Final Year Project Plan

Artificial Intelligence and App Development

for Elderly Care

Supervisor: Dr. Reynold Cheng

Lakhani Amsal Murad 3035393729
Kanodia Kushagra 3035343449
Arora Saksham 3035343217
Su Jingyi 3035331953
Lau Ka Wun 3035372488
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Background

The society of Hong Kong is rapidly ageing, which will prove to be great challenges as Hong Kong struggles to satisfy the ever-growing demand for Elderly services and goods while her labor force reduces. The number of elderly persons is projected to at least double its numbers in the next two decades, while reaching 36.6% of the total population in the year 2066 [1]. On the other hand, some NGO and elderly care homes reported a 70% shortage of employees, which shows the fact that Hong Kong society is facing a lack of manpower and resource for elderly care.

Our team intends to develop a computer system for HKL3C (Hong Kong Life Commitment Charity Club) which will assist in the digitization of documentation, record storage, and report generation. Currently, HKL3C handles all membership, service, and event records using pen and paper while inputting data background into excel files. Moreover, we plan to use the concepts of artificial intelligence and design algorithms to conduct statistical analysis and provide HKL3C with better solutions. Technology is meant to lessen the burden on social service providers, enabling them to focus on priorities.
Objectives

Using cloud services, we intend to design a content management system where the staff of HKL3C can record, manage and link all the information about their elderly, staff, volunteers and donors. A large portion of responsibility, namely marketing, system security, hardware maintenance and updates can be outsourced to cloud service providers. A higher standard can be achieved even with a lower budget. An interface will be provided to input data and a database will be set up to handle data storage. Functions will be developed as requested to handle some data processing, such as profile, report and E-receipt generation. User training and manuals will be provided, but continuous maintenance and update will not be.

Another goal is to integrate the database designed for HKL3C in a centralized system called HINCare (Heterogeneous Information Network) which is a centralized system of knowledge graphs integrating databases from different elderly care organizations and other databases such as a geological database to make a complete network. The data contained in HINCare can be used for a wide range of data analysis and machine learning algorithms to derive meaningful insights from a centralized system of data from different sources.

Figure 1 HINCare representation. (KG = Knowledge Graph). Individual information (Nodes) are connected using relation (Edges).
**Scope**

We intend to fulfill the three major technical objectives throughout the course of this project which are, website design and management, Knowledge Graphs and Statistical Analysis.

**Website Development:** This part of the project will contain two aspects - frontend and backend development.

- **Frontend** - React.js framework will be used to build upon the HTML & CSS web skeleton. This has an advantage over other technologies that might be used for web development. The existence of over thousands of libraries and components provided by the Node Package Manager (npm) will allow for creative design and light weight of the website.

- **Backend** - We plan to use the Microsoft Azure cloud services to set up a server to host the website on, while also creating serverless functions to enable our application to be highly scalable applications with a reduced overhead cost. Server-side scripting will be implemented through the Django framework which is written in Python. We will also set up a MySQL database to store the data entered by the user.

**Knowledge Graphs and Statistical Analysis:** This part of the project deals with working with HINCare and their vast network of graphs which contain data from multiple NGOs and other organizations. This will allow for better statistical analysis as we will have more data to work with. Using the concept of Ontology Based Data Access (OBDA), we will use SPARQL to query the knowledge graphs which will in turn use SQL to query relational databases of the elderly care organizations. The data extracted from it which will then be analyzed using different machine learning algorithms.

*Figure 2 Overview of the virtual HINCare system connecting different RDBs of elderly care organizations*
Methodology

Top Level Architecture Design

The Users will perform tasks by browsing through a web application. (see Figure 3) The web application will serve as the interface for data insertion, update and deletion. Serverless applications will be used to build highly scalable applications with reduced overhead cost. Application Insight is included to help manage resources.

Security Design

The web application firewall can be configured to allow connection exclusively from the L3C office computers for higher security standard. The web application will include authentication and permissions. Communications between the web application and the database can be made to only go through the serverless applications, reducing chances of security vulnerabilities.
Database Design
The database will primarily store structured data with some exceptions. Structured data includes personal information, elderly self-care capability assessment, service records, event records, and donation records. Exception includes photo and HKID copy for elderly members. A SQL database will serve the majority use cases. As for the images, further study will be conducted with reference to Microsoft's study “To Blob or Not to Blob” [2]. Cost of hosting extra Blob storage will also be taken into consideration.

Cloud Service
Cloud service has been chosen for a number of reasons: Firstly, the system will be intended for staff use only and is of low traffic. Cloud services support pay-as-you-go, suitable low-intensity systems. Secondly, FaaS (Function as a Service) and SaaS (Software as a Service) can greatly reduce the responsibilities of HKL3C. HKL3C will maintain the system on their own after the final deliverable, yet they lack the expertise in managing IT systems. Outsourcing responsibilities will come handy in tackling this issue. Finally, cloud services such as Microsoft Azure, provide a user-friendly interface that assists in managing the system by providing decision suggestions on optimizing resources and enforcing policies. All in all, cloud services are a great way for businesses to implement small systems.

Not a lot of testing has been performed to compare different cloud service providers due to time constraint. However, preliminary studies show Microsoft Azure will probably be a good choice. First of all, services-wise, Azure provides a wide range of services with well-developed features capable of satisfying all the requirements of HKL3C. Secondly, regarding service cost, a quick examination of prices also show Azure is in the same price range as other similar cloud providers. Lastly, security-wise, Microsoft has won the most certifications out of all the service providers, the expertise maintaining the services can be trusted.

HINCare
The HINCare system concerns with the OBDA principle for the interpretation of database as a Knowledge Graph rather than a relational database for a variety of scalability reasons. It primarily rewrites SPARQL i.e. graph-based queries into corresponding SQL queries. The figure below illustrates the concept of OBDA.
One of the important concerns to keep in mind is the security of the data. The authentication mechanism will ensure that specific groups can access the data which they are permitted to access. Figure below illustrates authentication mechanism.

**Tools and Environment**

The Azure portal is a well-developed tool to assist in Azure system development. Built-in support for a wide range of third-party IDEs and tools such as Visual Studio, PowerShell, and Github also exist for easier development, maintenance, deployment, and testing. Popular languages such as C#, Javascript, and Python are also supported.
Schedule and Milestones

The first horizontal swim lane shows project critical modules. Mostly consisting of the designs and implementation of each component. Sub lane 1.1 and 1.2 will be roughly how the work is divided.

The second horizontal swim lane shows a non-project critical module, the login authentication will be the main security detail with the web app firewall as add on security.

The schedule goes as far as the first major milestone: the first prototype. The first prototype will ensure all baseline requirements are fulfilled and all basic features are functional.

Resource optimisation, UI improvement will then be carried out. Further direction will be decided afterwards, which could mean additional functions and features, or devoting more resources into the development of HINcare.

Conclusion

In the following phases of our final year project, we plan to build a web application for the HKL3C to digitise their workflow and improve upon their efficiency and deliver better services to the aged population of Hong Kong. Having set schedules and milestones to work upon throughout the course of the project, we will endeavour to accomplish the deliverables for each phase. We hope that we can achieve the aforementioned objectives and make our little contribution to this social cause.
References


[2] R. Sears\textsuperscript{2}, C. van Ingen\textsuperscript{1}, J. Gray\textsuperscript{1}, “To BLOB or Not To BLOB: Large Object Storage in a Database or a Filesystem?”, 1: Microsoft Research, 2: University of California at Berkeley. 2006