

Business Report

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Executive Summary

The project contains a website and mobile application that will use a machine learning model to generate shopping lists and advertise products based on the user's information. The project is estimated to take 4 months to develop and cost £113,132.14 over 5 years including staff costs for development and software licencing. There are 3 teams in total for the project. Website, Machine Learning and Mobile Application. In-house hardware is part of the cost to set up space for user accounts, product listings and storage of the machine learning data and model. The legalities and ethics have been considered for the dataset used and processed user data.

Introduction

The project will consist of developing and deploying a mobile application and website that customers can access with their own accounts to get personalised shopping lists and recommended products based on a few parameters given when they make an account.

The product suggestion and shopping list generation will use machine learning to give those recommendations through training based on a relevant dataset. The website will be able to create and access user accounts, display product listings and allow them to be bought, view receipts and display active promotion campaigns or deals. The mobile application will mirror the website functionality but also allow for users to get their own barcode which can be used to store digital receipts from purchases in-store.

Dataset Requirements

Overview

The data to be used for developing the machine learning model will be from a Customer Personality Analysis dataset used from Kaggle (Patel, 2021). This contains 2240 rows and 29 columns in its raw form and is in a csv file format. A list of columns is shown below.

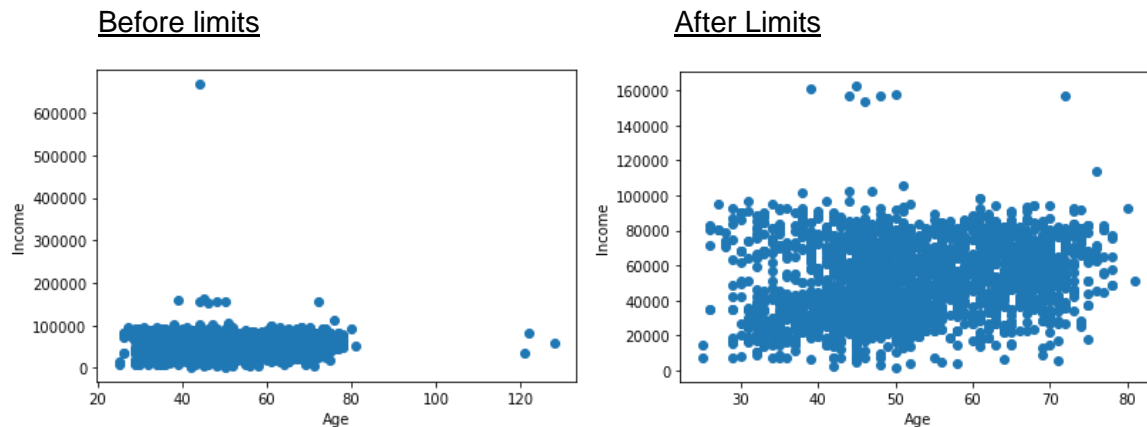
```

1 <class 'pandas.core.frame.DataFrame'>
2 RangeIndex: 2240 entries, 0 to 2239
3 Data columns (total 29 columns):
4 #   Column                Non-Null Count  Dtype
5 ---  ---
6 0   ID                    2240 non-null   int64
7 1   Year_Birth            2240 non-null   int64
8 2   Education             2240 non-null   object
9 3   Marital_Status       2240 non-null   object
10 4   Income                2216 non-null   float64
11 5   Kidhome               2240 non-null   int64
12 6   Teenhome              2240 non-null   int64
13 7   Dt_Customer           2240 non-null   object
14 8   Recency               2240 non-null   int64
15 9   MntWines              2240 non-null   int64
16 10  MntFruits              2240 non-null   int64
17 11  MntMeatProducts        2240 non-null   int64
18 12  MntFishProducts        2240 non-null   int64
19 13  MntSweetProducts       2240 non-null   int64
20 14  MntGoldProds           2240 non-null   int64
21 15  NumDealsPurchases      2240 non-null   int64
22 16  NumWebPurchases        2240 non-null   int64
23 17  NumCatalogPurchases    2240 non-null   int64
24 18  NumStorePurchases      2240 non-null   int64
25 19  NumWebVisitsMonth       2240 non-null   int64
26 20  AcceptedCmp3           2240 non-null   int64
27 21  AcceptedCmp4           2240 non-null   int64
28 22  AcceptedCmp5           2240 non-null   int64
29 23  AcceptedCmp1           2240 non-null   int64
30 24  AcceptedCmp2           2240 non-null   int64
31 25  Complain               2240 non-null   int64
32 26  Z_CostContact          2240 non-null   int64
33 27  Z_Revenue              2240 non-null   int64
34 28  Response               2240 non-null   int64
35 dtypes: float64(1), int64(25), object(3)
36 memory usage: 507.6+ KB
37

```

Data such as amount spent on food items, combined with income, number of children and responsiveness to advertising campaigns can be used to create a machine learning model for new users to get relevant adverts and customised shopping list recommendations on the website or mobile app.

To clean and organise the data, the dataset should be split into 4 separate data frames based on people, products, promotions, and place. Features are created on the people data frame called 'Age', 'TotalSpent' and 'NumChildren' to better visualise what data is there. The 'Age' feature was created by taking the Current system times year then subtracting the year of birth from the dataset. This was then used to create a simple scatter plot to show 'Age' against 'Income'.



This showed that there were some outliers in the data that would affect the training of a machine learning model. The Income column will need to have any rows over £500,000 to be removed and for the Age to be limited to under 100 years old. These modifications will need to be applied before the dataset is stored in a database and will reduce the total usable rows to 2212. This will also need to be split into a train and test set before using the data.

Ethical Consideration

For the dataset to be safely used, there needed to be some criteria set. The dataset could not contain any of the following:

- Personal Identifiers – Names, Specific locations.
- Biased, Gendered information
- Racial bias

For protected Characteristics such as Age, Disability, Race, Sexual orientation if present, they cannot be used to discriminate against that individual or be modified to introduce a bias under the Equality act 2010.

The users can create and modify their accounts and have the right to be informed how their data is being used. In the case of this project, their personal data must be protected as it contains bank details and personal identifiers.

Database Engine / Design

Engine

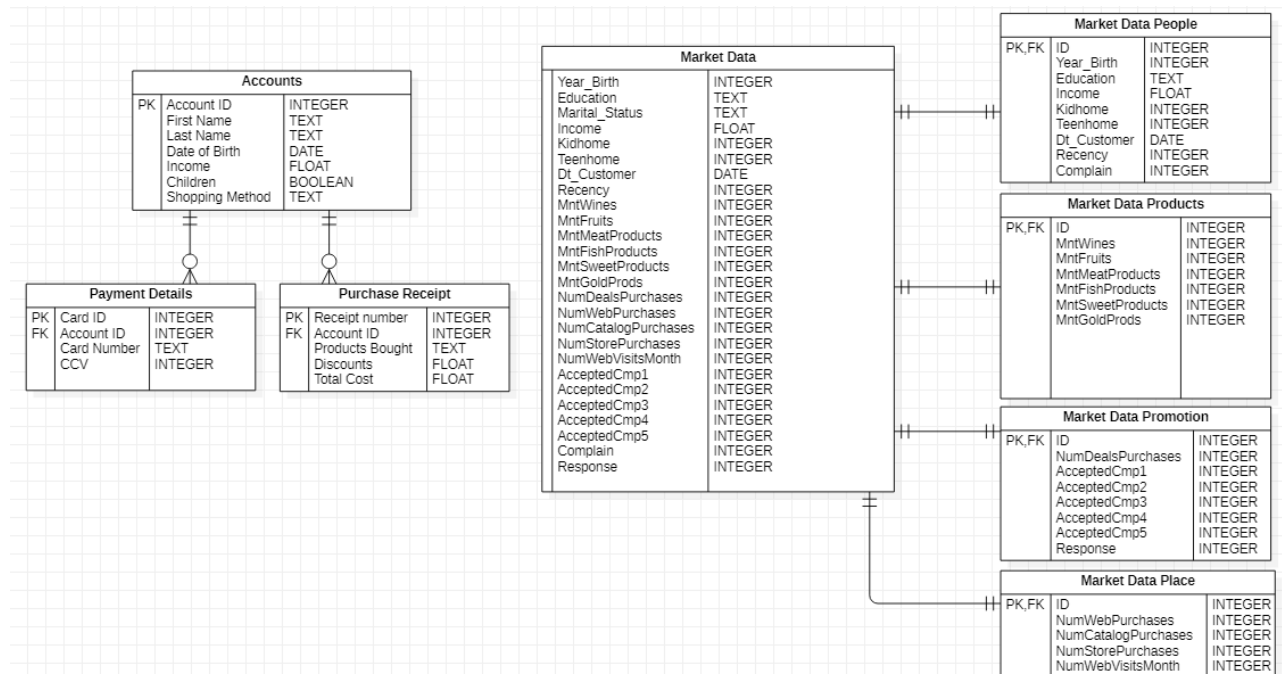
The possible database engine options are:

- Oracle - £35582.26 per unit (socket x core x core factor)
- MySQL - £3745.50 per 4 socket server.
- MS SQL Server - £10298.63 per 2 cores

From the above options, the cheapest option would be MySQL. This would allow for scalability up to 4 sockets per server before more licenses are needed.

For the database to be easily accessed from one place, an ORM (Object-relational mapping) will be used to connect to the storage server. As we would use MySQL, we have access to free-open source ORM options such as SQLAlchemy, DapperORM and Sequelize.

Data Relationship Model



Software Development Methodology

Overview

The project will contain 3 development areas. The mobile application, website and Machine learning. Each area should have its own team following a software development life cycle to efficiently produce features in each time frame. Possible frameworks for development could be, Scrum, Feature-Driven Development, Waterfall and Agile.

Website Team

The website will need front-end and back-end development to function. The front end will consist of html, CSS, and JavaScript. The back-end will consist of python collecting user's data, building a data frame or adding to it, and using an ORM to link it to a database so it is updated in real-time. As the website will have more tasks involved to complete, taking a scrum approach will equally produce functionality in key areas. The most efficient team size for scrum is 3-5 people over short lengths (Subhash, 2020). Breaking each aspect into chunks will improve efficiency and reduce the chance of scope creep. The average time to develop a web app is at least 3 months (Didenko, 2021) which will be the aim.

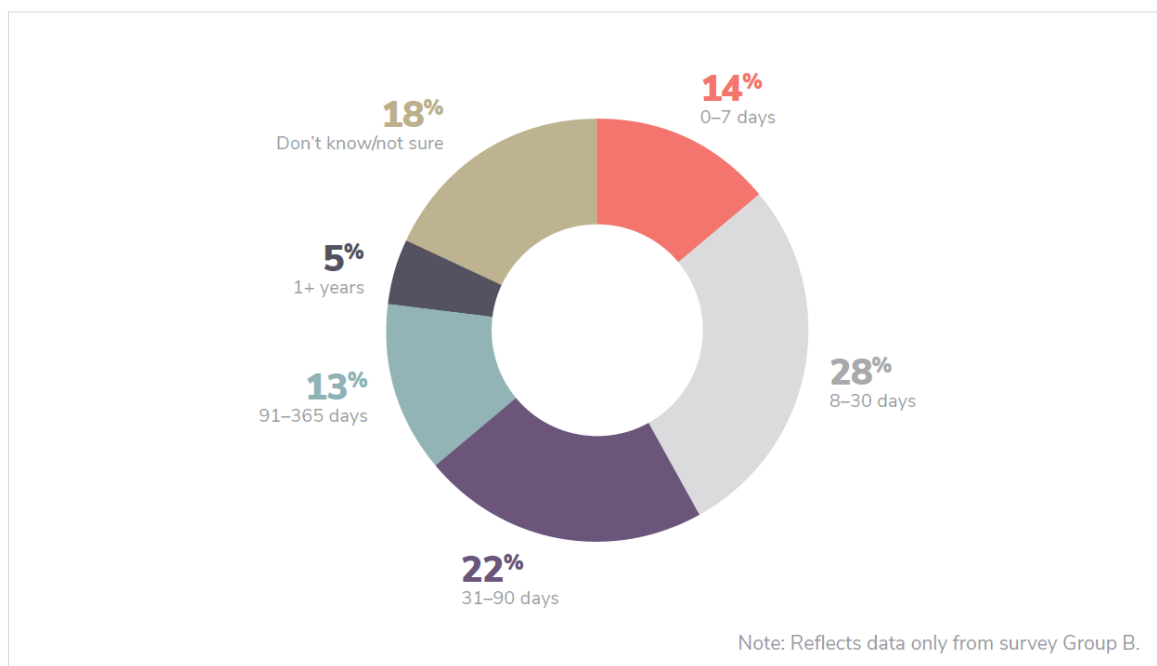
Mobile App Team

Like the website, the app can be developed using html, CSS and JavaScript. The app will be compatible with both Android and IOS. The initial development will start with Android and then modified to work with the IOS API. Making them native and not hybrid will greatly improve performance on each operating system (IBM, 2020). The mobile app will function mainly from existing features produced when making the website, so an ideal approach would be Feature-Driven Development to convert between the website code to Android and then IOS API. Feature-Driven is very similar to scrum except it has longer development lengths and is more attuned to a lightweight waterfall method.

Machine learning Team

The machine learning team will follow a data science specific life cycle when creating the model. The team will also be responsible for the cleaning and usage of the dataset. The team will use a notebook-based approach. The computing power for training the deep learning model will be outsourced as it will be cheaper than purchasing hardware. The deep learning model will be trained with Random Forrest generation and decision trees to produce an accurate result over multiple iterations.

Machine learning model deployment timeline



Pie Chart Source: Algorithmia's "2020 State of Enterprise ML". (Algorithmia, 2020)

The average time to develop a model is between 31-365 days so taking an average of 3 months to match the web development time will be used for calculating wages and project time.

Software and hardware requirements

Server-side software

The server will run on ubuntu server which is free and open source. The database used will be MySQL combined with the SQLAlchemy ORM to interface with the database. The machine learning model and feature engineering done in python notebooks sets up the relevant pipelines for the project to be completed and function.

Server-side hardware

The server to be used is an enterprise 2U rackmount type HyperServe RMXE-2U8 customised from Novatech which has 16GB Ram, 6TB HDD in slot, and 500GB SSD for software and boot. The rackmount solution will allow for quick scalability by filling expansion slots. The base processor is a Xeon-2224 Quad-core, 4 thread processor that will allow for a low setup cost with database software. The server will be installed with Ubuntu server and be setup with a yearly subscription to Ubuntu advantage for maintenance and security. A 1U TP-link 24 port network switch will also be added to interface between the server and local computers for development. The rack solution will be an Orion 12U standing rack for expandability.

Costing & Staffing

Cost table

Project Cost sheet						
Costs	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Non-Recurring Costs						
Hardware costs						
Server	£ 1,359.98	£ -	£ -	£ -	£ -	£ 1,359.98
Server Rack	£ 396.00	£ -	£ -	£ -	£ -	£ 396.00
Harddrives	£ 199.47	£ -	£ -	£ -	£ -	£ 199.47
Boot SSD	£ 140.27	£ -	£ -	£ -	£ -	£ 140.27
Additonal Memory	£ 62.44	£ -	£ -	£ -	£ -	£ 62.44
Dual port Ethernet Adapter	£ 118.49	£ -	£ -	£ -	£ -	£ 118.49
1U 24 port Network switch	£ 77.74	£ -	£ -	£ -	£ -	£ 77.74
Software						
Ubuntu Server	£ -	£ -	£ -	£ -	£ -	£ -
MySQL	£ 3,745.50	£ -	£ -	£ -	£ -	£ 3,745.50
Staff Costs						
Machine Learning Team	£ 28,344.00	£ -	£ -	£ -	£ -	£ 28,344.00
Website Team	£ 49,883.20	£ -	£ -	£ -	£ -	£ 49,883.20
Mobile App Team	£ 8,204.80	£ -	£ -	£ -	£ -	£ 8,204.80
Total Non-recurring costs	£ 92,531.89	£ -	£ -	£ -	£ -	£ 92,531.89
Recurring Costs						
Software costs						
MySQL	£ -	£ 3,745.50	£ 3,745.50	£ 3,745.50	£ 3,745.50	£ 14,982.00
Ubuntu Advantage	£ 1,123.65	£ 1,123.65	£ 1,123.65	£ 1,123.65	£ 1,123.65	£ 5,618.25
Total recurring costs	£ 1,123.65	£ 4,869.15	£ 4,869.15	£ 4,869.15	£ 4,869.15	£ 20,600.25
Overall project cost	£ 113,132.14					

Staff Cost

Average salaries were used from uk.talent.com

Staff Cost				
Development Time	Rate per hour	Development Time (Months)	Working hours	Total Pay
Machine learning Team				
Data Scientist	£ 28.28	3	480	£ 13,574.40
Machine learning engineer	£ 30.77	3	480	£ 14,769.60
Website Team				
Back-End Dev	£ 23.08	3	480	£ 11,078.40
Web Dev	£ 19.53	3	480	£ 9,374.40
UX/UI Design	£ 23.08	3	480	£ 11,078.40
Project Manager	£ 24.08	3	480	£ 11,558.40
Quality Assurance	£ 19.38	1	160	£ 3,100.80
Business Analyst	£ 23.08	1	160	£ 3,692.80
Mobile App Team				
iOS dev	£ 25.64	1	160	£ 4,102.40
Android dev	£ 25.64	1	160	£ 4,102.40
Total Staff Pay				
£				86,432.00

Legal Considerations

Data Protection Act

The user will create accounts that will be stored in a database. The account will contain personally identifiable information such as names and bank details which means only system administrators with security clearances in place may view that database. The code written to interact with it should not explicitly display that information in different components of the database or website and those identifiers must not be introduced into training the machine learning model.

Copyright and Licence

The Dataset is published under the Creative Commons universal license (Creative Commons, 2021) which allows it to be used with no copyright infringement on the author. The license allows the dataset to be modified, distributed, and used commercially without needing any permissions.

References

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- Subhash, D., 2020. *What is The Ideal Software Development Team Size*. [Online]
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Software References

Ubuntu server - <https://ubuntu.com/download/server>

Ubuntu Advantage - <https://ubuntu.com/support>

Hardware References

Server Rack - <https://www.rackcabinets.co.uk/collections/value-server-racks/products/12u-value-server-rack-600-x-900>

Novatech Server - <https://www.novatech.co.uk/newmodserver.html?s=SR-0246>

Network Switch - <https://www.dcdi.co.uk/tp-link-rackmount-switches-pure-gigabit-unmanaged>