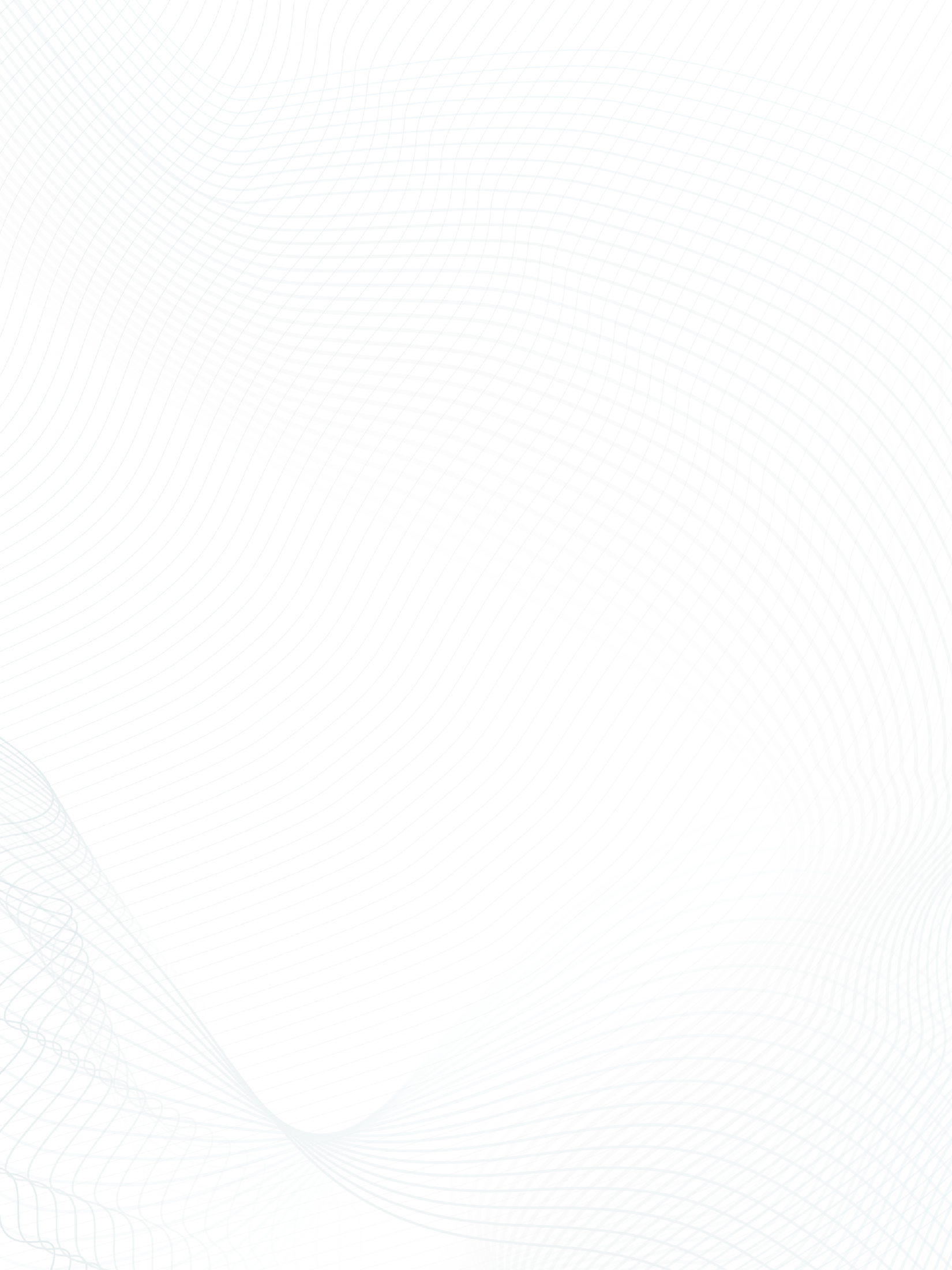


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|  | | myUpskill ChabotA cartoon of a robot with a chat bubble  Description automatically generated with low confidence | | | | |  | |
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|  | | | | Master of Technology **Project Report** |  | | | |
|  | | | | **Team Members** Kwatt Ivy  Chua Jack Yune  Nilothpal Bhattacharya  Borromeo, Angelie Quiapo |  | | | |
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|  | Executive Summary | | | | | | |  |
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|  |  |  | With the rise of technology and advancements in artificial intelligence, chatbots have become increasingly popular in various industries, including education.  **“*A chatbot is a software application that aims to mimic human conversation through text or voice interactions, typically online***” as defined on Wikipedia. They can be programmed to understand and respond to specific queries, making them an ideal tool for helping individuals choose courses that align with their preference, interests or expertise.  By using myUpskill Chatbot, individuals can easily choose to input either their interests or domain of expertise and receive tailored career path recommendations based on their responses. myUpskill Chatbots can also provide additional information about courses, such as course descriptions, and university options and potential compensation range.  Utilising the various techniques that were taught to us in the Intelligent Reasoning Systems (IRS) modules. The team has set out to build a sizable knowledge base by matching Singapore base datasets into Occupational Information Network (O\*Net) Database. Further details can be seen in the Knowledge Modelling section of the documentation.  The benefits of using myUpskill Chatbots for career path selection include convenience, accessibility, and personalised recommendations. myUpskill Chatbots can be potentially accessed through a variety of platforms, including social media, messaging apps, and websites (but for this project implementation the team have created a python flask base application hosted in Amazon Web Service). This makes it easier for individuals to receive initial course recommendations on the go, without the need for lengthy research or face to face consultations.  Overall, aim to have myUpskill Chatbots to be a valuable tool for helping individuals choose career path based on their interests or expertise. We hope to provide a convenient and personalised way to receive career recommendations, making the career path selection process more accessible and efficient. As technology continues to evolve, it is likely that chatbots will become an increasingly important part of education and career path selection. | | |  |  |  |
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|  | | | 2.0 PROJECT DESCRIPTION | | | | |  |
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|  | | Choosing a career path and selecting the right course of study can be a challenging and daunting task for both young adults and experienced professionals. With so many options available, it's important to take a structured approach and carefully consider one's interests, skills, and long-term career goals.  For those students who are in the lower socio-economic group there is a limited accessibility to engage with the career practitioner or draw any guidance from different professionals due to a finite social circle.  There is also some feeling of anxiety over raising simple questions, what question to ask and how career practitioners can be of support.  We hypothesise that by providing a tool as an initial point of assessment, would help the career path seekers to determine the best possible match based on their interests or field of expertise/skills. | | | | | |  |
|  | | 2.1 Project Objective The project aims to create a chatbot to give individuals in all socio-economic groups an accessible, interactive, and alternative medium for initial career assessment. We intend to help in determining which career path to take based on their interests or expertise and have them matched to the appropriate courses or training to take to equip them through their upskilling or reskilling journey. | | |  |  | |  |
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| 3.0 Knowledge Modeling | | | | | |  |
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| **Knowledge modeling** based in Wikipedia *“is a process of creating a computer interpretable model of knowledge or standard specifications about a kind of process and/or about a kind of facility or product”*. [It involves identifying the concepts and relationships that exist within a domain and representing them in a way that can be used by computer systems](https://en.wikipedia.org/wiki/Knowledge_modeling).  [The goal of knowledge modeling is to create a shared understanding of the concepts and relationships within a domain so that they can be used to support decision-making, problem-solving, and other activities](https://en.wikipedia.org/wiki/Knowledge_modeling).  Three main stages of knowledge modelling (Schreiber, et al, 2001)   1. Knowledge Identification 2. Knowledge Specification 3. Knowledge Refinement | | | | | |
| 3.1 Knowledge Identification Knowledge identification lays the foundation for the subsequent stage of knowledge management, which involves knowledge specification. During this stage, relevant information sources are identified and deemed useful in preparation for knowledge acquisition. | |  | In the context of the myUpskill chatbot, which provides career path recommendations, four primary sources of information have been identified and documented below (Table 1). | | |

*Table 1: Knowledge Source and Acquisition Technique*

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| S/N | Source of Information | Insights from Information Source | Knowledge Acquisition Technique |
| 1 | Career Service Expert | The Subject Matter Expert (SME) with years of experience will be able to provide insight on:   * Techniques which could be used to better provide a career path recommendation to an individual * Focusing the scope and intended audience | Manual Elicitation by acquisition of tacit knowledge from a SME |
| 2 | O\* NET Database | Occupational Information Network (O\*NET) is United States primary source of occupational information. It could provide information relative to the project such   * Interest and Occupation * Job Tittles * Level of relatedness between jobs | Manual Extraction of Knowledge Elicitation through documented knowledge. |
| 3 | MyCareersFuture | It’s designed to provide the most updated and reliable information about   * Job availability here in Singapore * Job description * Job requirements * Compensation details | Web scrapping to obtain publicly available data. |
| 4 | Singapore Graduate Data | It has a data set that provides information on Singapore base universities, possible compensation, degrees and equivalent overall employment rate | Manual Extraction of Knowledge Elicitation through documented knowledge |
| 5 | Generic Population | To validate and support the claims from the Subject Matter Expert with data | Elicitation of tacit knowledge through analysing results of a survey from the general population |

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| 3.2 Knowledge Specification   To capture the domain knowledge of the problem-solving process, we first identify the sources of knowledge. We use the techniques listed in Table 1 to acquire knowledge from these sources. The results of the knowledge acquisition are shown in Figure 1 using a dependency diagram.  The flowchart below in Figure 1 shows the dependencies for a career recommendation system. The system helps students decide on a career path based on their preferences and interests. The recommendation system depends on four factors: career interest, remuneration, work experience and education, and work context. Career interest is dependent on the RIASEC model, which is a personality model that matches individuals to career fields. Remuneration is dependent on fresh-graduate salary and job market salary. Work experience and education are dependent on job description, work tasks, and education. Work context is dependent on work contexts such as work hours, workplace environment, workplace hazards, and social environment.    ***Figure 1:*** Dependency Diagram of Career recommendation System    **The Anonymous Survey**  Following the advice and guidance of the Subject Matter Expert, we designed and administered a electronic survey to collect data on the research topic. The survey consisted of 6 multiple choice questions and 2 open ended questions. Although we have 132 views in the electronic survey, we have only managed to get a submission rate of 47% or 62 responses. The main findings of the survey analysis are presented below.  A screenshot of a web page  Description automatically generated with low confidence  ***Figure 2:*** Career journey survey  For reference the responses on the survey can be found in the Appendices  **Undergraduate Student:** The undergraduate students had a very low response rate of 4.83%. Among them, one third indicated that they chose their career based on their interest, while the remaining two thirds considered their domain expertise as the main factor for their career choice.  **Mid - Career:**  The majority of the survey respondents (72.58%) were mid-career professionals. More than half of them (55.55%) expressed their intention to change their career. Among those who wanted to switch their career, 40% based their decision on their domain expertise and another 40% on their interest. The remaining 20% had other reasons that were not included in the survey options.  **Long Term Career:** Long term career professionals constituted 22.58% of the total survey respondents. Interestingly, 28.57% of them are still willing to change their career despite working for a long time. Among those who wanted to switch their career, the majority (57.14%) based their decision on their interest, while the rest (42.86%) on their expertise.  **Career Counselling:** The survey results showed that only 32.26% of the respondents had engaged in career consultation as part of their career development, while the majority (67.74%) had not. The reasons for not using career counselling varied, but some common themes emerged from the mid-career and long-term career professionals. These included lack of awareness of the availability and benefits of career counselling, lack of access to qualified and trustworthy counsellors, and lack of motivation or interest in seeking career guidance. Some representative quotes from these respondents were: “I had no chance to try it before and I don’t know where to get this service”, “I’ve never thought of career counselling but will definitely consider it now”, and “Did not know where and who to approach”.  **Future Career Plan:** The respondents’ career aspirations for the next 10 years were also explored in the survey. Only 35.48% of them indicated that they would continue working in their current field, while 40.32% of them expressed their intention to change their career path. The main reasons for this change were retirement or pursuing entrepreneurship opportunities. The remaining 24.19% of the respondents were either undecided or did not respond to this question. |
| 3.3 Knowledge Refinement In this step we have conducted model validation and verification by running simulation test cases in the system (refer to the appendix for the sample test scripts). The result are planned to be validated with the Subject Matter Expert (SME) who can advise for potential areas of improvement. |

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| 4.0 Solution | |
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| In figure 2 depicts a process flow for a survey chatbot interface. The chatbot collects user input on user preferences and then displays a question. The response type can be either open-ended or multiple-choice. If the response type is open-ended, the user inputs text, and the chatbot checks the length of the response. If the response is adequate, the chatbot saves the response. If the response is inadequate, the chatbot prompts the user for more information, and the user inputs more text. If the response type is multiple-choice, the user selects an option by clicking one of the option buttons, and the chatbot saves the response. The process flow restarts by selecting the next question in the list after the chatbot saves the response.    ***Figure 3:*** process flow for a survey chatbot interface | |
| 4.1 System Architecture The diagram shows various components related to career advice, including job descriptions, work tasks, work contexts, education, and salaries. It also has several subgraphs that provide information about these components, such as job descriptions, work tasks, work contexts, and education. There is also a subgraph called "user\\_input" where users can enter their interests and experiences, which will be used to generate personalized career paths based on those inputs. Overall, it appears that this mermaid diagram provides a comprehensive overview of how career advice systems might operate. | |
| ***Figure 4:*** Components related to Career Advice | |

The system consist of 2 main parts: The front-end web interface developed using Vue Javascript Framework and back-end which uses Python Flask. The database use for this project is PostgreSQL Database (DB) and Database Schema is shown on Figure 5.

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***Figure 5:*** Architecture Diagram

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***Figure 6:*** PostgreSQL Database Schema

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| 4.2 Project Scope   **myCareerFuture Dataset**  In the present study, the process of data mining is subject to certain limitations, wherein the scope is constrained by a specific dataset acquired under the myCarreerFuture platform. Specifically, the scope is limited to (I) February 2023, (II) the date and time of the extraction, (III) the amount of data that is available, and (IV) the compensation offered based on the job posting. As such, the system offers a mere snapshot of job availability and salary ranges, pertaining to a fixed number of postings. Nonetheless, the research team opines that the closed list of approximately 8000 entries is adequate, given the time complexities involved in extracting a colossal amount of data from the site. | | |
| 4.3 Assumptions |  |  |
| **Target Audience**  The target audience of this project consists of students who are either studying at the university or have recently graduated and are looking for a suitable career path or job opportunity. Another potential group of users are mid-career professionals who want to change their career direction and explore new possibilities. However, they should be aware that switching to a different career path may not guarantee their expected salary range and may require them to acquire new skills based on the recommendations of the tool.  **Knowledge Acquisition**  The team has identified 5 types of knowledge acquisition process which has been describe in section 3 Table 1. These are   1. Career Service Expert 2. O\* NET Database 3. MyCareersFuture 4. Singapore Graduate Data 5. Generic Population   For MyCarrersFuture dataset Word2Vec was use to match the different job posting/availability in reference to O\*NET Code. This will aid in giving Job recommendation with salary ranges to a fixed number of posting (please refer to the project scope for more details). |  | Word2vec is a**two-layer neural net** that processes text by “vectorizing” words. Its input is a text corpus and its output is a set of vectors: feature vectors that represent words in that corpus. While Word2vec is not a deep neural network, it turns text into a numerical form that deep neural networks can understand. – as define by [Pathmind](https://wiki.pathmind.com/word2vec#:~:text=Word2vec%20is%20a%20two-layer%20neural%20net%20that%20processes,numerical%20form%20that%20deep%20neural%20networks%20can%20understand.)  For the Singapore Graduate Dataset various techniques were use like Word2Vec and Jaccard Similarity but did not yields a satisfactory matching. The main developer of the team has tried to match using Sentence Transformer to match the Singapore Graduate Dataset into ONET Code and have manage to match this dataset.  Cosine Similarity technique was use to match the open ended question in reference to user preference and interest. As it would yield better result in comparison of using K-NN. The distance use in K-NN systems is commonly Euclidean Distance. If there is a longer text then Cosine Similarity is often better as it only considers the angle and ignore the magnitude of the vectors.  Knowledge Elicitation though Survey and Subject Matter Expect were also done. |

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| 4.4 System’s Features   **System Intelligence**  The career path recommender system is an intelligent system that infers users’ preferences based on their input answers to the questions provided by the chatbot. It takes into account a range of factors such as career interests, remuneration, work experience and education, and work context. The details of these factors are presented using the dependency diagram in Figure 1. Career interest is determined by the RIASEC model, which is a personality model that matches individuals to career fields. Remuneration is determined by fresh-graduate salary and job market salary. Work experience and education are determined by job descriptions, work tasks, and education. Work context is determined by work hours, workplace environment, workplace hazards, and social environment.  **Ease of Access and Scalability**  The myUpskill Chatbot is built on a web-based application that is seamlessly deployed and accessible to all users with an internet connection. The system can be accessed using any device such as personal computers, tablets, or mobile phones.  **User Management**  To ensure that the recommendation is tailored specifically to the intended user and its preference. A login account is needed to be created prior to use of the system. We have use Vue Application to for our frontend which features the login page. |
| 4.5 Limitations Although the system have given career path recommendation base on the user preference/interest or expertise. It is still up to the user if he/she is willing to undergo the needed upskilling or reskilling in relation to the recommended careers. The tool is intended to help user for their initial assessment and result can be use as reference or if further consultation is intended we can connect to a professional career service practitioner. |

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| 5.0 Conclusion & References | | | | | |  |
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| 5.0 Conclusion   The team had gained useful skills along the way when creating the whole project. We encountered setbacks and had overcome them. The techniques learned during the Intelligent Reasoning System courses were proven useful such us Cosine Similarity, Word2Vec, Jaccard Similarity and the use of , vectorization, word embedding and sentence transformer were some of the technique used to match our datasets. Building the system itself presented a whole new set of learning curves, allowing our main developer in the team to apply his practical knowledge on Vue, Python Flask, ProsgreSQL and Dockerization.  Due to time, resource and cost constraints, the original plan to deploy the web application in AWS cloud has been postponed for future opportunities for further improvements and enhancements. But the Cloud formation template was made available in the repository. | | | | | | |
| 5.1 Improvements | |  |  | | | |
| User login are being manage at the local PostgreSQL Database at the moment. Integrating the login page to popular technologies like Google, Facebook, Cognito, Auth0 and Azure etc. could help in gaining user traction.  If a user would like to have a further discussion or any clarification about the career path and opt to have a live chat with a career service practitioner this platform can be leverage to initiate the first point of connection with a career service practitioner and the user. By introducing a live chat feature. | |  |  | | | |

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| 6.0 Bibliography | | | |  |
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| **MyCareersFuture:** https://www.mycareersfuture.gov.sg/  **Graduate Data**: <https://data.gov.sg/dataset/graduate-employment-survey-ntu-nus-sit-smu-suss-sutd>  **O’ NET**  **RIASEC Interest & Occupations:** <https://www.onetcenter.org/dictionary/27.2/excel/interests.html>  **Job Titles**: <https://www.onetcenter.org/dictionary/27.2/excel/occupation_data.html>  **Level of relatedness between jobs:**<https://www.onetcenter.org/dictionary/27.2/excel/related_occupations.html>  **Metadata:** <https://www.onetcenter.org/dictionary/27.2/excel/content_model_reference.html>  **Job Description**: <https://www.onetcenter.org/dictionary/27.2/excel/occupation_data.html>  **Chatot backend and UI:** <https://buffml.com/web-based-chatbot-using-flask-api/>  **Flask boilerplate:** <https://github.com/realpython/flask-boilerplate>  Chang Ye Han, Chua Zhen Liang Desmond, Chee Jia Wei, Ganesh Kumar, Goh Yu Chen, Jeanette Tan Yi Wen. BTO Recommender System – Project Report Master of Technology NUS-ISS Singapore.  Schreiber, G., Akkermans, H., Anjewierden, A., Wielinga, B. J., Hoog, R.D., Shadbolt, N., & Velde, W. V. (2001). Knowledge Engineering and Management – The CommonKADS Methodology. Cambridge, Massachusetts: The MIT | | | | |

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| 7.0 Appendices | | | | | |  |
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| APPENDIX A: Post Interview with Career Service Expert We had a 2-hour long interview with a NUS Career Service Expert to get her input about our project’s proposal objective, and scope of project. She had pointed several valid inputs which helped us recalibrate our intent and scope in the project. After our discussion she had reiterate here points within below email. | | | | | | |
| APPENDIX A: Survey Results | |  |  | | | |
| The anonymous survey result was uploaded in the teams shared drive and accessible through below link.  **LINK:** https://docs.google.com/spreadsheets/d/1w6I2Fn7OU9hZ03kVbzNrcaoYQtQqFVm1/edit?usp=share\_link&ouid=107036657032408819531&rtpof=true&sd=true | | | | | | |

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|  | APPENDIX B: Sample test script used to answer myUpskill Chatbot Open ended question (data below were generated using GPT Generated Text) **Prompt:** write a 300 word essay about "My dream job" involving math, science, biology research and medicine  **Response**: I have always been fascinated by the field of mathematics and its applications in various fields such as physics, engineering, economics, finance, etc. I believe that my strong foundation in these subjects will be valuable when pursuing a career in research and medicine. In addition, my interest in biology has led me to explore the subject further, with a particular focus on genetics and evolution. This knowledge can also be applied in medical research and development. Overall, I am excited at the prospect of combining my interests in math, science, and biology into a single career path.  **Prompt**: write a 300 word essay about "My dream job" involving modeling, acting, music, and fashion  **Response**: As a creative individual, I have always had a passion for modeling and acting. The ability to express myself through different mediums like clothing, makeup, and props has allowed me to develop skills in areas outside of academics. For example, I enjoy experimenting with different styles and techniques in photography and videography, which are essential tools for creating high-quality visual content. Additionally, my love for music and dance has inspired me to pursue a degree in performance arts, where I hope to become a professional musician or dancer. Finally, my fascination with fashion design has led me to study fashion merchandising and marketing, enabling me to create unique and innovative products that reflect my personal style. All of these passions combined make me feel fulfilled and motivated to continue learning and growing as an artist.  **Prompt**: write a 300 word essay about "My dream job" involving accounting, finance and managing client's investment portfolio  Response: Throughout my academic journey, I have developed a deep **understanding** of financial management and accounting principles. My goal is to use this knowledge to manage clients' investment portfolios effectively. As a result, I aspire to work in a role that involves overseeing multiple accounts and making informed decisions based on market trends and economic indicators. Furthermore, I am passionate about developing strategies to maximize returns while minimizing risk. Ultimately, I aim to build long-term relationships with clients and help them achieve their financial goals.  **Prompt**: write a 300 word essay about "My dream job" involving athletics and sports, namely basketball  **Response**: Basketball has always held a special place in my heart, and it continues to inspire me today. Growing up playing the sport, I learned early on the importance of teamwork, communication, and hard work. These values are crucial not only in basketball but also in life. Basketball taught me how to work together towards a common goal, communicate effectively with teammates, and adapt to changing situations. It was during my time in college that I discovered my true passion for the game. From then on, I dedicated myself to improving my skills and honing my craft. Today, I strive to embody those same qualities in all aspects of my life, including my future endeavors.  **Prompt**: write a 300 word essay about "My dream job" involving athletics and sports, namely ping pong, basketball and judo  **Response**: Growing up, I was always drawn to sports and physical activities. Ping pong became one of my favorite games due to its fast pace and strategic elements. Playing against friends helped me improve my coordination and reflexes. Basketball offered me a chance to hone my shooting skills and dribbling abilities. Judo provided me with discipline, strength, and mental toughness. Each sport taught me important lessons about perseverance, dedication, and self-improvement. Through each experience, I gained confidence in my own abilities and potential. With each new challenge, I grew stronger and more skilled. Now, I look forward to using my newfound skills and experiences to pursue my dreams and live out my passion for sports and physical activity.  **Prompt**: write a 300 word essay about "My dream job" involving competing with others, building a successful company and leadership  **Response**: Competing with others is something I've always enjoyed doing. Whether it's in school competitions or friendly matches, I thrive on pushing myself to excel beyond what I thought possible. Building a successful business requires both determination and creativity. Starting from scratch, I poured everything I had into launching a venture that would change the world. Every day brought new challenges and opportunities to grow and learn. But ultimately, it was worth every struggle and sacrifice because now I'm proud of what we accomplished together. Leadership comes naturally to me, thanks to my upbringing in a family of entrepreneurs. We were constantly pushing boundaries and taking risks, so I learned early on that persistence pays off. And even though our journey wasn't easy, we never lost sight of our ultimate goal - to succeed and leave a lasting impact on society.  **Prompt**: write a 300 word essay about "My dream job" involving software engineering, computer science and AI  **Response**: Software engineering, computer science, and artificial intelligence (AI) have always fascinated me. At first glance, they seem like vastly different fields, but upon closer examination, there are many similarities between them. Both require problem-solving skills, attention to detail, and a willingness to push boundaries. Software engineers must create complex systems that seamlessly integrate hardware and software components, ensuring seamless functionality across devices. Similarly, computer scientists must understand the underlying mechanisms behind digital technology and ensure efficient coding practices. AI, on the other hand, combines these two disciplines by harnessing machine learning algorithms to analyze vast amounts of data and provide insights that humans could never imagine. By studying these fields, I hope to gain a deeper understanding of the complexities involved in programming and contribute to advancements in the tech industry.  **Prompt**: write a 300 word essay about "My dream job" involving cooking and running a restaurant  **Response**: Cooking and running a restaurant has always been a dream of mine. Cooking allows me to experiment with flavors and ingredients, perfecting dishes to satisfy customers' cravings. Running a restaurant offers me the opportunity to bring people together and foster community through food. I want to create a space where everyone feels welcome and appreciated, just like a home away from home. To do this, I'll need to balance customer service with culinary expertise, ensuring guests receive exceptional meals without feeling overwhelmed. Running a restaurant also teaches me about balancing profit margins with providing quality food, keeping costs low while maintaining high standards. Ultimately, I aspire to combine my passions for cooking and hospitality, creating a thriving establishment that brings joy to patrons and fosters meaningful connections. | | | | | |
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