

**ELG/DTI/GNG 5902**

**Project Proposal**

**E- Hospital**

Prepared by: Team 2

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**Problem Definition and Project Overview:**

The healthcare industry is facing a growing demand for services, which has put a significant strain on hospitals and healthcare systems worldwide. Many hospitals rely on traditional phone-based communication methods to manage patient inquiries, appointment scheduling, and service requests. However, this method is inefficient in handling the increasing volume of patient interactions, leading to delays in response times, patient dissatisfaction, and a reduction in the quality of care provided. As a result, both patients and healthcare providers are experiencing frustration. Patients are left waiting for essential information or appointments, while healthcare providers are overwhelmed with administrative tasks that detract from their ability to focus on critical care services.

This project aims to address these challenges by creating an AI-driven chatbot that will revolutionize how hospitals handle patient interactions. The proposed solution will leverage advanced artificial intelligence, specifically the GPT-4 model and Azure AI services, to automate patient queries and provide accurate, real-time responses. To effectively identify patient intent and guide them to the suitable service—such as a nurse practitioner, doctor, psychologist, or other healthcare professional—this chatbot will utilize GPT-4 for natural language processing and conversation generation, and the Retrieval-Augmented Generation (RAG) model for accessing relevant, up-to-date information. This combination ensures effective and smooth communication with patients.

The chatbot will be designed to assist with a wide range of patient needs, including general information about hospital services, such as working hours and available services; appointment booking, modification and cancellation; and access to reliable medical knowledge. By integrating AI into the healthcare system, the chatbot will significantly reduce the burden on healthcare staff by handling routine inquiries and appointment scheduling, allowing them to focus on more complex tasks that require human intervention.

This project is of critical importance to the client, as it aligns with their goal of improving operational efficiency and patient satisfaction. In today’s fast-paced healthcare environment, there is an urgent need for digital solutions that streamline operations and enhance the patient experience. The client will benefit from the chatbot's ability to reduce the volume of phone calls, optimize appointment scheduling, and provide patients with immediate access to information. For the healthcare system as a whole, this project will demonstrate the value of AI in modernizing patient care and improving service delivery, ultimately setting a precedent for how healthcare providers can embrace technology to meet the growing demands of their patients.

Our strategy includes integrating the GPT-4 API, Azure AI services, and the RAG model to manage patient interactions efficiently. After development, the chatbot will undergo testing and refinement before deployment. The main objectives are to increase operational efficiency, improve patient satisfaction, and demonstrate the value of AI in enhancing healthcare services.

**Project Guidance:**

Our client, **Prof. Ali Abbas**, a respected professor from the Faculty of Engineering at the University of Ottawa, brings a wealth of knowledge in healthcare systems and technology integration. He has extensive experience in health promotion, case management, and medical services, making him an ideal mentor for this project. Prof. Abbas will ensure that the AI-powered chatbot is designed to meet the real-world needs of healthcare providers and patients. His insights will guide the project’s development, particularly in ensuring that the chatbot adheres to medical communication standards and delivers accurate, empathetic responses to patient queries. Prof. Abbas will also ensure that the chatbot aligns with the healthcare industry’s operational and ethical standards.

In addition, **Prof. Ismaeel Al Ridhawi**, an Associate Professor of computer engineering at Kuwait College of Science and Technology, is our technical mentor with expertise in AI, federated learning, wireless communications, and blockchain. He will provide invaluable guidance on the technical aspects of the project. His role is to help the team navigate the complexities of AI integration, ensuring that the chatbot’s natural language processing capabilities are both accurate and scalable. Prof. Al Ridhawi’s extensive experience in AI model development will be instrumental in overcoming challenges related to intent detection and data processing. His mentorship will also cover best practices in AI deployment and network efficiency to ensure the chatbot can handle high volumes of patient interactions without compromising performance.

We will engage with both mentors through weekly meetings, where they will provide feedback on our progress, discuss any challenges we encounter, and offer strategic guidance. These interactions will ensure that the project remains on track and that both the technical and healthcare aspects of the chatbot are addressed effectively. Our mentors’ combined expertise will be critical in ensuring that the project meets its objectives and delivers a high-quality, functional solution.

Additionally, senior students who previously worked on the project will assist with knowledge transfer, guiding us through setting up the environment, using required tools, understanding the project architecture, and managing core dependencies. This collaboration will ensure that we can address any doubts and stay on the right path throughout the project. All external systems and individuals will be available and accessible, and we have confirmed their availability to assist us when needed.

**Background:**

Conversational AI is increasingly used for healthcare services like medical information access and virtual assistance. NLP techniques, especially Large Language Models (LLMs) like GPT-3.5 and GPT-4, have shown promise in extracting clinical data, such as social determinants and family history, from unstructured clinical notes. Challenges remain in dealing with inconsistent outputs and preserving semantic meaning. Techniques like reinforcement learning and human feedback can improve accuracy.

Hu et al. [1] applied GPT-3.5 to extract medical data from clinical notes with good results. GPT-4’s success in few-shot learning for extracting social determinants. These studies highlight potential but note challenges such as inconsistency in model outputs.

Jitesh et al. [2] used GPT-3.5 for extracting social determinants from clinical notes in a zero-shot setting. While the approach showed high accuracy in demographic data extraction, social determinants performance was lower but competitive. The study highlighted issues like inconsistency and domain knowledge gaps.

Dr. Nazlı et al. [3] discussed the rising importance of operations research (OR) in healthcare efficiency, especially in outpatient appointment systems (OAS). Digitalization and AI/MLbased tools like the Intelligent Online Appointment Manager Application (IAMA) improve scheduling efficiency. IAMA uses AI for symptom analysis and appointment prioritization, aiming to enhance patient care and reduce wait times. Future work includes EHR integration and privacy considerations.

The cited sources provide detailed documentation on OpenAI's GPT-4 API, usage tiers, privacy policies, and Azure integration. These resources guide developers in utilizing AI services efficiently while ensuring data security and scalability.

1. GPT-4 API Documentation, OpenAI, 2023.

Available at: [https://platform.openai.com/docs/guides/gpt.](https://platform.openai.com/docs/guides/gpt)

1. Azure Open AI Documentation, Microsoft, 2023

Available at: [https://learn.microsoft.com/en-us/azure/ai-services/openai/.](https://learn.microsoft.com/en-us/azure/ai-services/openai/)

1. OpenAI’s documentation on usage tiers.

Available at: [Rate limits - OpenAI API](https://platform.openai.com/docs/guides/rate-limits/usage-tiers?context=tier-one)

1. OpenAI’s documentation on entreprise privacy.

Available at: [Enterprise privacy | OpenAI](https://openai.com/enterprise-privacy/)

**Team roles and responsibilities:**

Our team is composed of five members, each selected for their expertise and unique contributions to the project. The collaborative nature of this project requires a diverse set of skills, from software development to project management and operations. Here’s a brief overview of each team member's role and background:

* **Sharini Rithigaa Baranisrinivasan Sumalatha** and **Bansari Patel** are the lead AI and Natural Language Processing (NLP) developers for the project. Both have extensive backgrounds in AI system development and have worked on multiple projects involving NLP and machine learning. Their experience with AI frameworks makes them well-suited for developing the core functionalities of the chatbot, including query handling, intent detection, and conversation generation. They will be responsible for implementing the AI models, integrating them with hospital systems, and ensuring that the chatbot can process a wide range of patient queries accurately.
* **Venkateshwaran Coimbatore Venkatachalam** will serve as the backend developer, focusing on system integration and database management. With a strong background in backend development and cloud computing, Venkateshwaran will ensure that the chatbot communicates effectively with external hospital management systems through APIs such as Telus and Ventus. He will also be responsible for maintaining the system’s performance, security, and scalability, ensuring that patient data is handled securely and efficiently.
* **Shalini Singh**, the project manager, brings a wealth of experience in coordinating multidisciplinary teams and managing complex projects. Her role is to oversee the overall execution of the project, ensuring that the team meets all milestones and deadlines. Shalini will also manage communication between team members, mentors, and external stakeholders, ensuring that the project remains aligned with the client’s objectives.
* **Dorcas Kifungo Malemo**, the operations engineer, will manage the deployment of the chatbot and ensure that it operates reliably in a live healthcare environment. With her expertise in system operations and maintenance, Dorcas will be responsible for ensuring that the chatbot continues to function efficiently post-launch. She will handle ongoing system monitoring, troubleshooting, and updates, ensuring that the chatbot delivers consistent performance and meets user expectations.

Each team member’s background and expertise are well-aligned with their assigned roles, making the team highly capable of delivering a robust, AI-powered solution that meets the project’s objectives​.

**Project Context:**

Our project exists within the broader context of the healthcare industry, where the need for efficient, AI-powered solutions is more pressing than ever. One of the key challenges we face is ensuring the seamless integration of the AI chatbot with existing hospital management systems. These systems, often reliant on legacy software, can present challenges in terms of compatibility and data security. However, by leveraging external APIs such as Telus and Ventus, we will be able to access critical information related to patient appointments, service availability, and hospital operations. These APIs will allow the chatbot to interact with the hospital’s scheduling system, enabling features like appointment booking, rescheduling, and cancellations without human intervention.

In terms of third-party tools and systems, the chatbot will heavily rely on Azure AI, a cloud-based AI service from Microsoft that powers its natural language processing capabilities. Azure AI will be responsible for handling patient queries, detecting user intent, and generating appropriate responses. Additionally, we will use MySQL as the database solution for storing patient interactions and appointment data, ensuring that the chatbot can retrieve and process information quickly and securely. FastAPI, a high-performance web framework, will be used to manage the chatbot’s API connections and facilitate real-time conversation handling related to appointment management and general queries.

To successfully complete this project, we will need to interact with several key stakeholders, including hospital IT staff, who will provide guidance on integrating the chatbot with the hospital’s existing systems. We will also need to collaborate with external API providers to ensure that the data we need is accessible and that the APIs are functioning properly. Managing these dependencies and ensuring that we have the necessary access to external systems will be critical to the success of the project. Furthermore, we will work closely with the healthcare staff who will be using the chatbot to ensure that it meets their needs and improves the overall patient experience​.

**Project Design specs:**

The design specifications for the healthcare chatbot also incorporate a detailed cost structure based on the use of the GPT-4 API, providing both performance and budgetary metrics. Metrics such as response time (measured in seconds) and accuracy of appointment handling (95% or higher) address functional needs, ensuring timely and reliable communication with patients. Additionally, user satisfaction, measured through feedback surveys, targets a 90% or higher rating, meeting non-functional needs for a positive user experience. By benchmarking similar AI-powered healthcare products, we’ve set an ideal response time of 1-2 seconds and a conversational accuracy rate of at least 95%.

On the cost side, the GPT-4 API offers a clear pricing structure: $0.008 per 1,000 tokens for training, $0.003 per 1,000 tokens for input processing, and $0.006 per 1,000 tokens for output generation. Given the medical chatbot's training dataset of 40 million tokens, the estimated training cost is approximately $350 USD. This provides a cost-effective solution, ensuring high accuracy through training in medical textbooks while balancing budget considerations.

Overall, these design specifications offer a well-rounded solution that balances performance, user satisfaction, and cost-effectiveness while ensuring the system’s compliance with industry standards.

**Data/Testing Plan:**

The testing plan for the healthcare chatbot focuses on ensuring performance, accuracy, security, and user satisfaction across all functionalities. The plan includes unit testing to verify individual components, such as appointment handling and conversation generation with the GPT-4 API. Integration testing ensures smooth interactions between the chatbot, Azure AI services, and external APIs for booking and modifying appointments. System testing validates the entire workflow, from retrieving hospital hours to managing real-time patient queries, ensuring the system functions seamlessly under various conditions.

To develop and test the chatbot, we will integrate data from external providers such as Telus and the hospital's API. This includes patient information, appointment details, and language-specific content, which will be acquired via APIs and secure data-sharing agreements. Data will be synced in real-time or at scheduled intervals to ensure the chatbot is continuously updated. If certain data is unavailable, we will work with the respective teams to establish a data collection plan, including mock data creation for testing purposes. Testing will be conducted in a controlled environment, starting with unit tests for API interactions and data handling.

Additionally, performance testing will assess the chatbot’s ability to handle high volumes of users, maintaining response times under 3 seconds even during peak load. Security testing ensures compliance with data protection regulations, safeguarding patient information. End-to-end testing will ensure that the chatbot can handle various patient inquiries and successfully book or reschedule appointments. Finally, user acceptance testing (UAT) ensures that patients and healthcare staff find the chatbot intuitive and effective, with feedback mechanisms in place to fine-tune the user experience post-deployment. This comprehensive approach ensures the chatbot meets functional and non-functional requirements while enhancing patient care efficiency.

**Features of E-Hospital Chatbot:**

1. **Appointment Scheduling**

The chatbot simplifies appointment booking and cancellation for patients through conversational interactions. Patients can select preferred dates, check availability, and receive confirmations, streamlining the process while reducing administrative tasks and improving clinic scheduling efficiency.

1. **Patient-Hospital Communication**

Patients can easily communicate with healthcare providers via the chatbot, sending messages for appointment inquiries, medical clarification, or concerns. This feature enhances patient engagement and satisfaction, creating a more patient-centered healthcare experience.

1. **Doctor Appointment Management**

Doctors can manage their schedules effectively by creating, modifying, or deleting appointment slots through the chatbot. This flexibility allows providers to optimize their workflow, handle urgent cases, and improve the quality of care.

1. **Doctor-Patient Communication**

The chatbot enables two-way communication between doctors and patients, allowing providers to send updates, share medical information, and respond to inquiries. This strengthens the patient-doctor relationship, improves compliance, and builds trust.

1. **Task Management**

The chatbot offers task management tools, allowing doctors to assign tasks like medication reminders or follow-up appointments. Patients receive notifications and can track their healthcare tasks, promoting proactive health management.

**Solution Design and Implementation Methodology:**

When a patient submits a query through the chatbot’s front-end interface, the chatbot first classifies the user's intent by identifying whether the query relates to booking or canceling an appointment or sending a message. This classification is done using a Retrieval Augmented Generation (RAG) on GPT-4.0 model, specifically to access updated and relevant information in real-time, ensuring the model responds appropriately to healthcare related inquiries. It doesn’t modify the model’s internal weights but uses external sources of information to enhance the model's outputs.

Once the intent is classified, the chatbot checks the patient’s status by retrieving any existing conversation history or appointment details from the database. This ensures the system can offer a personalized experience, whether it’s for appointment modifications, cancellations, or transferring messages to the appropriate medical staff.

For appointment-related queries, the chatbot accesses predefined time slots using the hospital’s internal system, allowing patients to book or reschedule appointments based on availability. If the patient is looking to send a message to the clinic, the chatbot processes the request and relays it to the doctor, using structured formats to ensure clarity. In both cases, conversation history is stored for future reference.

In terms of system architecture, the chatbot interacts with the GPT-4.0 model for intent classification, the MySQL database for retrieving and storing patient data, and APIs that handle appointment booking, modification, or cancellations. The interaction between these subsystems ensures a seamless experience, minimizing the number of steps the patient must take.

Functional requirements include managing appointments, transferring messages, and maintaining a record of conversations. Non-functional requirements focus on ensuring scalability, response accuracy, and minimizing latency to provide an efficient user experience. To meet these requirements, the chatbot is designed with guided conversation structures, offering limited but relevant options to minimize unnecessary responses and reduce processing costs.

In cases where the chatbot cannot process the request, it escalates the query to human staff, ensuring the patient's consent is obtained before proceeding. Trade-offs are made in the form of limiting conversation flexibility to avoid errors, while prioritizing user-friendly interactions and system efficiency. By refining the chatbot's language model and optimizing API interactions, the project aims to enhance both patient satisfaction and staff productivity.

A diagram of a process

Description automatically generated

Fig.1: Basic Architecture

**Learning Outcomes:**

**Knowledge:**

We will gain expertise in Python and TypeScript and develop a strong understanding of Natural Language Processing (NLP), Large Language Models (LLM), Retrieval-Augmented Generation (RAG), and machine learning/AI algorithms. Additionally, we will learn to use Azure Cognitive Services, such as Conversational Language Understanding (CLU) and GPT 4.0 Model, to enhance our chatbot development.

**Problem Analysis and Research:**

We will benefit from knowledge transfer sessions with senior team members and review academic papers and industry reports on AI and chatbot advancements in healthcare. Our research will also include investigating existing chatbot implementations in healthcare and educational settings to identify best practices and areas for improvement.

**Design:**

We will gain hands-on experience in developing a chatbot, focusing on database integration, API interactions, security, and monitoring. We will experience the full software development lifecycle, from design and development to testing and deployment.

**Verification and Validation Techniques:**

We will develop skills in writing test cases, designing and executing unit tests, and conducting usability tests to enhance user experience and ensure product reliability.

**Tools:**

We will become proficient in using the GPT 4.0 model for chatbot development and familiarize ourselves with libraries and tools such as LLM, GitLab, and Co-pilot.

**Project Management and Professional Skills:**

We will gain experience with Atlassian Jira and Confluence for project tracking and documentation and learn to apply Agile and Scrum methodologies for effective project management and team collaboration.

**Society and Sustainable Development:**

We will ensure the chatbot is available in two languages for accessibility and automate tasks like appointment scheduling to optimize staff resources. Our chatbot will comply with university and healthcare regulations to deliver quality service and build trust in the technology.

**Project Plan:**

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| --- | --- |
| **Milestone Deliverables** | **Hours per**  **Student** |
| **Project Proposal and Presentation – Sep 25th**   1. Development Environment    * Tools and resources (GPT-4 API, Azure AI, MySQL, Fast API)    * Installation of necessary software packages    * Setup of local and cloud environments 2. Product specs    * Appointment scheduling    * patient-hospital/doctor communication 3. Datasets and Test Environment    * Setup of test environments for chatbot interactions    * Collection of required medical datasets and APIs 4. Definition of Methodology, Algorithms, Models, …    * Intent classification and conversation generation using GPT-4 API    * Integration of RAG model for enhanced results.    * Azure AI services as development platform E. Detailed Project Plan | 20 |
| **Minimum Viable Prototype Presentation – Oct 9th**   1. MVP Demo    * Initial integration of GPT-4 API and Azure AI 2. Component 1: Azure AI Intent detection    * Creation of Intents    * Entity Recognition 3. Component 2: Backend Integration    * Implementation of database (MySQL) and Fast API    * Integration with external APIs for appointment booking 4. Test Results    * Initial results from unit tests of API interactions and user queries    * System’s usability test using responsiveness and latency 5. Technical Advisor and Sponsor Validation    * Present results to mentors and gather feedback    * Adjustments based on feedback for further improvements | 70 |
| **Beta Release Presentation – Nov 6th**   1. Beta Demo    * Showcase improved features of the chatbot, including two-way communication    * Implementation of appointment management 2. Component A: Enhanced NLP and Intent Classification    * Improved accuracy in detecting patient intent using RAG in GPT-4.0. C. Component B:    * Implementation of security protocols    * Ensure scalability for multiple users 3. Test Results    * Comprehensive system testing (unit, integration, and user testing) 4. Technical advisor and Sponsor Validation    * Present beta version to mentors and receive feedback for final adjustments | 80 |
| **Video, Final presentation, and prototype showcase – Nov 20, 27& 28**   1. Recorded video presentation 2. The pitch video (problem definition, solution proposal, and prototype) 3. Full prototyping 4. Testimonials from sponsor and advisor 5. Testimonials from group members 6. Student evaluations 7. Design Day | 40 |
| **Final Report, Client Evaluation, Team Peer Review – Dec 1**  A. Final Release   * Finalize chatbot for deployment on the hospital’s website B. Fully Functional AI Solution: * The final version of chatbot includes features such as appointment management, communication, task management, etc.  1. Deployment of Technology and Handoff of Documentation 2. Evaluation Forms 3. Client Feedback | 30 |
| **Total Hours** | 240 |

**Detailed Project Plan:**

|  |  |  |
| --- | --- | --- |
| **Iteration** | **Tasks** | **Hours** |
| 1 | 1. Discuss project with mentor 2. Research approaches, relevant technologies 3. Plan project schedule and deliverables 4. Present proposal | 20 |
|  | **Project Proposal and Presentation** |  |
| 2 | 1. Finalize research on relevant technologies (GPT-4 API, Azure AI, MySQL, Fast API). 2. Environment setup 3. Complete initial design documents for system architecture. 4. Define detailed use cases for chatbot functionalities 5. Collection and preparation of the datasets for testing and integration. | 23 |
| 3 | 1. Set up the integration of GPT-4 API and Azure AI for intent detection and conversation generation. 2. Begin the initial development of the chatbot's backend 3. Develop the database structure (MySQL) and start implementing the connection with Fast API. 4. Conduct initial unit testing on the backend functionality. 5. Document the progress and report it to the mentor for feedback. | 23 |
| 4 | 1. Demonstrate progress in terms of minimum viable prototype to project mentor 2. Complete requirements analysis and finalize evaluation criteria with project mentor 3. Create presentation with screenshots of current progress | 24 |
|  | **Minimum Viable Prototype Presentation** |  |
| 5 | 1. Implement advanced features such as task management and message handling 2. Conduct further testing for latency and response accuracy 3. Prepare demo for MVP presentation | 22 |
| 6 | 1. Continue refining the backend and system integration 2. Perform comprehensive testing for security and data management 3. Finalize all MVP features for the presentation 4. Gather mentor feedback on the MVP and make improvements | 22 |
| 7 | 1. Demonstrate project in terms of complete but not finalized release to project mentor 2. Validate project results with project mentor. Finalize design. Finalize TO-DO list. 3. Create presentation (Screen shots of status, Results, Design, TODO) | 36 |
|  | **Beta Release Presentation** |  |
| 8 | 1. Final demonstration and delivery of results to project mentor 2. Create a short pitch video showcasing the prototype and testimonials from advisors/client and team members c. Full prototyping | 40 |
|  | **Video presentation and prototype showcase** |  |
| 9 | 1. Draft report to project mentor and projects coordinator. 2. Submit a final report. 3. Complete Project Mentor Evaluation Form and Team Peer Review | 30 |
|  | **Final Report, Evaluation, (Team Peer Review)** |  |
|  | **Total Hours** | 240 |

**References:**

1. Yan Hu, Iqra Ameer, Xu Zuo, Xueqing Peng, Yujia Zhou, Zehan Li, et al., "Zero-shot clinical entity recognition using ChatGPT", arXiv preprint arXiv:2303.16416, 2023.
2. N. J. Bhate, A. Mittal, Z. He and X. Luo, "Zero shot Learning with Minimum Instruction to Extract Social Determinants and Family History from Clinical Notes using GPT Model"
3. Nazlı Tokatli, M. T. Koc, A. Kirtay, G. G. Öztepeli, I. S. Aktas, and H. Altun, "Healthcare service accessibility path planner: Unveiling a new era of intelligent appointment management systems based on outpatient prioritizing"