



**London South Bank
University**

SCHOOL OF ENGINEERING

Implementing AI powered virtual assistance capabilities on Edu-Cloud using Open AI GPT-3 Models

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MSC in Data science

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Abstract

In recent times, the advancements in the field of Artificial Intelligence has created immense possibilities to build intelligent software systems. Edu-Cloud is a proposed cloud based solution aimed to create an all in one Educational platform that would provide students with technical and soft skills. Applying the current AI technology can help Edu-Cloud to comply with its objectives. In this dissertation, A end to end software solution has been designed and developed that leverages Open AI's GPT-3 models APIs to make Edu-Cloud a smart solution that would provide AI assistance to students. To implement the infrastructure of Edu-Cloud's AI features, MERN stack which is a Full-Stack based framework has been used.

This dissertation's primary objective is to harness the capabilities of AI to enhance the educational journey. There are plethora of AI features in Edu-Cloud AI that showcases the immense application of Artificial Intelligence in the Education sector. For example, Automated book chapter summarization, various contents such as books, courses, and academic paper recommendations, Students Query system, Assignment Feedback, AI exam tips generation on a particular topic, AI Roadmap generation etc. Edu-Cloud AI empowers both the students and the teacher, making learning a fun and collaborative experience.

Also another important aspect of this study is the personalization and customization of the responses generated by the GPT-3 models. The models were re-trained and Fine-tuned using custom datasets .

In this study, it would be tested and analysed how artificial intelligence can shape the future education system. Various tests have been conducted in order to gain insights on how Edu-Cloud AI can assist students in their learning outcomes. Also various findings, insights and limitations are discussed to find a overall notion of the project.

Finally, A complete system was developed which showcase the immense capabilities of the artificial intelligence in education sector. Also Future development and ideas that can improve the system are discussed in this dissertation. This project shows that AI technology can make education better without replacing real teachers. It's about learning that's easy, fun, and for everyone, no matter where you are. This project is a glimpse into the future of education, where learning has no limits.

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Chapter 1

Introduction

Artificial intelligence (AI) has revolutionized almost every sectors of human life in modern society. It has successfully emulated human behaviour and intelligence in many aspects , and AI is only getting smarter and better. AI is capable of performing human task with utmost precision which would lessen human efforts in many sectors. The main purpose of AI is to solve various complex problems that can adapt to different situations and learn from it . In most cases Artificial Intelligence differs with human level intelligence for example, thinking ability -humans think with emotion but machines do not think , but only calculates (**Anwer, T., 2018**). Applying AI in education sector can be great beneficial for both teachers and students who can make use of immense possibilities of AI to benefit their causes.

There are many existing education based platforms that tries to emulate physical classroom environment to a online-based platform. But most of them fails to bring the true essence of physical classroom and the education is mostly discrete and disorganized. The main benefit of using a virtual classroom platform is that students can access high level study materials which are selected and provided by instructors. Another benefit of using a virtual classroom platform is serving a large number of students which is quite difficult to organize physical classrooms (**Sgouropoulou, C., 2022**). So a online Education platform which can emulate physical classroom with utmost precision can benefit students at a mass. Edu-Cloud is a proposed cloud based platform that addresses the design of such a sophisticated virtual educational platform that can emulate classroom level education in the platform (**M.Iqbal & Dagiuklas,2018**). As in this generation AI has evolved tremendous amount, specially the contribution of Open AI making AI accessible for everybody, integrating AI capabilities on Edu-cloud can be bring out more productive results for bringing out the best of educational platform that will take it closer to real life physical classroom experience for the students. The current advancements in AI and data science made it possible to encapsulate the immense possibilities of Artificial intelligence to Edu-Cloud, making it a very smart and intelligent educational platform.

The AI based features can be implemented to Edu-Cloud in order to assist students and teachers. Various methodologies and technologies are available to integrate the power of AI in Edu-Cloud. For this research, Open AI's GPT-3 and GPT-3.5 models have been used to integrate AI capabilities to Edu-Cloud. The GPT model is the open source Natural Language processing model which has been trained on terabytes of data and can be finetuned according to need. The pedagogical ability of current GPT 3.5 models are still not as good as human, but the constant improvement of the Models give hope for building AI teachers who can participate constructive pedagogical conversations with students (**Piech, C., 2022**) . The current open source models of GPT 3.5 are trained on massive data and was last updated on 2021 (as of 2023 August). These models can be used to integrate various AI capabilities and features to Edu-Cloud, for example books recommendation, online course recommendation,

book summarization, providing exam tips, providing career guidance, providing roadmap etc. By implementing the GPT-3 API on the Edu-Cloud, a virtual assistant can be developed which can comprehend user questions, understand different educational contents, and generate informative and coherent responses for the students. Students can use the Edu-Cloud AI capabilities based on GPT-3 API to assist in various tasks for example solving complex problems, Ask for feedback for their assignments, guidance for study strategies etc. The Edu-Cloud AI can become an indispensable part of a student's learning companion.

To Implement the Edu-Cloud AI, various Back End and Front End technologies can be used. The Front End of Edu-Cloud needs to be attractive with good user interface (UI) that will be intuitive for the students and teachers. For developing intuitive and interactive web based platforms, various technologies can be used for example Html, CSS, Bootstrap, React JS etc. Also a Back-end technology is needed to implement various user related profiles, for example , user profile, password, authorization, preferences, remembering old queries, assessment etc. Back end technologies such as JAVA Spring boot, Node JS, Python , PHP etc can be used . Finally, A database is required to save data, for example MySQL, PostgreSQL , Mongo DB can be used. In Order to implement Edu-Cloud AI services, MERN stack has been used in this project. The MERN stack stands for Mongo, Express (Routing Lib) , React JS and Node JS (**Bachwani, S.A., 2022**). The reason for using MERN stack for this project is MERN stack gives flexibility for applying full stack development with JavaScript knowledge. Although MERN uses complex UI framework like React JS, Its immense Library availability and community support makes it easier to develop a full stack web application with intuitive and beautiful UI.

Dissertation Overview

This dissertation comprises of seven chapters. The First chapter contains the introduction to the project and research. It tries to identify the research domain problems, some background information of the research being conducted , its aim and objectives, and tries to summarize the approaches taken to develop the project. Chapter 2 contains the Literature review, where various articles and research papers were referred that supports the dissertation objectives and purpose. This section contains previous research works on similar topics and some insights were drawn out from their research that can be a key development for our dissertation research. This section summarizes previous works done in AI in education and how GPT models were previously used in similar situations. Chapter 3 contains the Methodologies and solution design analysis, how agile methodologies were used to develop the Edu-Cloud web application using GPT-3 APIs, Also Fine tuning methodologies are explained in this chapter. Chapter 4 contains the part of Project Implementation, the features that been developed for this project are discussed broadly in this chapter. This chapter discusses the AI capabilities for Edu-Cloud , and how they can help students and teachers for their works. Chapter 5 contains various testing methods, as well as the results for this experiment. This chapter also contains various Insights , Findings and Limitations of the project. Chapter 6 contains the Future works that can be done to improve the stability and scalability of the Project. This chapter describes the immense possibilities of this project for the future. Chapter 7 contains the conclusion of this project.

AIM of the Project

This dissertation hopes to achieve the following aims-

1. To Design and Develop a system or application that showcases the AI capabilities of Edu-Cloud.
2. To apply GPT-3 Model API to Edu-Cloud and generate responses for prompt .
3. Finetune the GPT-3 Model API and train the model with custom Dataset.
4. To emulate a real life classroom environment to Edu-Cloud and showcase the role AI can play to create a virtual classroom environment.
5. To Evaluate and analyse the responses generated by GPT-3 Api, and find out how to improve the virtual assistant.

Project Objectives

The objectives of this Dissertation is given below-

1. To implement AI capabilities for Edu-Cloud, which is a virtual educational platform.
2. To explore the Possibilities and capabilities of GPT-3 API.
3. To apply and learn about Natural Language Processing Models .
4. To develop a web based application for Edu-Cloud.
5. To develop a MERN stack based full stack application for Edu-Cloud AI.
6. To add high level security and authentication system for the project.
7. To explore GPT-3 Api capabilities for summarizing books , articles etc.
8. To Create a recommendation system that can recommend students high level contents.
9. To create a student query system that will engage students with conversations and answers query.
10. To apply Fine Tuning techniques to improve the performance of the GPT-3 Models and train the GPT model on custom dataset.
11. To Analyse the output from Edu-Cloud responses and evaluate the results.

Chapter 2

Literature Review

In this chapter, a thorough review of existing literatures and implementations of AI capabilities on various Educational sectors is presented. The topic of this research is related with three main terms, they are Education, Cloud computing and Artificial Intelligence. As Edu-cloud is a proposed all in one educational platform, we will explore some existing research ideas relevant to the topic which highlights the role of cloud computing in Education. Also as our main purpose is to integrate AI capabilities on Edu-Cloud with Open AI's GPT Models, we will explore available GPT models and their capabilities.

Edu-Cloud

Edu-cloud is a proposed Open stack cloud based educational platform and service that provides collaborative knowledge exchange and broadcasts interactive learning contents to address distinct learning requirements of a group of students who share similar abilities and skills (**M.Iqbal & Dagiuklas,2018**). The goal of Edu-cloud is to endorse peer learning and connecting students with industry experts which will allow reducing the skill gap between traditional on campus universities and global industry market expectations from graduates.

The proposed model of Edu-cloud consists of a 3-tier architecture that uses OpenStack with Network nodes, Compute and Controller , and provides IaaS (Infrastructure as a service). Edu-cloud is a distributed cloud system that comprises of many compute nodes in different physical machines that can be deployed to various geological locations. The proposed architecture of Edu-cloud is depicted in the figure below (Fig 1).

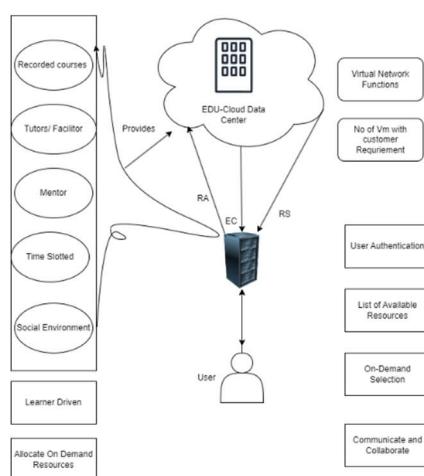


Fig 1. Proposed Architecture of Edu-Cloud. (M.Iqbal & Dagiuklas,2018)

There are various existing researches on cloud based educational platforms similar to Edu-cloud that propose various ideas and insights. Some of the existing innovative research are presented below .

Atan and Jusoh proposed a **CEAAS** (Cloud based education as a service) system that is highly scalable that is designed with IR 4.0 (Industrial Revolution 4) technology in mind (**Atan and Jusoh ,2022**). They introduced four key elements of their CEAAS design, which are Teaching 4.0, Service 4.0, Learning 4.0and Research 4.0. Their model operates with the underlying Industry 4.0 design principles. Their design comprises of four phases which are Analysing, Formulation, Conversion and Evaluation. The main attributes of the proposed CEAAS are adaptability, decentralization, modularity , technical assistance and interoperability.

H. Chen and H. Junmei has highlighted the drawbacks of existing cloud based educational web based platforms in their research (**H. Chen and H. Junmei, 2019**). They pointed out that existing educational platforms are not designed to perform well in larger scale, also they argued that the existing systems are kind of linear- not much interactions between the stakeholders. Also they argued that the learning assessment of a particular individual learner is mostly ignored in most of the existing platforms. To tackle the drawbacks, they proposed four layer hierarchical approach architecture for futuristic cloud based educational platform.

Aydin in his paper proposed a hybrid framework for universities to adopt cloud computing (**Aydin, H., 2021**). The proposed framework comprises of two clouds, they are Private University Cloud and another one is Community University Cloud. Private University Cloud is built with the resources available by each university and it will deliver IaaS and SaaS services to the stakeholders. Community University Cloud is comprised of many member universities who will have a common platform portal for resource sharing or to provide any specific service to its users. Also a thorough architecture of the proposed model is provided by the author.

AI in Education :

Artificial Intelligence (AI) has begun to revolutionize various sectors, marking a significant transformation in the modern era. The recent advancements in AI have empowered the emulation of human-like interactions with computer systems like never before. Implicating the immense possibilities of AI in educational sector can dramatically change and revolutionize the Educational sectors. Yuan, J. and Li, Y. in their review paper showed recent advancements on artificial intelligence in educational sectors (**Yuan, J. and Li, Y., 2021**). They showed the current research trends in AI in Educational sector which are adoption of IoT (Internet of Things) , Swarm intelligence, Deep Learning , Natural Language processing (NLP) and Neurocomputation.

AI has the potential to provide more accessible ,efficient and engaging education to future generation students. Kengam, J. in his paper showed various use cases of Artificial intelligence in educational sectors (**Kengam, J., 2020**). He also presented various pros and cons of implementing AI capabilities on educational platforms. He argued that AI application can be used to understand student sentiments and moods during lecture in classroom using Gesture Recognition Technology which will help teachers to understand if a student is struggling to understand the lecture. Also He pointed out that admission and enrolment procedures can be performed using AI in the Future. He pointed out AI can help students to

do their homework or preparation for tests. Also he pointed out six main steps to develop an AI based educational platform. Finally the drawbacks of using AI in education sectors were discussed.

Al-Dossary, H.K in his paper demonstrated the implementation of Artificial Intelligence features on a virtual classroom using tools like TensorFlow and Face-api.js (**Al-Dossary, H.K.,2022**).They proposed a method to implement face detection and recognition ,also implemented hand gesture in virtual classroom environment.

Schwartz, D.L. in his paper showed an instructional technique called Role-Play that encourages students to engage in various problem solving task by assuming varied roles (**Schwartz, D.L., 2009**).In this scenario students are taught and assessed by Intelligent agents. This would encourage students to learn by engaging and interacting with computer systems by various methods which would keep the students hooked with the system. Schwartz argued that student's commitment towards the intelligent systems help to rise sense of responsibility, which is called the **protégé** effect. In his paper, he conducted two researches confirming that students are more inclined towards engaging with intelligent systems who behave like a normal social being ,and the students don't consider the intelligent agent as a piece of software.

Gašević, D. in his paper showed how intelligent Web services can be integrated to aid in the implementation of AIED (AI in Education). He focused on applying Web intelligence (WI) such as intelligent web services, web mining and semantic markups in order to solve difficult and challenging research problems in AIED. Web intelligence (WI) allows for the organization of course sequencing and material presentation, considering not only the learner's model but also incorporating the most current and relevant content sourced from the web. This would help learners save time to search for contents over the internet on their desired subject, and they can emphasize on learning rather than searching.

GPT Models and its capabilities :

GPT is a term that stands for Generative Pre-Trained Transformer. It is basically a very powerful language model that uses deep learning technology to generate text. GPT models were released by a company called Open AI . OpenAI is a leading Artificial intelligence research institute that was founded in 2015 by some influencer minds like Elon Mask, Sam Altman, GREG Brockman with a goal of developing AI in a safe and beneficial way.

The recent advancements of natural language processing (NLP) has paved the way to integrate enormous amount of text to deep learning models which led the way to create intelligent systems that can interact with human like another human by answering queries , or performing advanced text based tasks. GPT-3 was the first open source model that was released for public use. GPT 3 was trained on over 45 Tera Bytes of text data that includes subset of **commonCrawl** dataset, **webText** dataset, Wikipedia and two huge databases of online books. One of the most prominent use cases of GPT 3 model is the Chat GPT which uses custom fine tuned GPT 3 model under the hood. GPT3 has 175 billion parameters and it is trained on 96 layers the model size is over 800 GB (**Dale, R., 2021**).

GPT is based on a type of neural network called a transformer. Transformers are a deep learning model that excel at processing sequential data, for example Natural Language Text. Transformer neural network (TNN) Works best with text data. A team at Google Brain released a groundbreaking paper in 2017 named “Attention is all you need. *Advances in neural information processing systems*” where they constructed the architecture of Transformers (**Polosukhin, I., 2017**). They showed that traditional sequence-to-sequence models with recurrent neural networks (RNNs) cannot handle long-range dependencies effectively. The Transformer solves this issue by exclusively employing attention mechanisms, eliminating the need for recurrence and significantly speeding up training. Attention in a neural network is a mechanism that allows the network to selectively focus on certain parts of input data, while ignoring other. The architecture of a transformer is shown in **Fig 2** below.

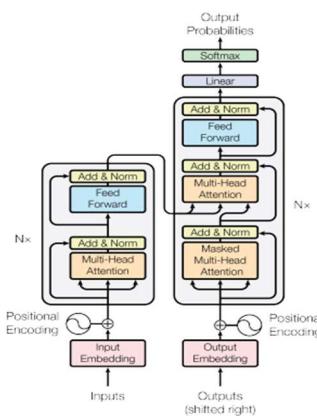


Fig 2. The Transformer model architecture (Polosukhin, I., 2017)

There are various GPT-3 models available based on performance and costing. For example,

- **text-curie-001**- it is a model that is capable, faster and costs less than davinci
- **text-babbage-001**- performs straightforward jobs, really fast and low cost model.
- **davinci**-This model can perform all tasks that other models can do and does perform with extremely high quality. It is the most capable GPT-3 model in the market right now.
- **Curie** – it is moderately capable, but it is faster than davinci
- **Bababge** -does straightforward tasks and really fast
- **ada**- this is the fastest model available and comes with lower cost.

A newer improved GPT 3.5 model was released by Open AI in 2022 which consists enhanced models based on GPT-3 models. They are-

- **gpt-3.5-turbo** - optimized for chat api
- **text-davinci-003** - can do any language task with better quality , longer output , consistent instruction-following than curie, babage, or ada models. Can do completing text as well

- **code-davinci-002** - optimized for code-completion tasks.

Zhou, J. in his paper conducted research to test the capabilities and limitations of GPT 3 and 3.5 models by analysing the performances of the models in 21 different datasets and 9 Natural language understanding tasks(Zhou, J., 2023). In most cases, two of the GPT-3.5 models performed the best results which are **text-davinci-003** and **gpt-3.5-turbo**.

GPT-3 is a very powerful language model that can perform wide ranges of tasks (**Rangwala, A. (2023b)**). Below Some of the key capabilities of GPT 3 and GPT 3.5 models are discussed.

1. **Creative Writing-** GPT models can generate writings on a particular topic with beautiful linguistic
2. **Chatbots-** GPT-3 can be used to build AI powered chatbots and it can be deployed to services for example on an ecommerce. The model can be finetuned with some custom data so that it gain knowledge about user's business.
3. **Translations-** GPT-3 has the capabilities to translate from one language to another language.
4. **Natural or Human language understanding-** GPT models can understand human language with exceptional accuracy. It can even understand texts with spelling and grammatical mistakes.
5. **Text Summarization -** GPT models can take a big piece of text and then summarize the essence of the paragraph into shorter sentences.

Chapter 3

Methodology and Solution Design

In this Project, there are two types of methodologies were used. There are two major aspects of this project, they are software development and Data science . For software development, part **AGILE** Methods were used to incrementally develop the software in the MERN stack. Also there is a data science part of the project, where we needed to finetune GPT-3 model on a custom dataset and train it, so that the GPT 3 model is capable of answering custom pre made answers . For this development , we used some elements from **CRISP DM** methodologies were used, for example- Data Preparation, Data Understanding, Fine Tune the Model, and Evaluation of the models were used. The methodologies are described below in details.

1. Agile Method:

In this dissertation, a piece of software is developed that showcases the Edu-Cloud's potential AI capabilities. For this development, MERN stack has been used which is a full stack framework for software development. To design , develop and manage the project, Agile method has been used.

Agile method is a framework or software development method that breaks down the project into several pieces ,which are known as sprints. It is an iterative method to design ,develop and test the software. Once a sprint is completed, the development team looks back and try to figure out if there was anything that can be done to improve the completed sprint, so that they can move forward with the next sprint (**Carvalho, M.M., 2022**).

Agile has 4 pillars for Agile Project Management. They are mentioned in Agile Manifesto (**Agile Alliance ,2001**). The first of the pillar is- Agile method emphasize on people and interactions over tools and processes. Secondly, Agile method prioritize software functions, rather than excessive amount of documentation. It focuses on productivity and efficacy. Thirdly, Agile method involves customer stakeholder interactions and getting feedbacks constantly. This helps to achieve iterative development and it dramatically improves the quality of the software. Lastly, Agile method is very responsive to quick changes in requirements. This gives adaptability to the software development process.

From the above pillars , there were 12 Agile principles were derived (**Agile Manifesto ,2001**). The most prominent of these principles were customer satisfaction by delivering valuable software frequently and involving customers throughout the process. After building a sprint, there should be constant communication with the customer or stakeholders, to gain insights about improvements. The principles also highlights the importance of delivering working software consistently, rather than focusing on other aspects such as documentation. The principles also value face to face communication with the stakeholders and thus try to measure the progress of the software development. Agile method principles encourages to take simplicity measures for development cycle. Agile method believes that sometimes simplicity is the best solution while approaching a problem. Another important principle is to break the project tasks into smaller pieces and incrementally develop the piece.

The agile iterations or sprints need to follow a workflow . The workflow is explained below-

- **Plan Requirements-** Every Sprint requirements need to be planned before hand. Each Sprint should have clear requirements, and state how they integrate to overall project.
- **Develop Product-** In this phase, the actual product development is carried out. The development should follow the sprint requirements and need to be finished on assigned sprint deadline.
- **Test Software-** In this phase , the product is tested for Potential bugs or functionality tests. The findings of the product is documented and send back to the developer team.
- **Software Delivery –** In this part, the product is delivered to stakeholders so that they can take a look and use it first hand.
- **Feedback-** In this phase, feedback is taken from the customers or stakeholders. If the feedback is positive then move on to the next sprint, if negative and requires changes , then they need to go to development phase again and run the Agile flow until the feedback is changed to positive.

The difference between Traditional method and Agile method is shown in the diagram below (Fig 3). As we can see Traditional method is mostly Linear and Agile method is dynamic and iterative. As we can see Agile is a continuous develop , test and feedback method. Until the

feedbacks are positive and the sprint is bug free with proper testing has been performed after each feedback, the product is not delivered.

For the development of Edu-Cloud AI , Agile method has been used to design, develop, and manage the project. First of all, The System requirements for Edu-Cloud AI platform was gathered by constant communication with the supervisor. Then Planning was made and confirmed on how to approach this project for development. Planning was conducted by weekly three days meeting and discussing about the features. After that , The project was developed using Sprint Method. Each requirement was counted as a sprint, and each sprint was assigned a deadline. After completing a single sprint, The sprint tasks were demonstrated to the supervisor for Feedback. If there was any issue, the issues were addressed and fixed.

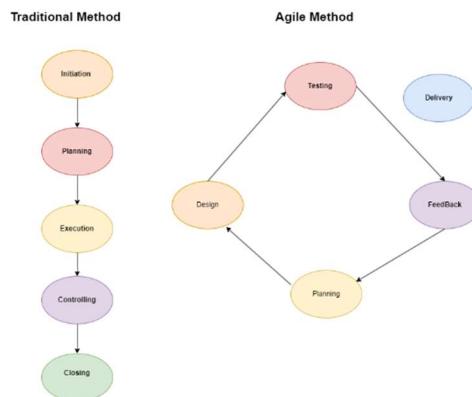


Fig 3: Difference between traditional and Agile Method

2. Fine Tuning using CRISP DM method :

Fine tuning is one of the most popular techniques of Transfer learning. Transfer learning is a process in machine learning where a pre trained model which has been trained on large dataset is applied to slightly different but related task. The idea of this process involves transferring the knowledge learned from the larger dataset and use the knowledge to improve the performance on other task. Fine tuning is a common technique for transfer learning. In fine tuning, a pre-trained model is trained further on a smaller dataset . Thus Fine tune applies the concept of transfer learning by adjusting and updating a pre-trained model which is capable of performing a new task (Smith, N., 2020).

In Edu-Cloud AI project, Fine tuning is applied in order to improve the performance and quality of the responses generated by GPT -3 model. Also there are some custom question sets that students would ask which need guided responses which are backed by tutors and professors. Fine Tuning gives the Edu-Cloud AI the customization it needs . Fine tune would allow Edu-Cloud AI to be trained with its own specific dataset.

Open AI allows GPT-3 and GPT-3.5 models to be fine tuned on a specific dataset ([OpenAI Platform](#)). According to official Open AI documentation, Fine tuning can be performed at a high level by following the steps below.

- ✓ Preparing the training data and then Uploading it to Open AI
- ✓ Train a new fine-tuned model
- ✓ Use the newly trained fine tuned model for generating response.

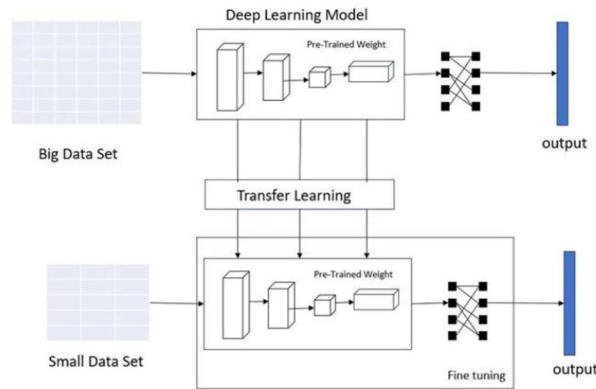


Fig 4: Fine Tune

To Implement Fine Tuning on Edu-Cloud, some of CRISP DM Method aspects are used. CRISP DM stands for The Cross-industry standard process for data mining, and one of the most popular methods for data science projects. The reason for choosing CRISP DM for Edu-Cloud AI fine tuning is that CRISP DM provides a well defined framework for various stages of a data driven project. Since we dealing with a custom dataset for finetuning the GPT-3 model for Edu-Cloud AI, CRISP DM method can bring excellent productivity and integrity. There are six key phases for CRISP DM method ([Hotz, N. ,2023](#)) . They are briefly explained below.

- **Business Understanding-**

In this phase, what is the main business problem the project will solve is determined. The main purpose of this phase is to understand the context and requirements of the project , and also determine what outcome is desired from the project.

- **Data Understanding –**

In this phase , Data is collected and explored. In this phase, some basic levels of Exploratory data analysis are performed in order to gain some valuable insights about the data and determine some relationships between variables.

- **Data Preparation:**

In this phase, Data is cleaned, transformed and pre-processed so that it can perform better for modelling. In this phased, Data is cleaned using various methods, for example, dealing with the null values, dealing with the duplicate values , handling the outliers etc.

- **Modelling :**

In this phase, appropriate modelling techniques are used based on business understanding. Also data is trained using various machine learning modelling techniques in this phase. Fine tune data training also is performed in this phase.

- **Evaluation:**
- In this phase, Model performances are evaluated and tested . Various metrics are used in order to evaluate the trained models for example accuracy, ROC curve , cross validation etc.
- **Deployment:**

In this phase Model is deployed in the business environment and generate result on new data. Also the response of the model is monitored in this phase in order to constantly update the model .

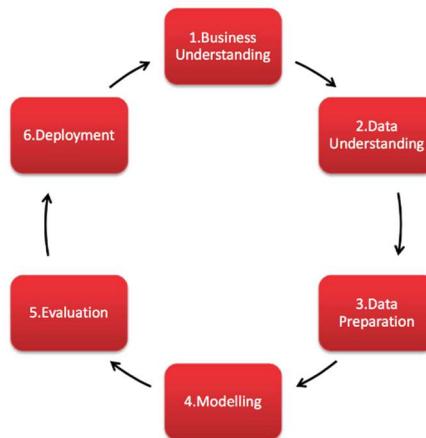


Fig 5: CRISP DM phases (For GPT-3 model Fine tuning)

So The CRISP DM method is a perfect method for Fine Tuning the GPT-3 model .

3. Solution Design Analysis :

Solution design is the process of creating a detailed plan and architecture for solving a specific problem .Solution Design involves outlining the components, algorithms, processes , techniques, technologies etc that will be used to solve a particular problem or implement in a project. It is the generalized process of making input parameters transform into output parameters.

For Edu-Cloud AI development there are five phases of the solution design . Each phase is connected with another phase. The five phases are explained below-

- i. **Input Phases :** In this phase, There is a User Interface that interacts with the user. User can enter the prompt for the problems which are counted as input, and then send request to Frontend APIs. In Edu-Cloud AI , the Input phase is design with React Based JSX (JavaScript XML), CSS (Cascading Style Sheets),HTML elements.

- ii. **Frontend Management** : In this phase, Frontend Logics are handled. Inputs are gathered from input phase and then in this phase, User Inputs are handled and various event listeners are triggered. For the Frontend part of Edu-Cloud AI, React is chosen for Frontend framework. By Using React Fetch method or Axios Library, API request to backend is performed. API is the communication gateway with backend that syncs the data between frontend and backend.
- iii. **Backend Management** : In this phase, various Backend Logics are handled. For example, Authentication, Authorization , API logic etc. In Edu-cloud project the Backend is managed using NodeJS and Express JS. Also in this phase, Request to Open AI GPT 3 API is performed and the responses are handled. For database storage. Mongo DB has been used in Edu-Cloud AI.
- iv. **Data Processing**: After getting responses from Open AI GPT -3 API, the response is raw in format. For sending the value to frontend , the responses need to formatted to specific JSON format so that the frontend can understand it.

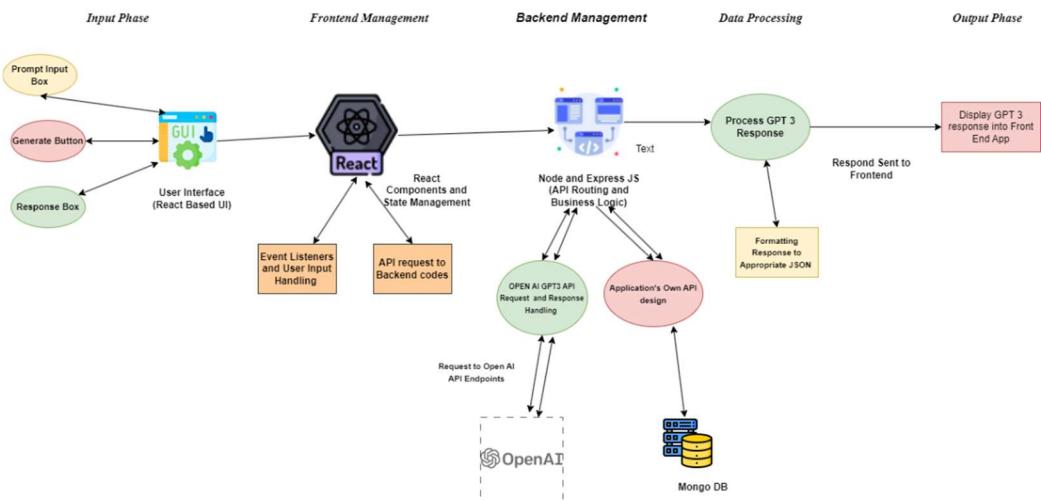


Fig 6: Solution Design for Edu-Cloud AI

- v. **Output Phase:** In this phase, the formatted responses from Open AI's GPT 3 API are sent back to the frontend and then displayed in the response box . The output of this project is the display box that is presented to the end user where the user's query are satisfied.

Chapter 4

Project Implementation/Development

In this section, the project implementation procedures are broadly discussed. For this dissertation, a web application for Edu-Cloud AI has been developed using the MERN stack and GPT-3 API. After that the responses of GPT-3 API are fine tuned using custom dataset so that the GPT-3 models can be manipulated for customized query. So there are two major aspects of this project, one is the software development aspect which covers the Web application development for Edu-Cloud AI, Another one is data science aspect which covers the Fine Tuning of GPT-3 model on custom dataset. These aspects and implementation procedure are covered in this section.

1. Project Implementation features :

Edu-Cloud AI aims to assist students in various ways by implementing AI to Edu-Cloud platform. The goal of the using the AI for Edu-Cloud is to leverage the power of artificial intelligence for teaching , and recommending. Some of the possible features for Edu-Cloud AI are implemented in this project that could become a part and parcel of a student's learning curve. They are discussed below-

Summarizing: The GPT-3 model can understand the natural language of human being with unbelievable precision. Summarizing contents can be beneficial for students to get the insights on a topic or book. For Edu-Cloud AI , two summarizing features are implemented. The first one is Book Summarizer where the student would input the name of the book and the chapter of the book, the AI would summarize it in appropriate word count. As we know, GPT-3 has been trained on a huge database of books, the summarizer would be able to give proper summary of any chapters of the book. Secondly, The Edu-Cloud AI would be able to summarize articles from Any web Link, or directly from any text. This way students can do research from the web by understanding essence of large text from the web by reading the summary of the article.

Study Material Recommender: GPT-3 is trained on humongous data, thus it has knowledge on various study materials available in the world for a particular topic. Thus GPT-3 has the capability to recommend and advice students study materials where they can gain maximum knowledge on a particular topic. This provides Edu-Cloud AI to implement material recommendation features and make the full use of AI generated material recommendations which would be recommended by experts. There are three types of Recommendation tools are built in Edu-Cloud AI , They are-

- *Book Recommendation:* Students just have to Enter the name of a topic or a Subject in a prompt box, and the Edu-Cloud AI would recommend top 10 books available on that topic.
- *Online course Recommendation :* This is where Edu-Cloud AI shines the most. Students just have to enter the name of the subject or topic, GPT-3 model API would generate top

online contents such as UDEMY course, Coursera , EDX etc on that topic. This would help students to choose courses on a particular subject.

- **Academic paper Recommendations:** Students need to conduct a lot of research works while pursing their degree or learning new knowledge. For this reason, they had to collect and look for academic papers, but its hard to find by traditional google search. For this reason, Edu-Cloud AI will help students to help them research by recommending Academic paper on certain topics.

Student Query System: This is the chat module for students to ask any queries they have on academic topics. The chat with students generate constructive and to the point short and concise answers. For example, Student can ask the Student Query system about the top study hacks that can let them improve performance in exam or ask about top 10 schools about business etc . This Query system can be customized according to the need of any organization. Using GPT-3 fine tuning capabilities , the chat responses can be customized by training the GPT-3 model with custom training data.

Assignment Feedback : Edu-Cloud has the ability to give feedback on student's assignment, also give them opinion how to improve their assignment's quality. Students will be able to upload their assignment to the Edu-Cloud system. The system will extract the assignment from the uploaded document and then send it to GPT-3 API. The GPT-3 will give constructive feedback of the assignment . This feature can help students to improve the quality of their assignments dramatically.

Exam Tips: Edu-Cloud AI has the future to provide exam tips to students on particular topics for example transfer learning of data science or super massive black hole of cosmology. The AI would generate exam tips for the students so that they can prepare the best for their upcoming exams.

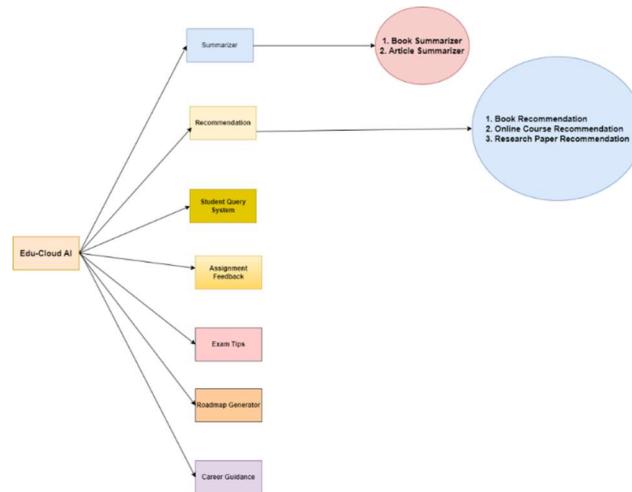


Fig 7. Edu-Cloud AI implementation Features

Roadmap Generator: Edu-Cloud AI will be able to generate Roadmap for learning a particular subject to the students. For example, If the students want to learn about machine learning , the Edu-Cloud AI would be able to give a complete roadmap how to learn and master machine learning step by step. This is just a guideline provided to students so that they know where they can begin and understand what to learn first , and then learn in a complete guided path.

Career Guidance: Edu-Cloud AI would provide career guidance to students so that they can prepare themselves for the Job Market. For this, The User has to provide their career field in the prompt and the Edu-Cloud AI would generate the career guidance to succeed in that particular field.

2. Project Development :

In this section , the development of each features of the Edu-Cloud AI is presented. To manage the development, Agile method has been used. The project is implemented and developed using REACT as frontend and Node JS as backend. The project uses mongo DB as database. The project uses communication with an external API source, which is Open AI's GPT-3 API . After developing the Web Application , Fine Tuning is applied to GPT-3 so that the GPT-3 responses can be customized. The project implementation is broadly described below.

I. Authentication and Authorization: One of the most fundamental element of any software is security and access control. Edu-Cloud will have proper Authentication system. Authentication is the process of verifying a user. Edu-Cloud AI will have a sign up form where students can register. There they will have their own profile. Every time for a session with Edu-Cloud AI, students need to login to the system with their appropriate username and password. The Login and Registration UI for the Edu-Cloud is shown in the figure below (fig 8) .

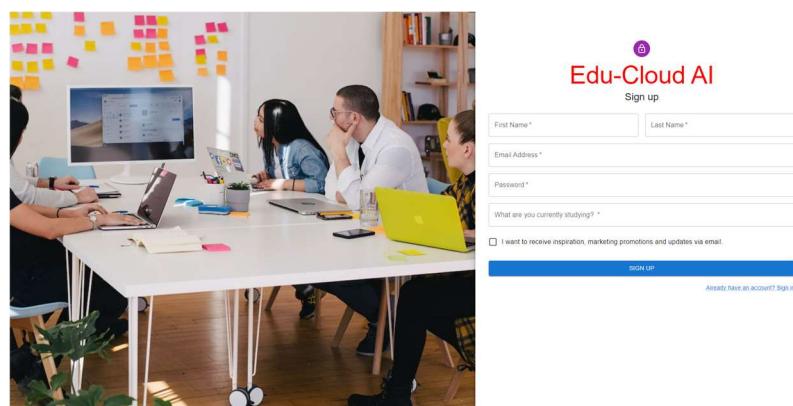


Fig 8: Edu-Cloud AI registration

As we can see the user is registered by providing a First name, Last Name, Email address, password and current study field . All this information will be stored to Mongo DB database, and used to create a profile for the student. After registration the student can login by entering their email address and password (fig 9).

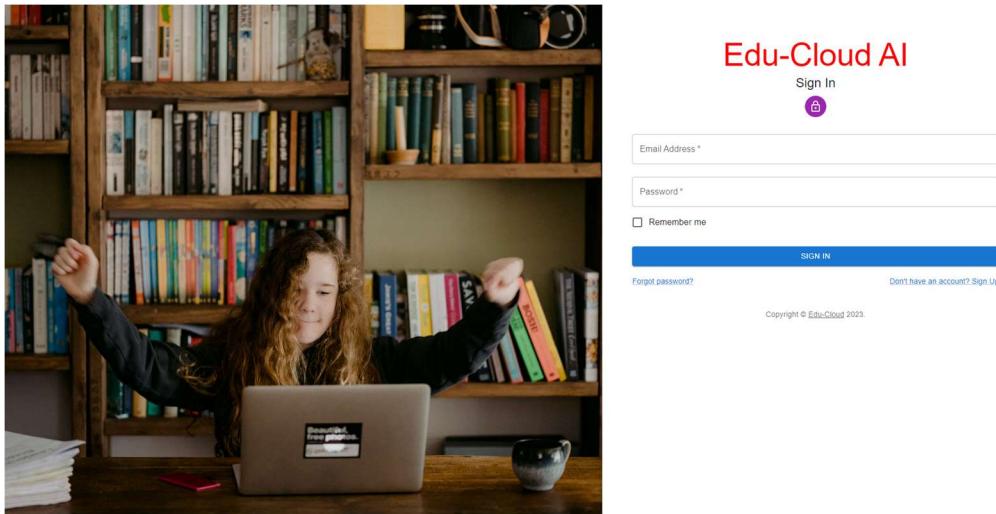


Fig 9 :Edu-cloud AI sign in

For this project, immense security measures have been taken. The password has been hashed using the Bcrypt hashing algorithm (Nababan E.B., 2021). Bcrypt is a popular hash function which uses cryptographic method to store and restore password. The real reason for password hashing is to protect the application from various cyber attacks for example, Dictionary attack.

Edu-Cloud AI would use a role based Authorization. There will be three primary roles for Edu-Cloud, they are Student, Teacher and Admin . But for the scope of this project, only the role of student has been developed.

II. Dashboard: After Login with appropriate username and password, the user will be redirected to the dashboard of the Edu-Cloud AI. The dashboard will contain all Edu-Cloud features. The dashboard of Edu-Cloud is shown in the figure below (fig 10). As you can see the Edu-Cloud features are implemented in the left navigation bare of the Dashboard.

This is the initial version of the dashboard. This will be constantly updated. In the future , The dashboard will contain analytics where student can see different types of charts and visualization to track their progress. For example, They will be able to track how many hours they spent in the Edu-Cloud, see their completed modules etc.

There will be other basic features that will be included in the dashboard. For example, Profile Personalization where the users will be able to update their profile information, Password

changing, Logout features etc. Also there will be a notification bar where users will be notified for important changes, events, or dates etc.

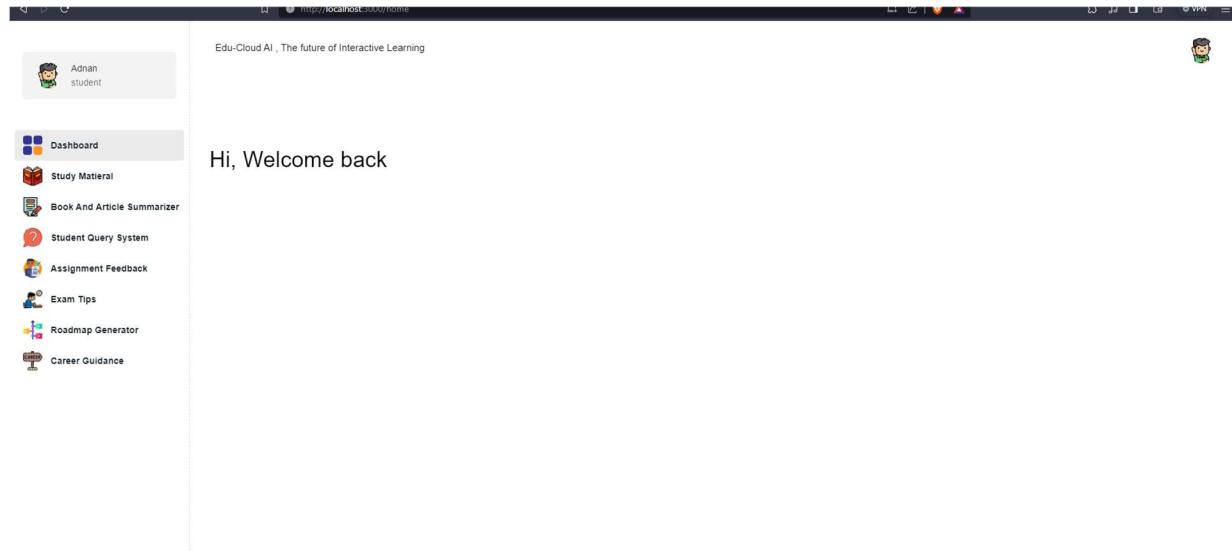


Fig 10: Edu-Cloud AI dashboard (Initial Version)

III. Study Material Recommendation: One of the most important features of Edu-Cloud AI is study material Recommendation. There are three types of study materials that Edu-Cloud AI would recommend. They are Book Recommendation, Online Course Recommendation, And Academic paper Recommendation. So we needed a UI to choose between the three possible options (**Fig 11**).

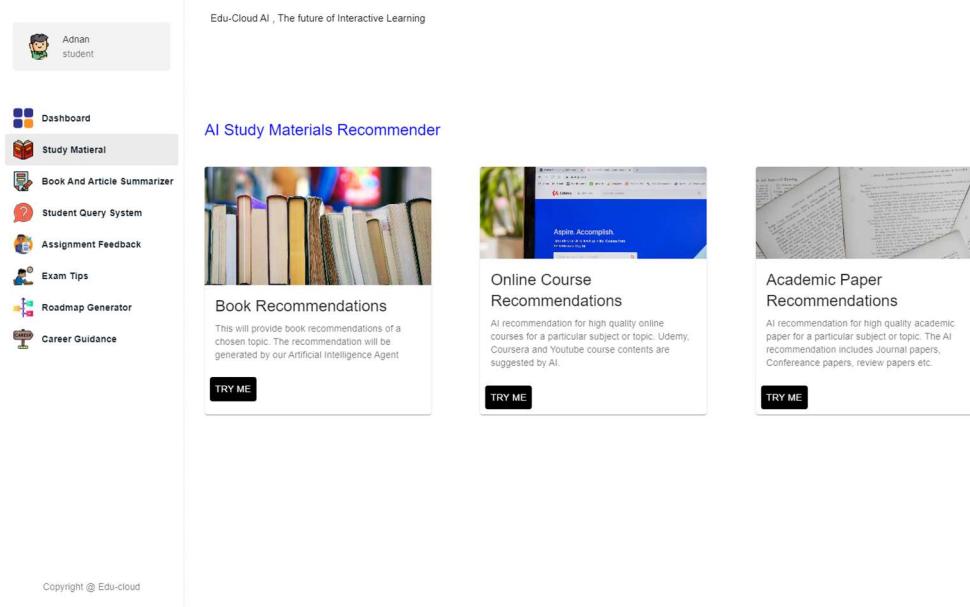


Fig 11: Study material recommendation

In Book Recommendation, the user will have to give input the subject and topic name. Edu-Cloud AI will generate the top 10 books available for the topic. For example, If we want to see top books available on Blockchain, the Edu-Cloud AI would generate the following output (**fig 12**). As we can see Edu-Cloud AI has generated Books information such as Title, Author, Rating, Price and Description. There is a Link as well where it will take users to Amazon link of that book.

Top 10 Books of blockchain					
Title	Link	Price	Author	Rating	Description
Blockchain Revolution: How the Technology Behind Bitcoin Is Changing Money, Business, and the World	Link	\$14.99	Don Tapscott, Alex Tapscott	4.6 stars	In Blockchain Revolution, Don and Alex Tapscott explain how blockchain technology - which underlies Bitcoin - is shifting how the world does business
Blockchain Basics: A Non-Technical Introduction in 25 Steps	Link	\$19.99	Daniel Drescher	4.3 stars	Blockchain Basics is a non-technical introduction in plain English to the revolutionary blockchain technology and its implications for business, government, and society
The Business Blockchain: Promise, Practice, and Application of the Next Internet Technology	Link	\$17.99	William Mougayar, Don Tapscott, Alex Tapscott	4.4 stars	The definitive pioneering blueprint covering the what, why and how of the blockchain. Authored by Don Tapscott and Alex Tapscott, this book is a fascinating read for anyone looking to get to grips with this revolutionary technology
Blockchain: The Complete Guide to Understanding Blockchain Technology	Link	\$17.99	Mark Gates	4.3 stars	This book is your one-stop-shop for everything that you need to know about blockchain technology and how it will shape our future
Mastering Bitcoin: Programming the Open Blockchain	Link	\$26.99	Andreas M. Antonopoulos	4.5 stars	Mastering Bitcoin is your guide through the seemingly complex world of bitcoin, providing the knowledge you need to participate in the internet of money

Fig 12: Book Recommendation Output

Edu-Cloud AI will be able to recommend students various online courses mainly from Udemy, Coursera or YouTube etc. These will be high level content that will benefit students by prompting them to purchase one of the best available courses available on their chosen subject. The output for Edu-Cloud AI online course recommendation is given below (**fig 13**).

Top 10 Online Courses of blockchain						
Title	Link	Price	Author	Website Name	Rating	Description
Blockchain and Bitcoin Fundamentals	Link	9.99	George Levy	Udemy	4.5	Learn the key elements of blockchain and Bitcoin in this bestselling video course.
Blockchain Solutions Architect	Link	49	IBM	Coursera	4.8	Accelerate your understanding of how blockchain technology will revolutionize transactions and business networks.
Blockchain Fundamentals	Link	29	Ethan Fast	Pluralsight	4.5	Learn the fundamentals of blockchain technology, from distributed ledger technology and smart contracts to Bitcoin and Ethereum.
Blockchain for Business	Link	19.99	Jim Wilson	LinkedIn Learning	4.4	Learn how blockchain technology works, and how it can be used to build new business applications.
Blockchain Developer Nanodegree	Link	999	Udacity	Udacity	4.7	Learn to design, develop, and deploy smart contracts and blockchain-based distributed applications to the Ethereum/Quorum network.

Fig 13: Online Course Recommendation Output

As we can see, the course recommendations for Blockchain has been generated from Popular Educational platforms such as Udemy ,Coursera, Pluralsight ,Udacity etc.

Finally Edu-Cloud AI will have a Academic paper recommendation, where the students will be recommended different review paper or conference paper. This will benefit students for conducting research on particular topic by helping them to choose top quality academic papers . Below is the output for Edu-Cloud academic paper recommendation given (Fig 14)

The screenshot shows the Edu-Cloud AI interface. On the left is a sidebar with icons for Dashboard, Study Material, Book And Article Summarizer, Student Query System, Assignment Feedback, Exam Tips, Roadmap Generator, and Career Guidance. A user profile for 'Adnan student' is at the top. The main area has a search bar with 'blockchain' entered, a 'GET RECOMMENDATIONS' button, and a table titled 'Top 10 Research Papers of blockchain'. The table includes columns for Title, Author, Website Name, Rating, and Description. Five papers are listed:

Title	Author	Website Name	Rating	Description
The governance of blockchain technology	Link G. Wüst and K. Gugler	ResearchGate	4.3	This paper addresses the governance of blockchain technology from the perspective of the common good. It discusses questions of smart regulation, such as the legal status of the technology, the content of regulation, the enforcement thereof and the interaction with existing market structures. Additionally, the paper spots ethical issues which may arise from the application of blockchain technology and scrutinizes what reasonable limits to its use can be derived from fundamental ethical principles.
The Economics of Blockchain Technology and Cryptocurrencies	Link N. Kalra and A. K. Jindal	ACM Digital Library	4.4	In this paper, we provide a systematic analysis of blockchain technology and cryptocurrencies. We review the historical development of these technologies, analyze their current state, and discuss possible applications. We discuss economic aspects of blockchain technology and go through some of the economic problems related to incentives, scalability, and privacy. Furthermore, we explain some of the open legal issues related to blockchain technology. Finally, we provide an outlook on the potential future trends and discuss potential implications of blockchain technology on the global economy.
The Social Implications of Blockchain Technology	Link L. Shechter	CEUR-WS	4.3	This paper examines the potential social implications of blockchain technology. It looks at the ways in which the distributed ledger technology can affect individuals, institutions, and society as a whole. The paper also looks at the ways in which the technology can be used as a tool for social empowerment, and considers the implications of the technology on privacy, decision-making, and security.
The Potential of Blockchain Technology in Health Care	Link G. Hardjono et al.	Wiley Online Library	4.2	This paper investigates the potential of blockchain technology in the field of health care. The authors discuss major challenges facing the health care sector that could be addressed through the use of blockchain technology, such as security, patient data privacy, and the streamlining of health care processes. The paper examines the potential applications of blockchain technology in the health care sector, and considers the implications for data governance and public health policy.
The Potential of Blockchain Technology in Education	Link K. Schock	Springer Nature	4.5	This paper explores the potential of blockchain technology in education. It examines how the distributed ledger technology can be used to improve the quality and efficiency of education services. The authors discuss the potential applications of blockchain technology in education, such as tracking student data and verifying credentials. The paper also looks at the implications for data privacy and security.

Fig 14: Academic Paper Recommendation Output

IV. Book and Article Summarizer: Edu-Cloud AI will have a book and Article summarizer which will benefit students by summarizing an entire book or chapter of a book or an article. This will give students important essence of a chapter or article, and get the important facts out of tons of text . Using GPT-3 API it has been possible to generate short and concise summary of huge texts.

For the Edu-Cloud book summarizer, the user has to input the name of the book, the author name of the book (it is optional, in most cases GPT-3 API can identify the book by its name) and the Chapter number the students want to summarize, After pressing the Generate button the GPT-3 will generate the summary of the book and display the summary in the screen (Fig 15).

Edu-Cloud AI can also summarize large text or an article from a link. The student have to give the link of the Article and paste it in the input box. The GPT-3 Api will be able to Summarize the link .

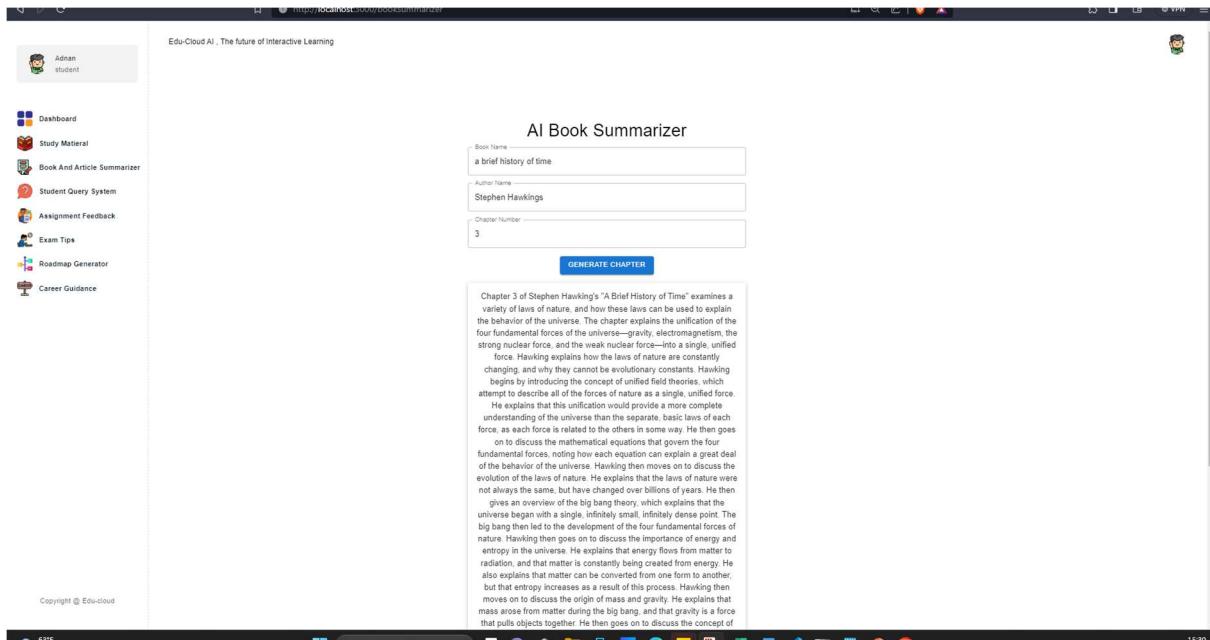


Fig 15: Edu-Cloud AI book summarizer

The Article summarizer of Edu-Cloud AI is shown below (fig 16). Here we pasted a Wikipedia link on Theory of Relativity and then pressed the summarize button. As we can see that, the contents of the link has been summarized .

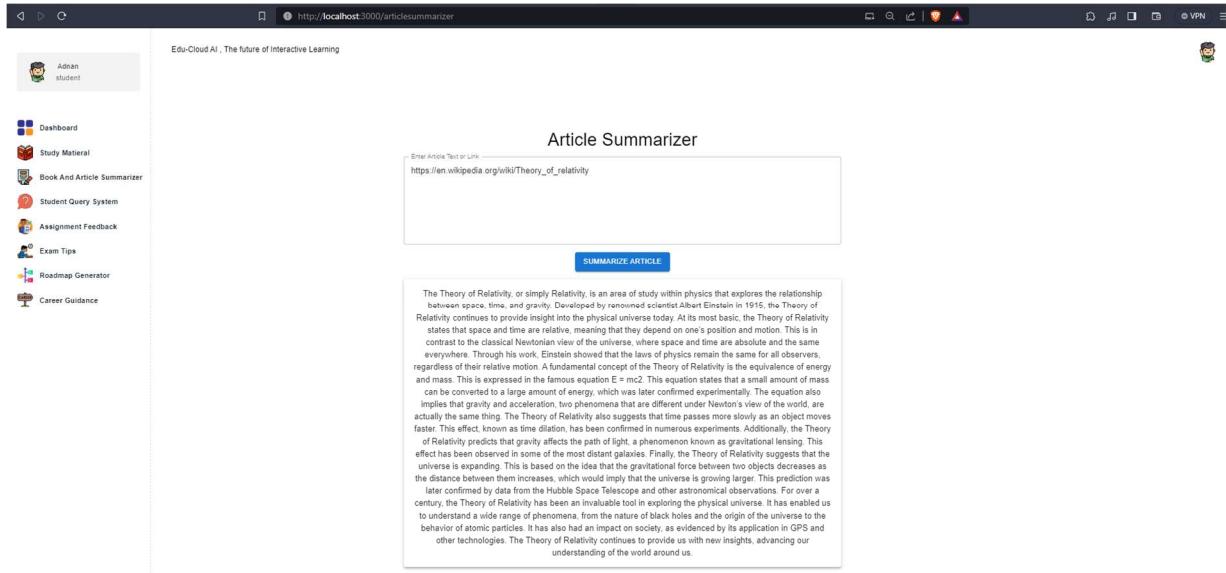


Fig 16: Article Summarizer of Edu-Cloud AI

Also the if someone pastes a complete large text on the summarizer, Edu-Cloud AI article summarizer would be able to summarize the entire text.

V. Student Query System : In the student Query system, Student has ask any Query they have about a particular subject or course. The student Query system will be able to answer the student in a short and concise manner. It is kind of like a chat bot that is there to help the students to answer their instant queries. There will be chat input box where students need to ask questions, and the system will generate the response and display in a display box. The User interface and output of the student query system is shown in the figure below (**fig 17**).

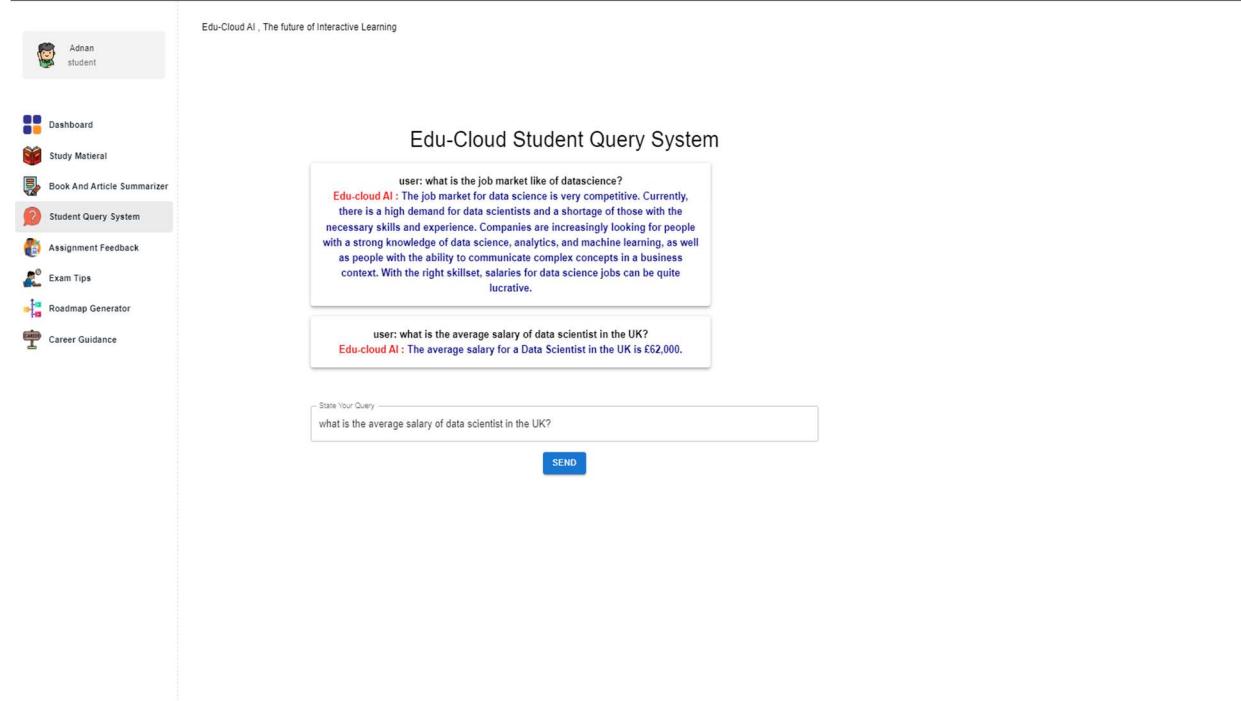


Fig 17: Student Query system

As we can see , Edu-Cloud is answering any questions that student ask in a short and to the point manner. The Student Query system can be customized by Fine Tuning the GPT-3 model API on custom dataset, it will be able to answer any new questions that GPT-3 pretrained model is not supposed to answer.

Vi. Assignment Feedback: Using Edu-Cloud AI, students can get real time assignment feedback. The GPT-3 API can understand the context of large text and can provide its own notion and opinion. Students will have an UI interface where they can upload their assignment. After extracting the words from the Assignment, it is sent to GPT-3 API as a prompt and then asked for feedback. The GPT-3 API will be able to provide a comprehensive feedback on the assignment, also GPT-3 API will also suggest further improvements that can be made to the assignment. This way, students can be benefited by knowing how to improve their assignment. The output for the Assignment Feedback system is given below (**fig 18**). As we can see, we uploaded a word document in the Edu-Cloud assignment feedback system and the Edu-Cloud provided a feedback – that it is actually a good assignment and gave many tips on how to improve the assignment. For this feature, Students need to upload document that

are less than 2000 words as the GPT-3 is not capable of processing words more than 4000 tokens, so we divided the tokens for input and output.

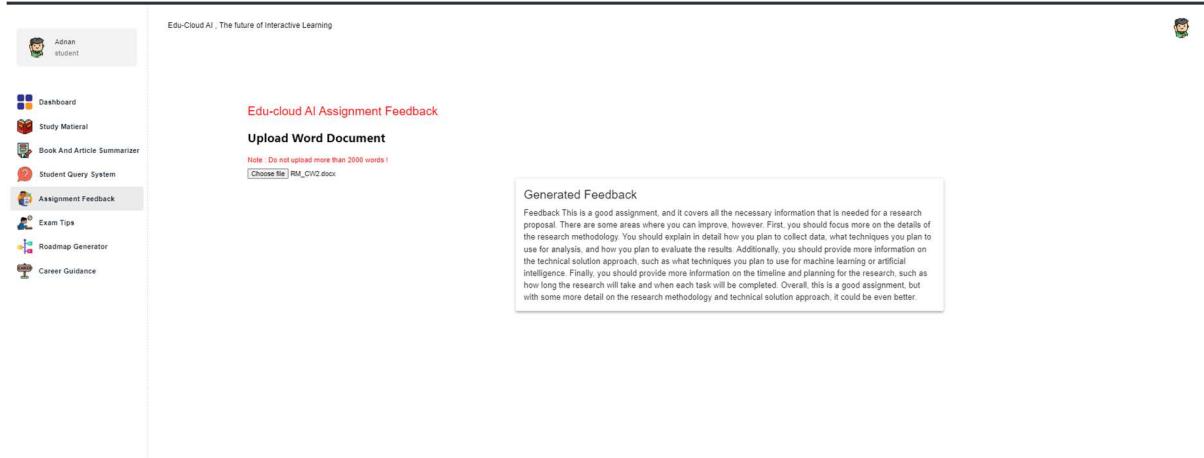


Fig 18: Edu-Cloud AI Assignment Feedback system

VII. Exam Tips : Edu-Cloud AI would be able to provide exam tips on a particular subject or topic. Using the exam tips , students can focus on important things during their examination. Student have to input the topics they need the tips, then Edu-Cloud AI would be able to provide some Important exam tips on those topics. The output of Edu-Cloud AI is shown below.

Exam Tips Generator

Subject: data science

Topics: machine learning, statistics

GENERATE TIPS

and programming

1. Spend time understanding the basics of machine learning, statistics, and programming.
2. Learn the fundamentals of each subject, including probability, linear algebra, calculus, and programming languages.
3. Review and practice the concepts and algorithms related to machine learning, statistics, and programming.
4. Familiarize yourself with the types of questions that may appear on the exam.
5. Utilize practice exams to test your knowledge and identify areas of weakness.
6. Develop a study plan and stick to it.
7. Take notes and review them regularly.
8. Make sure you understand the concepts before attempting to solve problems.
9. While studying, take time to practice solving problems.
10. Pay attention to the details of the exam questions.
11. Make sure you understand the difference between supervised and unsupervised machine learning.
12. Understand the key concepts of statistics, such as sampling, hypothesis testing, and linear regression.
13. Be aware of the different programming languages related to data science.
14. Make sure you can identify and explain the purpose of common data structures and algorithms.
15. Understand the different methods for data visualization and how to interpret the results.
16. Pay attention to the details of the data sets provided in the exam.
17. Understand when to use specific machine learning algorithms.
18. Familiarize yourself with the most common libraries and tools used in data science.
19. Practice analyzing data sets and creating models.
20. Understand the importance of data cleaning and pre-processing.

Fig 19: Edu-Cloud AI Exam Tips

As we can see, The Edu-Cloud AI generated exam tips on Data science topic such as Machine learning and statistics.

VIII. Roadmap Generator : Edu-Cloud AI can generate roadmap to learn a particular subject of topic. It will help students to learn a new technology or new topic by following the Edu-Cloud AI roadmap generator's suggested guidelines. For example, If some one wants to learn web development, he should first learn the basic HTML and CSS, then learn the backend and SQL etc. As we can see in the figure below, Edu-Cloud AI generated the step by step process to learn web development (Fig 20).

Edu-Cloud AI , The future of Interactive Learning

Adnan
student

Dashboard
Study Material
Book And Article Summarizer
Student Query System
Assignment Feedback
Exam Tips
Roadmap Generator
Career Guidance

Copyright @ Edu-cloud

RoadMap Generator

Enter the topic you want to Learn
web development

GENERATE ROADMAP

1. Learn HTML & CSS: Start with the basics of web development and learn HTML & CSS. This includes understanding HTML tags, HTML attributes, CSS selectors, CSS properties, and more.
2. Learn JavaScript & jQuery: JavaScript is the main programming language used for web development. Learn the fundamentals of JavaScript, such as variables, functions, objects, and loops. You should also learn jQuery, a popular JavaScript library.
3. Learn a Server-Side Language: A server-side language is used to write scripts that execute on the server. Popular server-side languages include PHP, Python, and Ruby.
4. Learn to Use a Database: A database is used to store data. Learn how to use databases such as MySQL or MongoDB to store and retrieve data from a website.
5. Learn a Web Framework: Web frameworks are a set of tools and libraries that make it easier to build web applications. Popular web frameworks include Ruby on Rails, Django, and Express.
6. Learn Responsive Design: Responsive design is an approach to web development that makes websites look good on any device. Learn how to use media queries and other techniques to create a responsive web design.
7. Learn a CSS Pre-Processor: CSS pre-processors are used to make writing CSS easier. Learn how to use popular pre-processors such as Sass or Less.
8. Learn Version Control: Version control is a system for tracking changes to files in a project. Learn how to use version control systems such as Git or SVN.
9. Learn Cross-Browser Testing: Cross-browser testing is a process of testing a website in different web browsers. Learn how to use tools such as BrowserStack or SauceLabs to perform cross-browser testing.
10. Learn Testing & Debugging: Testing and debugging are essential parts of web development. Learn how to use tools such as Selenium and Firebug to test and debug web applications.
11. Learn a JavaScript Library: JavaScript libraries make it easier to write JavaScript. Learn how to use popular libraries such as jQuery, Underscore.js, and React.
12. Learn Web Security: Web security is essential for protecting websites from malicious attacks. Learn about web security topics such as authentication, authorization, and encryption.
13. Learn Deployment: Learn how to deploy a web application to a web server. This includes setting up a web server, configuring permissions, and deploying the application.
14. Learn SEO: SEO (Search Engine Optimization) is the process of optimizing a website for search engines. Learn how to use SEO techniques such as keyword research, meta tags, and sitemaps to improve search engine rankings.

Fig 20: Edu-Cloud AI Roadmap Generator

VII. Career Guidance: Edu-Cloud AI can provide guidance for career development on a particular field. This will help focus students on career oriented developments and try to maximize their learning to enhance their career. There will be a prompt where the student will be asked to provide their career field, and the Education AI would be able to generate career guidance to that student. For example, If a student want career guidance on Frontend development then he has to gain knowledge and experience in HTML, CSS, JavaScript etc. The Edu-Cloud AI gives comprehensive guidance for career development on a particular career field (fig 21).

The screenshot shows the Edu-Cloud AI interface. On the left, there's a sidebar with a user profile for 'Adnan student' and a list of features: Dashboard, Study Material, Book And Article Summarizer, Student Query System, Assignment Feedback, Exam Tips, Roadmap Generator, and Career Guidance. The main area is titled 'AI Career Guidance' and has a search bar with 'front end development'. A blue button labeled 'GUIDE' is present. Below it, under 'Career Guidance', are five numbered steps:

1. Get to Know Front-End Development: Start by researching the basics of front-end development. Get familiar with the languages, tools, and frameworks that are commonly used. Get a basic understanding of HTML/CSS, JavaScript, and libraries such as jQuery.
2. Develop Your Computer Science Knowledge: A strong foundation in computer science principles such as data structures, algorithms, and software engineering is essential for success as a front-end developer.
3. Learn UX/UI Principles: Additionally, you will need to understand user experience and user interface principles in order to effectively produce front-end code.
4. Advance Your Soft Skills: Developing soft skills such as communication, problem-solving, teamwork, and creativity will help you stand out as a front-end developer.
5. Keep Learning: Technology changes quickly, and as a developer you must stay up-to-date on the newest tools and best practices.

Fig 21: Edu-Cloud AI Career Guidance

3. Fine Tuning the GPT-3 Models :

Open AI allows certain models of their to be finetuned on custom dataset, so that the responses can be customized according to the need. As of today, The following models can be fine-tuned –

- Babbage-002
- Davinci-002
- Gpt-3.5-turbo-0613

Fine-Tuning can dramatically improve the Edu-Cloud AI's performance and the quality of generated responses. Fine-Tuning the GPT-3 models could help more targeted and guided responses for students which can be customized for different educational organizations.

In Edu-Cloud, the ultimate goal is to create a virtual classroom where students can learn from AI generated contents for example books, online courses etc. For this project, GPT-3 model has been used, but sometimes the generated response or GPT-3 Recommendations might have quality responses and sometimes some recommendations could be outdated and old. That's why the model Fine-Tuning can be applied in order to train the model again with new or custom dataset. The dataset can be prepared by a team of high quality educators such as professors or course coordinators etc. This way , we can keep the Edu-Cloud AI up to date and relevant .

To Fine-Tune the Edu-Cloud AI , CRISP DM methodologies and steps were followed, as well as the Open AI's guidelines were followed for coding the Fine-Tuning API. The steps were described below.

I. Business Understanding : The main purpose of Fine-Tuning the Edu-Cloud AI is to allow customized responses to improve the quality of the model so that the model serves its purpose to recommend and help students with high level quality contents. Also Fine-Tuning would increase the accuracy of the model, and will help the model to perform better on what it is intended to do. This would dramatically improve the user experience and provide satisfactory contents for the students. Fine-tuning can help in generating customized learning pathways and recommendations, which can adapt to each student's learning pace and preferences, which will ultimately improve learning outcomes.

II. Data Understanding : This dataset comprises of user interactions with a chatbot recommending data science books, online contents etc. There is a guideline for the data structure for Open AI's model Fine-Tuning in their official documentation. The Model API's for fine-tuning expects to upload **Jsonl** format data. The dataset instance is made up of three main components: system messages explaining the role of the system , user queries requesting book recommendations, and Edu-Cloud assistant responses providing book details. The example of the data structure instance is given below.



```

[{"messages": [
    {"role": "system",
     "content": "This chatbot recommends various content, including books, online courses, articles, movies, YouTube channels, and more."},
    {"role": "user",
     "content": "recommend me top 5 books on data science."},
    {"role": "assistant",
     "content": [
        {"title": "What is Data science - Learn with python",
         "link": "https://www.amazon.com/Data-Science-Scratch-Principles-Python/dp/1492041130",
         "price": "$29.19",
         "description": "Data Science from Scratch is a comprehensive introduction to data science, covering the fundamentals of Python programming, data wrangling, exploratory data analysis,",
         "rating": 4.7,
         "author": "Joel Grus"
        },
        {"title": "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython",
         "link": "https://www.amazon.com/Python-Data-Analysis-Wrangling-IPython/dp/1491957662",
         "price": "$32.99",
         "description": "Python for Data Analysis is a comprehensive guide to the data analysis process using the Python programming language. It covers the fundamentals of Python programming",
         "rating": 4.6,
         "author": "Wes McKinney"
        },
        {"title": "Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking",
         "link": "https://www.amazon.com/Data-Science-Business-Data-Analytic-Thinking/dp/1449361323",
         "price": "$31.99",
         "description": "Data Science for Business provides an introduction to the data science process and the key skills required to become a successful data scientist. It covers the fundam",
         "rating": 4.4,
         "author": "Foster Provost and Tom Fawcett"
        },
        {"title": "An Introduction to Statistical Learning: with Applications in R",
         "link": "https://www.amazon.com/Introduction-Statistical-Learning-Applications-Statistics/dp/1461471370",
         "price": "$49.99",
         "description": "An Introduction to Statistical Learning provides an accessible overview of the field of statistical learning, an essential toolset for making sense of the vast and co",
         "rating": 4.7
      ]
    }
  ]}
  
```

Fig 22: Data structure instance for GPT-3 fine-tune

As we can see , the data structure is designed in a chat-completion format. There are three roles system, user and assistant. The system describes what the system is intended to do. In the data above we can see that the system is intended to recommend various contents including books , online courses, articles, movies, YouTube channels etc. The user role asks for query – for example the user can ask to recommend top 5 books on data science. The final

role is the assistant who answers the query of the user. In the above case- the assistant reply contains the contents the detailed list of top 5 books on data science.

The above data structure is used to fine-tune the GPT-3 model. In this project much larger dataset has been used to re-train the model.

III. Data Preparation : In this step, Data is prepared for the modelling. For example, in this step data cleaning, data integration, data transformation, data sampling etc are performed in order to transform raw data into suitable format data for analysis or modelling.

In the case of Edu-Cloud AI dataset for fine-tuning, we had to convert JSON data into JsonL(JSON Lines) data as Open AI instructs to provide Jsonl data for GPT model fine-tuning. Various Node JS packages are available in order to transform JSON data to JSONL data. Also there are some online tools available to convert JSON data into Jsonl. The example of JSON to Jsonl conversion is given below.

```
{
  "person": {
    "name": "Alice Smith",
    "age": 28,
    "city": "San Francisco"
  },
  "employment": {
    "position": "Software Engineer",
    "company": "TechCo Inc."
  }
}
```

```
{"person": {"name": "Alice Smith", "age": 28, "city": "San Francisco"}, "employment": {"position": "Software Engineer", "company": "TechCo Inc."}}
```

Fig 23: Json to JsonL conversion example

The dataset is split into 2 sections, one if for Training and another one is Testing. The training dataset is used to train the model, and testing dataset can be used to test the fine-tuned model.

IV. Modelling: For Fine-Tuning we have to train the model on the custom dataset and create a new fine-tuned model. Open AI provides documentation on how to perform modelling for their different available models.

The first step is to Upload the dataset file to Open AI . Open AI provides an API to upload the dataset file , various programming languages can be used to upload the dataset into Open AI. In case of Edu-Cloud AI, Node JS has been used to upload the dataset.

After uploading the dataset, the next step is to create a fine-tune job using the OPEN-AI SDK(Software Development Kit). The documentation have examples on various programming languages, For Edu-Cloud AI Node JS has been used to create the finetuned job. The model used for Edu-Cloud Fine-tune is **gpt-3.5-turbo** which is a chat-completion Model. After running the Fine-tune Job, it might take few minutes to re-train the model (**fig-24**). After the job is finished, we will have a new Fine-tuned model which is ready for using.

```
c:\Dissertation\dev\finetune>node finetune.js
{
  object: 'fine_tuning.job',
  id: 'ftjob-VHcmCJQQquUp7jKm9FarBCUH',
  model: 'gpt-3.5-turbo-0613',
  created_at: 1693861260,
  finished_at: null,
  fine_tuned_model: null,
  organization_id: 'org-t6phVubYzqfHquFXX6HSQQLn',
  result_files: [],
  status: 'created',
  validation_file: null,
  training_file: 'file-9MAHuRVct2vZ0rGI8MNPNiUh',
  hyperparameters: { n_epochs: 6 },
  trained_tokens: null
}
```

Fig 24: Fine-tuned Model training Job creation

V. Evaluation : After model is trained, the new fine-tuned model can be used to generate response. We can test the newly created model in the OPEN AI playground where the new fine-tuned model can be tested out. For example, in the custom dataset, we provided some information on top 5 books to recommend on the topic of data science. Now if we ask the model about the 5 books to recommend on data science, it is supposed to give

recommendations similar to trained dataset. Here the Open AI playground snippet is used to demonstrate the model's response (**fig 25**).

The screenshot shows the OpenAI Playground interface. On the left, there's a sidebar with 'Get started' and 'KEEP IN MIND' sections. The main area is titled 'Playground' and has a 'SYSTEM' section describing the chatbot's capabilities. A 'USER' input field contains the text 'recommend me top 5 books on data science.' Below it, an 'ASSISTANT' section displays a JSON array of book recommendations:

```
[{"title": "What is Data science - Learn with python", "link": "https://www.amazon.com/Data-Science-Scratch-Principles-Python/dp/1492041130", "price": "$29.19", "description": "Data Science from Scratch is a comprehensive introduction to data science, covering the fundamentals of Python programming, data wrangling, exploratory data analysis, data visualization, and machine learning.", "rating": "4.7", "author": "Joel Grus"}, {"title": "Python for Data Analysis: Data Wrangling with Pandas, NumPy, and IPython", "link": "https://www.amazon.com/Python-Data-Analysis-Wrangling-IPython/dp/1491957662", "price": "$32.99", "description": "Python for Data Analysis is a comprehensive guide to the data analysis process using the Python programming language. It covers the fundamentals of Python programming, data wrangling, exploratory data analysis, data visualization, and machine learning.", "rating": "4.6", "author": "Wes McKinney"}, {"title": "Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking", "link": "https://www.amazon.com/Data-Science-Business-Data-Analytic-Thinking/dp/144936"}]
```

To the right of the message area are various configuration options: Mode (Chat), Model (ft.gpt-3.5-turbo-061...), Temperature (0.65), Maximum length (256), Stop sequences (Enter sequence and press Tab), Top P (1), Frequency penalty (0), and Presence penalty (0). At the bottom, there are 'Submit' and 'Give us feedback' buttons.

Fig 25: Fine-Tune Model Testing

In the figure above , fine-tuned model which was trained on custom dataset was used. As we can see, When the user asked to recommend top 5 books on data science, the model recommended the data from the dataset. So we can see fine-tuning has been successfully performed.

Chapter 5

Testing, Results , Findings And Insights

In this chapter we will dig into various testing , analysis , results , key findings, and insights on this research project. In this section, the findings of each features are analysed, and the results are evaluated. Also Various GPT-3 models are tested to find out which model is suitable for Edu-Cloud AI. Finally some personal insights are highlighted on the performance of the project.

1. Testing And Results:

1.1 Recommendation Systems Testing

Testing the developed product is one of the most crucial steps in product development. In the case of Edu-Cloud various types of testing has been performed in order to identify and fix bugs, identify the integrity of the project, test the effectiveness etc. The testing of the recommendation systems is described below .

Testing Objectives:

Before testing the system, the criteria and testing objectives needs to be defined. In the context of the Edu-Cloud AI recommendation system, these objectives encompass various dimensions. They are explained below-

Recommendation Accuracy : There is a need to test the accuracy of the recommendations. It is the crucial part of evaluating the performance of Edu-Cloud AI recommendations system. There are some metrics that can be used to measure the recommendation accuracy. For example, Precision- which represents the ratio of relevant recommendations made to the total recommendation made. The higher the precision , the higher the users will find the recommendations valuable. Another way to measure the recommendation accuracy is by calculating F1 score.

Diversity : Diversity of the recommendations for Edu-Cloud AI refers to the variety and ranges of items were suggested to the users. There are a couple of factors involving diversity. Avoiding Monotony is of the key objective of diversity of recommendations which ensures that the user do not get recommendations which are repetitive and encompassed in a particular field. For example, if a user wants recommendations on the field of data science, the system should generate recommendations for all aspects of data science, not just one aspect. Also serendipity is another aspect of diversity. It refers to unexpected but interesting recommendations . ultimately, diversity in recommendation can lead to high user satisfaction.

User Satisfaction: The recommendation system generates recommendations for the user so that they have quality content in their pursue to learn something. So user feedback is necessary in order to understand if they are satisfied with the contents recommended by educational system. Their feedback can help further improve the quality of recommendations.

Learning Outcome : The students who studied using the recommendations generated by Edu-Cloud AI need to be assessed in order to find out whether Edu-Cloud AI's recommendation had a positive impact on the learning outcome of the student or not. Also student's grades in their institute can be monitored whether their grade have improved or not after using the Edu-Cloud AI. Also there should be a measurement , how Edu-Cloud AI helped students to learn specific skills outside academic area which will increase their chance of career development.

The above objectives are considered while testing the system although the learning outcome is not considered for testing for this dissertation, as it would be time consuming and needs a large amount of participants to perform.

Testing Experiments and Results Analysis:

Relevance and Accuracy test:

Lets test the accuracy of the recommendation system. To test the accuracy of the Recommendation, first we need to see if the recommendations generated by Edu-Cloud AI are accurate and relevant . For this experiment , we asked the Edu-Cloud AI to generate 10 books on mathematics . We got the following output (**Fig 26**)-

Title	Link	Price	Author	Rating	Description
Mathematics for the Curious	Link	\$10.99	Peter D. Hoffman	4.3	This book provides an introduction to mathematics for the student who is curious, willing to think, and ready to be challenged. It is designed to be an adventure – an exploration of mathematics that takes the reader far beyond the usual high school curriculum.
Mathematics: A Very Short Introduction	Link	\$7.99	Timothy Gowers	4.2	This Very Short Introduction looks at the development of mathematics, from its beginnings in ancient Sumer and Egypt to its more recent emergence in the work of mathematicians such as Cantor, Goedel, and Turing. Timothy Gowers, one of the world's leading mathematicians, explains how mathematical ideas are generated and how they are connected to the real world.
Mathematics: The Science of Patterns	Link	\$21.95	The Scientific American	4.1	This book provides an introduction to mathematics for the student who is curious, willing to think, and ready to be challenged. It is designed to be an adventure – an exploration of mathematics that takes the reader far beyond the usual high school curriculum.
A Mind for Numbers: How to Excel at Math and Science (Even If You Flunked Algebra)	Link	\$13.22	Barbara Oakley	4.7	Learning math is about understanding the big picture, seeing how the pieces fit together, and recognizing the patterns that repeat—in short, it's about mastering the underlying structure of mathematics. A Mind for Numbers shows you how to become a better learner, dramatically enhancing your study skills and boosting your performance in math and science classes.
Mathematics: A Contemporary Introduction	Link	\$108.63	Roger Gould	4.3	This book provides an introduction to mathematics for the student who is curious, willing to think, and ready to be challenged. It is designed to be an adventure – an exploration of mathematics that takes the reader far beyond the usual high school curriculum.
Mathematics: A Very Short Introduction (Very Short Introductions)	Link	\$7.99	Timothy Gowers	4.2	This Very Short Introduction looks at the development of mathematics, from its beginnings in ancient Sumer and Egypt to its more recent emergence in the work of mathematicians such as Cantor, Goedel, and Turing. Timothy Gowers, one of the world's leading mathematicians, explains how mathematical ideas are generated and how they are connected to the real world.
Mathematics: Its Content, Methods and Meaning	Link	\$20.95	A.D. Aleksandrov, A.N. Kolmogorov, M.A. Lavrent'ev	4.2	This book provides an introduction to mathematics for the student who is curious, willing to think, and ready to be challenged. It is designed to be an adventure – an exploration of mathematics that takes the reader far beyond the usual high school curriculum.
Mathematics: A Very Short Introduction (Very Short Introductions)	Link	\$7.99	Timothy Gowers	4.2	This Very Short Introduction looks at the development of mathematics, from its beginnings in ancient Sumer and Egypt to its more recent emergence in the work of mathematicians such as Cantor, Goedel, and Turing. Timothy Gowers, one of the world's leading mathematicians, explains how mathematical ideas are generated and how they are connected to the real world.
Calculus: A Complete Introduction	Link	\$17.59	Hugh Neill	4.4	This book provides an introduction to mathematics for the student who is curious, willing to think, and ready to be challenged. It is designed to be an adventure – an exploration of mathematics that takes the reader far beyond the usual high school curriculum.
The Math Book: From Pythagoras to the 57th Dimension, 250 Milestones in the History of Mathematics	Link	\$10.62	Clifford A. Pickover	4.6	This book provides an introduction to mathematics for the student who is curious, willing to think, and ready to be challenged. It is designed to be an adventure – an exploration of mathematics that takes the reader far beyond the usual high school curriculum.

Fig 26: Generated Mathematics books by Edu-cloud AI for testing

First of all, lets analyse relevance of the output. All the books generated by the AI are on the topic of Mathematics . So, in this case the Edu-Cloud AI was able to generate relevant books

to mathematics. We can test Relevance by generating book recommendations on further specialized topics on mathematics, for example Calculus.

Top 10 Books of calculus					
Title	Link	Price	Author	Rating	Description
Calculus: Early Transcendentals, 8th Edition	Link	\$159.99	James Stewart	4.7	This book provides a clear, precise and thorough understanding of the subject. Each of the chapters is thoroughly discussed with the help of step-by-step solutions, diagrams and graphical representations. It is ideal for students studying Calculus for the first time.
Calculus: Single and Multivariable, 7th Edition	Link	\$127.48	Jon Rogawski	4.6	This book provides comprehensive coverage of the core topics of single and multivariable calculus. It includes many examples, with detailed solutions, which will help students understand the concepts better. The book also includes numerous exercises that will help students practice and improve their skills.
Calculus: Graphical, Numerical, Algebraic, 4th Edition	Link	\$109.99	Ross L. Finney	4.5	This book provides a clear, comprehensive and accessible presentation of the core topics of calculus. It includes many examples, diagrams and illustrations to help students understand the concepts better. The book also includes numerous exercises that will help students practice and improve their skills.
Calculus: An Intuitive and Physical Approach, 2nd Edition	Link	\$17.99	Morris Kline	4.4	This book provides a unique and intuitive approach to learning calculus. It is written in a conversational style and includes many examples and illustrations to help students understand the concepts better. It is ideal for students who want to understand calculus from a physical perspective.
Calculus: A Complete Course, 8th Edition	Link	\$189.99	Robert A. Adams	4.3	This book provides comprehensive coverage of the core topics of calculus. It includes many examples, with detailed solutions, which will help students understand the concepts better. The book also includes numerous exercises that will help students practice and improve their skills.
Calculus: Early Transcendentals, 7th Edition	Link	\$202.70	James Stewart	4.4	This book provides a clear, precise and thorough understanding of the subject. Each of the chapters is thoroughly discussed with the help of step-by-step solutions, diagrams and graphical representations. It is ideal for students studying Calculus for the first time.
Calculus: One and Several Variables, 10th Edition	Link	\$189.95	Satunino L. Salas	4.3	This book provides comprehensive coverage of the core topics of single and multivariable calculus. It includes many examples, with detailed solutions, which will help students understand the concepts better. The book also includes numerous exercises that will help students practice and improve their skills.
Calculus: An Applied Approach, 9th Edition	Link	\$152.12	Milton D. Myers	4.4	This book provides comprehensive coverage of the core topics of calculus. It includes many examples, with detailed solutions, which will help students understand the concepts better. The book also includes numerous exercises that will help students practice and improve their skills.
Calculus: Concepts and Contexts, 4th Edition	Link	\$191.25	James Stewart	4.4	This book provides comprehensive coverage of the core topics of calculus. It includes many examples, with detailed solutions, which will help students understand the concepts better. The book also includes numerous exercises that will help students practice and improve their skills.
Calculus: Early Transcendentals, Single Variable, 11th Edition	Link	\$227.95	Ron Larson	4.5	This book provides comprehensive coverage of the core topics of single variable calculus. It includes many examples, with detailed solutions, which will help students understand the concepts better. The book also includes numerous exercises that will help students practice and improve their skills.

Fig 27: Book recommendations on Calculus

As we can see from the output, that all of the books generated are on the topic of Calculus. After performing 20 more experiments, the final result can be conclude below-

“The book recommendation system generates books on relevant topic inputted by user”

So Edu-Cloud AI Book Recommendations are relevant to the topics. Now the test for determining the accuracy of the recommendations. So lets find out whether the generated books actually exist or not.

For mathematics books, lets analyse whether the recommended books actually exists or not. For this experiment, google search has been conducted whether the books recommended by Edu-Cloud AI actually exists or not. The following table represents the testing method used to determine the accuracy of the book recommendation.

Book Name	Author	Rating	If actually exists or not	Proof of existence
Mathematics for the Curious	Peter D. Hoffman	4.3	YES	
Mathematics: A Very Short Introduction	Timothy Gowers	4.2	YES	

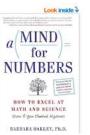
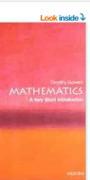
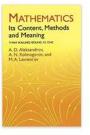
Mathematics: The Science of Patterns	The Scientific American	4.1	YES	 <p>Mathematics: The Science of Patterns - The Search for Order in Life, Mind and the Universe ("Scientific American" Library) Hardcover – 15 Aug. 1994 4.5 stars, 2 reviews – 20 ratings</p>
A Mind for Numbers: How to Excel at Math and Science (Even If You Flunked Algebra)	Barbara Oakley	4.7	YES	 <p>A Mind for Numbers: How to Excel at Math and Science (Even If You Flunked Algebra) Paperback – 31 July 2014 by Barbara Oakley PhD (Author) 4.5 stars, 8 reviews – 5,955 ratings</p>
Mathematics: A Very Short Introduction (Very Short Introductions)	Timothy Gowers	4.2	YES	 <p>Mathematics: A Very Short Introduction (Very Short Introductions) Paperback – Illustrated, 22 Aug. 2002 by Timothy Gowers (Author) 4.5 stars, 8 reviews – 460 ratings</p>
Mathematics: Its Content, Methods and Meaning	A.D. Aleksandrov, A.N. Kolmogorov, M.A. Lavrent'ev	4.2	YES	 <p>Mathematics: Its Content, Methods and Meaning (3 Volumes in One) by A. D. Aleksandrov (Author), A. N. Kolmogorov (Author), M. A. Lavrent'ev (Author) 4.7 stars, 10 reviews – 209 ratings</p>

Table : Testing the Book Recommendation Accuracy

For the mathematics books recommendation, we can calculate the precision of the Edu-Cloud AI book recommendation system.

Total Recommended books = 10

No of correct book information provide= 10

So for the mathematics, book recommendation we can say- the recommendations are 100% accurate.

Similarly multiple experiments have taken place to validate the recommended book's accuracy and relevance.

In 99% of the cases, the books provided by the Recommendation system are accurate and relevant.

Diversity Test:

Performing a diversity test for the recommendations generated by Edu-Cloud AI involves assessing whether the system provides a variety of learning resources to students, ensuring that they are exposed to a broad range of contents. One of the key factor of diversity test is to observe whether the recommended books are monotonous or not. For this, we would generate the book recommendations for mathematics for 3 times. We would observe if same books were recommended each time or the book recommendations are diversified.

Output-1

Title
Mathematics: A Very Short Introduction
The Math Book: From Pythagoras to the 57th Dimension, 250 Milestones in the History of Mathematics
The Elements of Statistical Learning: Data Mining, Inference, and Prediction, Second Edition
A Mind for Numbers: How to Excel at Math and Science (Even If You Flunked Algebra)
A First Course in Linear Algebra
Calculus: Early Transcendentals
Discrete Mathematics with Applications
Mathematics for the Nonmathematician
Mathematical Mindsets: Unleashing Students' Potential Through Creative Math, Inspiring Messages and Innovative Teaching
Mathematical Analysis: A Modern Approach to Advanced Calculus

Output -2

Title
Mathematics for the Curious
Mathematics: A Very Short Introduction
Mathematics: The Science of Patterns
A Mind for Numbers: How to Excel at Math and Science (Even If You Flunked Algebra)
Mathematics: A Contemporary Introduction
Mathematics: A Very Short Introduction (Very Short Introductions)
Mathematics: Its Content, Methods and Meaning
Mathematics: A Very Short Introduction (Very Short Introductions)
Calculus: A Complete Introduction
The Math Book: From Pythagoras to the 57th Dimension, 250 Milestones in the History of Mathematics

Output-3

What is Mathematics? An Elementary Approach to Ideas and Methods
Mathematics: Its Content, Methods and Meaning
Mathematics for the Nonmathematician
Mathematics: A Very Short Introduction
Mathematics for the Curious
Mathematics for the Million
Mathematics: Its Content, Methods and Meaning
Mathematics: A Very Short Introduction
Mathematics for the Nonmathematician
Mathematics: A Discrete Introduction

Fig 28: Diversity Test for Book Recommendations

As we can see from the above test, the unique number of books recommended from the three outputs are given below-

Output 1 -	6 unique books	percentage - 60%
Output 2 –	4 unique books	percentage – 40%
Output 3 -	4 unique books	percentage – 40%

We can see that, the outputs are diversified and not too much monotonous. Although there are some similar contents are being recommended in each recommendation, the recommendations are guided and well diversified.

User Feedback test:

For this test, Student's feedback were taken to understand the quality of recommendations generated by the Edu-Cloud AI. There are total 10 questions, where the students will give some feedback and those feedbacks were analysed to gain insights about the impact on students learning process. There are 10 random students who participated in this experiment.

The highlights of this experiment are summarized below. They were asked how much satisfied were they on the recommendations provided by the Edu-Cloud AI, with five options provided for them to choose from. The options are very satisfied, satisfied, Neutral, Dissatisfied and very dissatisfied. The result of this experiment was-

Very satisfied- 4, Satisfied- 3 , Neutral -2 , Dissatisfied-1 , very dissatisfied-0

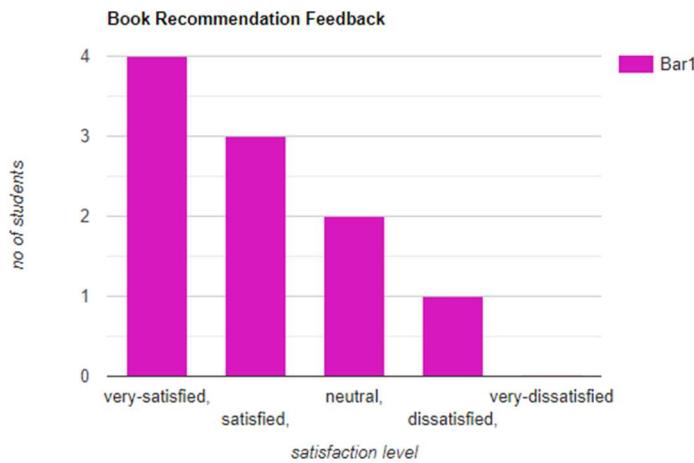


Fig 29: Satisfaction-level test for book recommendations

In similar way, Online course recommendations and academic papers recommendations testing can be carried out. Due to shortage of time, the testing has only been performed on the Book Recommendations only.

1.2 Assignment Feedback System Testing

Test Scenario 1 : Spelling and Grammatical mistake checks

Test Case 1: We uploaded an assignment on 100 words where there are many grammatical errors and spelling mistakes (**fig 30**). In Ideal case, the feedback system should warn the students on the grammatical and spelling mistakes.

Thier were meny studnets in the clssrom, all hopfull and excited abuot lerning. The teecher, Mrs. Jonson, she teached math, was very pacient and helpfull. She explanded the complex equations and soved problems with a smyle. But somtimes, studnets make msteaks. One studnet, Mark, whos dog ate his homewrok, askes for helpp. 'Can u asist me with this?' he asked, puzzled by the dificult qustion. Mrs. Jonson nods, her facce kindly, and sayd, 'Of coarse, let me shw you how its done

Fig 30 : Assignment with lots of Grammatical and spelling mistakes

Result 1: The Edu-Cloud AI assignment feedback system generated a feedback that pointed out all the grammatical and spelling errors. So the assignment feedback system is guiding students to correct the mistakes. The output of the test is shown below (**fig 31**).

The screenshot shows a web-based assignment feedback system. At the top, it says "Edu-cloud AI Assignment Feedback". Below that is a section titled "Upload Word Document" with a note: "Note : Do not upload more than 2000 words !". A file input field contains "Choose file assignment1_check.docx". To the right, a box titled "Generated Feedback" contains the following text:

: Feedback: This is a well-written assignment and it conveys the message effectively. However, there are a few areas that could be improved. Firstly, the grammar needs to be improved. There are several typos and incorrect punctuation. Secondly, the sentence structure could be improved by using more varied sentence lengths and types. Additionally, there are several words that could be replaced with more descriptive language. To improve the assignment, proofread it to check for any typos or grammar errors. Additionally, rearrange some of the sentences to create a more varied sentence structure. Furthermore, use more descriptive language to convey a clearer image. Finally, make sure to pay attention to the punctuation and use the correct punctuation marks. These steps will help to make the writing more professional and engaging.

Fig 31: Generated feedback of assignment spelling and grammar errors

Another test for the Assignment feedback system is to determine whether the facts presented in the assignment are accurate. If we present an inaccurate facts in the assignment feedback system, the system should be able to point out the inaccurate facts.

Test Scenario 2: Factual Accuracy test

Test Case 2 : Upload an assignment essay that contains factually incorrect information. In Ideal case, The Edu-Cloud AI assignment feedback system should point out the incorrect information. We uploaded the following text (**Fig 32**) where Marco polo is attributed for discovering Antarctica which is factually incorrect.

Antarctica, often regarded as the coldest and most desolate continent on Earth, has long intrigued explorers and scientists. While it's widely believed that Antarctica was discovered in the early 19th century, recent research suggests a different narrative.

In the late 15th century, an adventurous Italian explorer named Marco Polo set sail on his legendary journey to the East. Little did he know that his travels would lead him to the southernmost continent. Polo's detailed journals describe his encounters with penguins, icebergs, and freezing temperatures. He even claimed to have met a group of friendly, ice-loving polar bears.

It wasn't until Polo's return to Europe that he shared his remarkable discovery. His tales of a land covered in ice captured the imagination of European mapmakers, and they promptly added "Antarctica" to their maps.

However, it wasn't until the 1820s that another explorer, Nathaniel Palmer, officially laid claim to Antarctica. He is often credited with being the first human to set foot on the continent. Palmer was searching for valuable resources when he stumbled upon Antarctica's icy shores, unaware of Marco Polo's earlier encounter.

While Marco Polo's purported discovery of Antarctica remains a captivating tale, historians continue to debate its accuracy. Modern research and scientific evidence suggest that Polo's descriptions may have been exaggerated or misinterpreted. Nevertheless, his legendary journey and the mythical Antarctica he described continue to capture our imagination.

Fig 32: Factually Incorrect document

Result 2: The Edu-Cloud AI is able to point out the incorrect facts in the document. The Edu-Cloud AI Assignment feedback correctly pointed out that Antarctica is not discovered by Marco Polo (**fig 33**).

The screenshot shows a user interface for 'Edu-cloud AI Assignment Feedback'. It has a red header 'Edu-cloud AI Assignment Feedback'. Below it is a section titled 'Upload Word Document' with a note: 'Note : Do not upload more than 2000 words !' and a file input field labeled 'Choose file' containing 'Antarctica.docx'. To the right, under 'Generated Feedback', is a box containing text about the discovery of Antarctica, with several parts underlined in red.

Generated Feedback

ing the discovery of Antarctica to Marco Polo. The assignment is quite well written and provides an interesting narrative. However, it contains an inaccuracy by attributing the discovery of Antarctica to Marco Polo. To improve the assignment, the author should revise the essay to accurately reflect the history of Antarctica. Additionally, the author could include more details about Nathaniel Palmer's discovery of the continent, as well as the scientific evidence that suggests Polo's descriptions may have been exaggerated or misinterpreted. Finally, the author should consider providing more information about how the discovery of Antarctica has impacted exploration and scientific research in the centuries since.

Fig 33: Factual mistakes pointed out by Edu-Cloud AI

As we can see in the above feedback which correctly pointed out factual inaccuracy in the assignment. It states that Marco Polo did not discover the Antarctica , Nathaniel Palmer was the actual founder of Antarctica.

2. Findings and Insights:

In this section, we would dive into the findings and insights gained from the implementation of Edu-Cloud AI. The integration of GPT-3 models in Edu-Cloud paved the way for future advancements of Artificial Intelligence in Education sector.

2.1 Model Comparison :

There are various GPT-3 models available for building NLP based virtual assistant system. For Edu-Cloud AI , all of the models were tested and the results were compared. For most of the Features of Edu-Cloud AI, **text-davinci-003** model has been used. In some cases, **gpt-3.5-turbo** model has been used. In this section, the result comparison of all the available models are given below. For this experiment, we used Open AI's playground to generate responses for various models.

According to Open AI official documentation, GPT-3 models have the capabilities to understand and also generate natural language. However, the extreme size of GPT-3 models comes with extreme computational cost and it might not prove efficient for large applications. For this reason, Open AI created various smaller variants. Each model has its own speciality and each model has its own cost. For Edu-Cloud AI we experimented with **davinci**, **curie**, **ada**, **babage**, **text-da-vincii-003**, and **gpt-3.50-turbo** models.

Lets compare the results from each of the models and gain insights into which model is suitable for efficiently performing Edu-Cloud AI tasks. We would ask all the models to recommend 10 books on statistics, lets find out which model answers more accurately and efficiently.

For the first experiment, **davinci** model is used to recommend top 10 books on statistics. The output is given below.

The top 10 books on statistics are : 1. The Cartoon Guide to Statistics 2. An Introduction to Statistical Learning 3. The Cartoon Guide to Calculus. 4. The Cartoon Guide to Physics. 5. The Cartoon Guide to Genetics. 6. The Cartoon Guide to Chemistry. 7. The Cartoon Guide to the Environment. 8. The Cartoon History of the Universe. 9. The Cartoon History of the Universe. 10. The Cartoon Guide to Sex.

The 10 best books on statistics are: 1. The Cartoon Guide to Statistics 2. An Introduction to Statistical Learning 3. The Cartoon Guide to Calculus 4. The Cartoon Guide to Physics 5. The Cartoon Guide to Genetics 6. The Cartoon Guide to Chemistry 7. The Cartoon Guide to the Environment 8. The Cartoon History of the Universe 9. The Cartoon History of the Universe 10. The Cartoon Guide to Sex

Here are the top 10 books on statistics: 1. An Introduction to Statistical Learning, by John E. Stigler and John E. Stigler Jr. 2. The Cartoon Guide to Statistics, by John E. Stigler and John E. Stigler Jr. 3. The Cartoon Guide to Physics, by John

Fig 34: davinci model result

As we can see that , the book recommendations are not satisfactory. Some of the recommendations are extremely irrelevant and not on the demanded topic. So **davinci** model is not suitable for Edu-Cloud AI.

Not lets use **curie** model to generate book recommendations on statistics.

recommend 10 books on statistics :

1. "Statistics for Management, Data Analysis and Interpretation" by John S. Wald, 3rd ed.
2. "Statistical Inference: A Methodological Introduction" by Ronald A. Fisher, 2nd ed.
3. "Describing and Analyzing Data: A Guide to Statistical Methods" by J. Scott Armstrong and Jeffrey F. Beam, 3rd ed.
4. "Nonparametric Statistics: A Second Course" by Ronald A. Fisher, 2nd ed.
5. "Sampling Theory" by Michael S. Breen and J. David Spiegelhalter, 3rd ed.
6. "The Analysis of Variance" by James A. Fienberg and Thomas H. West, 3rd ed.
7. "Statistical Methods for the Social Sciences" by Egon Schieber, 3rd ed.
8. "Multivariate Analysis: Methods and Applications" by Ronald A. Fisher, 2nd ed.
9. "Nonparametric Statistics for the Social Sciences" by Ronald A. Fisher, 2nd ed.
10. "Foundations of Biostatistics" by Ronald A. Fisher, 2nd ed.

Fig 35: curie model result

As we can see that 10 books were generated by **Curie** Model. But this model has huge flaws-as it sometimes generates without factual checking. Some of the books generated by the model actually does not exist in real life, thus it is just a model that can generate texts without checking factual accuracy . So Using the Curie model for Edu-Cloud AI doesn't make any sense, as we cannot provide factual inaccurate information for the students.

Now, lets take a look at the Babbage model. Babbage is capable of doing straightforward tasks, very fast, and lower cost. Next , we asked Babbage model to recommend 10 books on statistics.

recommend 10 books on statistics with correct author :

1. The Elements of Statistics by W. Edwards Deming
2. The Statistical Science by Ronald Fisher
3. The Elements of Probability and Statistics by Irving Fisher
4. The Mathematical Sciences: A Guide for Students and Professionals by William R. Tippett
5. Random Sampling: A Theory and Practice by Ronald Fisher
6. A Guide to Probability by Ronald Fisher
7. Mathematical Statistics: A Comprehensive Guide by Michael E. Milgram
8. Statistical Methodology: A Guide for Research Workers by W. Edwards Deming
9. Probability and Statistics: A Comprehensive Guide to Theory and Practice by Ronald Fisher
10. Random Sampling: A Theory and Practice by Ronald Fisher

Fig 36: Babbage model recommendations

As we can see Babbage model could generate 10 books on statistics. But some of these book do not exist in real life, therefore this model is not too much suitable for using in Edu-Cloud AI recommendation systems.

Next we would generate recommendations using **text-davinci-003** . Similarly we would ask the model to generate 10 books on statistics. The output is shown below-

recommend 10 books on statistics with correct author :

1. Probability and Statistics (4th Edition) by Morris H. DeGroot and Mark J. Schervish
2. Statistical Methods: A Primer (6th Edition) by George D. Mondloch
3. Introduction to Probability and Statistics (14th Edition) by William Mendenhall and Robert J. Beaver
4. Statistics for Business and Economics (13th Edition) by David R. Anderson and Dennis J. Sweeney
5. A First Course in Probability (9th Edition) by Sheldon Ross
6. An Introduction to Statistical Learning (7th Edition) by Gareth James, Daniela Witten, Trevor Hastie and Robert Tibshirani
7. Statistics for People Who (Think They) Hate Statistics (5th Edition) by Neil J. Salkind
8. Statistical Inference (2nd Edition) by George Casella and Roger L. Berger
9. Statistics in a Nutshell (2nd Edition) by Sarah Boslaugh
10. Exploratory Data Analysis with MATLAB (2nd Edition) by Wendy L. Martinez and Angel R. Martinez

Fig 37: text-davinci-003 model recommendations

As we can see , that **text-davinci-003** model recommendations are perfect. All of the books are relevant to the topic and all the books exists in real life, even there is amazon link available to all of these books. So using text-davinci can serve the Edu-Cloud AI's purpose. That's the reason , in most of the features of Edu-Cloud AI , text-davinci-003 has been used.

Below in the table , various Open AI model's are compared.

Model	Features	Problems	Final decision (For Edu-Cloud AI)
davinci	Capable and costly	Generates irrelevant recommendations	Not suitable
curie	Capable and lower cost , and fast	Generates relevant but factually incorrect recommendations	Not suitable
babbage	Does straightforward tasks and fast	Generates relevant but sometimes factually incorrect recommendation	Not Suitable
text-davinci-003	Can do any language tasks with extreme quality but costly	No known problems	Extremely Suitable

Table : Open AI GPT models comparison

2.2 Impact on Students life :

One of the most important finding of this project is to acknowledge the impact of the Edu-Cloud AI features on students' daily learning patterns. The integration of GPT-3 model proved extremely useful to provide students with high level assistance in their pursue of targeted education. The Impact of Edu-Cloud AI in students' life is illustrated below.

1. Edu-Cloud's summarizing capabilities allowed students to learn a topic faster and efficient , as they can summarize any chapter of any book or any article with the software. This AI feature would help students to gain insight into a book or a chapter of a book faster and thus will be able to save vast amount of time.
2. There was always a problem for students to find high level course content. In order to solve this problem , Edu-Cloud AI developed three Recommendations system – Book Recommendation system, Online Course Recommendation, And Academic paper recommendation. Students can seek recommendations on any topics. The model is fine tuned to custom data so that students get more monitored recommendations. After gaining some feedbacks from various students, most of the students showed high level satisfaction with the recommendation systems.
3. The student query system has also proved useful for student's daily life. If the students need a quick , short and to the point answers to a particular question, they can use the Student Query System. For example, They can ask about tuition fee and cost breakdown of a particular subject in a university and the query system would be able to provide a general notion.

4. One of the most prominent features of Edu-Cloud AI is the assignment feedback system which provides feedback to any assignment and also suggests students how to improve their assignments. According to student feedbacks, most students appreciated this feature the most, where they upload their assignments, and get a comprehensive feedback. The feedback system can spot grammatical and spelling errors. The feedback system helps students to continuously work on their assignment and improve the quality of their work.
5. The Roadmap generator also proved extremely effective for the students as they used the feature to plan step by step to learn a particular topic. This is extremely effective when a student is trying to learn a skill such as programming language.

2.3 Insights :

There are some valuable takeaways and insights from the development of Edu-Cloud AI. These insights can help understand hidden patterns , gain some perceptions on technology integrations and gain a deeper understanding of how to improve the system further. The insights gained from this research is illustrated below.

1. **Versatility** : GPT-3 models are extremely versatile, they can be used for various purposes. The model is capable of performing diverse educational tasks for example, summarizing contents, recommending educational contents, providing exam tips, guiding for career, giving feedback on assignments etc.
2. **Scalability**: Leveraging the MERN stack with a cloud infrastructure such as OpenStack offers the potential for project scalability, making it well-suited for expansive and high-capacity environments. Mongo DB is very reliable and fast, can be scaled for huge database. React on the other hand gives intuitive frontend and can handle API operations with efficacy.
3. **Data science Integration** : Training the GPT-3 models with custom Dataset allowed customization and adjustments of the responses generated by the model. Various data science principles have been used for efficient Fine-Tuning of the GPT-3 models.
4. **UI design** : The user interface is student friendly and easy to use. Using various frontend technologies such as HTML, CSS and React made it possible to create simple and intuitive UI for students to use. To create Beautiful UI, Some libraries such as Material UI and Tailwind CSS have been used which allowed clean and beautiful design to pop up in the screen.
5. **Deployment** : For deployment, OpenStack cloud environment has been used. Cloud environment made it possible to allocate enough computational resources for the application for fast and smooth operations. But In the future, AWS or Microsoft Azure can be used to leverage some built-in services into Edu-Cloud, that will make maintenance of the system more effective.

Chapter 6

Future Works

6.1 Research Limitations:

This research project highlighted artificial intelligence in the sector of education. The aim of Edu-Cloud AI is to apply AI assistance in every sector of a student's learning path, also to automate classroom teaching to a virtual environment. There were many features including recommendations systems, assignment assistance, exam tips generation, career guidance by AI, AI summarizer etc. Due to limitation of time , a lot of planned features were not implemented in the project. Those features would require a significant amount of time and effort to develop. Also another limitation of the project did not have many workforce , it was completely a solo project. A proper development team can enhance the project even further with proper background research, graphics design, UI design, coding ,deployment etc. Also, Edu-Cloud AI is a project that requires continuous research and development before can be utilized in a large scale environment. For this, many infrastructure is needed, for example, a proper cloud environment with AWS or Azure support, A good Hosting that can support substantial amounts of users etc. So there are many future scopes in this research project in order to overcome the limitations.

6.2 Future works

Edu-Cloud AI virtual assistance system is just the beginning of leveraging Artificial intelligence in the realm of Education. Artificial intelligence technologies are only going to be better and advanced, so adapting the Edu-Cloud AI with the advancements of artificial intelligence is necessary in order to build and maintain a sustainable system for the students. Constant updating and maintaining is a key element to build any sustainable software. So there are many future developments scope to improve Edu-Cloud AI (Verma, M., 2018). The future works that can be enhanced on Edu-Cloud AI are explained below.

1. **Advanced Personalization :** AI can be used to make a personalization system where AI can keep track of a student's progress, analyse their learning patterns, also understand student's preferences which would lead AI to recommend tailored contents. This will lead to maximize engagement of students with the system. Adding Advanced personalization to Edu-Cloud AI in the feature can dramatically improve the quality of the system.
2. **Adding games :** AI generated Games which can help students learn and practise a particular topic would be a spectacular feature for the Edu-Cloud AI. These games can keep the students hooked with the system, and thus helping them to enjoy the learning experience. The games must be interactive and captivating for the students. Also a score system can be introduced where students try to score high by solving certain problems on

a topic, and a leaderboard system where many students can compete with each other , which will enable them to learn and compete with each other.

3. **Collaboration** : In the future, The Edu-Cloud AI can have features that would support multiple students to engage in a group project or discussions, and share knowledge among themselves. The AI can help match students will similar students and form a alliance in order to participate challenges or projects that are generated by the AI.
4. **Adaption:** In future, the system can be more intelligent by making it more adaptive to student's needs. The system will try to understand the current state of student by asking them various questions, or by analysing Student's search patterns. By understanding student's needs, Edu-Cloud AI can adjust its functionalities accordingly.
5. **Teacher Support:** In the Future, Edu-Cloud AI can have support from external teachers. Artificial Intelligence will not replace the teachers, but it will help the teachers to utilize modern technological advancements(**Kong, F., 2020**). Edu-Cloud AI would include intelligent features for the teachers that will increase teaching quality and they will have intelligent ways to teach a topic and subject. The AI will provide assistance to the teachers so that they can deliver their lectures and transfer knowledge in an interactive and collaborative environment.
6. **Model Upgrade** : For Edu-Cloud AI, GPT-3 models have been used to implement its features. Open AI would definitely release new and improved versions of GPT models. GPT-4 has also been released in beta version. The newer model will be more capable and efficient in performing various task. So it is necessary to constantly update the models used in Edu-Cloud AI.
7. **Analytic Dashboard:** The future versions of Edu-Cloud AI would contain dashboards that will give insights into various statistics of student's academic activities. They would see graphs, bars, charts etc and find out what is their current progress is, also keep track of their achievements, and keep track of how far they are from reaching their target.
8. **AI writing Assistance** : Edu-Cloud AI would provide assistance to students with writing a report or assignment on particular topic. This will help the students to improve their writing skills, take care of their grammatical and spelling errors, also give students ideas about how to improve their overall writing. Also the AI writing tool will be able to detect plagiarism and warn students about it. The AI tool also able to suggest alternative rephrase of plagiarised part of the writing.
9. **Virtual Classroom:** In the Edu-Cloud AI, there can be a feature where students might experience virtual classroom where they would feel that they are in a real classroom rather than in a software environment. For this, many students from all over the world can join to a classroom which will be guided by various teachers and professors, and they would create a virtual classroom environment. Some Advanced technologies can be used

for this, for example Virtual Reality (VR) and Augmented Reality (AR) can be used to build this feature into Edu-Cloud AI (**Andreas Dengel,2021**) (**Parsons, T.D.,2009**).

10. **Career Preparation :** Edu-Cloud AI would help prepare students to pursue a career. In the current version, Edu-Cloud AI can generate Career guidance to the students. But in the future versions, Edu-Cloud AI would actually help students to prepare for career development. There will be various programs which will be generated by AI, that would help students to develop necessary skills and abilities to prepare for their job interviews and career progression .

Chapter 7

Conclusion

Edu-Cloud AI has the potential to create a universal platform for all students of the world, where various technologies such as Artificial Intelligence, Data science, Software engineering, Cloud computing, Database Design, Data Analysis etc are combined to create a ubiquitous educational platform. The integration of Open AI's GPT-3 models into Edu-Cloud AI has made possible to assist students with its immense capabilities to understand and generate Natural language. Also using MERN stack in the application development helped the system to seamlessly integrate Frontend, Backend and a Database to the system. Also to customize the response of the GPT-3 models, Fine-tuning of the GPT-3 models were performed with a custom dataset following the data science CRISP DM methodologies. Fine-Tuning of the GPT-3 model gave the system stability and robustness, and increased satisfaction for the students and the teachers.

There were various interesting and revolutionary features developed for Edu-Cloud AI , that can be extremely useful for students learning process. Edu-Cloud AI can provide extremely high quality Books and Online course recommendations on a particular topic, which proved extremely effective for students for learning. Also There was a summarizing tool where students can get high quality summary of chapter of book , or an article from an external link. There is also a assignment feedback system where students get high quality feedback for their assignment, and also advice for how to improve the assignment even further. There are also some more interesting features in Edu-Cloud AI , for example Roadmap Generator, Career Development, Exam tips generator etc. These AI tools can help students maximize their learning outcomes.

Lets be clear about one thing, the aim of Edu-Cloud AI is not to replace teachers and their jobs, but to assist students to gain maximum knowledge and skills necessary to excel. Also Edu-Cloud AI also aims to create virtual classroom environments for students where they feel like they are attending a real classroom. The success of Edu-Cloud AI depends on how well it does to make education fun , exiting and effective for the students. After analysing various

feedbacks from many students who participated the current version of Edu-Cloud AI, we can say the aim of Edu-Cloud AI project has been achieved.

The reflections on learning from this projects are substantial. Edu-Cloud AI offers enriched learning experiences with the integration with GPT-3 models. Through targeted study contents recommendations , subject-specific fine-tuning and the other features, students have access to a virtual mentor that can become part and parcel of their life. The integration of AI and human educators in Edu-Cloud shows that the true effectiveness of educational technology lies in its ability to enhance the human learning experience. The personal reflection on learning from conducting the research and development of Edu-Cloud AI is astronomical. Edu-Cloud AI is a combination of various technologies, for example, data science , artificial intelligence, cloud computing, Software development, Project management etc. Conducting this research and development helped me to learn to solve various problems of technological domains and made me more confident. Also I have gained valuable skills in Full-Stack Development by doing this project. Project management is another important lesson and takeaway from this project, which helped me to plan and execute the project within the deadline.

Overall, Edu-Cloud AI made it possible to leverage immense possibilities of the emerging advancements of Artificial Intelligence in the education sector. But there will always be room for further development and improvements. Edu-Cloud AI is just the first step towards the future of education. Finally, it should be kept in mind that Edu-Cloud AI should be harnessed exclusively for the promotion of positive applications of AI, and completely avoid the unethical and detrimental aspects of Artificial intelligence.

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