## Project Plan

Project Title:Fraudulent Transactions detection using Retrieval Augmented Generation (RAG)

Research Question:   
How effective is Retrieval-Augmented Generation (RAG) in detecting anomalies in payment transactions compared to traditional machine learning methods?

### Project Objectives:

Assess the capability of RAG in detecting payment anomalies.  
Compare the effectiveness of RAG with traditional anomaly detection techniques.  
Develop a RAG-based model tailored for the detection of fraudulent transactions.

### Summary of Project and Background:

Payment anomalies, such as fraudulent transactions, pose significant risks to financial institutions and their customers. Traditional anomaly detection methods often rely on predefined rules or supervised learning models that may fail to capture novel or evolving patterns of fraud. Retrieval-Augmented Generation (RAG) combines retrieval-based and generative models, leveraging large datasets to enhance the detection of anomalies.

This project aims to explore the efficacy of RAG in identifying anomalous payment transactions. RAG integrates a retrieval component that fetches relevant information from a database and a generative component that synthesizes this information to make informed predictions. By utilizing this approach, the project seeks to improve the detection of subtle and complex anomalies that traditional models might overlook.

The research will involve collecting and preprocessing a dataset of payment transactions, implementing the RAG model, and comparing its performance to conventional methods such as logistic regression, decision trees, and neural networks. The effectiveness of RAG will be measured using metrics such as precision, recall, and F1 score.

#### Reference List: Correa Bahnsen, A., Aouada, D., Stojanovic, A., & Ottersten, B. (2016). Feature engineering strategies for credit card fraud detection. Expert Systems with Applications, 51, 134-142. doi:https://doi.org/10.1016/j.eswa.2015.12.030. Lewis, P., Perez, E., Piktus, A., Petroni, F., Karpukhin, V., Goyal, N., Küttler, H., Lewis, M., Yih, W., Rocktäschel, T., Riedel, S., & Kiela, D. (2021). Retrieval-Augmented Generation for Knowledge-Intensive NLP Tasks. arXiv.org. doi:https://doi.org/10.48550/arXiv.2005.11401.

Raghavan, P., & Gayar, N. E. (2019). Fraud Detection using Machine Learning and Deep Learning. IEEE Xplore. doi:https://doi.org/10.1109/ICCIKE47802.2019.9004231.

## Task List and Project Timeline

### Task List:

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| **Task** | **Description** |
| Preparing PDM Plan | Develop a Project and Data Management Plan outlining project objectives, methodologies, and data management strategies. |
| Submission of PDM Plan | Assignment: Submit PDM Plan |
| Data Collection and Preprocessing | Gather and preprocess necessary data for analysis and model development. |
| Feature Engineering | Engineer relevant features from collected data to improve model performance. |
| Explorative Data Analysis (EDA) | Perform exploratory analysis to gain insights into the dataset and identify patterns. |
| Data Ethics Quiz | Assignment: Attend Ethics Quiz |
| Experiments of Traditional models | Conduct experiments using traditional machine learning models to establish baseline performance. |
| Model Implementation (RAG) | Implement selected models, ensuring adherence to Responsible AI Guidelines (RAG). |
| Model Training and Testing | Train and test models using collected data to assess performance and adjust parameters. |
| Performance Evaluation | Evaluate model performance against predefined metrics and analyze results. |
| Model Optimizations | Fine tuning the model to result promising results |
| Comparative Analysis | Compare the performance of different models and methodologies to identify strengths and weaknesses. |
| Literature review and Report writing | Compile project findings, methodologies, and results into a comprehensive report with proper documentation. |
| Final Review | Conduct a final review of the project, ensuring all aspects are complete and meet requirements. |
| Buffer | Allocate buffer time for any unforeseen delays or additional tasks. |
| Final Project Report + Logbook Submission | Assignment: Submit the final project report along with the logbook documenting project activities and progress. |
| Preparation for Viva | Prepare for the viva session |
| Viva | Assignment: Participate in Viva |

Timeline:  
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Description automatically generated with medium confidence

## Data Management Plan

Data Overview: The dataset, collected and synthesized by BankSim, uses an aggregated sample of transactional data from a Spanish bank. Its primary purpose is to generate synthetic data for fraud detection research.

### Data Collection:

#### The dataset is available for download as a .csv file from the Kaggle repository (Link: [Kaggle BankSim Dataset](https://www.kaggle.com/datasets/ealaxi/banksim1/data))

#### Summary of data: This dataset contains historical data on 594,643 transactions from 4,112 unique users. The target variable (fraud) identifies fraudulent payments, while the remaining seven columns include a time step identifier, personal information about the payer (such as an identifier, age, and gender), and transaction details (including merchant, category, and amount). The dataset is 46.7 MB in size. Document Control:

GitHub Repository: [fraud-detection-rag](https://github.com/21062872/fraud-detection-rag.git)  
GitHub repository will be utilized for version control and documentation of the project. All code, data, and documentation files will be stored in the repository, ensuring accessibility and traceability of changes throughout the project's lifecycle.

File Naming Conventions:  
Code Files: module-name\_version\_number.py (e.g., data\_preprocessing\_v1.0.py)  
Data Files: dataset\_name\_version\_number.csv (e.g., transaction\_data\_v1.0.csv)  
Documentation: document\_name\_version\_number.docx (e.g., project\_plan\_v1.0.docx)  
Reports/Visualizations: report\_name\_version\_number.pdf (e.g., evaluation\_report\_v1.0.pdf)  
Version Control:  
I will be using the ‘main’ branch to store stable versions of the code and the ‘development’ branch for ongoing development. Once the development of a particular file is complete and tested, it will be merged into the main branch. A comprehensive README file will be included in the GitHub repository, providing detailed instructions and information about the code.  
Security and storage: Backups of the project repository will be performed weekly to ensure data integrity and minimize the risk of data loss. These will be stored securely on Google cloud, with restricted access.

Ethical Requirements:  
GDPR Compliance:  
The dataset does not contain personal information or disclose legal and private customer transactions. Therefore, it meets the GDPR requirements as it does not involve the processing of personal data. The synthetic nature of the data ensures that privacy and confidentiality are maintained.  
Conformity to UH Ethical Policies: Yes, the data is anonymized.  
Permission to Use Data:  
The dataset is openly available for academic and research purposes, as stated by BankSim. *(Link:* [*Kaggle BankSim Dataset*](https://www.kaggle.com/datasets/ealaxi/banksim1/data)*)*Ethical Data Collection:  
The dataset was collected, synthesized, and validated using statistical and Social Network Analysis (SNA) techniques by the original creators of the dataset. The dataset does not contain any personal or sensitive information, ensuring that ethical standards were maintained during the data collection process.