UNIVERSITY OF LONDON

# Final Project Ideas

***This is a collection of starting points for ideas for your Final Project. There are two for each level 6 module.***

April 2025

**Changelog**

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|---|---|---|
| v1.0 | 2025-02-28 | All new; only one template for Games Development |
| v1.1 | 2025-03-25 | Both Games Dev templates available |
| v1.2 | 2025-03-28 | Only one template for NLP |

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# 1 CM3005 Data Science

## 1.1 Project Idea 1: Data-Driven Personalised Educational Content Recommendation

**What problem is this project solving, or what is the project idea?**

Can we leverage advanced data science techniques to build a highly accurate and personalised educational content recommendation system?

**What is the background and context to the question or project idea above?**

The explosion of online learning resources presents a challenge: how do learners find the most relevant materials? Traditional recommendation systems often rely on simplistic metrics. This project aims to apply sophisticated data science methods to understand individual learning patterns and preferences. By analysing large datasets of user interactions, content metadata, and learning outcomes, we can build models that predict optimal learning pathways. This involves exploring techniques from machine learning, natural language processing, and network analysis to create a system that truly personalises the educational experience, improving knowledge retention and learning efficiency.

**Here are some recommended sources for you to begin your research.**

- `https://developers.google.com/machine-learning/recommendation/` (Google's resources on recommendation systems)
- `https://scikit-learn.org/`(Scikit-learn documentation for machine learning)
- `https://www.tensorflow.org/` (TensorFlow documentation for deep learning)
- `https://www.nltk.org/` (NLTK documentation for natural language processing)
- Research papers on "Educational Data Mining" and "Learning Analytics" (search on Google Scholar or ACM Digital Library)

**What would the final product or final outcome look like?**

The final product should be a data-driven recommendation engine, likely implemented as a Python API or a web service. It should demonstrate the ability to process user data, apply machine learning models, and generate personalised recommendations. The project should include a thorough evaluation of the model's performance using relevant data science metrics.

**What would a prototype look like?**

A prototype would demonstrate the core data science pipeline: data ingestion, preprocessing, model training, and recommendation generation. It needs to prove that the chosen algorithms can learn from data and produce meaningful recommendations. It's important to clearly show the data transformations and model outputs. A complete user in-

terface is not essential at this stage.

**What kinds of techniques/processes/CS fundamentals are relevant to this project?**

- Machine Learning: Collaborative Filtering, Content-Based Filtering, Matrix Factorisation, Deep Learning (e.g., Recurrent Neural Networks for sequence modelling).
- Natural Language Processing: Topic Modelling, Sentiment Analysis, Text Embeddings (Word2Vec, BERT).
- Data Mining: Clustering, Classification, Association Rule Mining.
- Statistical Analysis: Hypothesis testing, A/B testing.
- Data Visualization: using tools like Matplotlib, Seaborn, or Plotly to show data trends and model performance.

**What would the output of these techniques/processes/CS fundamentals look like?**

- Trained machine learning models (e.g., serialized model files).
- Recommendation scores for each content item.
- User profiles with learned preferences.
- Visualisations of model performance metrics (e.g., precision-recall curves, ROC curves).
- Dataframes containing processed and analysed data.

**How will this project be evaluated and assessed by the student (i.e. during iteration of the project)? What criteria are important?**

Evaluation will focus on:

- Precision and recall of recommendations.
- Root mean squared error (RMSE) or other relevant metrics for rating prediction.
- Area under the ROC curve (AUC) for binary classification tasks.
- Statistical significance of A/B testing results.
- The use of cross validation to ensure model generalisation.

**For this brief, what might a minimum pass (e.g. 3rd) student project look like?**

- Implementation of a basic recommendation algorithm (e.g., collaborative filtering using a simple matrix factorisation technique).
- Use of a publicly available dataset.
- Basic evaluation using a single metric.
- Clear documentation of the data science pipeline.

**For this brief, what might a good (e.g. 2:2 – 2:1) student project look like?**

**It should meet the minimum pass criteria and in addition:**

- Implementation of a more advanced machine learning model (e.g., a hybrid recommendation system).
- Data preprocessing and feature engineering.
- Evaluation using multiple metrics and cross-validation.
- Clear explanation of the strengths and weaknesses of the chosen approach.

**For this brief, what might an outstanding (e.g. 1st) student project look like?**

**It should meet the minimum pass criteria and in addition:**

- Development of a novel data science approach or adaptation of a state-of-the-art technique.
- Creation or curation of a high-quality dataset.
- Comprehensive evaluation, including comparisons with baseline models and statistical significance testing.
- Detailed analysis of model performance and insights.
- Potentially publishable results in a data science or educational technology venue.

## 1.2 Project Idea 2: Predictive Modelling of Social Media Trend Emergence

**What problem is this project solving, or what is the project idea?**

Can we develop a data-driven model that predicts the emergence and spread of trends on social media platforms?

**What is the background and context to the question or project idea above?**

Social media platforms are dynamic environments where trends rapidly emerge and evolve. Understanding these trends is crucial for businesses, marketers, and researchers. This project aims to apply data science techniques to analyse large-scale social media data and build predictive models. By analysing factors such as user engagement, content characteristics, and network structure, we can identify patterns that indicate the potential for a trend to gain traction. This project will explore how data science can be used to forecast and understand the dynamics of social media trends, providing valuable insights for strategic decision-making.

**Here are some recommended sources for you to begin your research.**

- `https://www.tweepy.org/` (Python library for accessing Twitter API)
- `https://networkx.org/` (Python library for network analysis)
- `https://scikit-learn.org/` (Scikit-learn documentation for machine learning)
- Research papers on "Social Media Trend Analysis," "Network Diffusion," and "Time Series Forecasting" (search on Google Scholar or ArXiv)
- `https://www.kaggle.com/datasets` (Kaggle datasets for social media data)

**What would the final product or final outcome look like?**

The final product will be a predictive model implemented in Python, along with a report detailing the data analysis, model development, and evaluation. It should demonstrate the ability to process social media data, extract relevant features, and predict the likelihood of a trend's emergence. The project should include visualizations of trend patterns and model performance metrics.

**What would a prototype look like?**

A prototype would demonstrate the core data science pipeline: data collection (e.g., using APIs), preprocessing (e.g., text cleaning, feature extraction), model training (e.g., using time series models or machine learning classifiers), and trend prediction. It needs to prove that the model can identify patterns associated with trend emergence. It is important to show the data transformations and the model's predictive capabilities. A real time dashboard is not important at this stage.

**What kinds of techniques/processes/CS fundamentals are relevant to this project?**

- Time Series Analysis: ARIMA, LSTM
- Network Analysis: Centrality measures, community detection
- Natural Language Processing: Sentiment analysis, topic modelling, word embeddings
- Machine Learning: Classification, regression
- Data Visualization: Time series plots, network graphs

**What would the output of these techniques/processes/CS fundamentals look like?**

- Time series forecasts of trend popularity.
- Network graphs showing the spread of trends.
- Sentiment scores and topic distributions related to trends.
- Classification probabilities for trend emergence.
- Visualizations of model performance1 (e.g., ROC curves, time series plots).

**How will this project be evaluated and assessed by the student (i.e. during iteration of the project)? What criteria are important?**

Evaluation will focus on:

- Accuracy of trend prediction (e.g., precision, recall, F1-score).
- Root mean squared error (RMSE) for time series forecasting.
- Statistical significance of model results.
- Robustness of the model to different datasets and platforms.
- The use of cross validation to ensure model generalisation.

**For this brief, what might a minimum pass (e.g. 3rd) student project look like?**

- Basic data collection from a social media platform.
- Simple time series analysis or classification model.
- Basic evaluation using a single metric.
- Clear documentation of the data analysis process.

**For this brief, what might a good (e.g. 2:2 – 2:1) student project look like?**

**It should meet the minimum pass criteria and in addition:**

- Integration of multiple data sources and features.
- Implementation of a more advanced predictive model.
- Evaluation using multiple metrics and cross-validation.
- Analysis of the factors influencing trend emergence.

**For this brief, what might an outstanding (e.g. 1st) student project look like?**

**It should meet the minimum pass criteria and in addition:**

- Development of a novel predictive model or feature engineering technique.
- Analysis of trend diffusion patterns using network analysis.
- Comprehensive evaluation, including comparisons with baseline models and statistical significance testing.
- In-depth analysis of the social dynamics underlying trend emergence.
- Potentially publishable results in a data science or social science forum.

# 2 CM3010 Databases and Advanced Data Techniques

## 2.1 Project Idea 1: Working with works–a new approach to music cataloguing

**What problem is this project solving, or what is the project idea?**

Create a portal for catalogues of works by classical composers

**What is the background and context to the question or project idea above?**

Book publications listing all music by a classical composer have been around for centuries (e.g. Mozart kept one). Software for creating digital lists was developed in 2014 by the Danish national library to support a catalogue of the works of Carl Nielsen. This system uses MEI XML to encode catalogue data, a Java-based XML database, and a Java web forms manager for data entry. The original publication system could generate a PDF (for printing) and web pages.

This software is hard to maintain, and inflexible. As a result, when the Danish library stopped supporting development, and a German university took over, the publication system stopped working.

You should identify ways to work with existing catalogues, currently encoded in XML. Decide whether to keep the data as it is or transform it into a different model (e.g. JSON, SQL or Linked Data), and then make a new interactive web interface for exploring the catalogues.

**Here are some recommended sources for you to begin your research.**

About MerMEId software

**Code:** `https://github.com/Edirom/MerMEId/` (also on DockerHub)

**Catalogues published using MerMEId** :

- **Carl Nielsen:** `https://www.kb.dk/dcm/cnw/navigation.xq`
- **Frederick Delius:** `https://delius.music.ox.ac.uk/catalogue/navigation.html`

**Literature** :

- **2012:** Niels Krabbe & Axel Teich Geertinger, ‘MEI (Music Encoding Initiative) as a Basis for Thematic Catalogues: Thoughts, Experiences, and Preliminary Results’, RISM Conference (2012), `https://music-encoding.org/downloads/TeichGeertinger_Final.pdf`
- **2022:** Stadler et al, ‘Towards MerMEId 2.0’ Music Encoding Conference (2022), `https://works.hcommons.org/records/hkgc6-ztm37`

**What would the final product or final outcome look like?**

- A user-friendly website for exploring musical works, and their themes, performances and manuscripts
- A web API for work catalogue data
- Transformation scripts to convert MEI works catalogues into a different database model (optional).
- An evaluation of the MEI catalogue model, with recommendations (optional).

**What would a prototype look like?**

The catalogue information in MerMEId is complex. A prototype would take only the most basic data and extract it into a form that can be used for the Web API. The prototype should then consist of a basic API and web front end for this reduced data model.

**What kinds of techniques/processes/CS fundamentals are relevant to this project?**

Data modelling and transformation, information retrieval, UI/UX, web programming.

**What would the output of these techniques/processes/CS fundamentals look like?**

A clear evaluation and recommendation for an alternative to the current system, first steps towards that system, including data pipeline, API and UI.

**How will this project be evaluated and assessed by the student (i.e. during iteration of the project)? What criteria are important?**

1. The project must engage with some of the complexities of the data model (not everything needs to be covered, but more than just title and composer).
2. The website should make sense and be appropriate to the data.
3. Web API and backend structure should be clearly thought through and well argued.

**For this brief, what might a minimum pass (e.g. 3rd) student project look like?**

Data from a catalogue has been taken and used to build a live website.

**For this brief, what might a good (e.g. 2:2 – 2:1) student project look like?**

A significant proportion of the original data model has been implemented, and most data transformed and presented to the users in a new way.

**For this brief, what might an outstanding (e.g. 1st) student project look like?**

A perceptive evaluation of the data model and alternative approaches, which could be taken further. A significant proportion of the original data model has been implemented, and most data transformed and has been presented to the users in a new way that potentially unlocks new insights into the data. The catalogues of multiple composers can be explored together, or connected to other sources of information (such as Wikidata, Musicbrainz or IMSLP).

## 2.2 Project Idea 2: Reconciliation service for a dataset

**What problem is this project solving, or what is the project idea?**

You will implement or adapt a Reconciliation Service API for a dataset of your choice to support connecting it to other data.

**What is the background and context to the question or project idea above?**

Datasets become far more powerful when they are connected together – for example, a database with references to places can become more useful if those places can also be connected to socio-economic or historical information about those places. Identifying common entities between datasets is often a manual, time-consuming task. OpenRefine is an example of software designed to make the task easier, but is most effective at connecting data to a dataset which has a Reconciliation API available. Wikidata has this, for example.

A Reconciliation Service API allows software to query entities from a data table and retrieve possible matches from the dataset. It is possible to implement a server for this from scratch, but tools have been developed including at least one Python library.

**Here are some recommended sources for you to begin your research.**

- The API itself is maintained by a W3.org community group at `https://www.w3.org/community/reconciliation/`. This group develops the documentation for the evolving standard.
- An example of a library for implementing the API is here: `https://github.com/derenrich/py-reconciliation-service-api`.
- A description of the goals by a host of one service is here: `https://blog.museum-digital.org/2024/07/03/reconciliation-apis-arrive-to-museum-digital/`
- The originator of the API and main client software is OpenRefine: `https://openrefine.org/`

**What would the final product or final outcome look like?**

- A description of the dataset being used, including evaluation of the data consistency and reliability and assessment of any data cleaning needs;
- An implemented reconciliation API as a server. This need not be feature complete (the standard allows implementations with minimal functionality);
- An example of data being reconciled with the original dataset, using a client that calls the API;
- Evaluation of the efficacy of the API – what works and what would need more data or more development.

**What would a prototype look like?**

A working API server, but with hard-coded or minimal data. The documentation lists a set of possible functional elements, but very little needs to be implemented for the server to conform.

**What kinds of techniques/processes/CS fundamentals are relevant to this project?**

Data transformations, advanced web development, text search/information retrieval, data modelling.

**What would the output of these techniques/processes/CS fundamentals look like?**

Good system architecture, efficient database searches, good selection of fields to expose in the API, good choice of dataset(s)

**How will this project be evaluated and assessed by the student (i.e. during iteration of the project)? What criteria are important?**

1. The API must be successfully called by a client (OpenRefine, probably).
2. It must be possible to reconcile matching data.
3. Close matches should, ideally, also be retrieved, with sensible criteria for relevance.

**For this brief, what might a minimum pass (e.g. 3rd) student project look like?**

A minimal API – the reconciliation service exists, can be connected to OpenRefine, and conforms (more or less) to the standard.

**For this brief, what might a good (e.g. 2:2 – 2:1) student project look like?**

A functional API – the service exists, can be connected to from OpenRefine, and returns relevant matches when identical strings of the right datatype appear in the data.

**For this brief, what might an outstanding (e.g. 1st) student project look like?**

An interesting, well-chosen dataset is exposed through the API – the service works from within OpenRefine, and has been tested with a relevant second dataset. Approximate matching, or matching on multiple fields has been implemented. The resulting combined dataset would support further research. A test framework has been written and checks aspects of the API against the specification.

# 3 CM3015 Machine Learning and Neural Networks

## 3.1 Project Idea 1: Neural Style Transfer

**What problem is this project solving, or what is the project idea?**

Neural Style Transfer is a generative deep learning technique for altering images to make them appear to have been painted in a particular style. For example, a cityscape of skyscrapers and flyovers as if painted in the characteristic circular brush strokes Van Gogh.

**What is the background and context to the question or project idea above?**

The idea is to merge a preserve the content of an image (a cityscape) whilst adopting a reference style (for example, Van Gogh's Starry Night). Style transfer is related to the area of texture generation in computer vision, but the power of deep learning takes the process to new level. Within the deep learning approach, content, a global property of an image, is captured by the upper levels of a convnet whereas style, a local property, is represented in multiple lower layers. Transfer proceeds by the minimisation of a loss function which measures the style and content distance between the original and the generated image.

**Here are some recommended sources for you to begin your research.**

- Gatys, L.A., Ecker, A.S. and Bethge, M., 2016. Image style transfer using convolutional neural networks. In Proceedings of the IEEE conference on computer vision and pattern recognition (pp. 2414-2423).
- Francois Chollet (2018). Deep Learning with Python. Manning, Shelter Island (pp 287-295).
- Jing, Y., Yang, Y., Feng, Z., Ye, J., Yu, Y. and Song, M., 2019. Neural style transfer: A review. IEEE transactions on visualisation and computer graphics, 26(11), pp.3365-3385.

**What would the final product or final outcome look like?**

A portfolio of stylised images.

A study of the relationship between deep learning architectures, hyperparameter settings and outputs.

**What would a prototype look like?**

An NST system with default settings, as suggested, for example in Chollet's book.

**What kinds of techniques/processes/CS fundamentals are relevant to this project?**

Machine learning; deep learning; a deep learning library such as Tensorflow or PyTorch.

**What would the output of these techniques/processes/CS fundamentals look like?**

A series of deep learning statistical models.

**How will this project be evaluated and assessed by the student (i.e. during iteration of the project)? What criteria are important?**

A review of content manipulation by various styles, and of different contents with the same style.

A survey of the complete hyperparameter space for a particular neural architecture.

An understanding of minimal models and maximal models and the sensitivity of outputs to hyperparameters such as the weighting between style and content distances.

**For this brief, what might a minimum pass (e.g. 3rd) student project look like?**

A working NST system with some investigation of hyperparameter adjustment.

**For this brief, what might a good (e.g. 2:2 – 2:1) student project look like?**

A good survey of hyperparameter settings, different architectures (e.g. various VGG models) and production, with comment, of a variety of content and style couplings.

**For this brief, what might an outstanding (e.g. 1st) student project look like?**

Novel adaptations (e.g. different optimisers) of readily available code (e.g. from tensorflow.org and Chollet's book). Imaginative applications e.g. video neural style transfer. Qualitative and quantitative evaluation. Multiple style models. Something comparable in range to the early review paper of Jing et al.

## 3.2 Project Idea 2: Deep Learning Breast Cancer Detection

**What problem is this project solving, or what is the project idea?**

The aim is to establish if Deep Learning assisted X-ray mammography can improve the accuracy of breast cancer screening. The project will achieve this aim by modelling the Digital Database for Screening Mammography (DDSM) with convolutional neural networks (CNNs).

**What is the background and context to the question or project idea above?**

The UK national health service (NHS) launched, in early 2025, a major research project to address the above research question. If successful, a DL system could replace one of the two radiologists currently reporting on scans with the consequence of faster diagnostic turn-around and the liberation of specialists for other tasks. CNNs are deep learning neural networks that apply a succession of filters to the input layer. They are capable of impressive image recognition tasks.

**Here are some recommended sources for you to begin your research.**

- Wang L. Mammography with deep learning for breast cancer detection. Front Oncol. 2024 Feb 12;14:1281922. doi: 10.3389 `https://doi.org/10.3389/fonc.2024.1281922` PMID: 38410114; PMCID: PMC10894909.
- Lee, R., Gimenez, F., Hoogi, A., Miyake, K. K., Gorovoy, M. & Rubin, D. L. "A curated mammography data set for use in computer-aided detection and diagnosis research.", Sci Data 4, 170177 (2017). `https://doi.org/10.1038/sdata.2017.177`
- Francois Chollet (2018). Deep Learning with Python. Manning, Shelter Island
- `https://www.tensorflow.org`

**What would the final product or final outcome look like?**

A CNN statistical model, predictions from this model and comparisons to specialist reporting accuracy.

**What would a prototype look like?**

A small CNN capable of achieving statistical power.

**What kinds of techniques/processes/CS fundamentals are relevant to this project?**

Artificial neural networks; dataset splitting, model building with tensorflow, training and testing.

**What would the output of these techniques/processes/CS fundamentals look like?**

One or more test metrics for the best statistical model trained on the DDSM dataset.

**How will this project be evaluated and assessed by the student (i.e. during iteration of the project)? What criteria are important?**

The student will seek to improve the chosen test metrics by network scaling up and regularisation.

**For this brief, what might a minimum pass (e.g. 3rd) student project look like?**

A working CNN that at the minimum has statistical power. Some attemot to follow the Depp learning workflow, as described in the text book by Chollet.

**For this brief, what might a good (e.g. 2:2 – 2:1) student project look like?**

A succession of regularised CNN networks; strict adherence to the Deep Learning workflow.

**For this brief, what might an outstanding (e.g. 1st) student project look like?**

Application of transfer learning (e.g. VGG models), and any of the alternatives listed in Table 3 of Wang 2024. For a high first: near publishable results for an original model that is competitive with the best reported DL models in the literature.

# 4 CM3020 Artificial Intelligence

## 4.1 Project Idea 1: Orchestrating AI models to achieve a goal

**What problem is this project solving, or what is the project idea?**

This project is based around the idea of combining multiple pre-trained models into a workflow that achieves a particular goal. It is up to you to decide what that goal is. For example, in the artificial intelligence course, you saw how it is possible to combine multiple models to generate lyrics, music and a singing performance for a pop song. You do not need to address a creative problem like this, but you do need to combine multiple models to solve a well specified problem. Below we provide some starting ideas for the kinds of models you might work with. You should think of a problem space (e.g. music, cybersecurity, creative writing, education, healthcare) then build a system that can operate in that space based around multiple pre-trained models operating on different types of data.

**What is the background and context to the question or project idea above?**

Many pre-trained models are now available that allow 'artificially intelligent' computer programs to extract information from the world, and to generate information to put back into the world. As a final year computer science student, we would like to challenge you in this project to identify a problem space that you feel is important to you and to build a system that can operate in that problem space. The system should make use of several pre-trained models to make sense of the world and to put information into the world.

**Here are some recommended sources for you to begin your research.**

Example of the kinds of pre-trained models you can use are as follows. Note that these links are valid and working at the time of publication of this document. You should be able to use them as starting points to find working models.

1. Speech to text: transcribes audio containing speech into text e.g. openai whisper: `https://github.com/openai/whisper`
2. Language processing and generation: using local language models to understand and generate text e.g. ollama: `https://ollama.com/`
3. Image to text: Image analysis and description, detect objects in images, describe images e.g. mobilenet: `https://github.com/tensorflow/tfjs-models/tree/master/mobilenet` and `https://huggingface.co/Salesforce/blip-image-captioning-base`
4. Audio to text: audio scene description e.g. yamnet `https://huggingface.co/STMicroelectronics/yamnet` and `https://github.com/tensorflow/tfhub.dev/blob/master/assets/docs/google/models/yamnet/1.md`
5. Sentiment analysis: detect emotions in text `https://huggingface.co/tabularisai/multilingual-sentiment-analysis`
6. Human body and face analysis, for example ml5 models for hands and poses: `https://docs.ml5js.org/`

7. Other sources: You can find many pre-trained models for many different tasks here: `https://huggingface.co/models`

**What would the final product or final outcome look like?**

The final product should consist of a working piece of software that can be used to achieve your specified goal or to operate in your specified problem space. The product should include at least THREE pre-trained models, operating in different domains/ data spaces, for example, text, image and audio. You should clearly state what the purpose of the system is and show how you went about identifying, operationalising, testing etc. your models. It is likely that you will have to go through a process of testing and rejecting models to find the ideal choices for your project. We would like to see evidence of that process and your decision making process.

**What would a prototype look like?**

A prototype should show the chosen models operating successfully, generating and processing data in several different models, with a clearly described objective or purpose for the overall system.

**What kinds of techniques/processes/CS fundamentals are relevant to this project?**

This project will involve working through lots of different models – getting them working, testing them out to see if they will work with the data you want to use. We want you to use your software engineering and testing skills here.

You will need to work with different types of data, figuring out how to feed it into the different models.

You should show that you can evaluate pre-trained models for example by sending test data and validating the outputs.

Also you might need to test the performance of the models and to relate this to the system you are building and how it shall be used.

**What would the output of these techniques/processes/CS fundamentals look like?**

We are keen to see evidence that you have tested several models and made decisions about which are and are not appropriate for your needs. One aspect of this will be testing the performance of the models to see if they are viable to use for your project. We will want to see evidence that you have thought about how to combine different models to achieve an overall system goal.

**How will this project be evaluated and assessed by the student (i.e. during iteration of the project)? What criteria are important?**

As noted above, we anticipate that you will be installing and testing lots of different models in order to figure out which ones are appropriate for your needs. You should evaluate

your process here and be able to come up with an overarching method for doing this. You should ensure that you meet the requirement to have at least THREE pre-trained models working on different types of data in the project. You should ensure that the project delivers a working system that achieves a clear goal. Just downloading some models and running them is not enough!

**For this brief, what might a minimum pass (e.g. 3rd) student project look like?**

A minimum pass would include a working system which includes three pre-trained models working to achieve a clearly specified goal. There should be evidence that you have evaluated the models using appropriate criteria.

**For this brief, what might a good (e.g. 2:2 – 2:1) student project look like?**

A 2:2 – 2:1 project would include a working system which includes three pre-trained models working to achieve a clearly specified goal. You should have chosen a challenging goal which is not easily achievable using standard software engineering techniques and automation – it should be clear why these pre-trained models are needed. We are looking for an integrated piece of software here. We would like to see evidence of software testing, ideally with unit testing but potentially with users as well.

**For this brief, what might an outstanding (e.g. 1st) student project look like?**

An outstanding project would use an original approach to address an interesting and challenging problem. We would like to see evidence that you have thoroughly explored the space of pre-trained models relevant to your project and chosen appropriate models based on evidence presented in the report. You should choose a difficult problem and consider the best way to design the user interaction. We want to see thorough evaluation of the models and solid software testing, including user testing and iteration of the design based on the testing results.

## 4.2 Project Idea 2: Financial Advisor Bot

**What problem is this project solving, or what is the project idea?**

This project involves the creation of a financial advisor bot. The bot analyses financial data in order to make recommendations for a dynamic investment strategy, which you might also call ‘active portfolio management’.

**What is the background and context to the question or project idea above?**

You will need to identify which kind of financial systems the bot will advise about. For example, the stock market, currency exchange market, crypto-currencies, classic car trading and so on.

You will need to decide what kind of AI/ML techniques you will use to implement the bot. We recommend that you use techniques that you have seen in the course, for example, modelling the problem as ‘decision making under uncertainty’ would lend itself to reinforcement learning. Or you might attempt to evolve an investment strategy.

It should be possible for a non-technical user to interact with the bot to receive advice, for example, via a web interface. The bot should present its analysis and recommendations to the user with explanations. For example, the bot might say ‘NVIDIA stock is likely to rise by 25% so we recommend taking up a position on that now and exiting after 20% growth’. It is up to you to decide how the bot presents this advice. You could consider using local language models to format the recommendations into prose.

**Here are some recommended sources for you to begin your research.**

You can find stock price data feeds:
`https://github.com/ranaroussi/yfinance`

Or crypto data feeds:
`https://github.com/ccxt/ccxt`

You might need a backtesting system to test your advisor’s trading strategies:
`https://github.com/topics/backtesting`

You might consider using local language models to help the user interact with the advisor bot. For example, you might conceive of the bot as a tool-using agent. The following systems might prove useful:
`https://ollama.com/`
`https://docs.openwebui.com/`

**What would the final product or final outcome look like?**

The final product would be an integrated and tested system designed for non-technical users to use. You will probably need separate systems for training models and gathering data, if you choose to do that. We would not expect the non-technical user to be able to

interact with the model training system. But they should be able to interact with the advisor bot once trained. You should present evidence that you have evaluated the advice that the advisor bot generates.

**What would a prototype look like?**

A prototype would need to have the main parts functioning but it would not need to have the full user interface. So you would need a way to interact with the advisor bot, even if it is command line based. You would need to identify appropriate data sources and to gather and ingest that data.. You would need a way for the advisor bot to analyse and/ or learn from data.

**What kinds of techniques/processes/CS fundamentals are relevant to this project?**

You can choose how to implement the advisor bot, but reinforcement learning, evolutionary strategies, neural networks and so on would be the typical techniques. You might want to use some language model techniques as well.

You will need to do some significant software engineering and testing here so you would need the techniques from the degree relating to those.

There is also a strong data science component around gathering and analysing data.

Web programming will be needed to create the web interface.

**What would the output of these techniques/processes/CS fundamentals look like?**

- We expect to see well tested software
- We expect to see a solid data analysis and machine learning/ AI workflow implemented
- We expect to see a working web user interface

**How will this project be evaluated and assessed by the student (i.e. during iteration of the project)? What criteria are important?**

We imagine that you will work iteratively on designing, implementing and testing the components of the system. The components include the data gathering, training, advisor bot interaction, web interface.

**For this brief, what might a minimum pass (e.g. 3rd) student project look like?**

A basic project should present a complete working system but with limited complexity of components. We would need to see some design, implementation and evaluation work.

**For this brief, what might a good (e.g. 2:2 – 2:1) student project look like?**

A 2:2-2:1 project should present a complete working system with some significant development and testing work evident in some or all of the components. You should present

some detailed evaluation of the components of the system and clear planning. We would want to see some thought put into the design of the advisor bot and its algorithm in particular.

**For this brief, what might an outstanding (e.g. 1st) student project look like?**

An outstanding project should present a complete working system with some significant development and testing work evident in all of the components. You should present detailed evaluation and testing of the components of the system and clear planning. We would expect the advisor bot to implement some sort of interesting and advanced algorithm with significant effort put into it.

# 5 CM3025 Virtual Reality

## 5.1 Project Idea 1: VR Game Escape Room

**What problem is this project solving, or what is the project idea?**

The project aims to create an immersive VR escape room experience using physics-based gameplay. It explores how VR can enhance player engagement through interactive narratives and realistic physics interactions. Players must use their body to manipulate objects, solve physics-based puzzles, and uncover hidden clues to escape within a time limit. The game will leverage environmental storytelling and spatial problem-solving to create a deeply immersive and challenging experience.

**What is the background and context to the question or project idea above?**

Virtual Reality offers unparalleled immersion, making it a powerful medium for escape room experiences. Physics-based interactions can create engaging and dynamic puzzles that challenge players in new ways. With the rise of VR platforms like Meta Quest and SteamVR, there is growing interest in escape room games that fully utilize VR's unique capabilities. The escape room in this project should draw on your knowledge of both VR and game development modules, making full use of VR interaction techniques to create an immersive and interactive environment—rather than simply replicating a traditional escape room in VR.

**Here are some recommended sources for you to begin your research.**

In addition to the material in the module:

- Online store fronts such as Steam, the Meta Store and VIVEPort are the best places to find interesting VR games and experiences for inspiration.
- The Room VR: A Dark Matter, I Expect You To Die, Escape Simulator VR, A Fisherman's Tale, AVO Escape Space, Escape Legacy VR are some examples of the diversity of gameplay and style that is possible in VR.
- 3D User Interfaces: Theory and Practice by Bowman et al. is a very good starting point for VR interaction techniques
- The IEEE VR, Virtual Reality Software and Technology (VRST), ACM SIGGRAPH and GDC conference proceedings are an excellent source of cutting edge techniques
- The Book of Puzzles and Enigmas - Fabrice Mazza for puzzles inspiration

**What would the final product or final outcome look like?**

A playable VR game demonstrating multiple escape room mechanics through a narrative-driven experience and/or physics-based gameplay mechanics. It should include player interactions, sound design, and visual effects. It should:

- include a suitable VR navigation technique;

- make use of, and show off the unique features of VR (it would not work as a screen based game);
- not cause significant nausea or discomfort.

The ultimate goal for the final product will be a fully functional VR game suitable for play with a VR headset, aligning closely with the project brief's goals. VR escape room would feature a single, fully interactive room with a cohesive theme. Players would start in a locked environment and need to solve a series of physics-based puzzles to escape. Core mechanics would include grabbing, pushing, rotating, and assembling objects using VR hand-tracking or controllers. Simple interactions, like pulling levers, pressing buttons, or stacking objects to reach new areas, would showcase the game's physics engine. Environmental storytelling elements, such as hidden clues, interactive props, and dynamic lighting, would enhance immersion. The game would prioritize smooth locomotion, intuitive controls, and a balanced difficulty curve, ensuring players engage with the space naturally. Additionally, a timer or hint system could be implemented to guide players without breaking immersion. It will demonstrate core gameplay mechanics and showcase VR's unique capabilities through:

- Full-body interaction: Players will engage physically with the environment, using gestures, body movement, or hand tracking to drive gameplay.
- VR navigation technique: A suitable movement system, such as teleportation or continuous locomotion, will be implemented to support gameplay and immersion.
- VR-exclusive design: The experience will leverage VR's spatial, interactive, and immersive qualities, making it a uniquely VR-first experience that could not be replicated on a standard screen.
- Comfort-focused design: The game will integrate comfort techniques, such as snap-turning or vignetting, to minimize motion sickness and ensure accessibility.

**What would a prototype look like?**

- The prototype should demonstrate the core gameplay loop, highlighting the main player interactions and mechanics. It should be engaging, simple to pick up, and show potential for deeper complexity as gameplay progresses. The prototype must clearly convey what the player is doing and how they are meant to engage with the game. It should include basic mechanics and broad aspects of level design, such as objectives or challenges.
- At this stage, it is crucial to focus on gameplay and interaction rather than visuals. Placeholder objects like boxes or basic shapes are acceptable, and advanced graphics or sound design are unnecessary. The key is to prove that the gameplay concept works and is compelling in its simplest form.

**What kinds of techniques/processes/CS fundamentals are relevant to this project?**

- Iterative development.
- Frequent playtesting.
- VR Interaction design.
- Unity/C#.

**What would the output of these techniques/processes/CS fundamentals look like?**

- A series of incrementally improving prototypes – showing how you have tested and incorporated feedback from play testers.
- Some aspects of the game have been dropped from the first iterations, some have been added, some have been modified, in line with AGILE development practices.
- Several sets of feedback from players that inform your ongoing development and design process.

**How will this project be evaluated and assessed by the student (i.e. during iteration of the project)? What criteria are important?**

Student will use play testers and solicit feedback on the developing game. Main source of data will be player opinions and, where possible, player actions where it is possible to directly observe playtesting. Student should also use standard metrics such as the Simulator Sickness Questionnaire and a presence questionnaire to assess how well it works in VR.

Example Criteria for the Student's Iteration Process (VR Physics-Based Game):

**Gameplay Mechanics and Interaction:**

**Core Mechanics:** Evaluate the implementation of physics-based interactions, such as object manipulation, collisions, and environmental responses. Are these interactions intuitive and engaging in VR?

**VR-Specific Features:** Assess how the game utilizes full-body interactions and VR-specific navigation techniques (e.g., teleportation, hand-tracking).

**Performance and Optimization:**

**Frame Rate and Responsiveness:** Measure frame rates during gameplay. Does the game maintain a consistent, comfortable frame rate to minimize motion sickness?

**Real-Time Rendering:** Evaluate performance with applied physics simulations and shaders. Is the game optimized for real-time play on VR hardware?

**Player Experience and Immersion:**

**Player Feedback:** Gather feedback from testers on VR interactions and physics realism. Are the controls intuitive and immersive?

**Comfort:** Assess the game's comfort level, ensuring it minimizes nausea through appropriate design choices (e.g., smooth locomotion or teleportation).

**Progression and Iteration:**

**Iteration Quality:** Track improvements made to mechanics, physics interactions, and performance based on playtesting feedback.

**Documentation:** Maintain logs of design choices, technical changes, and challenges during development.

**Final Product Quality:**

**Polish and Presentation:** Evaluate the final version's visual appeal, smoothness of physics interactions, and overall cohesion.

**Engagement:** Determine if the game effectively uses VR features to create an immersive and rewarding gameplay experience.

**For this brief, what might a minimum pass (e.g. 3rd) student project look like?**

- Game can be loaded, started and finished without major bugs/crashes.
- The game works in VR, but is not designed to make full use of the features of the medium, it might be a too literal port of a standard screen-based game
- The game does not generate high levels of presence and/or generates some nausea or discomfort
- Poor audio-visual presentation.
- Gameplay is confusing and/or lacks any complexity.
- Written report lacks research, detail of process, issues encountered in production, and/or doesn't name influences or audio-visual assets used appropriately.

**For this brief, what might a good (e.g. 2:2 – 2:1) student project look like?**

- Game functions well without bugs.
- The gameplay and interaction is well designed for VR and shows off the best features of VR (it would not work in other media)
- The game does not cause discomfort in most people and scores well for presence
- Good audio-visual presentation.
- Gameplay is quickly understandable, it's easy to start playing.
- Written report makes clear the challenges faced and how they were overcome. Makes clear the influences that went into the game (e.g. games played and analysed, which mechanics were inspired from where etc.).
- Audio-visual assets appropriately credited.
- Playtesting feedback is clearly gathered and acted on.

**For this brief, what might an outstanding (e.g. 1st) student project look like?**

- Game is highly-polished technically, and in terms of audio-visual presentation.
- Game uses innovative and original mechanics (or well-known mechanics in a novel manner), that really show off the potential of VR
- The game does not cause discomfort in most people and scores well for presence
- Game requires no instructions – it's very clear what the objective is and how to achieve it from the opening screen.

- Game is easy to start playing, but repeated play shows a well-selected set of simple mechanics that lead to depth and emergent complexity as the player replays the game over several sessions.
- Written report has excellent and concise writing style. Research and influences behind the project are clear and detailed, with extensive analysis of background works.
- Playtesting has been frequent/ongoing, extensive feedback has been gathered and documented and it's very clear how this has been incorporated into the iterative development of the game.
- It is evident there have been several version/iterations of the game, and the challenges at each point have been documented and analysed.

## 5.2 Project Idea 2: VR Educational Experience

**What problem is this project solving, or what is the project idea?**

This project aims to create an immersive VR educational tool, helping users learn about a complex real life topic through interactive, hands-on experiences. The topic could be anything from history to physics to recycling and global warming. The focus is on immersive, experiential learning that goes beyond traditional methods.

**What is the background and context to the question or project idea above?**

Virtual Reality (VR) holds immense potential for learning because it offers the ability to directly experience scenarios that would otherwise be inaccessible. VR can enhance traditional classroom learning by allowing users to interact with virtual representations of concepts, such as molecules in chemistry. It can extend to vocational training, such as practicing surgical procedures or assembling complex machinery. VR can also provide experiential learning opportunities, such as visiting historical locations or exploring underwater ecosystems. Additionally, VR has been used effectively for empathy-building experiences, such Stanford VR's Becoming Homeless. These experiences are impactful because they go beyond simply conveying information—they immerse users in the subject matter, creating a deep, lasting understanding through direct interaction and perspective-taking.

**Here are some recommended sources for you to begin your research.**

- Online store fronts such as Steam, the Meta Store and VIVEPort are the best places to find interesting experiences for inspiration.
- Experience on Demand by Jeremy Bailenson is a great book about VR in general but experiential learning in particular.
- 3D User Interfaces: Theory and Practice by Bowman et al. is a very good starting point for VR interaction techniques.
- The IEEE VR, Virtual Reality Software and Technology (VRST), ACM SIGGRAPH and GDC conference proceedings are an excellent source of cutting edge techniques.

**What would the final product or final outcome look like?**

The final product will be a fully functional VR experience that allows users to learn through experience. It should be 3-5 minutes of experience It will have the following game design characteristics:

- Allows users to experience a simulation of an experience and learn from it
- It minimises explicit "telling" via voice overs or text, and should focus on learning by doing and through experience
- Includes suitable VR interaction and navigation techniques that are as close as possible to the real experience
- Makes use of, and shows of the unique features of VR (it would not work as a screen-

based game)
- Does not cause significant nausea or discomfort

**What would a prototype look like?**

Prototype needs to show a core VR interaction technique that simulates how people would interact with the experience in the real world. At the first prototype the focus should be on reproducing the experience rather than on learning yet.

**What kinds of techniques/processes/CS fundamentals are relevant to this project?**

- Iterative development
- Frequent playtesting
- VR Interaction design
- Unity/C#.

**What would the output of these techniques/processes/CS fundamentals look like?**

- A series of incrementally improving prototypes – showing how you have tested and incorporated feedback from play testers.
- Some aspects of the experience have been dropped from the first iterations, some have been added, some have been modified, in line with AGILE development practices.
- Several sets of feedback from participants that inform your ongoing development and design process.

**How will this project be evaluated and assessed by the student (i.e. during iteration of the project)? What criteria are important?**

Student will use testers and solicit feedback on the developing experience. The main measure should be how well they learn. This could be done by testing before and after the experience on a tasks and see how much they improve. In some cases this could be about factual knowledge (e.g. about history of Ancient Greece or Han Dynasty), in others it could be practical skills (assembling machinery) or changes in attitude (experiencing being homeless). Another source of data will be participants' opinions and, where possible, actions where it's possible to directly observe playtesting. Students should also use standard metrics such as the Simulator Sickness Questionnaire and a presence questionnaire to assess how well it works in VR. Criteria for the Student's Iteration Process (VR Educational Experience):

1. Learning Experience Quality:
   a. Educational Impact: Does the VR experience effectively teach or demonstrate the intended concept? Are learning objectives clear and engaging?
   b. Interactivity: Are the interactions designed to reinforce understanding (e.g., hands-on simulations, quizzes, or problem-solving tasks)?

   c. Immersive Storytelling: If applicable, does the experience place learners in scenarios that foster empathy or practical knowledge?
2. Performance and Usability:
   a. Frame Rate and Optimization: Is the VR experience smooth, with minimal motion sickness (consistent high frame rate)?
   b. Usability: Are controls intuitive, and is navigation user-friendly, especially for educational audiences?
   c. Accessibility: Is the experience designed with diverse learners in mind (e.g., subtitles, adjustable difficulty levels)?
3. User Feedback and Testing:
   a. Educational Effectiveness: Gather feedback on whether users found the experience educational and engaging.
   b. Immersion and Comfort: Measure user comfort, including ease of interaction and VR navigation.
4. Progression and Iteration:
   a. Iteration Based on Feedback: Is the project improving based on user and instructor feedback?
   b. Documented Development Process: Is there a clear record of changes, learning outcomes, and design decisions?
5. Final Product Quality:
   a. Cohesiveness: Does the final project combine visuals, sound, and interactions into a polished, immersive educational experience?
   b. Learning Outcomes: Does the project clearly achieve its educational goals, and is it enjoyable for users?

**For this brief, what might a minimum pass (e.g. 3rd) student project look like?**

- The experience can be loaded, started and finished without major bugs/crashes.
- The experience works in VR, but is not designed to make full use of the features of the medium. The learning might rely too much on explanation (Reading) rather than direct experience.
- The experience does not generate high levels of presence and/or generates some nausea or discomfort
- The experience attempts to teach something but there is little evidence of successful learning.
- Poor audio-visual presentation.
- Gameplay is confusing and/or boring.
- Written report lacks research, detail of process, issues encountered in production, and/or doesn't name influences or audio-visual assets used appropriately.

**For this brief, what might a good (e.g. 2:2 – 2:1) student project look like?**

- The experience functions well without bugs.
- The interaction is well designed for VR and shows off the best features of VR (it would not work in other media), and uses experiential learning

- The experience does not cause discomfort in most people and scores well for presence
- The experience has clear learning objectives, and evidence from participants that they have been achieved
- Good audio-visual presentation.
- Gameplay is quickly understandable, it's easy to start playing.
- Written report makes clear the challenges faced and how they were overcome. Makes clear the influences that went into the game (e.g. games played and analysed, which mechanics were inspired from where etc.).
- Audio-visual assets appropriately credited.
- Playtesting feedback is clearly gathered and acted on.

**For this brief, what might an outstanding (e.g. 1st) student project look like?**

- The experience is highly-polished technically, and in terms of audio-visual presentation.
- The experience uses innovative and original VR technique to enable experiential learning)
- The experience does not cause discomfort in most people and scores well for presence
- There is strong evidence that participants have learned effectively or changed their attitude. Participant research is well conducted
- Written report has excellent and concise writing style. Research and influences behind the project are clear and detailed, with extensive analysis of background works.
- Playtesting has been frequent/ongoing, extensive feedback has been gathered and documented and it's very clear how this has been incorporated into the iterative development of the game.
- It is evident there have been several version/iterations of the experience, and the challenges at each point have been documented and analysed.

# 6 CM3030 Games Development

## 6.1 Project Idea 1: Custom Car Physics for Racing and Open-World Driving Games

### 6.1.1 What problem is this project solving, or what is the project idea?

This project focuses on developing a realistic custom car physics system for use in racing or open-world driving games. The goal is to create an accurate and responsive vehicle handling model that considers factors such as suspension, tire friction, weight transfer.

**What is the background and context to the question or project idea above?**

Many driving games rely on physics models that simulates real-world vehicle dynamics. While arcade racing games prioritise accessibility, simulation-based games require more advanced physics for realism. This project will explore real-world vehicle dynamics principles and implement them within a game engine like Unity or Unreal Engine. Features such as realistic acceleration, braking, drifting, and suspension behaviour will be integrated into the physics system. Inspiration can be drawn from games like "Assetto Corsa," "BeamNG.drive," and "Forza Motorsport," which demonstrate high-fidelity driving physics.

**Here are some recommended sources for you to begin your research.**

- David Bourg & Bryan Bywalec, "Physics for Game Developers: Science, math, and code for realistic effects", Wiley, 2nd Edition, 2013
- GDC talks on vehicle physics in games.
- Unity and Unreal Engine documentation on physics and rigid body dynamics.
- Research papers on real-time vehicle simulation and tire physics.

### 6.1.2 What would the final product or final outcome look like?

A fully functioning custom car physics system where vehicles handle realistically based on real-world physics principles. The system should allow for customisation of car parameters (e.g., weight, tire grip, engine power) to simulate different types of vehicles.

### 6.1.3 What would a prototype look like?

A simple driving simulation with at least one vehicle that demonstrates realistic acceleration, braking, and cornering physics. The prototype should include visual debugging tools for forces, tire friction, and weight distribution.

### 6.1.4 What kinds of techniques/processes/CS fundamentals are relevant to this project?

- Physics and force calculations.
- Rigid body dynamics and collision detection.

- Suspension simulation using spring-damper systems.

#### 6.1.5 What would the output of these techniques/processes/CS fundamentals look like?

- Vehicles that respond naturally to player input and environmental conditions.
- Debug visualisation of forces acting on the car (e.g., gravity, normal force, lateral forces).
- Adjustable vehicle parameters for tuning and testing.

#### 6.1.6 How will this project be evaluated and assessed by the student (i.e. during iteration of the project)? What criteria are important?

- Realism of vehicle handling and physics response.
- Accuracy of force calculations and simulations.
- Performance optimisation to ensure smooth frame rates.
- Modular and extensible code design for future improvements.
- Comparison with real-world vehicle physics models.

#### 6.1.7 For this brief, what might a minimum pass (e.g. 3rd) student project look like?

- A basic car physics system with acceleration and braking.
- Simple friction and weight transfer calculations.
- Some unrealistic or unpolished aspects of handling.

#### 6.1.8 For this brief, what might a good (e.g. 2:2 – 2:1) student project look like?

- Improved car handling with better suspension and weight transfer.
- Some degree of vehicle tuning options.

#### 6.1.9 For this brief, what might an outstanding (e.g. 1st) student project look like?

- Highly realistic car handling with advanced physics features.
- Proper suspension simulation and tire deformation.
- Aerodynamic effects such as drag and downforce.
- Fully adjustable vehicle physics parameters with a user-friendly tuning system.

## 6.2 Project Idea 2: Procedural Dungeon Generation in Roguelike Games

**What problem is this project solving, or what is the project idea?**

This project explores the implementation of procedural content generation (PCG) techniques to create dynamic and unique dungeon layouts for roguelike games. The goal is to design an algorithm that generates varied and playable dungeons while ensuring balanced gameplay.

**What is the background and context to the question or project idea above?**

Roguelike games, such as "The Binding of Isaac" and "Hades," heavily rely on procedurally generated dungeons to provide an engaging and unpredictable gameplay experience. Procedural generation allows for the creation of infinite variations of levels without manually designing each one. However, designing a procedural algorithm that ensures playability, challenge progression, and aesthetic appeal is a complex task. This project will involve researching existing PCG methods, such as cellular automata and BSP (Binary Space Partitioning), to create an effective dungeon generator. The outcome will be a working prototype demonstrating dynamically generated levels, ensuring balance in enemy placement, rewards, and difficulty scaling.

**Here are some recommended sources for you to begin your research.**

· "Procedural Content Generation in Games" by Noor Shaker, Julian Togelius, and Mark Nelson. · "Game Programming Patterns" by Robert Nystrom. · Unity/Godot/Unreal documentation on procedural generation techniques.

**What would the final product or final outcome look like?**

A fully functional prototype of a roguelike game with procedurally generated dungeon levels. The game should include randomised room layouts, enemy placements, and item distributions while maintaining a structured difficulty curve.

**What would a prototype look like?**

A basic 2D or 3D dungeon explorer with procedurally generated rooms, corridors, and interactive elements such as enemies, doors, and loot. The prototype should showcase a variety of generated layouts and allow player navigation.

**What kinds of techniques/processes/CS fundamentals are relevant to this project?**

- Procedural content generation (PCG)
- Data structures (graphs, trees, BSP trees)
- Algorithm design (random walk, cellular automata, Perlin noise)
- Pathfinding algorithms (A* for enemy AI movement)

- Game loop and state management
- AI behaviour scripting

**What would the output of these techniques/processes/CS fundamentals look like?**

- A visualization of generated dungeon layouts
- Playable levels with dynamic enemy encounters
- Logs/metrics measuring generation efficiency and balance
- A working AI for enemy behaviour based on pathfinding algorithms

**How will this project be evaluated and assessed by the student (i.e. during iteration of the project)? What criteria are important?**

- Quality of procedural generation (variety and playability of dungeons)
- Algorithm efficiency and performance optimization
- Balance in level difficulty and progression
- User feedback on game experience
- Clean and maintainable code

**For this brief, what might a minimum pass (e.g. 3rd) student project look like?**

- A working dungeon generator with basic random room placement.
- Limited enemy AI behaviour with static movement.
- Some playability but unbalanced level progression.

**For this brief, what might a good (e.g. 2:2 – 2:1) student project look like?**

- More refined procedural generation ensuring connected rooms and navigability.
- Basic AI with patrolling and simple attack logic.
- Some variety in room designs and item placements.

**For this brief, what might an outstanding (e.g. 1st) student project look like?**

- Sophisticated PCG algorithm with multiple generation techniques (BSP, cellular automata, etc.).
- Well-balanced levels with adaptive difficulty scaling.
- Smooth AI behaviour with pathfinding and dynamic decision-making.
- Additional gameplay elements such as puzzles, environmental interactions, and adaptive enemy AI.

# 7 CM3035 Advanced Web Design

## 7.1 Project Idea 1: Identity and profile management API

**What problem is this project solving, or what is the project idea?**

We have different names, usernames and ways of presenting ourselves in different contexts. Devise a Web API to manage them securely and flexibly.

**What is the background and context to the question or project idea above?**

Many people present themselves differently in different contexts. Some have legal names that differ from the names they use in their daily lives, or use middle names or numbers to distinguish similarly-named individuals. In some cultures, their given names may be only used administratively, and in other cases, they may have special names for religious use. On marriage, people may change their legal names, but not use the new name professionally. Meanwhile, online, we manage many identities, usernames and profiles of ourselves. Which identity we use depends on context, but also on who is asking for the information and why. You will devise a REST API for reading and writing identities to a server securely and sensitively, so that users requesting information about an individual get the correct preferred name for the context about which they are enquiring. Confidential information should be concealed as necessary, and users should only be able to write data where this is appropriate.

**Here are some recommended sources for you to begin your research.**

- For context about naming, a reasonable start is the Wikipedia article (`https://en.wikipedia.org/wiki/Personal_name`), but better references should be found.
- For secure account management and REST API creation, course materials should provide a good start.
- A good understanding of the HTTP protocol will be helpful – e.g. students might use Accept-language in content negotiation in this context. An overview is at `https://developer.mozilla.org/en-US/docs/Web/HTTP/Content_negotiation`

**What would the final product or final outcome look like?**

A requirement specification (based on literature survey and, optionally user consultation) for an identity management system An implementation that at least covers names and, optionally, adds gender identities, online profile data and other relevant information.

**What would a prototype look like?**

A completed API, a backend datastore and a UI. Some form of authentication and user management will be necessary.

**What kinds of techniques/processes/CS fundamentals are relevant to this project?**

Web API, Data/web security, data modelling, social computing

**What would the output of these techniques/processes/CS fundamentals look like?**

A study of the requirements for such a system and a secure implementation

**How will this project be evaluated and assessed by the student (i.e. during iteration of the project)? What criteria are important?**

- A good understanding of the user needs
- A well-thought-through API

**For this brief, what might a minimum pass (e.g. 3rd) student project look like?**

To pass, an implementation must be secure and have appropriate user management. It must at least cover names used in different contexts. Several different types of use must be implemented, and the API must have clear logic.

**For this brief, what might a good (e.g. 2:2 – 2:1) student project look like?**

A requirements document with evidence of reading and thinking about the contexts. Strong security and privacy decisions. An API that supports a good variety of use contexts. An example web front end works and is user-friendly and accessible.

**For this brief, what might an outstanding (e.g. 1st) student project look like?**

A strong requirements document that shows research and imagination. Solid security and privacy, possibly with reference to GDPR and optionally using external authentication. The data model goes beyond the simplest use cases. The API is robust and would be widely applicable. A web front end clearly demonstrates multiple use cases for the API.

## 7.2 Project Idea 2: NextTrack: A music recommendation API

**What problem is this project solving, or what is the project idea?**

Design a music recommendation API that gives a 'next track' based on an HTTP request, providing listening history and some preference parameters, along with data about the tracks available.

**What is the background and context to the question or project idea above?**

Music recommendation and playlist generation systems are popular and much researched. It's quite common for these to operate within applications that users log into, and which profile that user based on their listening habits. This has implications for privacy. It can also be undermined by shared accounts and listening (for example, a household with a child, may wind up with nursery rhymes in the recommendations).

You will build a RESTful recommendation system with no user tracking instead, the user will provide a sequence of track identifiers that the next track should follow from, and some preference parameters (which you can choose). The system will use data from external sources, such as musicbrainz, genius.com, spotify, Wikidata to inform its choices.

**Here are some recommended sources for you to begin your research.**

The ISMIR conference (ismir.net) has many papers on recommender systems that should give an idea of the sorts of things you could do. There's no necessity to use audio features – some of Brian Whitman's work in early ISMIR conferences uses non-content information, such as metadata and online reviews.

**What would the final product or final outcome look like?**

A RESTful API that takes a set of track identifiers and other parameters and returns the id of a suitable next track. There should be some form of evaluation (for example, based on user testing or some prior work giving good sequences).

**What would a prototype look like?**

The basic API. This could return tracks at random for prototyping purpose, but it should reproduce the input/output format. If a frontend is to be implemented, a basic implementation with music player (e.g. via YouTube or logged in Spotify).

**What kinds of techniques/processes/CS fundamentals are relevant to this project?**

Web API, UI/UX, Music information Retrieval

**What would the output of these techniques/processes/CS fundamentals look like?**

A stateless playlist generating API that has a strategy for choosing new tracks that is better than random selection.

**How will this project be evaluated and assessed by the student (i.e. during iteration of the project)? What criteria are important?**

- A good overview of playlists/recommender systems and what users might want
- A well-thought-through RESTful API that offers some user control
- Sensible evaluation of the results

**For this brief, what might a minimum pass (e.g. 3rd) student project look like?**

A working API that gets some data from elsewhere, and combines it with user-provided information to choose a track.

**For this brief, what might a good (e.g. 2:2 – 2:1) student project look like?**

A literature review that identifies a good strategy for recommending the next track, a working API that offers real choice to the user. A Web application that demonstrates that the API works. Good evaluation (such as user testing)

**For this brief, what might an outstanding (e.g. 1st) student project look like?**

An insightful overview of recommendation approaches and the data that is available to a server process. An API that recommends based on well-chosen parameters. A web application that provides an interactive music playing experience. Strong user testing and reflection on the results of it (ideally, modifications based on user testing, which are themselves tested).

# 8 CM3040 Physical Computing and the Internet of Things

## 8.1 Project Idea 1: Secure IoT Device Management in a Safety-critical Smart Environment

**What problem is this project solving, or what is the project idea?**

This project aims to develop a framework and a technological solution to monitor, manage and take control of IoT devices to create a trusted network for safety critical systems such as smart grids, smart motorways, healthcare and manufacturing systems.

**What is the background and context to the question or project idea above?**

Various industries are developing and manufacturing large-scale and heterogeneous nature of Internet-of-Things (IoT) devices and seamlessly weaving them into our everyday lives. Securely managing these IoT devices that are dynamically added to the trusted smart environment could be challenging due to incompatibilities of communication protocols, commercial/opensource platforms, and limited third-party integration challenges.

**Here are some recommended sources for you to begin your research.**

- S. A. Chaudhry, K. Yahya, F. Al-Turjman and M. -H. Yang, "A Secure and Reliable Device Access Control Scheme for IoT Based Sensor Cloud Systems," in IEEE Access, vol. 8, pp. 139244-139254, 2020, doi: 10.1109/ACCESS.2020.3012121.
- D. F. Deva Shahila, D. L. P. Suresh, P. Aruna Jeyanthy, V. Stephen and A. R M, "Designing and Analyzing Secure SoC Architecture for IoT Devices," 2024 7th International Conference on Circuit Power and Computing Technologies (ICCPCT), Kollam, India, 2024, pp. 1893-1899, doi: 10.1109/ICCPCT61902.2024.10673314.
- O. Alruwaili, F. Mohammed Alotaibi, M. Tanveer, S. Chaoui and A. Armghan, "PSAF-IoT: Physically Secure Authentication Framework for the Internet of Things," in IEEE Access, vol. 12, pp. 78549-78561, 2024, doi: 10.1109/ACCESS.2024.3407353.

**What would the final product or final outcome look like?**

A dashboard to allow various types of IoT devices to be integrated into the system with various levels of security policies. The system should be able to visualise and monitor the behaviour of the IoT devices within the network and raise alerts or take actions to mitigate the impact the device can have on the overall IoT network and the application. The solution should allow users to create their own policies for IoT devices in the trusted network to abide by before raising alerts or automating certain tasks.

**What would a prototype look like?**

A prototype could have a client-server system architecture to allow devices to be managed remotely. The client devices could provide a user interface to the system and act as a bridge to link a new IoT device to the secure trusted network of devices. These IoT devices could have special access control to IoT-based smart environment data and policy management.

**What kinds of techniques/processes/CS fundamentals are relevant to this project?**

This project will have programming applications that could be deployed on cloud services and potentially develop bespoke hardware components that act as an add-on device to monitor/control the behaviour of the devices.

**What would the output of these techniques/processes/CS fundamentals look like?**

A web service and/or addon hardware device capable for monitoring/controlling the behaviour of the devices to create a trusted network of IoT devices.

**How will this project be evaluated and assessed by the student (i.e. during iteration of the project)? What criteria are important?**

This project requires a review of state-of-the-art frameworks and approaches to managing IoT devices to create a secure and trusted network.

A proof-of-concept solution should be developed to demonstrate the monitoring and management of the IoT devices virtually, physically or both.

**For this brief, what might a minimum pass (e.g. 3rd) student project look like?**

Pass projects should be able to show some understanding of state-of-the-art frameworks and approaches to managing IoT devices. Develop a prototype showing a dashboard which simulates different IoT devices being added to the network and attempts to monitor or enforce policies on the type of activities it can conduct.

**For this brief, what might a good (e.g. 2:2 – 2:1) student project look like?**

Merit student projects should review state-of-the-art approaches and develop their own security framework for managing IoT devices to allow both monitoring and automating actions to be programmed and dynamically applied to the smart environment. A prototype could attempt to apply their proof-of-concept on real IoT devices—bespoke or commercially available.

**For this brief, what might an outstanding (e.g. 1st) student project look like?**

An outstanding project could demonstrate the unique approach to managing real IoT devices in a given smart environment with suitable tools to monitor and manage their behaviour remotely.

## 8.2 Project Idea 2: Towards a Low-cost Resilient Early-warning Natural Disaster Monitoring, Notification and Rapid Response Platform

**What problem is this project solving, or what is the project idea?**

This project aims to develop a framework and a low-cost Internet-of-Things (IoT)-based technological solution to allow local authorities to monitor, notify impacted regions, communities and individual homeowners to prepare for potential natural disaster such as flooding, wildfire and even a spread virus such as COVID19.

**What is the background and context to the question or project idea above?**

Traditional methods such as TV, radios and telephones for relaying emergency or warning messages to impacted population of people in given region has proven to be challenging for the local authorities due to various factors such as damages to network infrastructure, electricity outage and viruses. Despite the early prediction of excessive rainfall and risk of flooding / landslides, there were many lives still lost mainly due to lack of awareness and preparedness to handle such natural disasters which are only becoming more unpredictable due to the climate change. Therefore, a low-cost IoT-based solution should be developed to overcome some of the above factors.

**Here are some recommended sources for you to begin your research.**

- R. Raman and S. M. U. Iqbal, "IoT-based Flood Early Warning System for Effective Disaster Management," 2024 International Conference on E-mobility, Power Control and Smart Systems (ICEMPS), Thiruvananthapuram, India, 2024, pp. 1-5, https://doi.org/10.1109/ICEMPS60684.2024.10559355
- Esposito M, Palma L, Belli A, Sabbatini L, Pierleoni P. Recent Advances in Internet of Things Solutions for Early Warning Systems: A Review. Sensors (Basel). 2022 Mar 9;22(6):2124. https://doi.org/10.3390/s22062124. PMID: 35336296; PMCID: PMC8954208.
- Ashwini, A., et al. "IoT-Based Smart Sensors: The Key to Early Warning Systems and Rapid Response in Natural Disasters." Predicting Natural Disasters With AI and Machine Learning, edited by D. Satishkumar and M. Sivaraja, IGI Global, 2024, pp. 202-223. https://doi.org/10.4018/979-8-3693-2280-2.ch010
- Hanifah Yulia, Subuh Pramono, Sutrisno, B. D. Jati; IoT based early warning system of landslide and flood disasters. AIP Conf. Proc. 12 May 2023; 2674 (1): 030041. https://doi.org/10.1063/5.0114101

**What would the final product or final outcome look like?**

A dashboard to allow various types of interconnected IoT devices with various climate change related sensors and community notification IoT devices integrated into the system with various levels of security policies and notification services to local communities. The system should be able to visualise and monitor the behaviour of the sensing IoT devices and raise alerts to communities in a affected regions and take actions if needed (i.e.,

activating flood barriers automatically) to reduce the impact of the disaster. The solution should allow local authorities to create their own policies for climate sensing IoT devices in the trusted network and other community base notification and response IoT devices to function securely and efficiently.

**What would a prototype look like?**

A prototype could have a peer-to-peer or mesh networking IoT devices communication protocol to be resilient against IoT devices becoming damaged, have power cut or go offline and still provide climate sensing data using a different sensing node for the early warning system to automatically raise alerts or allow local authorities to intervene as required.

**What kinds of techniques/processes/CS fundamentals are relevant to this project?**

This project will have programming microcontrollers with advance communication techniques, sensing various climate disaster-based risks and provide various types of notifications to affected communities in the regions.

**What would the output of these techniques/processes/CS fundamentals look like?**

A trusted network of early disaster detection, notification and responsive IoT devices that is resilient to communications network, electricity grid outage and infectious viruses.

**How will this project be evaluated and assessed by the student (i.e. during iteration of the project)? What criteria are important?**

This project requires a review of state-of-the-art frameworks and approaches to low-cost, self-powered and self-organising IoT devices interconnected to create a secure and trusted network for sensing climate disaster, notifying and rapidly responding when needed. A proof-of-concept solution should be developed to demonstrate the monitoring, notifying and rapidly responding to at least one disaster risks (i.e., flooding, wildfire, ...) for a given region with the IoT devices virtually, physically or both.

**For this brief, what might a minimum pass (e.g. 3rd) student project look like?**

Pass projects should be able to show some understanding of state-of-the-art frameworks and approaches to disaster resilient IoT platform which can monitor, notify and respond when required. Develop a prototype showcasing these with a dashboard which simulates different IoT devices on the network.

**For this brief, what might a good (e.g. 2:2 – 2:1) student project look like?**

Merit student projects should review state-of-the-art approaches and develop their own disaster resilient IoT platform which can monitor, notify and respond when required. A prototype could attempt to apply their proof-of-concept on real IoT devices with wide range of sensing devices (bespoke or commercially available), notifying and rapidly re-

sponding to the disaster risks.

**For this brief, what might an outstanding (e.g. 1st) student project look like?**

An outstanding project should demonstrate the unique approach early disaster detection, monitoring, notifying and taking action within a given environment with suitable tools to monitor and manage their behaviour remotely. The project can make use of other APIs or systems in neighbourhood/towns/ cities to coordinate various disaster pre-during and post procedures/aids.

# 9 CM3045 3D Graphics and Animation

## 9.1 Project Idea 1: 3D Game with different difficulty levels

**What problem is this project solving, or what is the project idea?**

Create a 3D physics based game with a minimum of two levels of difficulty.

**What is the background and context to the question or project idea above?**

This project involves developing a 3D physics-based game that challenges players with puzzles or tasks influenced by real-world physics principles such as gravity, collisions, and momentum. Physics-based games are popular for their engaging, dynamic gameplay, where players interact with objects in a realistic virtual environment. Examples include games like Angry Birds, Portal, or Human: Fall Flat, which leverage physics to create entertaining and sometimes unpredictable challenges. The project requires implementing at least two levels with increasing difficulty, encouraging players to master game mechanics progressively. The first level should introduce core gameplay concepts and simple challenges, while the second level should increase complexity with additional obstacles, time limits, or environmental hazards. This project will develop technical skills such as 3D modeling, physics engine integration (e.g., Unity's Rigidbody and Colliders), and gameplay scripting. It also fosters creativity in level design, user experience, and balancing difficulty to maintain player engagement.

**Here are some recommended sources for you to begin your research.**

- Human Fall Flat (`https://www.nobrakesgames.com/humanfallflat`)
- Garry's Mod (`https://store.steampowered.com/app/4000/Garrys_Mod/`)
- Free Physics games on itch.io (`https://itch.io/games/free/tag-physics/tag-sandbox`)
- Katamari Damacy Reroll (`https://en.bandainamcoent.eu/katamari/katamari-damacy-reroll`)

**What would the final product or final outcome look like?**

The final product will be a fully playable 3D physics-based game with at least two levels, each offering increasing difficulty and unique challenges. The game will feature a well-designed 3D environment with interactive objects and realistic physics behaviours such as gravity, collisions, and object dynamics.

The gameplay should be a maximum of 5 minutes. Shorter and more polished is preferable and will receive higher marks than longer and not as well executed.

It will have the following game design characteristics:

- Easy to pick up and play.

- Uses physics simulation as a key element of gameplay.
- Include an additional level/state with complexity (in the form of increased speed, obstacles etc).
- May optionally use other elements of the 3D Graphics and Animation course, such as keyframe animation and shaders, to enhance the effect.
- 3rd party assets may be used for graphics, animation and audio, but you must have permission and credit them appropriately.

**What would a prototype look like?**

The prototype will showcase the core physics-based gameplay loop, highlighting the main mechanics that make the game engaging, challenging, and easy to pick up, while demonstrating potential for emergent complexity. It will clearly define what the player is meant to do and how they will interact with the game world to achieve their objectives. The focus will be on gameplay mechanics and level design, not on visuals or sound. The prototype will use simple shapes such as boxes, spheres, and capsules to represent objects, characters, and obstacles. Players will be able to interact with these objects using physics-based actions like pushing, stacking, rolling, or launching. Core mechanics such as gravity, collisions, and object responses to player input will be functional. The prototype will also include basic versions of at least two levels, showcasing progressively increasing difficulty and demonstrating how mechanics combine to create engaging challenges.

**What kinds of techniques/processes/CS fundamentals are relevant to this project?**

- Iterative development
- Frequent playtesting
- Unity/C#.
- 3D scene design
- Unity Physics Engine

**What would the output of these techniques/processes/CS fundamentals look like?**

- A series of incrementally improving prototypes – showing how you have tested and incorporated feedback from play testers.
- Some aspects of the game have been dropped from the first iterations, some have been added, some have been modified, in line with AGILE development practices.
- Several sets of feedback from players that inform your ongoing development and design process.

**How will this project be evaluated and assessed by the student (i.e. during iteration of the project)? What criteria are important?**

Student will use play testers and solicit feedback on the developing game. Main source of data will be player opinions and, where possible, player actions where it’s possible to directly observe playtesting.

Example Criteria for the Student's Iteration Process (Physics-Based 3D Game):

1. **Core Mechanics:**
   a. Evaluate the effectiveness of the physics-based gameplay loop. Are interactions such as collisions, forces, and object behaviours realistic and engaging?
   b. Level Design: Assess the level design for challenge and progression. Does it showcase the physics mechanics effectively?
   c. Emergent Complexity: Does the gameplay demonstrate opportunities for player creativity or unexpected outcomes through physics interactions?
2. **Performance:**
   a. Frame Rate and Optimization: Measure FPS during gameplay, especially during physics-heavy interactions. Are there performance issues such as lag or stuttering?
   b. Physics Efficiency: Check if physics simulations are optimized (e.g., using rigid-body constraints or simplified colliders).
   c. Testing Across Devices: Test performance on different hardware setups to ensure consistency.
3. **Player Response:**
   a. Playtesting Feedback: Gather player feedback on gameplay experience. Are the controls intuitive, and do players find the physics interactions engaging?
   b. Challenge and Engagement: Assess if the difficulty levels feel appropriate and if players enjoy experimenting with the physics-based mechanics.
4. **Progression and Iteration:**
   a. Continuous Improvement: Track how gameplay mechanics, level design, and physics interactions evolve with each iteration. Are improvements made based on playtesting feedback?
   b. Documentation of Changes: Maintain a log of major adjustments, such as changes in physics parameters or gameplay balance.
5. **Final Product Quality:**
   a. Polish and Presentation: Ensure the final game is cohesive, with smooth physics interactions and a refined player experience.
   b. Player Engagement: Assess how well the game maintains player interest through gameplay depth, challenge, and physics-based problem-solving opportunities.

**For this brief, what might a minimum pass (e.g. 3rd) student project look like?**

- Core Gameplay Loop: A simple, functional physics-based mechanic (e.g., rolling a ball through a maze or knocking over objects) that clearly shows what the player is meant to do and how they interact with the environment.
- Two Levels: Two distinct levels with increasing difficulty, though level design may be simplistic or repetitive. The second level should introduce at least one new challenge (e.g., moving platforms, obstacles, or a time limit).
- Basic Physics Implementation: Use of built-in physics (e.g., gravity, collisions, and object movement) with occasional glitches or inconsistencies.
- Prototype-Quality Graphics: Placeholder assets (e.g., cubes and spheres) without

textures or animations.
- Basic Controls: Functional but potentially clunky or unrefined player controls (e.g., keyboard for movement and interaction).
- Limited Feedback: Minimal player feedback (e.g., basic win/lose conditions) with no scoring or sound effects.
- Written report lacks research, detail of process, issues encountered in production, and/or doesn't name influences or audio-visual assets used appropriately.

**For this brief, what might a good (e.g. 2:2 – 2:1) student project look like?**

- Core Gameplay Loop: A clearly defined and engaging physics-based mechanic (e.g., rolling a ball through obstacles, stacking objects to solve puzzles, or using momentum to cross gaps). The gameplay should be intuitive, challenging, and show potential for emergent complexity.
- Two Well-Designed Levels: Two distinct levels with increasing difficulty and clear progression. The first level should introduce core mechanics, while the second level should build on them with additional challenges, such as moving obstacles, timers, or interactive objects (e.g., pressure plates, seesaws, or trampolines).
- Improved Physics Implementation: Realistic use of physics components (e.g., rigidbodies, colliders, forces) with consistent object behaviour. Basic mechanics such as jumping, pushing, or stacking objects should function smoothly.
- Playable Prototype with Clear Mechanics: The prototype should have a simple but functional user interface (e.g., start, restart, and level selection) and clearly indicate win/lose states.
- Better Controls: Responsive and intuitive player controls with smooth movement and interactions, such as dragging objects or using physics-based switches.
- Basic Game Loop: A full gameplay loop, including starting the game, playing through levels, and displaying a victory or game-over screen.
- Slight Visual/Audio Polish: Placeholder assets with some basic improvements (e.g., simple textures, lighting, or background music) to enhance the player experience, though the focus remains on gameplay. Possibly using keyframe animation and/or shaders.
- Written report makes clear the challenges faced and how they were overcome. Makes clear the influences that went into the game (e.g. games played and analysed, which mechanics were inspired from where etc.).
- Audio-visual assets appropriately credited.
- Playtesting feedback is clearly gathered and acted on.

**For this brief, what might an outstanding (e.g. 1st) student project look like?**

- Game is highly-polished technically, and in terms of audio-visual presentation.
- Game uses innovative and original physics-based mechanics (or well-known mechanics in a novel manner)
- Possibly also using advanced animation and shader techniques

- Game requires no instructions – it's very clear what the objective is and how to achieve it from the opening screen.
- Game is easy to start playing, but repeated play shows a well-selected set of simple mechanics that lead to depth and emergent complexity as the player replays the game over several sessions.
- Written report has excellent and concise writing style. Research and influences behind the project are clear and detailed, with extensive analysis of background works.
- Playtesting has been frequent/ongoing, extensive feedback has been gathered and documented and it's very clear how this has been incorporated into the iterative development of the game.
- It is evident there have been several versions.

## 9.2 Project Idea 2: Animated Short film with VFX

**What problem is this project solving, or what is the project idea?**

This project aims to use GPU shader techniques to create a distinctive and visually striking style for a short, animated film developed in Unity. By leveraging real-time rendering, lighting and custom shaders, the film will showcase a unique aesthetic that highlights the creative potential of modern game engines for cinematic storytelling.

**What is the background and context to the question or project idea above?**

The rise of real-time game engines like Unity has revolutionized animation, making it possible to produce high-quality animated films without the long rendering times traditionally associated with offline rendering techniques. This shift is largely due to advances in GPU programming, which enable diverse visual styles ranging from photorealism to stylized effects like cel-shading or glitchy cyberpunk aesthetics.

In particular, real-time shaders, such as custom lighting, post-processing effects, and particle systems, play a crucial role in defining the look and feel of a scene. Shaders can simulate everything from dynamic lighting and reflections to atmospheric effects like fog, fire, or holograms.

This project will explore the artistic potential of shaders to establish a cohesive visual style, blending animation with real-time rendering techniques. The final outcome will be a short film that highlights how modern GPU effects can transform storytelling and evoke emotion through distinct visual aesthetics.

**Here are some recommended sources for you to begin your research.**

**Watch Animated, VFX-based, or Live-Action Films:** Analyze different visual styles (e.g., Pixar shorts, Love, Death & Robots, Spider-Man: Into the Spider-Verse) to gain inspiration for aesthetic choices and visual storytelling.

**Alan Zucconi's Shader Programming Tutorials:** A practical and beginner-friendly resource to learn the fundamentals of shaders and visual effects in Unity. `https://www.alanzucconi.com`

**The GPU Gems Book Series (NVIDIA):** Although somewhat dated, these books contain a wealth of practical techniques for real-time graphics, many of which can be applied directly to shaders in Unity. Available for free online at NVIDIA Developer

**ACM SIGGRAPH and GDC Conference Proceedings:** Explore cutting-edge research and industry techniques for VFX, animation, and real-time rendering. SIGGRAPH | GDC Vault

**Unity Shader Graph and URP/HDRP Documentation:** Official Unity documentation offers essential guidance for implementing custom shaders and post-processing effects. Unity Learn

**"The Book of Shaders" by Patricio Gonzalez Vivo and Jen Lowe:** A fantastic resource to understand shader programming concepts, particularly for GLSL shaders. `https://thebookofshaders.com`

**ArtStation and Polycount:** Communities for game developers and digital artists showcasing shader experiments and breakdowns. ArtStation | Polycount

**What would the final product or final outcome look like?**

The final product will be a Unity build/project that plays a short, non-interactive film showcasing technical graphics techniques. The film will be a maximum of 3 minutes, with a focus on polish and execution over length. A video recording of the film will also be submitted.

Required Features:

- Keyframe Animation and/or Physics/Particle Systems: The animation should include movement created using keyframes, physics simulations (e.g., rigidbodies, collisions), or particle effects (e.g., smoke, fire, or water).
- GPU Shader Effects: Custom or built-in GPU shaders should be applied to specific objects to produce distinctive visual effects (e.g., water reflections, toon shading).
- Lighting Design: The scene should feature appropriate lighting (e.g., dynamic shadows, global illumination, baked vs real-time) that complements and enhances the overall visual style.
- Technical Showreel Format: The project will be assessed on visual quality and technical execution rather than narrative or storytelling. The presentation should highlight the use of shaders and effects.
- Use of Third-Party Assets: Students may incorporate third-party models, animations, and audio, but proper credits and permissions must be provided. Focus:
- Visual Polish: Shorter, well-executed films will receive higher marks than longer, less-polished ones.
- Technical Implementation: Clear demonstration of shaders and rendering techniques.
- Style and Presentation: Effective use of lighting and effects to create a cohesive aesthetic.

**What would a prototype look like?**

Prototype needs to show at least one of the key shader techniques that will be used. It can be applied to simple objects, not necessarily the final scene.

**What kinds of techniques/processes/CS fundamentals are relevant to this project?**

- Iterative development
- Unity/C#.
- 3D scene design
- Keyframe Animation
- GPU Shader programming

**What would the output of these techniques/processes/CS fundamentals look like?**

A series of incrementally improving prototypes – showing how you have tested and incorporated feedback from play testers. The scene and visual style are gradually built up by adding more elements and shaders over time, while always having a working prototype.. Feedback is solicited from viewers to improve the film

**How will this project be evaluated and assessed by the student (i.e. during iteration of the project)? What criteria are important?**

Student will use play testers and solicit feedback on the developing game. Main source of data will be player opinions and, where possible, player actions where it's possible to directly observe playtesting.

Criteria for the Student's Iteration Process:

1. Graphics Quality:
    a. Visual Impact: Evaluate the overall aesthetic of the film, including the effectiveness of shaders, lighting, and animation. Does the project convey a distinct visual style? Is the visual appeal consistent throughout the film?
    b. Shader Implementation: Assess the use of GPU shaders, looking for creative and effective applications, such as lighting effects, material shaders, and post-processing effects. Are these shaders enhancing the visual storytelling or adding unique artistic elements?
    c. Animation and Effects: Evaluate the quality and fluidity of the keyframe animation, as well as the integration of physics or particle systems. Do these elements complement the style, or do they detract from it? Are the transitions in/ between scenes smooth and visually engaging?
2. Performance:
    a. Frame Rate and Optimization: Measure the frame rate (FPS) throughout the animation. Does the frame rate drop significantly with the addition of complex shaders or particles? Are there any noticeable performance issues or slowdowns in certain scenes?
    b. Real-Time Rendering: Assess how well the film performs in real-time within Unity, given the applied shaders and visual effects. Are there any areas where performance could be optimized without sacrificing too much visual quality (e.g., reducing shader complexity or using simplified models)?
    c. Testing Across Devices: If applicable, test the project on different machines or setups (e.g., lower-end PCs) to see how it performs across varying hardware configurations.
3. Viewer Response:
    a. Viewer Feedback on Visual Features: Show a small sample of viewers (e.g., peers, instructors, or testers) two versions of the film: one with and one without certain graphical features (e.g., a lighting effect or shader). Collect feedback on which version they prefer and why.
    b. Aesthetic and Emotional Impact: Gauge if the graphical elements, including shaders and animation, evoke the intended emotional or stylistic impact from

the viewer. Does the viewer feel immersed in the style of the film, or is the effect too jarring or distracting?

4. Progression and Iteration:
   a. Continuous Improvement: Assess how the project evolves over time. Are the graphics quality, animation smoothness, and shader effects improving with each iteration? Are changes being made in response to performance tests and feedback?
   b. Documentation of Changes: Maintain a log or journal documenting major changes, challenges, and decisions made during the iteration process. This helps to track progress and with your reporting.
5. Final Product Quality:
   a. Polish and Presentation: The final submission should have a high level of polish, demonstrating an understanding of the technical aspects and artistic choices. Does the final product look cohesive, with well-executed shaders, lighting, and animations that enhance the chosen style?
   b. Viewer Engagement: Ultimately, the success of the film will depend on how well it engages the viewer through both visual quality and smooth performance, with a clear balance between the artistic vision and technical execution.

**For this brief, what might a minimum pass (e.g. 3rd) student project look like?**

- The film can be loaded, started and finished without major bugs/crashes.
- The game makes use of GPU shaders and Unity's lighting and animation techniques
- The visual output is of poor quality and/or does not come together into a coherent style
- Written report lacks research, detail of process, issues encountered in production, and/or doesn't name influences or audio-visual assets used appropriately.

**For this brief, what might a good (e.g. 2:2 – 2:1) student project look like?**

- Film runs well without bugs.
- The gameplay makes good use of moderately complex GPU shaders, animation and lighting techniques to create a coherent visual style
- The graphical style is of good quality
- Written report makes clear the challenges faced and how they were overcome. Makes clear the influences and techniques that went into the film
- Audio-visual assets appropriately credited.
- Viewer feedback is clearly gathered, well-presented and acted on.

**For this brief, what might an outstanding (e.g. 1st) student project look like?**

- Film is highly-polished technically, and in terms of Graphical presentation.
- It makes use of very advanced, or original GPU shader, animation and lighting techniques
- The graphical quality is approach or reaching professional standards

- Written report has excellent and concise writing style. Research and influences behind the project are clear and detailed, with extensive analysis of background works.
- Extensive viewer feedback has been gathered and documented and it's very clear how this has been incorporated into the iterative development of the film.

# 10 CM3050 Mobile Development

## 10.1 Project Idea 1: Developing a Mobile App for Local Disaster Preparedness and Response

**What problem is this project solving, or what is the project idea?**

Natural disasters and emergencies often catch communities off guard due to inadequate preparation and lack of access to reliable information. This project involves developing a mobile app to assist users in preparing for disasters, offering real-time guidance during emergencies, and connecting them with local support networks.

**What is the background and context to the question or project idea above?**

Climate change has led to a rise in natural disasters, making disaster preparedness more critical than ever. Many communities lack tools that provide personalised, actionable guidance during emergencies. This project will create a mobile app that gamifies preparedness (e.g., checklists, quizzes) while offering real-time features like location- based alerts, step-by-step response guidance, and access to local resources during emergencies. By leveraging gamification and real-time mobile capabilities, this app aims to make disaster preparedness engaging and effective.

**Here are some recommended sources for you to begin your research.**

**Books:** 'Emergency Management for the 21st Century' by Claire B. Rubin.

**Papers:** Research on gamification in mobile applications and disaster management tools

- Kankanamge, N., Yigitcanlar, T., Goonetilleke, A. and Kamruzzaman, M., 2020. How can gamification be incorporated into disaster emergency planning? A systematic review of the literature. International Journal of Disaster Resilience in the Built Environment, 11(4), pp.481-506.
- Matsuno, Y., Fukanuma, F. and Tsuruoka, S., 2021. Development of flood disaster prevention simulation smartphone application using gamification. Dynamics of Disasters: Impact, Risk, Resilience, and Solutions, pp.147-159.

**Apps:** Research popular disaster apps such as the UK Met Office Weather Alerts app, and British Red Cross Emergency app.

**What would the final product or final outcome look like?**

The final product will be a functional mobile app with:

- Disaster preparedness gamification (e.g., checklists, tasks, badges, rewards and quizzes).
- Location-based alerts and notifications for emergencies.
- A resource hub with local contact information and safety guidelines.

**What would a prototype look like?**

The prototype would demonstrate

- One gamified preparedness task (e.g. building a safety kit).
- Location-based notifications for a simulated emergency.
- A basic resource hub with static information.

**What kinds of techniques/processes/CS fundamentals are relevant to this project?**

- Gamification design principles.
- Iterative testing and user feedback.

**What would the output of these techniques/processes/CS fundamentals look like?**

- Functional app prototypes with core features.
- Documentation of gamification logic and API integration.
- Usability testing results and iteration reports.

**How will this project be evaluated and assessed by the student (i.e. during iteration of the project)? What criteria are important?**

**Functionality:** Stability and effectiveness of app features.
**Engagement:** Quality and effectiveness of gamified elements.
**Educational Value:** Accuracy and usefulness of disaster preparedness content.

**For this brief, what might a minimum pass (e.g. 3rd) student project look like?**

A basic app with minimal features and limited interactivity.

Evidence of effort but no iterative design or user feedback.

**For this brief, what might a good (e.g. 2:2 – 2:1) student project look like?**

A fully functional app with multiple gamified tasks and basic real-time features.

Documentation of user testing and iteration based on feedback.

**For this brief, what might an outstanding (e.g. 1st) student project look like?**

A polished app with advanced gamified features, seamless real-time alerts, and strong community resources.

Thorough documentation of testing, iteration, and impact on disaster preparedness.

## 10.2 Project Idea 1: Developing a Gamified AR App for Eco-Conscious Urban Exploration

**What problem is this project solving, or what is the project idea?**

Sustainability awareness is often low in urban populations, and there's a need for engaging tools to educate people about eco-conscious practices in their local environments. This project involves building a mobile app that uses gamification and AR to encourage users to explore their surroundings and learn about sustainability.

**What is the background and context to the question or project idea above?**

With urbanisation and climate change, fostering sustainability awareness is critical. The app "Sustainability Detective" will gamify urban exploration, assigning players missions such as identifying green buildings, energy-efficient practices, or recycling facilities. Using AR overlays, the app will display information and provide real-time feedback, rewards, and achievements. This approach blends education with fun to encourage active participation in sustainability initiatives.

**Here are some recommended sources for you to begin your research.**

**Books:** "Making Sustainability Measurable: A Practical Book for Sustainable Living and Working" by Michael Wühle.

**Research on gamification and AR in mobile applications and Sustainability:**

1. Spanellis, A., Harviainen, J.T., Fernández Galeote, D. and Thibault, M., 2024., "Gamification for Sustainable Development. Simulation & Gaming", 55(3), pp.361-365.
2. Scurati, G.W., Ferrise, F. and Bertoni, M., 2020. Sustainability awareness in organizations through gamification and serious games: a systematic mapping. DS 101: Proceedings of NordDesign 2020, Lyngby, Denmark, 12th-14th August 2020, pp.1-10.
3. Strada, F., Lopez, M.X., Fabricatore, C., dos Santos, A.D., Gyaurov, D., Battegazzorre, E. and Bottino, A., 2023. Leveraging a collaborative augmented reality serious game to promote sustainability awareness, commitment and adaptive problem-management. International Journal of Human-Computer Studies, 172, p.102984.
4. Cosio, L.D., Buruk, O.O., Fernández Galeote, D., Bosman, I.D.V. and Hamari, J., 2023, April. Virtual and augmented reality for environmental sustainability: A systematic review. In Proceedings of the 2023 chi conference on human factors in computing systems (pp. 1-23).

**Apps:** Explore apps like Pokemon Go for AR implementation.

**APIs:** Google Maps API, ARCore/ARKit.

**What would the final product or final outcome look like?**

- At least one mission using AR to highlight eco-friendly practices or spaces.
- A gamified system with points, leaderboards, and challenges.

- Educational content integrated into the app.

**What would a prototype look like?**

- A single mission demonstrating AR functionality (e.g., identifying recycling bins).
- A simple leaderboard and points system.
- Basic UI for navigation and mission display.

**What kinds of techniques/processes/CS fundamentals are relevant to this project?**

Gamification design principles.
Integration of sustainability datasets.
Mobile development using React Native.
AR development (ARKit, ARCore).

**What would the output of these techniques/processes/CS fundamentals look like?**

A functional AR-enabled app prototype.
Documentation of the points system and AR logic.
User testing logs for gamification effectiveness.

**How will this project be evaluated and assessed by the student (i.e. during iteration of the project)? What criteria are important?**

**Functionality:** Stability and effectiveness of app features.
**Engagement:** Quality and effectiveness of AR and gamified elements.
**Educational Value:** Accuracy and usefulness of sustainability content.

**For this brief, what might a minimum pass (e.g. 3rd) student project look like?**

A basic app with limited AR functionality and minimal gamification.
Evidence of effort but limited design iteration or user feedback.

**For this brief, what might a good (e.g. 2:2 – 2:1) student project look like?**

A fully functional app with multiple gamified missions and basic AR features.
Evidence of usability testing and design iteration based on feedback

**For this brief, what might an outstanding (e.g. 1st) student project look like?**

A polished app with advanced AR functionality, engaging gamification mechanics, and rich educational content.
Strong documentation of testing, design iteration, and impact on user engagement and learning.

# 11 CM3055 Interaction Design

## 11.1 Project Idea 1: Designing an Online Empathy Simulation to Help Caregivers

**What problem is this project solving, or what is the project idea?**

Caregivers often struggle to fully understand the emotional and physical challenges faced by those they care for. This project aims to create an online empathy simulation tool that helps caregivers' step into the shoes of their care recipients, fostering greater empathy and understanding.

**What is the background and context to the question or project idea above?**

Caregiving is a demanding role that requires not just physical effort but emotional intelligence and compassion. Yet, caregivers frequently lack experiential tools to deeply connect with the realities of their care recipients' lives, such as living with dementia, physical disabilities, or chronic conditions. This project explores how interaction design can create immersive scenarios that replicate these challenges, allowing caregivers to experience these realities firsthand. By incorporating reflective feedback and user-centric design, this tool will help caregivers develop the empathy needed to provide more compassionate and effective care.

**Here are some recommended sources for you to begin your research.**

**Books:** 'Empathy: Why It Matters, and How to Get It' by Roman Krznaric.
**Web Resources:** AbleGamers Accessibility Guidelines, W3C Accessibility Standards.
**Papers:** Research on VR and AR tools for empathy training in healthcare:

- **2023:** Zwolinski, G., Kaminska, D., Haamer, R.E., Pinto-Coelho, L. and Anbarjafari, G., 2023. Enhancing empathy through virtual reality: Developing a universal design training application for students. Medycyna Pracy, 74(1), pp.199-210.
- **2017:** Foster, A., Trieu, M., Azutillo, E., Halan, S. and Lok, B., 2017. Teaching empathy in healthcare: From mirror neurons to education technology. Journal of Technology in Behavioral Science, 2, pp.94-105.

**What would the final product or final outcome look like?**

The final product will be an interactive online platform that features immersive caregiving scenarios. Users will complete simulated tasks that replicate challenges like navigating spaces with limited mobility or responding to a care recipient with cognitive impairments.

The platform will include

- Reflection prompts.
- Accessibility features (e.g., high-contrast mode, text-to-speech).
- Clear design demonstrating empathy-building principles.

**What would a prototype look like?**

The prototype would demonstrate at least one interactive scenario (e.g., managing daily tasks as someone with arthritis) and include:

- A basic user interface with interactive elements.
- Accessibility features.
- Reflective feedback and insights after completing the scenario.

**What kinds of techniques/processes/CS fundamentals are relevant to this project?**

- Interaction design and user journey mapping.
- Rapid prototyping using tools like Figma, ProtoPie, or Unity.
- Usability testing with caregiver-focused groups.
- Accessibility compliance (WCAG standards).

**What would the output of these techniques/processes/CS fundamentals look like?**

- Annotated wireframes and interactive prototypes.
- User testing documentation and iteration logs.
- Reports on usability and empathy-building effectiveness.

**How will this project be evaluated and assessed by the student (i.e. during iteration of the project)? What criteria are important?**

- Immersiveness of scenarios.
- Quality of interaction design (e.g., clarity, ease of use).
- Accessibility and user inclusivity.
- Evidence of user testing and feedback incorporation.

**For this brief, what might a minimum pass (e.g. 3rd) student project look like?**

- A single functional scenario with basic interactions and minimal accessibility features.
- Limited usability testing, but a clear design concept.

**For this brief, what might a good (e.g. 2:2 – 2:1) student project look like?**

- Multiple scenarios, each demonstrating unique empathy-building challenges.
- Evidence of iterative design and user testing.

**For this brief, what might an outstanding (e.g. 1st) student project look like?**

- A highly polished platform with diverse and innovative scenarios.
- Extensive usability testing and strong documentation of design evolution.
- Clear evidence of impact on caregiving practices.

## 11.2 Project Idea 2: Designing an Emotion-Aware Adaptive Email and Task Manager to Reduce Workplace Stress

**What problem is this project solving, or what is the project idea?**

Workplace stress is a significant challenge, especially when employees are overwhelmed with emails, deadlines, and task lists. Traditional email and task management tools can increase stress by bombarding users with complex interfaces, too many notifications, and no support for mental well-being. This project aims to develop an emotion-aware email and task management interface that detects user stress levels and adapts the experience to provide a calmer, more supportive workspace.

**What is the background and context to the question or project idea above?**

In a fast-paced work environment, email overload and constant task management contribute to stress and burnout. Emotion-aware systems offer a solution by adapting to a user's emotional state. This project focuses on an email and task manager application that uses emotion detection to tailor its interface. For example, if the user appears stressed, the system might reduce notification frequency, prioritise critical emails, or switch to a simplified interface. It can also provide features like calming themes, motivational prompts, and short stress-relief activities. This application promotes productivity while supporting emotional well-being in a demanding work environment.

**Here are some recommended sources for you to begin your research.**

**Books:** 'Affective Computing' by Rosalind Picard; 'The Paradox of Choice' by Barry Schwartz.

**APIs:** Affectiva Emotion AI, Microsoft Azure Face API; Applications like Microsoft Outlook Focused Inbox or Notion for inspiration.

**Papers:** Research on email overload and task management stress (e.g., studies on decision fatigue in work environments

**2020:** Pignatiello, G.A., Martin, R.J. and Hickman Jr, R.L., 2020. Decision fatigue: A conceptual analysis. Journal of health psychology, 25(1), pp.123-135.

**2017:** Decision-making processes in the workplace: How exhaustion, lack of resources and job demands impair them and affect performance. Frontiers in psychology, 8, p.313

**What would the final product or final outcome look like?**

The final product will be a functional prototype of an email and task manager app that:

- Detects stress levels via facial expressions, typing speed, or voice tone.
- Dynamically adapts features, such as:
  - Simplified UI to highlight high priority emails or tasks.
  - Reduction of notifications during stress peaks.
  - Stress-relief options like short guided breathing exercises or calming themes.

**What would a prototype look like?**

The prototype would demonstrate a basic interface for email and task management with:

- Emotion detection integrated via APIs.
- A responsive interface demonstrating adaptive UK changes based on simulated user stress.
- A sample adaptive feature (e.g. hiding non-urgent tasks or emails).
- Interactive elements that modify information display (e.g. minimising clutter, restructuring task lists).
- At least one stress-relief feature, such as a pop-up suggestion to take a break or a calming visual theme. Subtle real-time feedback mechanisms, such as colour shifts, progressive disclosure of information, or personalised UI suggestions.

**What kinds of techniques/processes/CS fundamentals are relevant to this project?**

- UX research on stress-reducing design elements (e.g., minimalistic design, priority sorting).
- Integration of interaction design principles, including cognitive load management and adaptive UI behaviours.
- Integration of emotion detection tools like Affectiva or Azure.
- Prototyping with user scenarios, using tools like Figma, Adobe XD, or ProtoPie to simulate real-world interactions.
- User testing methodologies, gathering insights on how emotional responsiveness impacts usability and engagement with participants in simulated workplace settings.

**What would the output of these techniques/processes/CS fundamentals look like?**

- A high-fidelity prototype demonstrating emotion-responsive UI interactions.
- Annotated user flows illustrating how the interface adapts to different stress levels.
- Testing reports evaluating interaction effectiveness and stress mitigation.

**How will this project be evaluated and assessed by the student (i.e. during iteration of the project)? What criteria are important?**

- Interaction quality: Effectiveness of adaptive UI in enhancing user experience.
- Technical Implementation: Integration of emotion detection and adaptive interface elements.
- Usability: Ease of use, accessibility and effectiveness of stress-reducing features.
- Relevance: Ability to address common workplace stressors like email overload and task prioritisation.
- Testing and User feedback Integration: Evidence of user testing and iteration based on feedback.

**For this brief, what might a minimum pass (e.g. 3rd) student project look like?**

- A prototype that integrates emotion detection and demonstrates one adaptive feature.
- Limited usability testing, with a basic concept of how the tool reduces stress.

**For this brief, what might a good (e.g. 2:2 – 2:1) student project look like?**

– A prototype with multiple adaptive features (e.g., simplified UI and stress-relief options).
- Evidence of usability testing, including participant feedback on stress-reduction effectiveness.

**For this brief, what might an outstanding (e.g. 1st) student project look like?**

- A polished prototype with seamless emotion detection, multiple adaptive features, and innovative stress-reduction elements (e.g., personalised relaxation techniques).
- Extensive user testing and strong documentation of design iterations.
- Clear evidence of the app's potential real-world impact in reducing workplace stress. A clear demonstration of how interaction design principles improve workplace well-being.

# 12 CM3060 Natural Language Programming

## 12.1 Project Idea 1: Identifying research methodologies that are used in research in the computing disciplines.

**What problem is this project solving, or what is the project idea?**

**What is the background and context to the question or project idea above?**

All research should be guided by a process that begins with the researcher's philosophical world view and then details why the research has value, how the research was done, and why the particular approach was used. In addition, this process should be made known to the research community. The "how" and "why" are the chosen research methodology. The idea behind this project is to take published research (journal articles, theses, etc.) in the computing fields, determine the computing discipline (Computer Science, Information Systems, Information Technology, etc.), determine the field within the discipline and then determine what research methodologies are used in these publications.

**Here are some recommended sources for you to begin your research.**

D Jurafsky and J Martin. Speech and Language Processing. An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition with Language Models, Third Edition draft, University of Colorado at Boulder

B. J. Oates. Researching Information Systems and Computing. SAGE, London, 2006.

C. Pilkington and L. Pretorius. A conceptual model of the research methodology domain. In Proceedings of the 7th International Joint Conference on Knowledge Discovery, Knowledge Engineering and Knowledge Management (IC3K 2015) - Volume 2: KEOD, pages 96–107, Lisbon, Portugal, November 2015.

The Natural Language Toolkit `https://www.nltk.org`

**What would the final product or final outcome look like?**

A system that classifies research publications according to computing discipline, field and the research methodologies used in that publication.

**What would a prototype look like?**

Some progress on the way to achieving the above.

**What kinds of techniques/processes/CS fundamentals are relevant to this project?**

Natural Language Processing – Information Retrieval in particular, but the whole spread of NLP is in the frame for this project.

Depending on the approach taken, some Machine Learning techniques.

Some of the NLP ‘black box’ approaches as appropriate.

**What would the output of these techniques/processes/CS fundamentals look like?**

A research methodology classification pipeline for the computing disciplines.

**How will this project be evaluated and assessed by the student (i.e. during iteration of the project)? What criteria are important?**

Depending on the approach taken, the relevant and appropriate metrics should be used to obtain feedback as to whether the approach is suitable, and there should be some points at which possible other approaches are considered and justified.

**For this brief, what might a minimum pass (e.g. 3rd) student project look like?**

A system that is able to take a publication as input, and isable to determine the computing discipline.

**For this brief, what might a good (e.g. 2:2 – 2:1) student project look like?**

As above, but able to also identify field within the discipline.

**For this brief, what might an outstanding (e.g. 1st) student project look like?**

A complete working classification pipeline that gives useful output.

# 13 CM3065 Intelligent Signal Processing

## 13.1 Project Idea 1: Gamified Smart Environment to Promote Mental and Physical well-being in our Everyday Life

**What problem is this project solving, or what is the project idea?**

This project aims to develop a creative robotic or Internet-of-things (IoT) based solution to tackle mental health well-being and promote physical activities for vulnerable individuals in the age of a hyper-connected world.

**What is the background and context to the question or project idea above?**

In the era of remote working and digital stream streaming services, mental health and obesity-related health concerns are on the rise in developed and developing countries around the world. This project aims to investigate potential opportunities to utilise IoT devices that are now pervasive in our everyday lives (i.e., smart speakers, smart mirrors, smart furniture, smart utensils, smart rings, smart clothes, ...) to develop a creative gamified solution to promote physical activities, reduce mental health impacts such as stress and anxiety.

**Here are some recommended sources for you to begin your research.**


- C. P. Obeng, V. Tsui, M. Mahmoud, S. Sandhu, R. Striker and E. Alvarez, "Enhancing Cybersecurity Awareness in Medical IoT through Gamification with a Card Game Approach," 2024 Cyber Awareness and Research Symposium (CARS), Grand Forks, ND, USA, 2024, pp. 1-5, doi: 10.1109/CARS61786.2024.10778688.
- M. Rane, R. Khanke, K. Kharat, K. Kolhe, R. Mane and J. Vaidya, "A Machine Learning Enabled Approach for Mental and Physical Health Management Using OpenCV, NLP and IOT," 2024 International Conference on Emerging Smart Computing and Informatics (ESCI), Pune, India, 2024, pp. 1-8, doi: 10.1109/ESCI59607.2024.10497431.
- F. Yakub, A. Azizan, I. Dhamanti, A. Z. M. Khudzari, N. Govindan and M. Muljono, "Smart Happy Device with IoT : For those who suffer anxiety, stress, and depression," 2024 IEEE 12th Region 10 Humanitarian Technology Conference (R10-HTC), Kuala Lumpur, Malaysia, 2024, pp. 1-6, doi: 10.1109/R10-HTC59322.2024.10778904.
- P. K. Dhal, T. Sivakumar, B. Vasudevan, V. T. Lakshmi, B. Muthaiyan and S. Murugan, "Mindful Breathing Coaches Using IoT-Integrated AI Systems for Personalized Anxiety Relief," 2024 First International Conference on Innovations in Communications, Electrical and Computer Engineering (ICICEC), Davangere, India, 2024, pp. 1-6, doi: 10.1109/ICICEC62498.2024.10808269.
- S. Subha, N.Mohankumar, A. S. Rao, A. Ayub Khan, I. M. V and S. Murugan, "IoT's Role in Personalized Dietary Support for Mental Health using RNN Model," 2024 Third International Conference on Electrical, Electronics, Information and Communication Technologies (ICEEICT), Trichirappalli, India, 2024, pp. 1-6, doi: 10.1109/ICEEICT61591.2024.10718428.

**What would the final product or final outcome look like?**

A bespoke gamified IoT-based end product which creatively engages mind and physical activities throughout the day. The end product would have a backend server application to manage and track users' activities over a period which can then be used to learn from their interactions to potentially change the level of difficulties of games or the needs of the users over time using machine learning/AI techniques.

**What would a prototype look like?**

A bespoke gamified IoT-based end product could have collections of microcontrollers (i.e., ESP32-CAM) or/and make use of existing IoT devices in the house like smart speakers to recognise people and proposed personalised mental, physical or hybrid challenges.

**What kinds of techniques/processes/CS fundamentals are relevant to this project?**

This project encourages individuals to engage in cognitive game development while learning to program microcontrollers using libraries such as TensorFlow to recognise individual interactions and other microcontrollers/devices to conduct the gameplay/ scenario.

**What would the output of these techniques/processes/CS fundamentals look like?**

The output of this project will be a collection of physical devices which can be statically installed pervasively in the home environment and become part of their daily routine or a robot that can be a buddy/ companion which encourages mental and physical activities.

**How will this project be evaluated and assessed by the student (i.e. during iteration of the project)? What criteria are important?**

Investigating a suitable mental, physical and hybrid gaming model which can motivate individuals with various incentives to repeatedly use the system over time without causing inconvenience or burden in their everyday activities. Developing a prototype based on the gaming model to improve mental and physical engagement using gaming techniques.

**For this brief, what might a minimum pass (e.g. 3rd) student project look like?**

Pass projects should be able to demonstrate a suitable prototype which encourages individuals to take part in daily mental and physical gaming challenges.

**For this brief, what might a good (e.g. 2:2 – 2:1) student project look like?**

Merit projects should be able to engage users in their gameplay with an appropriate level of incentives and gaming experience created using embedded IoT devices or robots.

**For this brief, what might an outstanding (e.g. 1st) student project look like?**

An outstanding project not only engages users to take part in IoT-based gameplay to improve mental and physical activities but also adapts to the changing needs of the users over time.

## 13.2 Project Idea 2: Multi-human Detection and Activities Tracking in a Shared Space

**What problem is this project solving, or what is the project idea?**

This project aims to detect, identify individuals and track their activities within a smart space using live image and audio signals. Based on the individual activities, personalised support or early predictions of health-related issues could be performed in the future.

**What is the background and context to the question or project idea above?**

Emerging ambient assisted living systems are being developed to support individuals conduct activities of daily living by themselves. However, these systems are unable to accurately tell who is performing what activities in a shared living environment in order to provide personalised support. These activities conducted by individuals in shared space may have a common goal or they are conducting their own parallel activities. Another aspect of this project is the privacy concerns when using computer vision and audio signalling methods on cloud computing resources that are also costly for the end user and take huge amount of energy to communicate over busy network connections. One area of investigation is adapting hybrid edge and cloud computing paradigms to perform model training in the cloud and supporting and storage locally on resource constrained edge devices.

**Here are some recommended sources for you to begin your research.**

T. Nakabayashi and H. Saito, "Multimodal Human Activity Recognition on Edge Devices," 2024 IEEE International Symposium on Mixed and Augmented Reality Adjunct (ISMAR-Adjunct), Bellevue, WA, USA, 2024, pp. 136-140, doi: 10.1109/ISMAR-Adjunct64951.2024.00037.

S. Golipoor and S. Sigg, "RFID-based Human Activity Recognition Using Multimodal Convolutional Neural Networks," 2024 IEEE 29th International Conference on Emerging Technologies and Factory Automation (ETFA), Padova, Italy, 2024, pp. 1-6, doi: 10.1109/ETFA61755.202

Q. Li, R. Gravina, C. Savaglio and G. Fortino, "A BSN-Enabled Collaborative Edge-Cloud Architecture for Multi-User Activity Recognition," 2023 19th International Conference on Distributed Computing in Smart Systems and the Internet of Things (DCOSS-IoT), Pafos, Cyprus, 2023, pp. 774-779, doi: 10.1109/DCOSS-IoT58021.2023.00121.

S. Cao and X. Huang, "The 24-Type Tai Chi Classic Motion System Based on Kinect Motion Capture in Mobile Edge Computing," in IEEE Access, vol. 12, pp. 146453-146462, 2024, doi: 10.1109/ACCESS.2024.3452553.

S. Cristina, V. Despotovic, R. Pérez-Rodríguez and S. Aleksic, "Audio- and Video-Based Human Activity Recognition Systems in Healthcare," in IEEE Access, vol. 12, pp. 8230-8245, 2024, doi: 10.1109/ACCESS.2024.3353138.

M. Moreaux, M. G. Ortiz, I. Ferrané and F. Lerasle, "Benchmark for Kitchen20, a daily life dataset for audio-based human action recognition," 2019 International Conference on Content-Based Multimedia Indexing (CBMI), Dublin, Ireland, 2019, pp. 1-6, doi: 10.1109/CBMI.2019

**What would the final product or final outcome look like?**

A bespoke software application that captures live or pre-recorded videos & other sensor inputs to identify multiple humans and track their activities over a given timeframe. An annotated dataset based on multi-human activities being tracked could further be the outcome of this project.

**What would a prototype look like?**

A bespoke software that could be deployed onto IoT-based end product such as microcontrollers (i.e., ESP32-CAM/ Raspberry Pi) process audio/video and other sensor signals to identify & track individuals activities.

**What kinds of techniques/processes/CS fundamentals are relevant to this project?**

This project encourages individuals to engage in multimodal signal processing (i.e., vision, audio and other non-/binary sensor data) while learning to potentially program microcontrollers using libraries such as TensorFlow to recognise individual interactions and other microcontrollers/devices to conduct the activities of daily living.

**What would the output of these techniques/processes/CS fundamentals look like?**

The output of this project will be a software application that could run on the edge devices (such as Raspberry Pi/ PC) to monitor multi human activities in a shared space after the model being trained on a cloud device.

**How will this project be evaluated and assessed by the student (i.e. during iteration of the project)? What criteria are important?**

Investigating a suitable approach to perform image/ audio recognition on resource constrained devices and iteratively testing the performance and suitability to recognise small subset of human activities.

**For this brief, what might a minimum pass (e.g. 3rd) student project look like?**

Pass projects should be able to demonstrate a suitable a prototype which could run on their own PC/ edge device and processes vision/ audio signals to detect and track at least two types multi-human activities. In addition, attempting to producing an annotated dataset with suitable documentations to allow modelling and training more accurate AI/ML models would be a good contribution.

**For this brief, what might a good (e.g. 2:2 – 2:1) student project look like?**

Merit projects should be able to demonstrate hybrid edge & cloud computing paradigm in a suitable a prototype and processes vision/ audio signals accurately to detect at least types of multi-human activities. In addition, good size annotated dataset produced from the software developed with suitable documentations to allow modelling and training

more accurate AI/ML models would enhance the project further.

**For this brief, what might an outstanding (e.g. 1st) student project look like?**

An outstanding project should be able to demonstrate hybrid edge & cloud computing paradigm prototype that processes vision/ audio signals to accurately and robustly detect and track two or more types of multi-human activities. The production of labelled dataset with a well-documented procedures and activities carried out that can be publishable with the consent of the participants.