroller and a small LCD screen. An oscilloscope is an essential tool for electronics enthusiasts and engineers to visualize electrical signals, monitor waveforms, and troubleshoot circuits. By leveraging the capabilities of the Raspberry Pi Pico and a compact LCD screen, this project will provide students with an opportunity to delve into both hardware and software aspects of electronics.

Key Project Objectives:

1. ****Hardware Integration:**** Students will connect the Raspberry Pi Pico to input probes, buttons, and a small LCD screen. They will learn about digital and analog signal processing, basic electronic connections, and interfacing sensors with microcontrollers.
2. ****Signal Acquisition:**** The project will involve capturing analog signals using the Raspberry Pi Pico's analog-to-digital converters (ADCs). Students will learn about signal sampling, quantization, and how to convert analog signals into digital data for processing.
3. ****Waveform Visualization:**** Using the connected LCD screen, students will develop code to display captured waveforms in real-time. This will involve programming the LCD display to show time-domain plots of the acquired signals, effectively turning the setup into a functional oscilloscope.
4. ****User Interface:**** Students will design a user-friendly interface on the LCD screen, allowing users to control settings such as timebase, voltage scale, and trigger settings. This will involve implementing user input handling and displaying relevant information on the screen.
5. ****Signal Analysis:**** Students can explore basic signal analysis functionalities such as measuring peak-to-peak voltage, frequency, and duty cycle. They will gain insights into digital signal processing concepts.

They will have a functional portable oscilloscope that demonstrates their skills and knowledge in building practical electronic devices. This project serves as an excellent opportunity for students to bridge theoretical knowledge with hands-on experience, preparing them for careers in electronics, embedded systems, and hardware development.

Skills the student will develop and any prerequisites

If the students choose to implement the Raspberry Pi Pico Oscilloscope project using the C programming language, they will develop a diverse set of skills that are valuable in the field of embedded systems, electronics, and software development. Here are some of the skills they will acquire:

1. **C Programming:** The entire project will involve programming the Raspberry Pi Pico using the C language. Students will become proficient in C syntax, data types, variables, pointers, and memory management.
2. **Microcontroller Programming:** Working with the Raspberry Pi Pico requires understanding its architecture, GPIO pins, and hardware peripherals. Students will learn to configure and utilize the Pico's components effectively through C programming.
3. **Signal Processing:** Capturing and processing analog signals from the input probes involves knowledge of signal conditioning, filtering, and analog-to-digital conversion. Students will learn about sampling rates, quantization, and signal representation.
4. **Data Structures:** Students will likely use data structures such as arrays and structs to organize and manipulate captured waveform data. This will improve their skills in managing and manipulating data efficiently.
5. **Hardware Interfacing:** Interfacing buttons, input probes, and LCD screens with the microcontroller requires a strong understanding of hardware connections and how to control external components through the microcontroller's GPIO pins.

Overall, implementing the Raspberry Pi Pico Oscilloscope project using the C language will provide students with a well-rounded skill set that includes programming, electronics, hardware-software integration, real-time systems, and project management skills. These skills are highly transferable and relevant in various industries, particularly in embedded systems development, firmware engineering, and electronics design.

Industrial Relevance

The project of implementing a Raspberry Pi Pico-based oscilloscope using the C programming language holds significant industrial relevance, particularly in the fields of electronics, embedded systems, and software development:

1. **Electronics Manufacturing and Testing:** In electronics manufacturing, oscilloscopes are essential tools for testing and debugging circuits. A low-cost and portable oscilloscope solution can be used for quality control, testing prototypes, and identifying manufacturing defects.
2. **Education and Training:** Educational institutions and training centers often require affordable tools for teaching electronics and embedded systems. The project can be utilized to provide students with hands-on experience in signal processing, hardware interfacing, and programming.
3. **Embedded Systems Development:** The project exposes students to the fundamentals of embedded systems development, including microcontroller programming, sensor interfacing, and real-time data processing. These skills are highly relevant in industries developing IoT devices, wearable technology, and smart appliances.
4. **Research and Development:** Engineers and researchers working on innovative projects that involve sensor data analysis, signal processing, and data visualization can use the project as a starting point to build custom tools for their specific applications.
5. **Prototyping and Rapid Development:** Startups and small businesses can benefit from rapid prototyping using the Raspberry Pi Pico-based oscilloscope. It provides a quick and cost-effective solution for testing and refining ideas before moving to production.

Overall, the project's industrial relevance lies in its potential to address various needs across industries, from electronics testing and prototyping to education and research. By implementing a cost-effective and versatile oscilloscope solution, the project contributes to the development of skills and tools that have practical applications in a wide range of sectors.

Title

Flexible Media Interaction

Advisor

Dr Michael Crabb

Project Description

Flexible media is a concept that breaks media down into small parts that can be put together in new and interesting ways on a client device. Example implementation of this can include:

- Recipe Information when watching a cookery show
- geoJSON data relating to a travel show
- Additional learning material that relates to an education show

This concept increases the opportunities for viewers to alter aspects of the television experience in real time while watching content. However, finding ways to implement this metadata and attach it to existing television shows can be challenging. The project has the following aims:

1. To understand how the inclusion of additional metadata could enhance viewing environments for television content
2. To develop a system capable of authoring metadata that can be attached to a movie file
3. To discover user sentiment towards systems of this type and how it could be implemented in the future

This project will involve a large development component and consists of the following steps:

- Conduct an initial scoping exercise to look at how different media genres could implement metadata
- Design a system capable of attaching this metadata to video files
- Design a system capable of demonstrating how these metadata attachments can be understood
- Design a research study to test several viewing adaptations
- Obtain ethics for this research study and then run it within a controlled lab setting
- Carry out a research study and analyze the results

In terms of the front and backend web programming languages that will be used, web-based delivery would be preferred. It is anticipated that the project will fully use several APIs built into the browser and will also use technologies such as webRTC, socket.io and node.js to facilitate interactions.

Skills the student will develop and any prerequisites

Web Development, research study design, user testing.

Related Papers:

- [Holmes, M. E., Josephson, S., & Carney, R. E. \(2012, March\). Visual attention to television programs with a second-screen application. In Proceedings of the symposium on eye tracking research and applications \(pp. 397-400\).](#)
- <https://www.bbc.co.uk/rd/object-based-media>

Title

Should I Put My Washing On?

Advisor

Dr Michael Crabb

Project Description

Modern new build houses have solar panel arrays that are used to generate electricity for the home. These panels require direct sunlight in order work and the amount of energy generated directly relates to the amount of sun that is present. Any energy that is not used within a house to power appliances is then:

1. Used to heat hot water within the home
2. Stored within a battery on the property
3. Fed back into the national grid

Most homes use option (1) or (3), with very little having an on-property battery. It is therefore in a home owners best interest to use any generated electricity immediately.

The purpose of this project is to create an application that gathers information about a solar array within a property, predicted weather patterns for a given day, and then suggests at what time of the day a homeowner should put-on high-power drain appliances (e.g. Washing Machine, Tumble Dryer, Dishwasher).

Skills the student will develop and any prerequisites

Mobile Application development, research study design, user testing.

Related Papers:

- Froehlich, J. (2009, February). Promoting energy efficient behaviors in the home through feedback: The role of human-computer interaction. In *Proc. HCIC Workshop* (Vol. 9, pp. 1-11).x
- Petromil Petkov, Suparna Goswami, Felix Köbler, and Helmut Krcmar. 2012. Personalised eco-feedback as a design technique for motivating energy saving behaviour at home. In *Proceedings of the 7th Nordic Conference on Human-Computer Interaction: Making Sense Through Design (NordiCHI '12)*. Association for Computing Machinery, New York, NY, USA, 587–596. <https://doi.org/10.1145/2399016.2399106>
- Lon Åke Erni Johannes Hansson, Teresa Cerratto Pargman, and Daniel Sapiens Pargman. 2021. A Decade of Sustainable HCI: Connecting SHCI to the Sustainable Development Goals. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems (CHI '21)*. Association for Computing Machinery, New York, NY, USA, Article 300, 1–19. <https://doi.org/10.1145/3411764.3445069>

Title

Fitts' Law and Mobile Screen Device Size

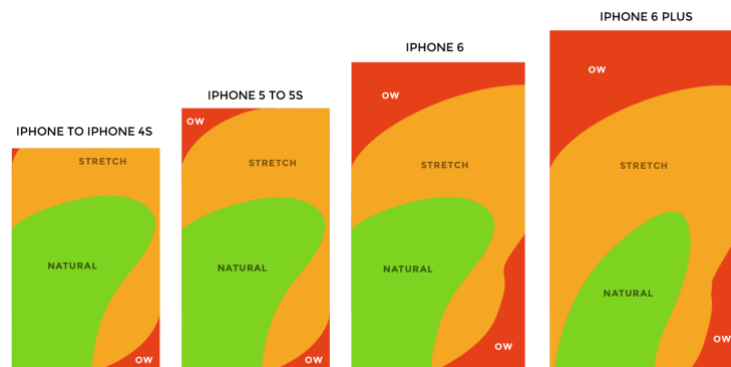
Supervisor

Dr Michael Crabb

Project description

Fitts' law is commonly used as a method to determine target accuracy and is based on the time to move to the target, the distance between the start position and the target location, and the target size. Whilst this works well for common interfaces where the user has free range of movement, this is not the case with modern mobile displays where the device size limits the overall movement that is possible.

This project will investigate this area and the student will be expected to design and run an experiment that will allow for data to be captured to understand this area and to develop an adapted version to the Fitts Law that takes into consideration.

**Skills the student will develop and any prerequisites**

Potential for skills to be developed in a number of software development areas based on the students chosen direction. Additional skills in Experiment Design and Mobile Interface Design may also be developed.

References

<https://www.interaction-design.org/literature/book/the-glossary-of-human-computer-interaction/fitts-s-law>

<http://scotthurff.com/posts/how-to-design-for-thumbs-in-the-era-of-huge-screens>

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.

Guiard, Y., & Rioul, O. (2015, July). A mathematical description of the speed/accuracy trade-off of aimed movement. In *Proceedings of the 2015 British HCI Conference*(pp. 91-100). ACM.

Title

Adaptive Subtitles – Personalising Remote Interaction.

Advisor

Dr Michael Crabb



Project Description

Subtitles can help improve the understanding of media content. People enable subtitles based on individual characteristics (e.g., language or hearing ability), viewing environment, or media context (e.g., drama, quiz show). However, some people find that subtitles can be distracting and that they negatively impact their viewing experience.

Our previous work in this area developed a system that allowed television viewers to select subtitles to be enabled for individual characters in a show. Giving users the ability to personalise the way they experience content is challenging. Any time that is spent implementing an adaption is time that is not spent consuming the media itself. The task that users' go through to adapt an interface follows the same, broad, iterative process:

consuming content → deciding that content should be adapted → selecting content to be adapted → evaluating if the adaption is acceptable

The purpose of this project is to investigate different methods that can be used to enable/disable subtitles for individual characters by creating a simpler UI interface. The project has the following aims:

1. To develop second generation Adaptive Subtitles system that allows users to select which characters have subtitles on/off
2. To create a new, phone based, remote for this system that improves on the remote that was created in our first-generation system
3. To test this system in a user study.

Skills the student will develop and any prerequisites

Mobile Application development, research study design, user testing.

Related Papers:

- Benjamin M. Gorman, Michael Crabb, and Mike Armstrong. 2021. Adaptive Subtitles: Preferences and Trade-Offs in Real-Time Media Adaption. In CHI Conference on Human Factors in Computing Systems (CHI '21), May 8–13, 2021, Yokohama, Japan. ACM, New York, NY, USA, 11 pages. <https://doi.org/10.1145/3411764.3445509>

Project title

Novel content types for AskMyClass

Client

Dr David Martin, School of Life Sciences

Project Description

AskMyClass (<https://askmyclass.dundee.ac.uk>) is a prototype interactive content delivery system intended for use in teaching and interactive presentations. The main application is a framework for the delivery of content in real time to the users device, and to capture and visualise feedback from the user. Essentially it implements a structured conversation between the participant and the presenter.

AskMyClass is entirely web based, allowing participation anywhere a network connection can be found on the users own device. Taking the concept of audience response systems such as Mentimeter and generalising them, any kind of javascript wrapable content can be delivered, and responses retrieved for analysis. The current version of AskMyClass implements multiple choice type responses and structured free drawn responses.

This project expands the repertoire of content types by packaging existing javascript based content in an AskMyClass container, allowing delivery and interaction with this content as part of an AskMyClass session.

This project will develop an understanding of Javascript APIs, user interaction and event process in browsers as well as a consideration of the pedagogical requirements for managing and visualising the responses obtained.

The specific nature of each project would be determined by discussion between the student and the client/supervisor. Content areas that could be packaged for deployment include (a non-exhaustive list):

Building molecules (applications in organic chemistry)

Visualising protein structures (application in biochemistry)

Visualising anatomical structures (application in physiology/medicine)

Improving the UI for the existing image based content type

Delivery of powerpoint-style content allowing text to be formatted to the preference of the recipient including screen reading, zoomable images etc to enhance accessibility.

STL viewer allowing for display and interaction with object models.

Skills the student will develop and any prerequisites

Web development, use of APIs, data structure design.

Related information

<https://askmyclass.dundee.ac.uk>

Specific public code for each feature area provided on request.

Project title

Engineering robustness in a multiuser audience response system

Client

Dr David Martin, School of Life Sciences

Project Description

AskMyClass (<https://askmyclass.dundee.ac.uk>) is a prototype interactive content delivery system intended for use in teaching and interactive presentations. The main application is a framework for the delivery of content in real time to the users device, and to capture and visualise feedback from the user. Essentially it implements a structured conversation between the participant and the presenter.

AskMyClass is entirely web based, allowing participation anywhere a network connection can be found on the users own device. Taking the concept of audience response systems such as Mentimeter and generalising them, any kind of javascript wrapable content can be delivered, and responses retrieved for analysis. The current version of AskMyClass implements multiple choice type responses and structured free drawn responses.

The core technology for client communication is websockets. The current prototype relies on individual clients (instructor or participant) maintaining state for a particular interaction. This is not always robust, requiring occasional reloading of the page and resetting of the page. This project will establish a more robust communication process where the user can be reasonably confident that they are up to date with the current state of the system.

The current implementation is a prototype written without much regard to modern quality standards. There may therefore be quite some refactoring needed to ensure robustness in the system.

Skills the student will develop and any prerequisites

Web development; client-server interaction with websockets; UI

Related information

<https://askmyclass.dundee.ac.uk>

Project title

Enhance the User Interface for an audience response system

Client

Dr David Martin, School of Life Sciences

Project Description

AskMyClass (<https://askmyclass.dundee.ac.uk>) is a prototype interactive content delivery system intended for use in teaching and interactive presentations. The main application is a framework for the delivery of content in real time to the users device, and to capture and visualise feedback from the user. Essentially it implements a structured conversation between the participant and the presenter.

AskMyClass is entirely web based, allowing participation anywhere a network connection can be found on the users own device. Taking the concept of audience response systems such as Mentimeter and generalising them, any kind of javascript wrapable content can be delivered, and responses retrieved for analysis. The current version of AskMyClass implements multiple choice type responses and structured free drawn responses.

The current AskMyClass framework was written with a view to function rather than form and as such the User Interface leaves much scope for improvement. Some work on this has already begun. The framework UI includes how users interact with the structure of a session – for the participant in a session the key interaction is submission of responses and being able to navigate back to previous content element. For the presenter, the controls need to be clear, intuitive and work well in allowing them to manage a session from whichever device they are on.

Skills the student will develop and any prerequisites

Web development, UI

Related information

<https://askmyclass.dundee.ac.uk>

Project title

Assembling a real time bat detector

Client

Dr David Martin, School of Life Sciences; Kevin Frediani, Botanic Gardens

Project Description

Biodiversity is increasingly of interest but has been relatively difficult to monitor and measure, requiring expert knowledge and labour intensive data collection. In recent years machine learning approaches have led to the emergence of low cost data collection apparatus and machine learning based automated species ID.

The BirdNET project at Cornell has been deployed successfully on a Raspberry Pi, allowing for real time identification of birds from their song in a convenient and easy to deploy package that is essentially plug and play on a low cost minicomputer (Raspberry Pi model 3 or 4). We have two currently running in Dundee and the 24/7 nature of their deployment allows for a rich source of data for avian biodiversity.

Of considerable interest for monitoring the health of an ecosystem is bat monitoring as they are a key indicator species for the presence of an abundance of insect life. Recent developments of low cost data recorders such as Audiomoth and Pi-pipistrelle have allowed large scale data collection for off-line processing using appropriate software.

This project seeks to bring these two areas together, using the bat detection software batdetect2 in place of the birdNET analysis in the BirdNET-Pi deployment framework to give a web based real time record of bat calls.

Skills the student will develop and any prerequisites

Unix system engineering. Machine Learning. Python/PyTorch, web deployment, Raspberry Pi

Related information

<https://github.com/mcguirepr89/BirdNET-Pi>

<https://github.com/macaodha/batdetect2>

<https://omenie.com>

<https://openacousticdevices.info/audiomoth>

Title

External Client Project: An interactive application to support Independence Advocacy in Dundee.

Supervisor

To be confirmed

Project description Dundee Independent Advocacy Service (DIAS) is an independent advocacy service that offers vulnerable people in Dundee the opportunity to take control over their own lives by enabling them to exercise choice and their rights based on their own needs and wishes ensuring that their views are heard and responded to.

One challenge faced by the service is supporting vulnerable parents and carers, who may struggle with the issues of literacy, numeracy, abstract concepts, time, organisation and planning.

This project is to develop an interactive application that provides information to users about different meetings, to support preparation and to build confidence. Some background research is required to determine the most appropriate tools and platforms for DIAS, as well as the level of usage analytics that should be incorporated. You would be expected to interact with end-users to support design and evaluation of the tool and meet regularly with the external client.

See <https://diasdundee.org> for more information about DIAS

Skills the student will develop

- Software Development (likely web-based)
- Qualitative Research Methods

Industrial Relevance

Software Development

Usage Data Analytics

Research Skills

End-User Engagement and Evaluation

Title

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Skills the student will develop

- Software Development (likely web-based)
- Qualitative Research Methods

Industrial Relevance

Software Development

Usage Data Analytics

Research Skills

End-User Engagement and Evaluation

Title

Data Health Survey Platform or custom Webflow's built-in form

External Client

Data Understood

Project Description

This project involves creating a data health survey using Webflow that will be hosted on our organisation's website. The aim of the survey is to assist our company to assess our customer's data management practices through quantitative and qualitative questions. The goal is to identify strengths, weaknesses, and opportunities to improve data quality, governance, infrastructure, and staff capabilities. Additionally, the student could research and recommend optimal UX/UI design for the survey, including question types, flow, branding, and visuals. As well as analyse our website's user journeys to determine ideal placement for survey access/entry points. Produce recommendations for linking to the survey page based on key personas and goals.

Skills Required

Web development through Webflow, survey design principles, data analysis, knowledge of data management best practices, user research, web analytics, UX/UI design.

Anticipated Outcomes

A well-designed data health survey hosted on our website built with Webflow and strategically placed based on UX research. The survey will connect to a third-party processor to capture responses and provide reporting. The background IP (i.e., survey questions) will belong to our company.

Company Resources Provided

Sample data health survey questions, access to Webflow and form backends like Microsoft Form or Typeform, expertise in effective survey design and data visualisation.

Title

Automated Interview Transcription and Tagging

External Client

Data Understood

Project Description

This project will develop a system to automatically transcribe audio/video interviews and identify topics of interest using natural language processing. The goal is to help our research team efficiently analyse large volumes of interview data. This will significantly reduce the need for manual review and transcription while making it easy for our team to extract key insights from customer interviews.

This project involves building a system to automatically transcribe audio/video interviews and tag the content using NLP techniques. Transcripts will be indexed to allow searching for relevant segments based on keywords. Create an interface that allows users to submit media files for transcription, view generated transcripts, and search/filter based on automatically applied tags and topics. A model will be trained to classify segments by topic (e.g. technology).

Skills Required

Python, natural language processing, speech/audio processing, machine learning.

Anticipated Outcomes

Application to ingest media files, transcribe, tag and index them. Searchable interface to find interview segments by topic. Background IP shall remain with our company.

Company Resources Provided

Sample interview recordings and transcripts, cloud hosting for model training.

Title

Image Library AI Index Generator

External Client

South Georgia Heritage Trust

Project Description

Use AI Vision Image Analysis techniques and conventional file data gathering to build an index of an Image and Video library stored on Microsoft SharePoint's Asset Library. The index is to be suitable for searching and for use in importing selected files into commercial Digital Asset Management systems. Configuration exporting of the index in spreadsheet format would satisfy this requirement. Additionally, copyright or ownership information for the files that may be held in a separate spreadsheet is to be incorporated into the index.

Skills Required

AI Vision Image Analysis, Machine Learning (Potentially), Digital Asset Management, Data Import/Export, Microsoft SharePoint's Asset Library

Anticipated Outcomes

An index generator that can be run at will on new sets of digital assets. This would for example produce a spreadsheet that can be manually searched or configured to import selected files into a Digital Asset Management. It is hoped we could use results from this project in our work so Intellectual Property arrangements would have to be made clear at the outset.

Company Resources Provided

Access to a sample Digital Asset Library on Microsoft Sharepoint and the charity's representatives for consultation. Software required for development (by negotiation)

Title

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Company Resources Provided

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Title

Retina image quality assessment

Advisor

Dr Hanhe Lin and Prof Emanuele Trucco

Project description

The quality of a retina image plays an essential role on doctors' clinical decision making for disease diagnosis as well as for the reliability of automatic software tools for retinal image analysis like VAMPIRE, a software developed by the University of Dundee and Edinburgh and in use worldwide. While image quality assessment (IQA) has been widely studied on natural images, retina IQA is still challenging and less studied. Unlike natural images whose qualities are reflected by high-level semantics such as objects and faces, in addition to low-level properties such as contrast and luminance, the quality of retina images is determined almost exclusively from low-level primitives and doctors' knowledge.

This project aims to

1. Investigate empirically the relation between two classes of methods for assessing quality:
 - a. based on image properties relevant for a given task; e.g., assessing glaucoma requires inspecting the optic disc and immediate surrounding area only;
 - b. purely from the image content, without reference to tasks.
2. Develop deep learning based IQA models for retinal images using benchmarking dataset.
3. Explore how these models could be applied to improve common retinal image analysis tasks (e.g., vessel segmentation) and clinical tasks (e.g., location and measurements of vascular geometric biomarkers, or lesion detection and assessment).

Skills the student will develop and any prerequisites

This is a project for students who:

- Have good programming skills,
- Are interested in medical image analysis,
- Have experience or interested in deep learning programming, e.g., tensorflow, pytorch, etc.

Industrial Relevance

Deep learning and computer vision have attracted an increasing interest in real-world applications. Student will develop knowledge and skills that are required for job positions such as deep learning engineer. There is a possibility to interact with a spinout, Eye to the Future, co-created by Prof Trucco and developing products for retinal image analysis.

Reference

- [1] Hosu, V., Lin, H., Sziranyi, T. and Saupe, D., 2020. KonIQ-10k: An ecologically valid database for deep learning of blind image quality assessment. *IEEE Transactions on Image Processing*, 29, pp.4041-4056.
- [2] Jin, K., Gao, Z., Jiang, X., Wang, Y., Ma, X., Li, Y. and Ye, J., 2023. MSHF: A Multi-Source Heterogeneous Fundus (MSHF) Dataset for Image Quality Assessment. *Scientific Data*, 10(1), p.286.

Title

Exploring Deep Learning for Accurate Facial 3D Reconstruction

Supervisor

Dr Ludovic Magerand

Project description

Obtaining accurate facial 3D model from a patient is key to enabling remote consultation in a number of dentistry and medical fields. Anatomical measurements in these applications requires high precision, and recently published work [1] in the Computer Vision community have provided impressive results falling below one millimetre.

While this method is modelling the 3D shape and camera pose, it falls short of capturing all the progress made in classical 3D reconstruction where multi-view geometry has been long studied. For example [2] fully exploits this knowledge to deliver highly accurate face model from videos using an optimization based approach.

The use of deep learning for 3D reconstruction has also been explored and methods such as [3,4] are starting to integrate 3D geometry and best practice in optimization inside a deep learning architecture.

The goal of this open project is to explore current state of the art deep learning based facial 3D reconstruction methods and identify limitations and possible solution to integrate more 3D geometry constraints into their architecture.

Please get in touch with the supervisor before selecting that project.

[1] Tianye Li, et al. Topologically Consistent Multi-View Face Inference Using Volumetric Sampling. Proceedings of the IEEE/CVF International Conference on Computer Vision, 2021.

[2] Agrawal S, et al. High Accuracy Face Geometry Capture using a Smartphone Video. Proceedings of the IEEE/CVF Winter Conference on Applications of Computer Vision, 2020.

[3] Jianyuan Wang, et al. Deep Two-View Structure-from-Motion Revisited. Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition, 2021.

[4] Xingkui Wei, et al. DeepSFM: Structure From Motion Via Deep Bundle Adjustment. Proceedings of the IEEE/CVF European Conference on Computer Vision, 2020.

Skills the student will develop and any prerequisites

- Working with deep learning frameworks such as PyTorch, TensorFlow or Keras (basic knowledge and experience is desirable)
- Mathematical tools for 3D geometry modelling and computer vision / graphics
- Research methodology

Industrial Relevance

Although the final product will be used mainly as a baseline for further research, accurate facial 3D reconstruction itself is relevant for many applications in medicine, dentistry, forensics, biometry, ...

Title

A Cross-Platform Mobile Application for Facial Images Acquisition

Supervisor

Dr Ludovic Magerand

Project description

The goal of this project is to develop a cross-platform mobile application and associated back-end server allowing the user to capture images of their face by themselves with some guidance and possibly validity check. Optionally, those images would ideally be securely uploaded to a remote server with the aim of processing them offline to build a highly accurate facial 3D reconstruction (not part of this project).

The developed application will have to run on the two main mobile systems (Android and iOS) and ensure a smooth user experience in order to obtain suitable images. The user should be guided throughout the acquisition process using on-screen and/or audio instruction to indicate the placement of the phone for the next image. Information on the camera calibration for each image acquisition should also be recorded as it is needed later for the 3D reconstruction.

Additional features for the application mostly related to ensuring the validity of the image might also be explored in the project: contains the face, adequate focus (i.e. not blurry), sufficient contrast/illumination, motion of the device between images,... This would be driven by user experience feedback to implement the most useful options.

Skills the student will develop and any prerequisites

- Cross-platform mobile development, including image acquisition
- Secure API for client-server file transfer
- User experience methodology

Industrial Relevance

The final product would be used as a prototype for a mobile application to collect data in the context of a pilot study in collaboration with the School of Dentistry. In the long term, such application will facilitate mass collection of data for genetic studies on disease affecting facial morphology and enable the exploration of clinical use for such system.

Title

Semi automated tests for a network programming coursework

Supervisor

Dr Ludovic Magerand

Project description

The programming project of the third year network module focus on implementing a text-based protocol (IRC) to help students understand how protocols are defined and implemented, especially in order to maintain interoperability with other implementations. To ensure the compatibility of students implementations with the protocol, automated tests can be used.

However in order to provide the marker with enough information to give students appropriate and meaningful feedback, these tests would need to be supervised by the marker. The goal of this project is to develop such semi-automated tests, which would need to be fully compliant with the main protocol while allowing insight into what is causing problems when a failure occurs. The resulting tests would also allow the marker to guide the process.

Students production are tested in two virtual machines, one acting mainly as the server and the other one as the clients. The tests are thus distributed among them and needs to be coordinated.

Skills the student will develop and any prerequisites

- Network programming and asynchronous event driven programming
- Distributed computing, message passing and/or RPC/RMI
- Standards and protocols specification
- Automated and Semi Automated tests

Industrial Relevance

From small to large software, fully or semi automated tests are more and more used in the computing industry to validate functionalities. Most software nowadays also contain network related functionalities which need to comply with existing protocols making it crucial to test their compatibility.

Title

Refactoring a 3D Reconstruction Software

Supervisor

Dr Ludovic Magerand

Project description

This project would be about refactoring the implementation of a method developed to build 3D models from a set of images of a scene or object. The method is currently implemented with Matlab and in order to allow for full parallelization of computations at low level, a more flexible implementation is required first. Although the choice of the language to be used is not fully determined, consideration are towards Python or C/C++.

The method itself [1] uses some concepts from algebra and 3D geometry. While it is not necessary to fully understand these at first, you must be willing to learn a bit about them. This project can be adapted to your interest as the final result would be either a library with parallelization (research oriented) or a full application with graphical interface but no parallelization (software development).

Please get in touch with the supervisor before selecting that project.

[1] Details and current implementation available at <https://phg.mgrnd.fr/source/ppsfm/>

Skills the student will develop and any prerequisites

- Working with numerical computation libraries in the chosen language (NumPy or any C/C++ equivalent)
- Knowledge of some mathematical tools often used in computer science (matrix decompositions, linear least squares minimization) and computer vision/graphics (3D geometry)
- CPU code parallelization (OpenMP or PyMP for example) if working on parallelization or graphical interfaces else

Industrial Relevance

Although the final product will be used mainly as a baseline for further research, 3D vision and reconstruction itself is relevant to any industrial field where computer vision can be useful, from architecture to robotics passing by cultural heritage or bio-medical applications.

Title

Alerting first-aiders on mobile based on their localisation

Supervisor

Dr Ludovic Magerand

Project description

The university of Dundee has its own internal emergency number and associated security staff. However when they receive a call about a situation involving the need for a first-aid, they currently have no way to contact the closest one directly.

In many cities around the world, there are initiatives to develop mobile applications where volunteer citizens trained in first-aid can be localized and alerted by emergency services in order for them to provide basic life support until an ambulance with first responder can be dispatched and arrived on site.

This project would aim at developing such an application with the goal of making first-aid more efficient on campus by allowing the security staff responding to the emergency call to be localized and contact directly the closer registered first-aiders at work.

Skills the student will develop and any prerequisites

- Mobile application development
- Server-side application development
- Databases

Industrial Relevance

The successful final product would be used for improving the dispatching of first-aiders on campus (or any other kind of large premises).

Title

Exploring Quantum Computing Optimization for Computer Vision

Supervisor

Dr Ludovic Magerand

Project description

In recent years, significant progress has been made in the field of Quantum Computing, either through real quantum processors or simulation. Quantum algorithms have been developed for a wide range of problems, and libraries implementing them have also started to appear. In particular, there has been some work done on developing optimization framework leveraging quantum processing and toolbox such as Qiskit Optimization [1] provides a ready to use interface.

Before the age of deep learning in the field of Computer Vision, many problems were solved using classical optimization algorithms, especially in 3D Vision where modelling of the problem is driven by geometric constraints and algebraic relationships.

The aim of this project will be to explore how Quantum Computing optimization can be leveraged for Computer Vision. The idea would be to select a classical and simple Computer Vision problem solvable through classical optimization methods, preferably related to 3D Vision, such as pose or transformation estimation under easy assumptions.

Please get in touch with the supervisor before selecting that project.

[1] <https://pypi.org/project/qiskit-optimization/>

Skills the student will develop and any prerequisites

- Quantum Computing and associated frameworks
- Optimization methods (classical and quantum algorithms)
- Computer Vision, 3D geometry

Industrial Relevance

Although the final product will be used mainly as a baseline for further research, Computer Vision is relevant to many industrial fields. Quantum Computing is also an emerging technology with potential to be as disruptive as deep learning and AI have been.

Title

Automating the Analysis of Cortical Bone Thin Sections with Deep Learning

Advisor

Prof Stephen McKenna

In collaboration with Dr Julieta Gomez Garcia-Donas (Centre for Anatomy and Human Identification)

Project description

Cortical bone histomorphometry is used in physical and forensic anthropology for the identification of human versus animal bone and for age estimation of deceased individuals, among other applications. It consists of the quantification of the microstructural features seen in cortical bone. Osteons are one of the key features to be assessed as they are a direct reflection of physiological and biological process. The identification and counting of osteonal structures are commonly performed manually by the expert, entailing a time-consuming process which is subject to potential observer error.

Our recent work has developed AI software, based on deep learning, to automate the segmentation of structures of cortical bone thin sections (Littek et al, 2023). It used a dataset of 99 bone images provided by CAHID. Figure 1 shows a manual annotation of an image of a cross-section of femur. Marked in green are the outlines of osteons. Automating the process of detecting and segmenting osteons enables image analysis to be done more quickly and potentially more reliably.

The project will build on this base system. It will aim to (i) improve performance through expansion of the dataset and improvements to the learning method, and (ii) evaluate the extent to which useful measurements can be made automatically using such a system.

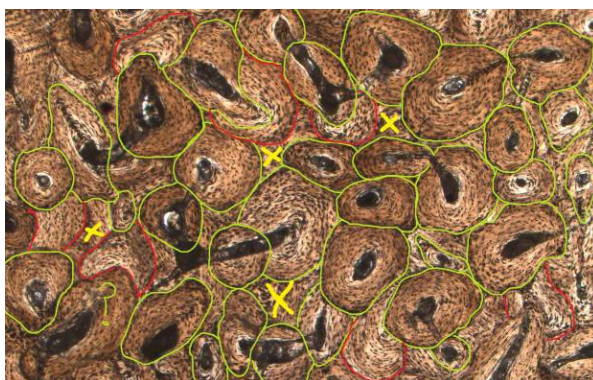


Figure 1: A manual annotation of osteons in a section of femur

Skills the student will develop and any prerequisites

Skills developed will include development and evaluation of a machine learning system, and its application to automated image analysis, while working on an inter-disciplinary project. Some prior knowledge of machine learning would be helpful (though not essential).

Industrial Relevance

Understanding of, and practical skills in, deep learning are highly sought after in industry.

Littek, A., McKenna, S. J., Chiam, W. X., Kranioti, E. F., Trucco, E., & García-Donas, J. G. (2023). *Automatic Segmentation of Osteonal Microstructure in Human Cortical Bone Using Deep Learning: A Proof of Concept*. *Biology*, 12(4), [619].
<https://doi.org/10.3390/biology12040619>

Machine learning for biomedical image analysis

Supervisor

Prof Stephen McKenna

Project description

Analysis of images from medicine and biology has seen progress in recent years due to application of improved machine learning methods (primarily deep learning) and large datasets (of images and other associated data). We have an active research group (CVIP) investigating such methods and their applications. I am happy to supervise projects in this general area, and to discuss with prospective project students, depending on their interests.

Skills the student will develop and any prerequisites

Skills developed will be in: Image and data analysis and modelling; deep learning; software development; experimental design and quantitative evaluation; Interdisciplinary project work.

This is a project most suitable for students who have some mathematics background. Ideally students would have knowledge of deep learning, or a willingness for self-study of it.

Industrial Relevance

Image analysis and machine learning are currently of widespread interest for a range of real-world applications. The student will develop knowledge and skills sought after by companies working on such applications.

Diagnosing skin cancer using deep learning

Supervisor

Prof Stephen McKenna (co-supervisor: Jacob Carse)

Project description

Skin disorders are a major health concern. Visual inspection plays an important part in their diagnosis and there is increasing interest in using artificial intelligence to automate or assist in diagnosis. Recent progress has been made through the use of deep learning systems trained on large numbers of images, e.g. [1].

This project aims to develop and evaluate a deep learning system for automatically diagnosing a range of skin disorders. Steps involved in development of this application will include training a deep learning method (a convolutional neural network) and measuring the performance of the method using appropriate metrics and test images.

Deep learning systems need to be calibrated to support optimal clinical decision making, and they often fail to generalise across datasets well. A useful focus for this project would therefore be to investigate methods for calibration and for obtaining better generalisation when, for example, training on data from one hospital and applying to another hospital's data.

A motivation for this project comes from an ongoing collaboration with clinical colleagues at Ninewells hospital [2,3]. Suitable datasets will be provided [4].

Skills the student will develop and any prerequisites

Computer vision using deep learning; Software development; Experimental design and quantitative evaluation; interdisciplinary project work.

This is a project most suitable for students studying Computing Science or who have some mathematics background. Ideally students would have knowledge of deep learning, or a willingness for self-study of it.

Industrial Relevance

Computer vision and machine learning are currently of widespread interest for a range of real-world applications. The student will develop knowledge and skills sought after by companies working on such applications.

[1] Esteva A., Kuprel B., Novoa R et al.. Dermatologist-level classification of skin cancer with deep neural networks. *Nature* 542:115, February 2017. <https://cs.stanford.edu/people/esteva/nature/>

[2] Carse J, Suveges T, Hogg S et al. Robust selective classification of skin lesions with asymmetric costs. *Lecture Notes in Computer Science* 12959. Springer, Cham. 2021. https://doi.org/10.1007/978-3-030-87735-4_11

[3] Carse, J., Alvarez Olmo, A., McKenna, S. Calibration of Deep Medical Image Classifiers: An Empirical Comparison Using Dermatology and Histopathology Datasets. *Lecture Notes in Computer Science* 13563. Springer, Cham. 2022. https://doi.org/10.1007/978-3-031-16749-2_9

[4] Chin GXM, Suveges T, Carse J, Butt S, Muthiah S, Morton C et al. Prepare to Succeed: Real-World Image Datasets for Artificial Intelligence in Skin Cancer Triage. *British Journal of Dermatology*. 2022 Jul 5;187((Suppl. 1)):125. <https://doi.org/10.1111/bjd.21386>

Developing a Computer Vision System for Evaluation of Soil Structure

Advisors: Prof Stephen McKenna and Dr Hanhe Lin

in collaboration with Dr Kenneth Loades and Dr David Boldrin (The James Hutton Institute)

Aim

This project aims to develop software to assess soil quality from images. It will use pattern recognition methods based on computer vision and machine learning.

Project Description

Soil and soil management have become central in both mitigation and adaptation strategies to climate change. Recently, the European Union released a new monitoring law, which will be adopted in Scotland, to ensure all soils are healthy by 2030. As part of monitoring, there is a requirement for robust measures and indicators of soil condition. Soil structure is a core measure of soil physical health; it develops over time through physical and biological processes. However, soil management (such as tillage) can degrade soil structure by erosion and compaction, and hence limit soil functionality. Therefore, there is a need to properly identify signs of soil degradation and understand fully the impact of soil management on soil structure.

Visual evaluation of soil structure (VESS) is used by farmers to assess soil structure. It is based on qualitative observation of the soil based on a VESS score chart. (For a full description of the VESS method and score chart, see <https://www.sruc.ac.uk/business-services/sac-consulting/agricultural-production/soils/soil-health-testing/>). In VESS, a person visually assesses soil features, including the presence of large clods (blocks of soil), porosity and shape of aggregates. Whilst this holistic approach is useful for soil assessment by farmers, its subjective nature represents a major limitation and makes VESS a not-fit-for-purpose tool for soil monitoring under a legislative framework.

This project aims to develop and demonstrate proof-of-concept computer vision software to reliably and quantitatively assess soil structure. This could more reliable, quantitative assessment. Currently, there is a lack of knowledge on the relationships between the visual features used by VESS and quantitative laboratory-based assessment of soil structure. So, additionally, results of the novel computer vision tool will be correlated with quantitative measurements of soil physical properties in a connected lab-based project.

Skills the student will develop and any prerequisites

- The student will develop technical skills in building and evaluating computer vision / pattern recognition systems.
- The student will experience working on an inter-disciplinary project and have the opportunity to collaborate with researchers from the James Hutton Institute and with student(s) from a Life Sciences background.
- Some prior knowledge of machine learning would be helpful (though not essential).

Industrial Relevance

Understanding of, and practical skills in, computer vision/pattern recognition/machine learning ('AI') are highly sought after in industry.

Title

Emoji Accessibility

Advisor

Rachel Menzies

Project description

Emoji are graphical symbols that appear in many aspects of our lives. Previous work has explored the impact of emoji accessibility for users with visual impairments. Worldwide, around 36 million people are blind and 217 million have a moderate to severe visual impairment. This portion of the population may use and encounter emoji, and many experience issues that lead to social exclusion. These issues are related to, e.g., searching for appropriate emoji, cultural use of emoji, platform differences. The aim of this project is to design and evaluate novel solutions to one or more of these issues.

Skills the student will develop and any prerequisites

Skills to be developed: Software Development, Qualitative Analysis, Design and Prototyping

Industrial Relevance

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Title

Gamified Research: A Game to Gather Research Data on Colour Contrast Perception

Advisor

Rachel Menzies

Project description

As mobile devices are becoming more popular, there is an increasing need to ensure that the content provided on screen is perceivable by the user. This includes ensuring that colour is of a sufficient contrast. However, existing colour contrast guidelines are out-dated and do not consider the context of use. To address this we developed 'BrightLights': an android application that collects information about on-screen colour contrast. A pilot project has shown that the application is viable for research purposes. This project is to develop a new Android application with a new game mechanic. This can then be compared to the existing BrightLights application in a quantitative experiment.

The student will be expected to:

- Conduct a literature review into colour perception and situational visual impairments (SVIs)
- Generate software engineering documentation for a new Android application based on existing designs and prototype
- Develop a mobile application based on your specification
- Complete a user evaluation of your application

For this project you should have a reasonable background in development. You will be required to create a mobile application that can access various sensors in a physical device, as well as a data storage facility in the cloud. A project extension could be to analyse the data generated, with the potential to get involved in writing research papers.

Skills the student will develop and any prerequisites

Skills to be developed: Software Development, Data Analytics, Quantitative Analysis

Industrial Relevance

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Title

Music Creation in Virtual Reality

Supervisor

Rachel Menzies

Project description

The creation of music using existing tools (such as GarageBand, Audacity, Ableton) can be difficult due to the learning curve required and the amount of features available to music creators. This may also be a barrier for novices to learn more complex musical theories.

In this project you will develop a virtual reality system that allows people to create simple music tracks. It is expected that you will also develop a research tool interface that can be used to evaluate your system.

Skills the student will develop

- Design of interfaces
- Virtual reality programming
- Research evaluation

Industrial Relevance

Follow a user centred design process

Development of a research-tool interface

Research skills

Title

Escape Rooms

Supervisor

Rachel Menzies

Project description

Escape Rooms are a recent phenomenon across the world, whereby a group of people are “locked” in a room for 60 minutes. Inside the room, there are clues to help them escape. Typically, there is a series of logic-based puzzles, and these are increasingly moving towards using technology in these puzzles.

Given the wide range of visitors to Escape Rooms, care must be taken to ensure that the physical and tangible interface is designed to allow for a wider range of abilities. For example, a child and an elderly grandparent may use the room, as well as visitors with disabilities such as physical impairments.

While the users are in the room, a game master will be monitoring their progress and providing clues to help along the way.

The purpose of this project is to investigate different options for technology-based puzzles, turn these into escape room artefacts and then evaluate your room in terms of usability and engagement of users.

Skills the student will develop

- Design of physical and tangible interfaces
- Evaluation of user requirements
- Evaluation of interfaces

Industrial Relevance

Follow a user centred design process to gain user requirements
Ability to evaluate different interfaces.

Title

Annual Module Enhancement System

Supervisor

Rachel Menzies

Project description

Each year, every module lead in the University is required to complete a module review. This is a way to consider successes and challenges of modules and record any enhancements or improvements that should be made.

This system is entirely based on Word documents being submitted and so there is a great deal of replication of effort and potential for errors.

This project is to develop an online system to support these annual reviews, track completion rates and flag potential issues based on the completed forms.

To complete this project you must be competent in full stack web development. You will need to develop a system with a web-based interface, Single Sign On capabilities and appropriate data storage. An administrative system will be required to support data entry and analysis.

Skills the student will develop

- Design of online interfaces
- Process design
- Web development
- Data storage and analysis

Industrial Relevance

Follow a user centred design process to gain user requirements

Title

Gamifying Digital Heritage – Heritage Trails

Advisor

Christina Moir

Project description

The aim of this project is to gamify heritage trails to encourage the public to go outside and be more active, as well as showcasing digital heritage in innovative ways to further engage the public with local heritage. You would be expected to research current heritage trails, design a way to gamify these, then create and evaluate an application or proof of concept which facilitates this gamification. The trail that the project focusses on can be one from the initial research, or you can create your own. The resulting application is expected to be web based for ease of accessibility for the public, however other platforms could be utilised if there is enough evidence that they would work as well.

Skills the student will develop and any prerequisites

Web development, gamification, programming

Industrial Relevance

This work is relevant to digital and cultural heritage, gamification, and web development

Title

Gamifying Digital Heritage – Building an Educational Game

Advisor

Christina Moir

Project description

The aim of this project is to gamify digital heritage to increase engagement and knowledge of cultural heritage. You would be expected to design, create, and evaluate a vertical slice of a playable game. The constraints of this project such as genre and style are completely up to you, however it must fulfil the scope of being educational regarding heritage information. This could be by using 3D or 2D models of heritage objects/sites or information provided in-game that is necessary to progress.

Skills the student will develop and any prerequisites

Games development, Games engines, game design

Industrial Relevance

This work is relevant to digital and cultural heritage, education, and games programming

Title

Interactive Data Visualisations of Historic Information

Advisor

Christina Moir

Project description

The aim of this project is to create interactive data visualisations of historic information to improve engagement and knowledge of cultural heritage. You would be expected to either create a web application to showcase multiple styles of visualisations that you create, or a tool for others to easily create their own visualisations focussing on one style. The historic information used could be a variety of mediums including textual, imagery, or 3D models.

Skills the student will develop and any prerequisites

Data visualisation, web/app development

Industrial Relevance

This work is relevant to Digital and Cultural heritage, and data visualisation.

Title

Immersive mobile museum

Advisor

Christina Moir

Project description

The aim of this project is to utilise immersive technology to create an interactive mobile museum for use in local communities and schools. You would be expected to design, create, and evaluate a mini-interactive exhibition. Within the design you would be expected to focus on ensuring that the tech used is lightweight and portable so that it could be easily transported around different venues. It should also be user friendly for a variety of ages. This would most likely be best developed using a games engine such as Unity as there is a lot of AR/VR support provided however there is no constraint on software used for development as long as it meets the needs of the project.

Skills the student will develop and any prerequisites

VR/AR application Development, Games engine or WebGL (or other)

Industrial Relevance

This work is relevant to Digital and Cultural heritage, immersive technology, and games programming

Title

EXPLORING VISUAL CONTENT TO SOUND MAPPING

Supervisor

Iain Murray

Project description

The student will explore how to convert a visual image into a sound picture, by developing and exploring a mapping between different image characteristics (colour, shape, angularity etc.) and different sound characteristics (pitch, volume, instruments etc.). An application will be developed which will allow experimental testing of different mappings.

Skills the student will develop

- programming (appropriate language to be decided by the student)
- HCI skills
- multimedia skills
- research skills

Industrial Relevance

N/A.

Title

DATABASES AS A TOOL FOR HISTORICAL SIMULATION

Supervisor

Iain Murray

Project description

The student will produce an application which uses a database of information about locations of military units, vehicles, ships, stores etc. and uses that to produce a time-based visualisation of the progress of a conflict or battle. An input tool for entering data into the database will also be developed.

Skills the student will develop

- programming (appropriate language to be decided by the student)
- database skills
- HCI skills
- research skills

Industrial Relevance

Application to commerce

Title

WHAT'S THAT MOUNTAIN?

Supervisor

Iain Murray

Project description

The student will create a mobile phone app which uses a digital elevation map (DEM) to recreate the landscape elevation at the user's current location. From this they will be able to identify hills and mountain peaks visible from that location. This app will be useful to hill walkers and others enjoying the landscape.

Skills the student will develop

- programming (appropriate language to be decided by the student)
- HCI skills
- research skills including terrain mapping
- graphics skills

Industrial Relevance

Application to commerce

Title

VIRTUAL ORGAN

Supervisor

Iain Murray

Project description

A set of recordings have been made of all of the pipes (notes) of a real church organ. The student will create a PC application that will recreate the sound of the original organ, using MIDI keyboards as input and signal processing to combine the recorded notes of the various organ stops to produce the output music.

Skills the student will develop

- programming (appropriate language to be decided by the student, possibly MATLAB)
- signal processing skills
- HCI skills
- research skills
- no pre-requisite knowledge of MATLAB or signal processing is required

Industrial Relevance

Application to commerce

Title

MULTIMEDIA TUTORIALS FOR ARCHITECTURE TOPICS

Supervisor

Iain Murray

Project description

In this project, you will develop a set of self-learning tutorials for Level 2 students, to demonstrate a number of architecture concepts (e.g. memory access, caches, branch target buffers, instruction execution) and to test their understanding of them.

Skills the student will develop

- programming (appropriate language to be decided by the student)
- HCI skills
- multimedia skills
- research skills

Industrial Relevance

N/A.

Title

Technology for Future Design

Supervisor

Alison Pease

Project description

Future Design is a Japanese movement which aims to overcome a focus on short-term thinking by policy makers by imagining how future citizens would feel about or be affected by a particular decision. This project combines the use of empathy in design, in which a user assumes different personas to see what challenges they may face when completing various tasks, with Future Design, to represent future citizens in areas such as democracy, culture and economics. The aim of this project will be to develop an application that enables users to take into account future citizens when making decisions. The application can be aimed at different user groups and incorporate different techniques (eg. textual prompts or a visual avatar), based on the interests of the student. The student will be expected to conduct a literature review into Future Design and the use of empathy in design; design and develop a Future Design application; and conduct a user evaluation of their application.

References:

The Research Institute for Future Design: <http://www.souken.kochi-tech.ac.jp/seido/>
The Good Ancestor - Roman Krznaric

Skills the student will develop

- Expertise with software design, prototyping and evaluation
- Experience with qualitative analysis

Industrial Relevance

This work is relevant to user-centred system design, development and evaluation.

Title

Outreach in Science, Technology, Engineering and Mathematics (STEM)

Supervisor

Alison Pease

Project description

This project entails designing, building and evaluating software which explains or demonstrates concepts in computing or science to a wider public. The particular area will be driven by the student, but may include theoretical concepts such as Turing machines, ethical considerations such as the effects of algorithmic bias, or design methodologies such as empathy-building for accessibility. In addition, the student will look at the wider context of educational software in STEM and ways in which impact and other factors can be measured. This would suit a student hoping to go into education or science communication.

Skills the student will develop

- Expertise with software design, prototyping and evaluation
- Experience with technology in education and science communication
- Experience with qualitative analysis

Industrial Relevance

Impact is more likely to be in the academic world, and the general public, but there are potential applications to industry.

Title

Creative software as therapy

Supervisor

Alison Pease

Project description

This project will look at how creative software can be used in therapeutic contexts, in similar ways to creative arts therapy. The student will design, develop and evaluate a system which incorporates creative software and follows a user-centred methodology to help people to process their feelings about an issue, via co-creating an artefact with a machine. This work will be carried out in the context of a wider project on this topic, and the student will benefit from being able to discuss their work with a number of interdisciplinary researchers.

Skills the student will develop

- Participation in user-centred system design, development and evaluation
- Experience in talking to users and understanding their needs and responses
- Experience in applying qualitative research methods to real world problems

Industrial Relevance

This work is relevant to user-centred system design, development and evaluation.

Title

Stories in Healthcare

Supervisor

Alison Pease

Project description

This project will look at how stories can be used to motivate, inspire and connect people who are suffering from health issues. The student will design, develop and evaluate a healthcare system which uses stories to increase engagement and encourage people to make lifestyle changes. The student will be expected to conduct a literature review into the use of stories in a healthcare context; design and develop a story-based healthcare application; and conduct a user evaluation of their application.

Skills the student will develop

- Designing and conducting experiments
- Software development and evaluation

Industrial Relevance

This work is relevant to user-centred system design and development, and healthcare applications.

Title

Technology for Sustainability

Supervisor

Alison Pease

Project description

The aim of this project will be to develop an application that enables users to monitor energy usage in a specific context with a view to seeing where and how it can be reduced. The student will be expected to conduct a literature review into sustainability issues; design and develop a sustainability application; and conduct a user evaluation of their application.

References:

<https://www.dundee.ac.uk/collections/sustainable-development-goals>

Skills the student will develop

- Expertise with software design, prototyping and evaluation
- Experience with qualitative analysis

Industrial Relevance

This work is relevant to user-centred system design, development and evaluation.

Title

Generative AI voice-enabled interface for a website or service

Advisor

Brian Plüss

Project description

ChatGPT disrupted several industries in recent months. Previously, the largest technology companies have deployed conversational AI systems (e.g. Amazon's Alexa, Apple's Siri, Microsoft's Cortana and Google's Assistant) to smartphones, speakers, TVs, headphones, cars and more. The dialogue models behind these assistants are structured around skills and can range from simple request-response pairs to more sophisticated interactions resembling human conversation. Developers can create new skills to provide a voice-enabled interface to their products or services (e.g. Spotify, or the BBC).

The purpose of this project is to design, implement and evaluate a virtual assistant that articulates Generative AI with in one of the four platforms mentioned above to allow users to interact with a website or service using speech.

The student will work as a part of the Centre for Argument Technology, an internationally recognised team of interdisciplinary researchers. ARG-tech has built a reputation on balancing high-quality theoretical research with robust and reliable software engineering. Its software is in use in thousands of schools, colleges and universities in over 80 countries around the world. It works with lawyers, magistrates, intelligence analysts, mediators, educators, programme-makers at the BBC, and data mining experts in IBM to explore deep challenges in artificial intelligence framed by the way in which real and very sophisticated arguments and debates are developed in demanding domains. Students with ARG-tech are treated as part of the team, and are invited to join both research activities, including weekly reading groups and discussions, and also to contribute to the groups general activities including demonstrations both at Dundee and elsewhere, blog posts, videos, and so on. The group has recently been contributing to an international effort to build the infrastructure for the Argument Web, a bold new vision of how debate and discussion will be conducted online in an environment of semantically rich, machine processable concepts.

The project will combine artificial intelligence, software engineering, machine learning techniques and dialogue technologies, and will focus on delivering usable, deployable conversational skills to be made available to users.

Skills the student will develop and any prerequisites

- Research skills, e.g. understanding the existing problem, wider background research into the general problem area to identify whether there are already existing solutions used elsewhere which could be built upon and/or adapted, background research into NLP techniques, dialogue technologies and applications.
- Requirements gathering. The main 'client' for the project will be the project advisor who will be an initial source of requirements for the system but it will be possible to

engage with other staff members or students to gather requirements or ideas and to test those ideas against later during evaluations. Additional requirements can be discovered through background research too.

- General software development tasks: interface design, application development and testing, project management, use of conversational and generative AI tools.
- Evaluation: to determine the effectiveness of the system developed. This may focus on the usability of the application, the accuracy of the application, and/or the effectiveness of the system in comparison to existing processes.
- Experience with dialogue structures and analysis, with virtual assistant representation and processing technologies, and their interaction with existing web applications and services.
- Experience in the design and assembly of various types of machine learning components, and use of techniques in computational linguistics, text mining and information extraction.

Industrial Relevance

- Research skills
- Project management skills
- Design and development of a complete system
- Developing a tool in a novel and highly active industrial domain
- Knowledge of ChatGPT and other generative AI tools
- Language processing techniques in extremely high demand in industry from all the major players (Amazon, Google, Apple, Microsoft, etc.)

Title

Conversational AI for software development

Advisor

Brian Plüss

Project description

Virtual assistants have become mainstream in the last few years. The largest technology companies have deployed conversational AI systems (e.g. Amazon's Alexa, Apple's Siri, Microsoft's Cortana and Google's Assistant) to smartphones, speakers, TVs, headphones, cars and more. The dialogue models behind these assistants are structured around skills and can range from simple request-response pairs to more sophisticated interactions resembling human conversation. Developers can create new skills to provide a voice-enabled interface to their products or services (e.g. Spotify, or the BBC).

The purpose of this project is to design, implement and evaluate a virtual assistant skill in one of the four platforms mentioned above to allow users to carry out computer programming and/or development tasks using speech.

The student will work as a part of the Centre for Argument Technology, an internationally recognised team of interdisciplinary researchers. ARG-tech has built a reputation on balancing high-quality theoretical research with robust and reliable software engineering. Its software is in use in thousands of schools, colleges and universities in over 80 countries around the world. It works with lawyers, magistrates, intelligence analysts, mediators, educators, programme-makers at the BBC, and data mining experts in IBM to explore deep challenges in artificial intelligence framed by the way in which real and very sophisticated arguments and debates are developed in demanding domains. Students with ARG-tech are treated as part of the team, and are invited to join both research activities, including weekly reading groups and discussions, and also to contribute to the groups general activities including demonstrations both at Dundee and elsewhere, blog posts, videos, and so on. The group has recently been contributing to an international effort to build the infrastructure for the Argument Web, a bold new vision of how debate and discussion will be conducted online in an environment of semantically rich, machine processable concepts.

The project will combine software engineering, machine learning techniques and dialogue technologies, and will focus on delivering usable, deployable conversational skills to be made available to users. The student can freely choose the underlying programming language or development technology, and there is room for emphasis to be placed on the resulting system as a tool for accessibility.

Skills the student will develop and any prerequisites

- Research skills, e.g. understanding the existing problem, wider background research into the general problem area to identify whether there are already existing solutions

used elsewhere which could be built upon and/or adapted, background research into NLP techniques, dialogue technologies and applications.

- Requirements gathering. The main 'client' for the project will be the project advisor who will be an initial source of requirements for the system but it will be possible to engage with other staff members or students to gather requirements or ideas and to test those ideas against later during evaluations. Additional requirements can be discovered through background research too.
- General software development tasks: interface design, application development and testing, project management, use of conversational AI tools.
- Evaluation: to determine the effectiveness of the system developed. This may focus on the usability of the application, the accuracy of the application, and/or the effectiveness of the system in comparison to existing processes.
- Experience with dialogue structures and analysis, with virtual assistant representation and processing technologies, and their interaction with existing web applications and services.
- Experience in the design and assembly of various types of machine learning components, and use of techniques in computational linguistics, text mining and information extraction.

Industrial Relevance

- Research skills
- Project management skills
- Design and development of a complete system
- Developing a tool in a novel and highly active industrial domain
- Accessibility
- Language processing techniques in extremely high demand in industry from all the major players (Amazon, Google, Apple, Microsoft, etc.)

Title

Infographics for a large multi-touch display

Advisor

Brian Plüss

Project description

The Argument Web has been developed at the Centre for Argument Technology (ARG-tech) at the University of Dundee as an integrated infrastructure of argument technologies and datasets. The argumentation and debate datasets curated by ARG-tech are the largest in the world. Our software has an international userbase in industry, academy and education alike. We have recently acquired a 55" multi-touch digital e-poster which is permanently set up in the corridors of the QMB. We intend to use the touch display to visualise and interact with elements of the Argument Web – such as real-time infographics summarising the current usage of the tools and databases, the arguments people are making and analysing, the debates being hosted, and so on. This project will involve both the data aggregation and analysis and the infographic design and creation for communicating up-to-the-second activity.



The student will work as a part of ARG-tech, an internationally recognised team of interdisciplinary researchers. ARG-tech has built a reputation on balancing high quality theoretical research with robust and reliable software engineering. Our software is in use in thousands of schools, colleges and universities in over 80 countries around the world. We work with lawyers, magistrates, intelligence analysts, Ministry of Defence, mediators, educators, the BBC, companies, and data mining experts in IBM to explore deep challenges in artificial intelligence framed by the way in which real and very sophisticated arguments and debates are developed in demanding domains. Students with ARG-tech work as part of the team, and are invited to join research activities, including weekly reading groups and discussions.

The project will combine data analysis with infographic design and presentation and will be a key part of ARG-tech's public engagement and communication strategy.

Skills the student will develop

- Experience with argumentation structures and analysis, with semantic web representation and processing technologies, including XML, RDF, OWL, scalable and federated database technologies.
- Experience in the design and assembly of visually arresting infographic components, and touch interfaces.
- In addition, optionally, experience techniques in computational linguistics, text mining and information extraction.

Industrial Relevance

We are working with users and major players in domains such as law, media and Defence, and the tools we are building are regularly demonstrated to groups within these domains. In addition to acquiring relevant skills, there are possibilities for the student to be exposed to potential employers through the work conducted on this project.

Title

Conversational AI for argument data

Advisor

Brian Plüss

Project description

Dialogue systems are computer programs that understand and respond to natural language. They are often deployed to the general public as virtual assistants (such as Amazon's Alexa or Apple's Siri) or automated customer service agents. Recent advances in machine learning techniques (e.g. deep learning) have improved considerably the quality of many of the processing steps in dialogue system pipelines, especially speech recognition (linking sounds to text), natural language understanding (linking text to speaker intentions) and text-to-speech (linking system responses to speech). At the centre of a dialogue system's architecture is the dialogue manager, which keeps track of the dialogue and decides on the system's next actions (verbal and otherwise). The Dialogue Game Execution Platform (DGEP, <https://arg-tech.org/index.php/projects/dgep/>) is a platform for the execution of dialogue protocols: i.e. the rules that govern conversational interactions, using argument data.

The purpose of this project is to design, implement and evaluate a spoken dialogue system to allow users to interact with DGEP dialogues using speech. The building blocks of the spoken dialogue system can be implemented and combined using existing frameworks (e.g. RETICO, <https://github.com/uhlo/retico>; <https://www.youtube.com/watch?v=ExnADSR4FaQ>).

The student will work as a part of the Centre for Argument Technology, an internationally recognised team of interdisciplinary researchers. ARG-tech has built a reputation on balancing high-quality theoretical research with robust and reliable software engineering. Its software is in use in thousands of schools, colleges and universities in over 80 countries around the world. It works with lawyers, magistrates, intelligence analysts, mediators, educators, programme-makers at the BBC, and data mining experts in IBM to explore deep challenges in artificial intelligence framed by the way in which real and very sophisticated arguments and debates are developed in demanding domains. Students with ARG-tech are treated as part of the team, and are invited to join both research activities, including weekly reading groups and discussions, and also to contribute to the groups general activities including demonstrations both at Dundee and elsewhere, blog posts, videos, and so on. The group has recently been contributing to an international effort to build the infrastructure for the Argument Web, a bold new vision of how debate and discussion will be conducted online in an environment of semantically rich, machine processable concepts.

The project will combine software engineering, machine learning techniques and dialogue technologies, and will focus on delivering usable, deployable spoken dialogue system to be made available to our users.

Skills the student will develop and any prerequisites

- Research skills, e.g. understanding the existing problem, wider background research into the general problem area to identify whether there are already existing solutions used elsewhere which could be built upon and/or adapted, background research into NLP techniques, dialogue technologies and applications.
- Requirements gathering. The main 'client' for the project will be the project advisor who will be an initial source of requirements for the system but it will be possible to engage with other staff members or students to gather requirements or ideas and to test those ideas against later during evaluations. Additional requirements can be discovered through background research too.
- General software development tasks: interface design, application development and testing, project management, use of conversational AI tools.
- Evaluation: to determine the effectiveness of the system developed. This may focus on the usability of the application, the accuracy of the application, and/or the effectiveness of the system in comparison to existing processes.
- Experience with dialogue structures and analysis, with dialogue protocol representation and processing technologies, and their interaction with existing spoken dialogue frameworks.
- Experience in the design and assembly of various types of machine learning components, and use of techniques in computational linguistics, text mining and information extraction.

Industrial Relevance

- Research skills
- Project management skills
- Design and development of a complete system
- Developing a tool in a novel and highly active industrial domain
- Dialogue processing techniques in extremely high demand in industry from all the major players (Amazon, Google, Apple, Microsoft, etc.)

Title

A conversational agent for critical literacy

Advisor

Brian Plüss

Project description

Fallacious and biased reasoning are central to misinformation, deception, fake news, conspiracy theories, and the 'infodemic'. In communication, we find the fallacies and biases in faulty argumentation in the defence of a particular standpoint. It is therefore of great importance that people have a high level of critical literacy to evaluate and identify such faulty arguments.

In this project, a dialogue protocol for fallacious argumentation will be implemented in a conversational agent. This protocol will then be leveraged for educational purposes, to teach a user through interactive conversation about reasonable and fallacious arguments, and how to distinguish them.

The student will work as a part of the Centre for Argument Technology, an internationally recognised team of interdisciplinary researchers. ARG-tech has built a reputation on balancing high-quality theoretical research with robust and reliable software engineering. Its software is in use in thousands of schools, colleges and universities in over 80 countries around the world. It works with lawyers, magistrates, intelligence analysts, Ministry of Defence, mediators, educators, programme-makers at the BBC, and data mining experts in IBM to explore deep challenges in artificial intelligence framed by the way in which real and very sophisticated arguments and debates are developed in demanding domains. Students with ARG-tech are invited to join research activities, including weekly reading groups and discussions.

Skills the student will develop

- Designing and conducting experiments
- Developing conversational agent technology
- Developing dialogue protocols for multi-agent systems
- Software development and evaluation
- Developing applications for the educational domain
- Experience working as part of an international research team
- Experience with analysis and evaluation of reasoning structures.
- Experience in the design and assembly of visually arresting infographic components, and touch interfaces. (option)

Industrial Relevance

We are working with users and major players in domains such as law, media and education, and the tools we are building are regularly demonstrated to groups within these domains. There are possibilities for the student to be exposed to potential employers through the work conducted on this project. Conversational agent technology is a growth-area with applications in various domains. Fake news and misinformation are important societal issues, leading to strong developments of fact-checking institutions and investment from social media companies and governments alike.

Title

Automated generation of UML class diagrams from Use Case specifications.

Advisor

Dr Craig Ramsay

Project description

There are well-known approaches to identifying the classes for a software design, e.g. such as highlighting nouns within a system description. Typically, these methods of identification require a manual inspection of the information available which has benefits (e.g. allowing nuances or ambiguities in the information to be handled) but possible disadvantages too (e.g. the time taken to explore the information, differences in skill levels among people in a team leading to different outcomes).

The purpose of this project is to explore the feasibility of automating or semi-automating the process of identifying the classes (and relationships) for a software system from the written information available, e.g. automatically identifying nouns from written descriptions such as use case specifications. The output of this process could be an initial, draft UML design for the system or a 'domain' model, i.e. representing the entities that make up the problem domain for the system which can then be enhanced later with implementation-specific details.

Another possible direction for the project is to develop a training tool or a semi-automated guide that helps someone to step through the process of identifying the classes within a system description and providing useful prompts to aid their learning and decision-making as they go along.

Of course, you may have your own ideas too about how such a tool could be used that you would be free to explore.

NOTE: although the project may rely on techniques for processing natural language (e.g. identifying nouns within a system description), it is anticipated that a Natural Language Processing (NLP) tool could be used to assist with this. For example, see Stanford's CoreNLP tool: <https://stanfordnlp.github.io/CoreNLP/>.

Skills the student will develop

- Research skills, e.g. understanding the existing problem, wider background research into the general problem area to identify whether there are already existing solutions used elsewhere which could be built upon and/or adapted, background research into NLP techniques and applications.
- Requirements gathering. The main 'client' for the project will be the project advisor (Dr Craig Ramsay) who will be an initial source of requirements for the system but it will be possible to engage with other staff members or students to gather requirements or ideas and to test those ideas against later during evaluations. Additional requirements can be discovered through background research too.
- General software development tasks: interface design, application development and testing, project management, use of NLP tools.
- Evaluation: to determine the effectiveness of the system developed. This may focus on the aesthetics of the application, the accuracy of the application, and/or the effectiveness of the system in comparison to existing processes.

Industrial relevance:

- Research skills
- Project management skills
- Design and development of a complete system
- Developing a tool that could assist software engineers and/or software engineering students.

Title

Automated generation of UML sequence diagrams from Use Case specifications.

Advisor

Dr Craig Ramsay

Project description

UML sequence diagrams are an important part of the software design process; they allow one to convey how the classes within a system design will deliver the system functionality as described within its use cases. To create a sequence diagram, one typically has to identify the classes required for the system and then work through the use case flow of events one step at a time, translating each step in the use case into the sequence diagram as a series of interactions that take place between the system classes. Usually, this is a manual, human, decision-making process and offers various benefits in terms of understanding and producing the system design as well as being able to reason about design quality, e.g. considering factors such as coupling and cohesion. However, making effective design decisions is a skill that needs practice and experience and someone who is learning UML for the first time also just needs the ability to understand how to create the diagram in the first place. The question posed by this research is whether there is scope for automated assistance which could (i) assist someone in the general process of producing a sequence diagram; (ii) assist someone in making decisions about design quality too.

Therefore, the purpose of this project is to explore the feasibility of automating or semi-automating the process of creating a UML sequence diagram from the use case specifications for a system design. This could involve the automatic identification of the classes for the system which are mentioned in the use case text and using references within the text to surmise possible interactions between the classes too. For example, take the following extract from a use case flow of events for an e-commerce website: "*The Customer's Order will be sent to the PayPal System for processing*". An analysis of this text could reveal Order as a possible <<entity>> class and PayPal or PayPalSystem as a <<boundary>> class and there is a suggestion of an interaction between them – the Order being sent to PayPal.

The output of the system could be an initial, draft sequence diagram design for the system which can then be enhanced or adapted manually if required. Alternatively, it is possible to foresee a training purpose for the automation too, e.g. to develop a semi-automated guide that helps someone to step through the process of identifying the classes and interactions within a use case specification so that they can create a UML sequence diagram as well as providing useful prompts on top of this to aid design decisions as they go along.

Of course, you may have your own ideas too about how such a tool could be used that you would be free to explore.

NOTE: although the project may rely on techniques for processing natural language (e.g. identifying nouns within a system description), it is anticipated that a Natural Language Processing (NLP) tool could be used to assist with this. For example, see Stanford's CoreNLP tool: <https://stanfordnlp.github.io/CoreNLP/>.

Skills the student will develop

- Research skills, e.g. understanding the existing problem, wider background research into the general problem area to identify whether there are already existing solutions

used elsewhere which could be built upon and/or adapted, background research into NLP techniques and applications.

- Requirements gathering. The main 'client' for the project will be the project advisor (Dr Craig Ramsay) who will be an initial source of requirements for the system but it will be possible to engage with other staff members or students to gather requirements or ideas and to test those ideas against later during evaluations. Additional requirements can be discovered through background research too.
- General software development tasks: interface design, application development and testing, project management, use of NLP tools.
- Evaluation: to determine the effectiveness of the system developed. This may focus on the aesthetics of the application, the accuracy of the application, and/or the effectiveness of the system in comparison to existing processes.

Industrial relevance:

- Research skills
- Project management skills
- Design and development of a complete system
- Developing a tool that could assist software engineers and/or software engineering students.

Title

Development of a system to automate assessment of UML design diagrams

Supervisor

Dr C. Ramsay

Project description

It can take considerable effort to mark / access UML design diagrams since it is a task that usually has to be done manually by visual inspection. Furthermore, there may not be a single correct answer to a given software design, e.g. several different solutions may be equally acceptable and viable. The purpose of this investigatory project is to determine the extent to which UML design diagrams can be assessed automatically to varying degrees, e.g. simple solutions versus more complex solutions. There are likely to be different approaches to solving this problem but one possibility is to utilise the text-based file formats that UML tools have: most diagrams are stored in an XML-like format with descriptors of the diagram content such as objects on a diagram and relationships between them. Therefore, it may be possible to assess the similarity of diagrams based on a textual definition of their content. This is rather than having to do image processing for example, e.g. compare images of diagrams to each other for similarity.

Skills the student will develop

Research skills: research into existing approaches for automating assessment of design diagrams, e.g. E-R diagrams, flowcharts, UML diagrams.

Problem solving skills: develop a method for automating assessment of UML design diagrams

Software engineering skills: implement a solution to the problem

Evaluation and testing: evaluate and test the application to determine its effectiveness

Report writing skills: the final report

General project management, planning and communication skills.

Industrial Relevance

This has the potential to contribute to research in the area of software engineering. It could also lead to the development of an effective tool that could be used by others when assessing diagram-based coursework.

Title

Developing a Plug-in for the BlueJ IDE

Supervisor

Dr Craig Ramsay

Project Description

BlueJ is a popular learning IDE which is used for Java development. BlueJ supports extensions / plug-ins which allow its functionality to be enhanced with custom behaviours. The BlueJ web pages provide [Examples of Existing BlueJ Extensions](#) and information about [Writing BlueJ Extensions](#). The purpose of this project is to explore the development of a BlueJ extension that will provide learning, or productivity enhancements to BlueJ, targeting (initially) students in our first year Computing courses who use BlueJ for their programming exercises. For example, perhaps a plug-in can be created that checks the student code for common issues (malformed main() method, overuse of 'static'). Perhaps a plug-in can be created that does code quality checks, e.g., naming of classes, fields, methods. Other possibilities could be a plug-in to do a spell-check on student code, a plug-in that integrates with online resources to pull in examples of Java code or documentation to aid development, or a plug-in to automatically generate tests, or perform auto-completion of certain tasks, or to allow students to create and edit activity diagrams. You may have ideas of your own.

Skills the student will develop

Java development, general research and development skills, familiarisation with APIs and plug-in methods (common to many apps).

Industrial Relevance

The plug-in you create can be made available to the BlueJ community for others to use and benefit from too.

Title

Developing a Plug-in for Visual Studio

Supervisor

Dr Craig Ramsay

Project Description

Visual Studio is a well-known IDE for professional developers and commonly used in learning and teaching too. Visual Studio supports the development of plugins or extensions which allow its functionality to be enhanced with custom behaviours. The Visual Studio web pages provide more information about [what extensions are, how to create them, and examples of existing extensions](#). The purpose of this project is to explore the development of a Visual Studio extension that will provide learning, or productivity enhancements to Visual Studio, targeting (initially) students in our Computing courses who use Visual Studio for their programming exercises. For example, perhaps a plug-in can be created that checks the student code for common issues (malformed main() method, overuse of 'static'). Perhaps a plug-in can be created that does code quality checks, e.g., naming of classes, functions, fields, methods. Other possibilities could be a plug-in to do a spell-check on student code, a plug-in that integrates with online resources to pull in examples of program code or documentation to aid development, or a plug-in to automatically generate tests, or perform auto-completion of certain tasks, or to allow students to create and edit activity diagrams. You may have ideas of your own.

Skills the student will develop

Software development skills in languages pertinent to VS extensions, e.g., C#, C++, etc. General research and development skills, familiarisation with APIs and plug-in methods (common to many apps).

Industrial Relevance

The plug-in you create can be made available to the Visual Studio community for others to use and benefit from too and can be made available to students and/or academics for use in their teaching and research. Visual Studio extensions have commercial potential too.

Title

A Timesheet Management System for Staff and Students in the Discipline of Computing

Supervisor

Dr Craig Ramsay

Project description

Each year, the Discipline of Computing recruits a number of undergraduate and postgraduate students to fulfil the role of Lab Assistants or to assist with marking of student assignments. Various administration tasks have to be completed during this process. For example, applications for temporary work contracts must be submitted to the University of Dundee for the students concerned. Later, when contracts are in place, students must submit monthly timesheets with details of the hours they have worked in order to claim payment. The time sheets are reviewed and signed by members of teaching staff. Currently, these processes are paper-based or reliant on sending documents around as attachments to obtain signatures and details from various people which creates overheads and increases the risk of things being overlooked or lost in inboxes. The purpose of this project is to research and develop a web site (or similar application) to automate the process of submitting time sheets. This will include allowing students / lab assistants to submit and manage their timesheets, allowing members of staff to review the time sheets (and record that they have done so), providing time sheets in a format that can be submitted to the University Human Resources department, and other general functionality that may be desirable, e.g. information about timesheet deadlines, stats or overviews about hours worked and hours verified for various students, and so on.

Skills the student will develop

- Research skills, e.g. researching the existing paper-based processes, wider background research into this general problem area to identify relevant solutions
- Requirements gathering from relevant users in the process and background research.
- General software development tasks: interface design, application development and testing, project management
- Evaluation: to determine the effectiveness of the system developed. This may focus on the aesthetics of the application or to evaluate the effectiveness of the system in comparison to the existing, paper-based systems.

Industrial relevance:

- design and development of a complete system
- experience of the software development lifecycle and project management
- working with a real client to develop a solution which could benefit staff and students at the University of Dundee (and with perhaps applications to wider organisations too).

Title

End-User Creation of Smartphone-based Text Adventure Games

Advisor

Dr Daniel Rough

Project description

'End-User Development' involves the tools and techniques that allow end-users to customise their experience of a piece of software, or even to create their own applications from scratch. Game creation is one such domain that has been explored through platforms such as [Game Salad](#) but less so in research, possibly due to the huge variety and complexity of modern games.

Text-based adventure games, however, could be an entry point into end-user development of games due to their simple mechanics and structure, but with a complexity and difficulty limited only by the developer's imagination. The goal of this project would be to develop an application allowing users to develop text-based adventure games to be run on smartphones.

The student would be expected to:

- Conduct a literature review into end-user development of simple games, and existing approaches to text-based adventure game generation
- Design and develop an end-user interface allowing users to create elements of a text-based adventure game, including a map, inventory, puzzles, traps, etc.
- Develop an Android or iOS app capable of running the end-user's adventure game specification
- Evaluate the usability of the developed interface through a lab study, and its functionality through demonstration of successful development of a text adventure game.

Skills the student will develop and any prerequisites

Ideally the student would have some prior experience of Android or iOS app development. The scope of the game would only be limited by ensuring that the end-user's interface does not become unusable through excessive or complex development tools.

Skills: Android/iOS Development; End-User Development; Research Methods

Related papers

- [Andrew Macvean, Sanjeet Hajarnis, Brandon Headrick, Azriel Ferguson, Chinmay Barve, Devika Karnik, and Mark O. Riedl. 2011. WeQuest: scalable alternate reality games through end-user content authoring.](#)
- [Marchiori, E.J., Torrente, J., del Blanco, Á., Moreno-Ger, P., Sancho, P. and Fernández-Manjón, B., 2012. A narrative metaphor to facilitate educational game authoring.](#)

Title

Creating a Context-Aware Music App

Advisor

Dr Daniel Rough

Project description

Today, most of the digital media we consume is through our smartphones. This often extends to music, where we either have audio files stored on our devices or access them through streaming apps such as Spotify and YouTube music. While playlists can be created for different situations (e.g., for driving, exercising, studying) and automatically generated by such streaming services, there is little customisation potential beyond this.

However, our phones today are filled with all sorts of sensors and data streams, which can accurately determine where we are, what we might be doing, and when we're doing it.

The primary goal of this project would therefore be to design and develop an Android app that allows users to create their own rules to determine what music should be played from their device in different situations.

The student would be expected to:

- Conduct a literature review into existing music apps and their customisation features, and other ways in which mobile context is used for app personalisation.
- Design and develop a mobile app on Android that allows users to create rules to determine the contexts in which certain music should be played, either from local files or via streaming APIs.
- Conduct a field study to understand how app users make use of these rules, and the benefits and challenges of rule creation for playing the right music in the right situation.

Skills the student will develop and any prerequisites

Android app development; End-user development; Context-aware computing; Qualitative research methods

Industry Relevance

Android remains the dominant operating system of a dominant device, so an ability to develop native or web apps for Android will be sought after across the software industry and beyond.

Further, recognising user contexts and working with existing apps and APIs to maximise user experience for these contexts is a critical strategy in tech industry giants (including Google itself) and a useful area to be familiar with.

Finally, understanding and empathising with the end-user applies not just to UX but to software engineering as a whole.

Title

Sound Survey - Development of a Voice User Interface for Survey Completion

Advisor

Dr Daniel Rough

Project description

Jeeves is a Java-based application that allows psychology researchers to create 'experience sampling method (ESM)' smartphone studies, by dragging and dropping blocks in a visual programming environment. More information on Jeeves is available [in the user guide](#) and from [the GitHub repository](#). The Jeeves app is [available on Android](#) via the Google Play store. ESM studies require participants to complete surveys through the app at specified times or contexts throughout their everyday life. While many of us are seldom without our smartphones, it is still often inconvenient to physically access our devices (e.g., while driving, exercising, cooking, etc.). Therefore, the aim of this project would be to develop an extension to the Jeeves Android app that allows study participants to complete surveys - with a variety of different question types - hands-free through a Voice User Interface (VUI).

The student would be expected to:

- Conduct a literature review into the experience sampling method (ESM) and mobile-based Voice User Interfaces (VUIs)
- Understand the design and architecture of the Jeeves Android app from existing source code
- Develop an extension to the Jeeves app that allows participants to access and complete surveys of various types of question through their voice alone
- Demonstrate the functionality of the developed app through a usability study

Skills the student will develop and any prerequisites

Ideally the student would have some prior experience of Android app development.

Skills: Android Development; Voice User Interface Programming; Working from Existing Source; Research Methods

Related Papers:

- [Daniel Rough and Aaron Quigley. 2015. "Jeeves - A visual programming environment for mobile experience sampling."](#)
- [Niels van Berkel, Denzil Ferreira, and Vassilis Kostakos. 2017. The Experience Sampling Method on Mobile Devices.](#)

Title

Helping Users Make Sense of their Social Networks

Advisor

Dr Daniel Rough

Project description

'Trust' on e-commerce websites such as Amazon and eBay is established through their reputation systems - a positive/negative/neutral feedback rating and a 5-star rating respectively. Our social networks, while previously more likely to be made up of people we know in-person, are now increasingly likely to consist of unidirectional relationships (i.e., follower/followee directional relationships) with strangers. The aim of this project would be to help users make sense of their social networks through visualisation of different metrics of their choice. A web application would allow the user to visualise their social media network in different ways and select and filter metrics of interest that would help determine trustworthiness or other aspects of their followers / those they follow.

The student would be expected to:

- Conduct a literature review into social network visualisation methods and end-user perceptions
- Design and develop a web application that allows users to view their social network (Twitter, for example, has APIs that enable programmatic access to this information) query it and understand it in different ways
- Design and conduct a research study to understand how users make use of the application to understand their social network

Skills the student will develop and any prerequisites

Ideally the student would have some experience with Javascript and use of Web APIs.

Skills: Social Network Analysis; Information Visualisation; End-User Development; Qualitative Research Methods

Related Papers:

- [Daniel Rough, Stefano De Paoli, and Francesco Botto. 2019. Supporting Social Innovation through Visualisations of Community Interactions.](#)
- [Nina Valkanova, Sergi Jorda, Martin Tomitsch, and Andrew Vande Moere. 2013. Reveal-it! the impact of a social visualization projection on public awareness and discourse.](#)

Title

Developing a GUI for Processing Sketches

Advisor

Dr Daniel Rough

Project description

Processing (<https://processing.org/>) is a popular, open-source programming language for creating visual artwork, animations, interactive games and more. It introduces all fundamental programming concepts with a simple syntax, low learning curve, and engaging output, making it ideal as a language for learning programming, and for teaching it too.

However, to someone completely new to coding, it can still be initially difficult to understand how shapes, interactivity, or animations map to the code used to create them.

The goal of this project would be to **create a graphical user interface for generating Processing code through dragging, dropping and resizing shapes**. This could be extended to generate code for animations or other behaviour demonstrated by the user, with the ultimate aim of creating a tool that is useful to those learning Processing.

The Processing 'Shape-Sketch' tool exists to perform some basic code generation (<https://github.com/joelmoniz/Shape-Sketch>) but is outdated and has limited functionality. This could be extended, or a completely new implementation would also be possible.

The student would be expected to:

- Conduct a literature review into existing tools for “programming by demonstration” and other tools to assist novice programmers.
- Design and develop a Processing tool, building upon existing work or starting from scratch, that allows Processing code to be generated through drag and drop actions on a GUI.
- Conduct a user study to determine the effectiveness of the tool for helping novice programmers understand Processing concepts.

Skills the student will develop and any prerequisites

User interface design and development; End-user development; Quantitative/Qualitative research methods

Industry Relevance

Java remains a dominant language in the software industry, with applications to data science and machine learning amongst other domains.

Working with and optimising existing source code is a necessary skill for new developers.

Finally, understanding and empathising with the end-user applies not just to UX but to software engineering as a whole.

Title

Prototyping an adaptive interface for fingerprint scanners

Supervised by

Oluwafemi Samuel

Project description

One of the challenges with using an Automatic Fingerprint Recognition System (AFIS) in operational settings is the correct and consistent placement of the fingertip on the scanner platen without instructions or human intervention. Inconsistent placement of the fingertip could result in inconsistently captured fingerprint images, significant variations in the quality of images and inaccurate matching of fingerprints.

The aim of this project is to improve the consistency with which a fingerprint scanner captures fingerprint images by restricting the extent to which users can vary the placement of their fingertips but ensuring adaptability to different finger sizes. This will be done by the design, construction and addition of an adaptive hardware interface to an existing fingerprint scanner. The interface could be constructed from materials that are commercially available off-the-shelf or by 3D printing. The expected outcome of this project is a modified fingerprint scanner that improves the accuracy of an AFIS.

Skills the student will develop

Knowledge of Automated fingerprint identification systems, hardware prototyping

Industrial Relevance

AFIS has a several areas of application e.g., access control, immigration checks, security for personal bank accounts etc.

Title

An e-voting system with biometric verification.

Supervised by

Oluwafemi Samuel

Project description

The use of technology has become an integral part of elections for countries around the world. One of the reasons for this development is to reduce or (if possible) eliminate electoral fraud, and the verification of eligible voters using one or more biometric modalities (e.g., fingerprint, face) has been instrumental in achieving this aim. In recent times, there has been a demand for the adoption of electronic voting in some countries, and perhaps one that includes biometric authentication will be most effective. However the following questions arise regarding the implementation of such as system:

- What biometric modality is most suitable to use for elections?
- For a secret ballot system, how best can anonymity of voters be maintained while using biometric authentication for an e-voting system?
- How can a transparent system be achieved so that there are no disputes about the eventual election results?

The student would aim to answer these questions through review of appropriate literature and design and implementation of an e-voting system.

Skills the student will develop

Automated biometric recognition, web development, system testing

Industrial Relevance

Web development jobs remain one of the widely available jobs till date, and biometrics is increasingly gaining acceptance with a wide range of applications.

Title

Comparing the fingerprint image quality and matching accuracy of fingerprint scanners

Supervised by

Oluwafemi Samuel

Project description

The quality of acquired fingerprints images is one of the factors that determine the matching accuracy of an Automatic Fingerprint Identification System (AFIS). However, the quality and by implication, the accuracy could also be dependent on the type of fingerprint scanner used for the collection of the fingerprint images. Some types of scanners that are used for an AFIS based on their sensors are optical, capacitive, solid state and light emitting sensor (LES), with the commonest being the optical. Because the LES-based sensor is a recent technology, there are not as many research outputs on it relative to the others.

This project aims to compare:

- The quality of fingerprints collected using an LES-based scanner to those collect using one of the other popular scanners.
- The accuracy between the sets of fingerprints.
- Assess if there is any consistency or disparity between the quality of fingerprint images and matching accuracy.

Skills the student will develop

Automated fingerprint identification, data collection, fingerprint quality assessment, data analysis, deep learning

Industrial Relevance

Knowledge in deep learning and data analysis are sought after, and the possibilities in biometrics are yet to be fully exploited.

Title

Language banking within an AAC system for nonspeaking people

Supervisors

Prof Annalu Waller & Dr Jacky Visser

Project Description

People who cannot use their natural speech can use voice output communication systems (like Prof Stephen Hawking). The ACE-LP Project (<http://aac.dundee.ac.uk/ace-lp/>) is working towards better prediction of words, sentences and stories. You will work across the AAC and ARG Research Groups to investigate how we can model language which would add value to the ACE-LP Project. This could involve developing a mobile app which allows disabled people to conduct a conversation using techniques from argumentation.

Skills the student will develop:

- Research skills – working in a multi-disciplinary team.

- Experience in Text Entry, Natural Language Processing, Argumentation.

- Experience in assistive technology.

- Development of mobile app programming skills.

- Writing research papers.

Industrial Relevance

Continuation of funded research.

For more information of the research group, see:

<http://aac.dundee.ac.uk/>

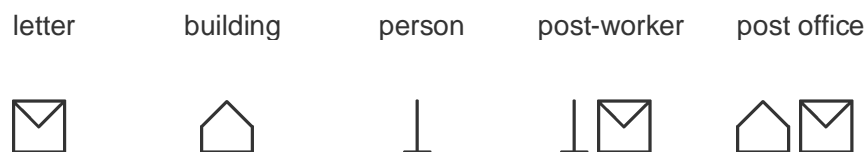
TITLE: The design and development of an online Blissymbolics dictionary management system.

SUPERVISOR: Prof Annalu Waller

PROJECT DESCRIPTION:

Blissymbolics is a graphic based language designed for non-speaking people who have difficulty reading and writing – see <http://www.blissymbolics.org/>

Based on Chinese writing, users can 'write' words by sequencing meaning based characters, e.g.



This project will involve the student working on a wider project – to encode Bliss into Unicode - to develop an online dictionary management system to:

- Allow for the maintenance of the Unicode character set;
- Enable the International Bliss Panel to maintain the Authorised Vocabulary (AV);
- Allow users of Bliss to search and print the AV, and to suggest new Blisswords.

SKILLS THE STUDENT WILL DEVELOP:

Insights into the ISO standards and processes for character sets;
Understanding of Unicode font technologies;
Experience of undertaking a complex database system project;
Application of accessible Web database/interface design/programming;
Involvement in a high profile international project.

INDUSTRIAL RELEVANCE:

ISO, W3C, Unicode.
Interaction with users of Augmentative and Alternative Communication.

For more information on Bliss and the Unicode project, see:

<http://www.blissymbolics.org/>
<https://www.unicode.org/roadmaps/smp/>

Title

ListenSmart – Implementing a Voice Recognition and Conversation Agent

Supervisor

Prof Annalu Waller and client

Project Description

The project is based on an idea to implement a speech recognition component into a communication app for nonspeaking people. (This kind of software is referred to as Augmentative and Alternative Communication – AAC – technology.) The client would like to have an app which uses speech recognition software to “hear” the conversation currently taking place and through keyword identification to search the text history to quickly find what he has said about that subject in the past. This could be similar to existing smart keyboard prediction software which can learn a user’s word patterns and provide predicted text based on the context of who you are speaking to and the topic but rather than provide a single word prediction, it could predict a whole sentence.

Potentially this could provide a few sentences for him to choose from based on the topic of conversation, maybe even giving him the option for a suggested sentence being close to what he is trying to say then use that as a basis to suggest some slightly different sentences.

This could be further expanded with automated web searches if the topic is about something he has looked at before online it could offer to open up the web page again. E.g., the topic is about current affairs for example it could provide a brief summary of the current headlines, even the weather.

One final piece of existing technology which could tie in to this is GPS. If the software knows the user is in a restaurant it could use that as a factor in the suggested sentences it offers. For example, if a friend asks what the user was doing at the weekend the software would already know.

Goals

1. Assist AAC users to participate in conversations in real time. Using as few button presses as possible to convey a sentence.
2. Develop software which can be used by a broad range of AAC users.
3. Learn a user’s vocabulary and how that vocabulary might change based on who is being communicated with, even as simple a formal or informal speech.
4. Use the context clues of who, where, what and when to focus the suggested sentence

This project would build on several research projects undertaken within the Dundee AAC Research Group (aac.dundee.ac.uk).

Skills the student will develop

- A real-life agile development project on mobile technology.
- Working with disabled clients and participants.
- Ethical procedures.
- Experience in HCI/AI/Natural Language Processing.
- Experience in AAC technology.

Industrial Relevance

- Links with potential assistive technology companies.

For more information of the research group, see:

<http://aac.dundee.ac.uk/>

Title

Tall Ships Helming

Supervisor

Prof Annalu Waller

Project Description

The Tenacious (<https://jst.org.uk/tenacious/>) is the only accessible Tall Ship in the world. Owned by the Jubilee Sailing Trust (JST), the ship offers a range of voyages, even joining the annual Tall Ships race. Tenacious is crewed by a small permanent crew and a temporary mixed abilities crew. The ship is equipped to support people with a range of abilities (see <https://jst.org.uk/tenacious-accessibility/>). Every crew member takes an active role in all aspects of sailing the ship, including helming (steering the ship).

The ship can currently be helmed via:

- A large hydraulic wheel
- An adjustable chair to allow crew to steer from their wheelchair
- Joystick control
- Switch (sip/puff) control
- A talking compass
- Large displays for steering and navigation information

Having sailed on Tenacious, Annalu has suggested that JST extend the steering control to allow people who use eyegaze to steer the ship.

You will work closely with a member of the permanent crew and relevant experts to design, develop and evaluate an eyegaze interface for Tenacious. The project will be user-centred and align with the JST philosophy of inclusivity, thus involving people with different abilities.

We will also endeavour to have you visit the ship when it visits Scotland in May 2024 (or around England in the Autumn of 2023)!

Goals

You will work with an advisory group to plan the project and to identify the project objectives. You will then undertake a user-centred design and development project, meeting with the advisory group on a regular basis to ensure the delivery of a working eyegaze interface to steer Tenacious!

Title

Hyperspectral Imagery Analysis for Enhanced Remote Sensing

Supervised by

Dr. Yijun Yan

Project description

Hyperspectral imagery, an extension of traditional imaging, has proven to be a significant tool in various scientific fields due to its ability to detect and identify objects based on their unique spectral signatures. This project aims to focus on the application of hyperspectral imagery in remote sensing. You will design, implement, and test a hyperspectral image processing method to identify object-of-interest in single or multi-temporal remote sensing imageries using Python or MATLAB.

The study will encompass the following key stages:

1. Literature review: A comprehensive review of existing literature on hyperspectral imagery and its applications in remote sensing. The review will encompass the historical development of the field, the current state of research, and the potential future directions. It will also cover different methodologies and algorithms used for hyperspectral data analysis, providing a theoretical framework for the practical aspects of the project.
2. Data Collection: Collection of hyperspectral imagery data from publicly accessible data repositories. The choice of the area under study will focus on land mapping.
3. Image Analysis: Development and application of image processing algorithms to extract significant information from the data, followed by the use of supervised learning methods for decision making.
4. Performance Evaluation: Cross-validation of results using ground truth data. This stage also involves a benchmarking comparison against other existing methods to assess the robustness and accuracy of your approach.

Skills the student will develop

While some prior knowledge of Python or MATLAB would be advantageous, this project will cultivate the following skills:

- Comprehensive understanding of hyperspectral imagery and its uses;
- Proficiency in conducting a literature review and synthesizing relevant findings;
- Expertise in applying various image processing algorithms to extract substantial information from hyperspectral data;
- Familiarity with machine learning and deep learning techniques, and their application to hyperspectral data analysis;
- Enhanced programming skills, specifically in Python or MATLAB.

Industrial Relevance

The application of hyperspectral imagery holds growing interest for a range of industries, including precision agriculture, non-destructive inspection, environmental monitoring, mineral exploration, and urban planning.

Related papers:

Li, Yinhe, Jinchang Ren, Yijun Yan, Qiaoyuan Liu, Ping Ma, Andrei Petrovski, and Haijiang Sun. "[Cbanet: an end-to-end cross band 2-d attention network for hyperspectral change detection in remote sensing](#)." IEEE Transactions on Geoscience and Remote Sensing (2023).

Ma, Ping, Jinchang Ren, Genyun Sun, Huimin Zhao, Xiuping Jia, Yijun Yan, and Jaime Zabalza. "[Multiscale superpixelwise prophet model for noise-robust feature extraction in hyperspectral images](#)." IEEE transactions on geoscience and remote sensing 61 (2023): 1-12.

Yan, Yijun, Jinchang Ren, Qiaoyuan Liu, Huimin Zhao, Haijiang Sun, and Jaime Zabalza. "[PCA-domain fused singular spectral analysis for fast and noise-robust spectral-spatial feature mining in hyperspectral classification](#)." IEEE Geoscience and Remote Sensing Letters (2021).

Title

Medical Image Segmentation for Enhanced Clinical Diagnosis

Supervised by

Dr. Yijun Yan

Project description

This project aims to develop an automated system to accurately segment regions of interest (ROIs) in medical images to aid in improved clinical diagnosis. Depending on the modality (CT, MRI, optic), this could apply to various anatomical structures or pathologies like tumors, blood vessels, the heart, the brain, etc. This project can involve developing novel image segmentation techniques or improving upon existing methods, applying machine learning or deep learning strategies.

The project will have three key stages:

1. Literature review and data collection: The student will undertake a comprehensive literature review centred on medical image analysis, focusing particularly on medical image segmentation techniques. Concurrently, the student will gather publicly available datasets suitable for modelling.
2. Image Segmentation: This stage will involve developing and implementing advanced image segmentation algorithms. The student will work on traditional methods like thresholding, region growing, watershed, active contours, and level set methods. The project may also incorporate modern machine learning-based methods, like U-Net, Vision Transformer, or other convolutional neural network architectures, to improve the accuracy and efficiency of the segmentation.
3. Performance Evaluation: The student will then evaluate the performance of the developed segmentation algorithms using metrics such as the Dice similarity coefficient, Jaccard index, sensitivity, specificity, and accuracy.

Skills the student will develop

While some prior knowledge of Python or MATLAB would be advantageous, this project will cultivate the following skills:

- Proficiency in conducting a literature review and synthesizing relevant findings;
- Expertise in both traditional and modern deep learning-based image processing techniques and their application to medical image segmentation;
- Enhanced programming skills, specifically in Python or MATLAB.

Industrial Relevance

The application of image segmentation in clinical diagnosis is significant and continually growing, primarily due to the proliferation of medical imaging modalities. Improved segmentation techniques can aid in better diagnosis, planning treatment strategies, and patient monitoring, significantly impacting the healthcare industry.

Related papers:

Ronneberger, Olaf, Philipp Fischer, and Thomas Brox. "[U-net: Convolutional networks for biomedical image segmentation](#)." In Medical Image Computing and Computer-Assisted Intervention—MICCAI 2015: 18th International Conference, Munich, Germany, October 5-9, 2015.

Siddique, Nahian, Sidike Paheding, Colin P. Elkin, and Vijay Devabhaktuni. "[U-net and its variants for medical image segmentation: A review of theory and applications](#)." *Ieee Access* 9 (2021): 82031-82057.

Shamshad, Fahad, Salman Khan, Syed Waqas Zamir, Muhammad Haris Khan, Munawar Hayat, Fahad Shahbaz Khan, and Huazhu Fu. "[Transformers in medical imaging: A survey](#)." *Medical Image Analysis* (2023): 102802.