PROJECT 4: MACHINE LEARNING INTEGRATION

ML Project

GP Pre-Appointment Questionnaire

UWA DATA ANALYTICS BOOTCAMP | **LIAM TWOMEY**

What's the GP's Challenge?

Limited time for accurate identification and prioritisation of health issues.

In primary care, doctors face challenges in identifying and prioritising health issues during short consultations due to limited time. Efficient comprehension of individual patients' health issues is crucial for accurate assessment and ranking of concerns.

Optimising the assessment process is vital to identify and prioritise critical health issues within the given timeframe. Overcoming these challenges requires exploring innovative approaches and utilising advanced technologies to enhance patient care outcomes.

AVERAGE GP CONSULT TIME

15 Minutes

Studies have shown that, on average, primary care physicians spend just 15 minutes with each patient during consultations.

Within this brief timeframe, they need to gather information, understand symptoms, and make critical decisions. With such limited time, accurate identification and prioritisation of health issues become increasingly challenging, leading to potential missed opportunities for early intervention and comprehensive care.

Consult Dynamics

Room for Improvement...

In typical consult dynamics, healthcare providers rely on the inital interactions with patients to gather information about their health.

This process is similar to piecing together a puzzle, where patients gradually share their symptoms and health issues.

However, there is a risk of missing crucial information until the last minute, leading to potential consequences for patient outcomes.

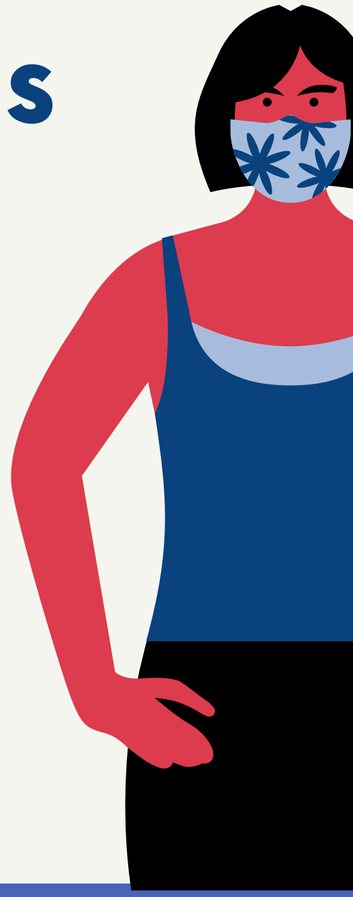
A Machine Learning Future for GP's

Where Consult Dynamics are Enhanced....

Imagine a future where consults are seamlessly enhanced by the integration of machine learning and a pre-appointment questionnaire.

Healthcare providers effortlessly gain comprehensive insights into patients' health profiles, leading to targeted care and timely interventions.

Frustration is minimized, and patient outcomes are maximized, ushering in a new era of efficient, informed, and patient-centered healthcare.



Project Overview

Develop an Enhanced Machine Learning Model for Symptom Classification and Prioritisation in Primary Care

The objective of this project is to develop an advanced machine-learning model that can effectively classify and prioritise symptoms reported by patients in a pre-appointment questionnaire. The model will use natural language processing (NLP) techniques to analyse and categorise the responses, providing healthcare providers with valuable insights into the patients' health profiles.

The primary goal is to expedite the discovery stage of consultations in primary care by leveraging the questionnaire as a tool to gather comprehensive information prior to the patient's arrival. By automatically classifying and grouping symptoms or health issues based on the patient's responses, the model will assist healthcare providers in understanding the potential risk factors and prioritising their care accordingly.

This project aligns with the vision of an integrated and patient-centred healthcare system where machine learning technologies seamlessly enhance consult dynamics. By optimising the assessment process, healthcare providers will be empowered to accurately identify critical health issues within the limited time frame of consultations. Ultimately, this advancement aims to improve patient outcomes by facilitating targeted care and timely interventions.

While this project represents a limited version of the envisioned all-encompassing symptom classification and prioritization tool, its successful implementation can pave the way for future advancements in primary care. By harnessing the power of NLP and machine learning, healthcare providers can move closer to achieving an efficient, informed, and patient-centred healthcare system.

Source of Data

Challenged by limited time and resources, I found sourcing fictitious data was the best solution to proceed with the project.

In order to overcome the time and resource constraints I was facing, I decided to leverage the power of ChatGPT to generate fictitious patient data for my project. I recognised that by utilising natural language processing and machine learning, I could simulate patient responses to pre-appointment questionnaires, specifically focusing on different health issues.

To start the process, I created a data frame called df_respiratory to capture the responses of patients who were experiencing respiratory health issues. This data frame included columns such as "reason_for_visit," "symptoms," "duration," "symptom_type," and "symptom_severity," among others. Using ChatGPT, I personally interacted with the model, prompting it to generate diverse phrases and variations for each column. This allowed me to obtain a wide range of symptoms, durations, severity levels, causes, medical histories, expectations, and health experiences. The resulting data in df_respiratory represented the fictitious responses that patients might provide when asked about their respiratory symptoms.

To ensure a comprehensive dataset, I also created additional data frames, such as df_digestive and df_mental, which focused on capturing responses related to digestive issues and mental health issues, respectively. Employing the same approach, I engaged with ChatGPT to generate fictitious patient data for these specific health concerns.

By utilising ChatGPT to generate the data, I successfully simulated a diverse array of patient responses. This allowed me to effectively train and evaluate my machine learning model, making significant progress on my project despite the limitations I faced in terms of time and resources.

Patient Response Generation Prompt

Using the recently released at the time ChatGPT, I used the following prompt to produce the data shown in the next 3 slides

```
"""
I\'m conducting a project that uses machine learning to classify responses to a pre-appointment questionnaire based on the symptoms or health issues reported by patients

1.  Please provide a brief summary of the reason for your visit today and the symptoms you are experiencing.
2.  How long have you been experiencing these symptoms?
3.  How would you describe the types of symptoms you are experiencing?
4.  How severe are the symptoms? In terms of mild, moderate, or severe.
5.  What do you believe is causing the symptoms?
6.  Are there any other symptoms you are experiencing along with the main symptoms?
7.  Do you have any past medical history or conditions that may be relevant to your symptoms?
8.  What are your expectations for your appointment today?
9.  Do you have any concerns or fears about your health that you would like to discuss with your healthcare provider?
10. Can you describe your overall feelings and experiences with your health and healthcare?

Generate dataframe of phrases that patients experiencing respiratory health issues might say in response to the questions above, concidering way/'s patients experiencing respiratory health issue\'s might describe their symptoms

base dataframe of phrases on the following example text

df = pd.DataFrame(columns=["reason_for_visit", "symptoms", "duration", "symptom_type", "symptom_severity", "symptom_cause", "additional_symptoms", "medical_history", "appointment_expectations", "health_concerns", "health_experiences"])

# add a row of data for each patient's response
df.loc[1] = ['Chest pain', 'Cough, shortness of breath, chest pain', '2 weeks', 'Respiratory', 'Moderate', 'Unknown', 'None', 'None', 'To receive a diagnosis', 'Worried about my heart', 'Scared and anxious']
df.loc[2] = ['Difficulty breathing', 'Shortness of breath, coughing, wheezing', '1 month', 'Respiratory', 'Moderate', 'Unknown', 'None', 'None', 'To receive a diagnosis and treatment plan', 'Concerned about my lung health', 'Frustrated and overwhelmed']
"""
```

respiratory.csv

Open with Microsoft Excel

reason_for_visit	symptoms	duration	symptom_type	symptom_severity	symptom_cause	additional_symptoms	medical_h
Exposure to mold	Cough, sneezing, watery eyes	2 weeks	Respiratory	Mild	Allergic reaction	None	None
Respiratory infection symptoms	Can't get my breath, chest feels tight, coughing, wheezing	3 weeks	Respiratory	Moderate	Unknown	None	None
Sinus infection	Cough, congestion, sinus pressure	2 weeks	Respiratory	Mild	Unknown	None	None
Difficulty breathing and wheezing	Difficulty breathing, wheezing, coughing	2 weeks	Respiratory	Severe	Unknown	None	None
Bronchitis symptoms	Cough, phlegm production, chest pain	2 weeks	Respiratory	Moderate	Unknown	None	None
Chest pain and chronic cough	Coughing, chest pain, can't get enough air, feeling winded, difficulty breathing	1 year	Respiratory	Severe	Unknown	None	None
Cough and chest pain	Coughing, chest pain, difficulty breathing	1 month	Respiratory	Moderate	Unknown	None	None
Chest pain and coughing	Chest pain, coughing, difficulty breathing	1 month	Respiratory	Moderate	Unknown	None	None
Pneumonia symptoms	Cough, fever, difficulty breathing, chest pain	3 days	Respiratory	Severe	Unknown	None	None
Following up on chronic bronchitis symptoms	Can't catch my breath, chest feels heavy, coughing, wheezing, difficulty breathing	1 month	Respiratory	Moderate	Unknown	None	Bronchitis,
Seeking treatment for chronic cough and chest pain	Coughing, chest pain, can't get enough air, feeling winded, difficulty breathing	1 year	Respiratory	Severe	Unknown	None	Bronchitis,
Bronchitis symptoms	Cough, phlegm production, chest pain	2 weeks	Respiratory	Moderate	Unknown	None	None
Exposure to allergens	Cough, sneezing, watery eyes	2 weeks	Respiratory	Mild	Allergic reaction	None	None
Respiratory distress	Can't catch my breath, chest feels heavy, coughing, wheezing	1 month	Respiratory	Moderate	Unknown	None	None
Chronic bronchitis symptoms	Coughing, chest pain, difficulty breathing, fatigue	6 months	Respiratory	Moderate	Unknown	None	Bronchitis,
Chronic cough and chest pain	Coughing, chest pain, can't get enough air, feeling winded, difficulty breathing	1 year	Respiratory	Severe	Unknown	None	None
Breathing problems	Cough, wheezing, difficulty breathing	3 days	Respiratory	Severe	Unknown	None	Asthma
Chronic bronchitis symptoms	Coughing, chest pain, difficulty breathing, fatigue	6 months	Respiratory	Moderate	Unknown	None	Bronchitis,
Wheezing and difficulty breathing	Wheezing, difficulty breathing, coughing	2 weeks	Respiratory	Severe	Unknown	None	None
Bronchitis flare-up	Coughing, chest pain, difficulty breathing, fatigue	1 month	Respiratory	Moderate	Unknown	None	Bronchitis,
Checking in on chronic bronchitis symptoms	Can't get my breath, chest feels tight, coughing, wheezing	3 weeks	Respiratory	Moderate	Unknown	None	Bronchitis,
Shortness of breath and chest pain	Shortness of breath, chest pain, coughing	1 month	Respiratory	Moderate	Unknown	None	None
Chronic cough	Cough, chest pain, phlegm production	6 months	Respiratory	Moderate	Unknown	None	None
Chest pain and difficulty breathing	Chest pain, difficulty breathing, coughing	2 weeks	Respiratory	Severe	Unknown	None	None
Sinus infection	Cough, congestion, sinus pressure	2 weeks	Respiratory	Mild	Sinus infection	None	None
Chest pain and chronic cough	Coughing, chest pain, can't get enough air, feeling winded, difficulty breathing	1 year	Respiratory	Severe	Unknown	None	None
Difficulty breathing	Shortness of breath, coughing, wheezing	1 month	Respiratory	Moderate	Unknown	None	None
Respiratory issues	Can't get my breath, chest feels tight, coughing, wheezing	3 weeks	Respiratory	Moderate	Unknown	None	None
Respiratory problems	Can't catch my breath, chest feels heavy, coughing, wheezing	1 month	Respiratory	Moderate	Unknown	None	None
Chest pain	Cough, shortness of breath, chest pain	2 weeks	Respiratory	Moderate	Unknown	None	None
Coughing and wheezing	Cough, wheezing, difficulty breathing	3 weeks	Respiratory	Mild	Unknown	None	Asthma

digestive.csv

Open with Microsoft Excel

reason_for_visit	symptoms	duration	symptom_type	symptom_severity	symptom_cause	additional_symptoms	medical_history	appointment_expectatior
Feeling like I can't keep anything down	Vomiting, diarrhea, abdominal cramps	1 week	Digestive issues	Severe	Unknown	None	None	To receive a diagnosis an
I can't stop shitting, my stomach is all twisted up	I've got a gut ache, I can't hold down any food	1 week	Digestive issues	Mild	Unknown	None	None	To receive a diagnosis an
Abdominal pain, bloating, gas	Diarrhea, constipation, loss of appetite	1 week	Digestive issues	Mild	Unknown	None	None	To receive a diagnosis an
I have been experiencing frequent stomach issues	Nausea, vomiting, diarrhea	1 month	Digestive issues	Severe	Unknown	None	None	To receive a diagnosis an
I'm puking my guts out	Nausea, vomiting, abdominal pain	1 month	Digestive issues	Severe	Unknown	None	None	To receive a diagnosis an
I can't stop shitting	Diarrhea, abdominal pain, bloating	2 weeks	Digestive issues	Moderate	Unknown	None	None	To receive a diagnosis an
I have been experiencing a lot of stomach pain	Abdominal pain, bloating, gas	1 week	Digestive issues	Severe	Unknown	None	None	To receive a diagnosis an
Heartburn, acid reflux, bloating	Nausea, vomiting, constipation	1 month	Digestive issues	Severe	Unknown	None	None	To receive a diagnosis an
Feeling like I'm constantly bloated	Diarrhea, constipation, loss of appetite	2 weeks	Digestive issues	Mild	Unknown	None	None	To receive a diagnosis an
I have a constant feeling of bloating and discomfort	Diarrhea, constipation, abdominal pain	3 weeks	Digestive issues	Moderate	Unknown	None	None	To receive a diagnosis an
Feeling like I have to go to the bathroom all the time	Diarrhea, constipation, bloating	1 month	Digestive issues	Mild	Unknown	None	None	To receive a diagnosis an
Nausea, vomiting, abdominal pain	Diarrhea, constipation, bloating	3 days	Digestive issues	Moderate	Unknown	None	None	To receive a diagnosis an
Feeling like I'm constantly bloated	Diarrhea, constipation, loss of appetite	2 weeks	Digestive issues	Mild	Unknown	None	None	To receive a diagnosis an
Heartburn, acid reflux, bloating	Nausea, vomiting, diarrhea	1 month	Digestive issues	Moderate	Unknown	None	None	To receive a diagnosis an
I have been throwing up	Nausea, vomiting, diarrhea	2 months	Digestive issues	Severe	Unknown	None	None	To receive a diagnosis an
Feeling sick to my stomach	Throwing up, can't go to the bathroom	3 days	Digestive issues	Moderate	Unknown	None	None	To receive a diagnosis an
Feeling nauseous and dizzy	Vomiting, diarrhea, abdominal pain	2 weeks	Digestive issues	Moderate	Unknown	None	None	To receive a diagnosis an
My stomach is constantly in knots	Nausea, vomiting, bloating	1 week	Digestive issues	Severe	Unknown	None	None	To receive a diagnosis an
I'm constantly experiencing stomach pain and discomfort	Abdominal cramps, bloating, gas	2 months	Digestive issues	Moderate	Unknown	None	None	To receive a diagnosis an
Feeling sick to my stomach	Throwing up, can't go to the bathroom	3 days	Digestive issues	Moderate	Unknown	None	None	To receive a diagnosis an
My stomach is killing me	I feel like I'm going to hurl, I'm puking my guts out	1 month	Digestive issues	Severe	Unknown	None	None	To receive a diagnosis an
I have been experiencing stomach pain and discomfort	Abdominal cramps, bloating, gas	1 month	Digestive issues	Mild	Unknown	None	None	To receive a diagnosis an
Heartburn, acid reflux, bloating	Nausea, vomiting, constipation	1 month	Digestive issues	Severe	Unknown	None	None	To receive a diagnosis an
My stomach is constantly in knots	Nausea, vomiting, bloating	1 week	Digestive issues	Severe	Unknown	None	None	To receive a diagnosis an
I have been experiencing stomach pain and discomfort	Abdominal cramps, bloating, gas	1 week	Digestive issues	Severe	Unknown	None	None	To receive a diagnosis an
Feeling sick to my stomach	Throwing up, can't go to the bathroom	2 weeks	Digestive issues	Moderate	Unknown	None	None	To receive a diagnosis an
I have been experiencing the runs	Nausea, vomiting, diarrhea	1 month	Digestive issues	Moderate	Unknown	None	None	To receive a diagnosis an
Abdominal pain, bloating, gas	Diarrhea, constipation, loss of appetite	1 week	Digestive issues	Mild	Unknown	None	None	To receive a diagnosis an
Abdominal pain, bloating, gas	Diarrhea, constipation, loss of appetite	1 week	Digestive issues	Mild	Unknown	None	None	To receive a diagnosis an
Abdominal pain, bloating, gas	Diarrhea, constipation, loss of appetite	1 week	Digestive issues	Mild	Unknown	None	None	To receive a diagnosis an
Diarrhea, constipation, bloating	Nausea, vomiting, abdominal pain	2 weeks	Digestive issues	Severe	Unknown	None	None	To receive a diagnosis an

mental_health.csv

Open with Microsoft Excel

reason_for_visit	symptoms	duration	symptom_type	symptom_severity	symptom_cause	ad
Stress, anxiety, irritability	Difficulty sleeping, lack of motivation, mood swings	2 months	Mental health issues	Moderate	Work-related stress	Nc
Feeling overwhelmed and irritable	Anxiety, mood swings, sleep problems	6 months	Mental health issues	Moderate	Unknown	Nc
Struggling with anxiety and stress	Sleep problems, mood swings, difficulty concentrating	1 year	Mental health issues	Moderate	Life stressors	Nc
Feeling down and anxious	Lack of motivation, loss of interest in activities	3 months	Depression and anxiety	Moderate	Unknown	Nc
Feeling stressed and overwhelmed	Mood swings, irritability, social withdrawal	1 week	Mental health	Mild	Personal problems	Nc
Feeling down and hopeless	Loss of interest in activities, sleep problems	1 month	Depression	Severe	Unknown	Nc
Struggling with managing stress	Stress, irritability, difficulty concentrating	2 weeks	Mental health issues	Moderate	Work and personal stressors	Nc
Feeling overwhelmed and stressed	Irritability, mood swings, sleep problems	1 week	Mental health issues	Moderate	Work stress	Nc
I'm not feeling like myself	Mood swings, irritability, social withdrawal	6 months	Mental health issues	Mild	Unknown	Nc
Seeking help for my mental health struggles	Depression, lack of motivation, social withdrawal	1 year	Mental health issues	Mild	Unknown	Nc
I'm feeling down	Depression, stress, sleep problems	3 months	Mental health issues	Moderate	Unknown	Nc
Feeling down and anxious	Lack of motivation, social withdrawal	1 year	Depression and anxiety	Severe	Unknown	Nc
Feeling overwhelmed and disconnected	Depression, loss of interest in activities	6 months	Mental health issues	Mild	Unknown	Nc
Stress, loss of motivation	Lack of interest in activities, social withdrawal	1 year	Mental health	Severe	Unknown	Nc
I'm struggling with stress and anxiety	Sleep problems, lack of motivation, difficulty concentrating	3 months	Mental health issues	Moderate	Work-related stress	Nc
Feeling anxious and depressed	Excessive worrying, difficulty sleeping, low mood	6 months	Mental health issues	Moderate	Unknown	Nc
Feeling overwhelmed and anxious	Depression, irritability, sleep problems	2 months	Mental health issues	Moderate	Unknown	Nc
Need support for anxiety and stress	Difficulty concentrating, lack of motivation	3 weeks	Anxiety and stress	Mild	Work and relationship stress	Nc
I'm stressed out	Stress, mood swings, difficulty concentrating	1 month	Mental health issues	Moderate	Unknown	Nc
I feel depressed and anxious all the time	Sleep problems, lack of interest in activities, difficulty concentrating	1 year	Depression and anxiety	Severe	Unknown	Nc
Feeling down	Tired all the time, lack of motivation, mood swings	2 months	Depression	Moderate	Stressful life events	Nc
I'm easily annoyed	Stress, irritability, mood swings	2 weeks	Mental health issues	Moderate	Unknown	Nc
Feeling burnt out	Insomnia, Lack of motivation, Irritability, Headaches	3 months	Stress	Mild	Work and family responsibilities	Nc
Feeling depressed and anxious	Difficulty sleeping, lack of motivation, irritability	2 months	Mental health	Moderate	Stressful work environment	Nc
Feeling down	Sleeping too much or too little, Appetite changes, Lack of interest in hobbies, Feeling hopeless	6 months	Depression	Moderate	Unknown	Nc
I'm not feeling like myself	Mood swings, irritability, social withdrawal	6 months	Mental health issues	Mild	Unknown	Nc
Feeling overwhelmed	Excessive worrying, Mood swings, Social withdrawal, Loss of interest in activities	1 year	Anxiety disorder	Severe	Unknown	Nc
Mood swings	Irritability, loss of interest in activities, sleep problems	1 year	Mental health	Moderate	Unknown	Nc
Needing support for my mental health	Anxiety, stress, mood swings	6 months	Mental health issues	Severe	Life events	Nc
Feeling overwhelmed	Anxiety, stress, lack of motivation	6 months	Mental health	Severe	Unknown	Nc
Mood swings, irritability, social withdrawal	Insomnia, difficulty concentrating, lack of motivation	2 months	Mental health	Mild	Unknown	Nc

ETL - Extract Transform Load

Data ETL: Extract, Transform, and Load for Model Training.

The ETL (Extract, Transform, Load) process used in the project involved extracting data from a CSV file, transforming, and pre-processing the data, and then loading it into a data frame for further analysis and model training.

To extract the data from the CSV file, the panda's library was used. The 'pd.read_csv' function was used to read the data from the 'pre-appointment-data.csv' file into a dataframe called 'df'.

The transformations applied to the data included dropping unnecessary columns using the 'df.drop' function. Columns such as 'duration', 'symptom_severity', 'symptom_cause', 'additional_symptoms', 'medical_history', 'appointment_expectations', 'health_concerns', and 'health_experiences' were dropped from the dataframe 'df'.

Text preprocessing was performed on the 'reason_for_visit' and 'symptoms' columns. This involved converting the text to lowercase using the 'str.lower()' function, expanding contractions using the 'contractions.fix' function, removing punctuation using regular expressions and the 're.sub' function, getting rid of double spaces using 're.sub', and lemmatizing the words using the WordNetLemmatizer from the NLTK library. These transformations were applied to the 'df_reason_for_visit' and 'df_symptoms' dataframes.

Label encoding was applied to the non-numeric columns using the 'LabelEncoder' class from the sklearn.preprocessing module. The 'LabelEncoder().fit_transform' function was used to encode the values in each column of 'df' that had the 'object' data type.

Data cleaning and preprocessing are important for accurate model training. They help in removing unnecessary or redundant information, standardizing the data, and transforming it into a suitable format for machine learning algorithms. By performing these steps, the data becomes more meaningful and can lead to better model performance and predictions.

Model Optimisation and Testing

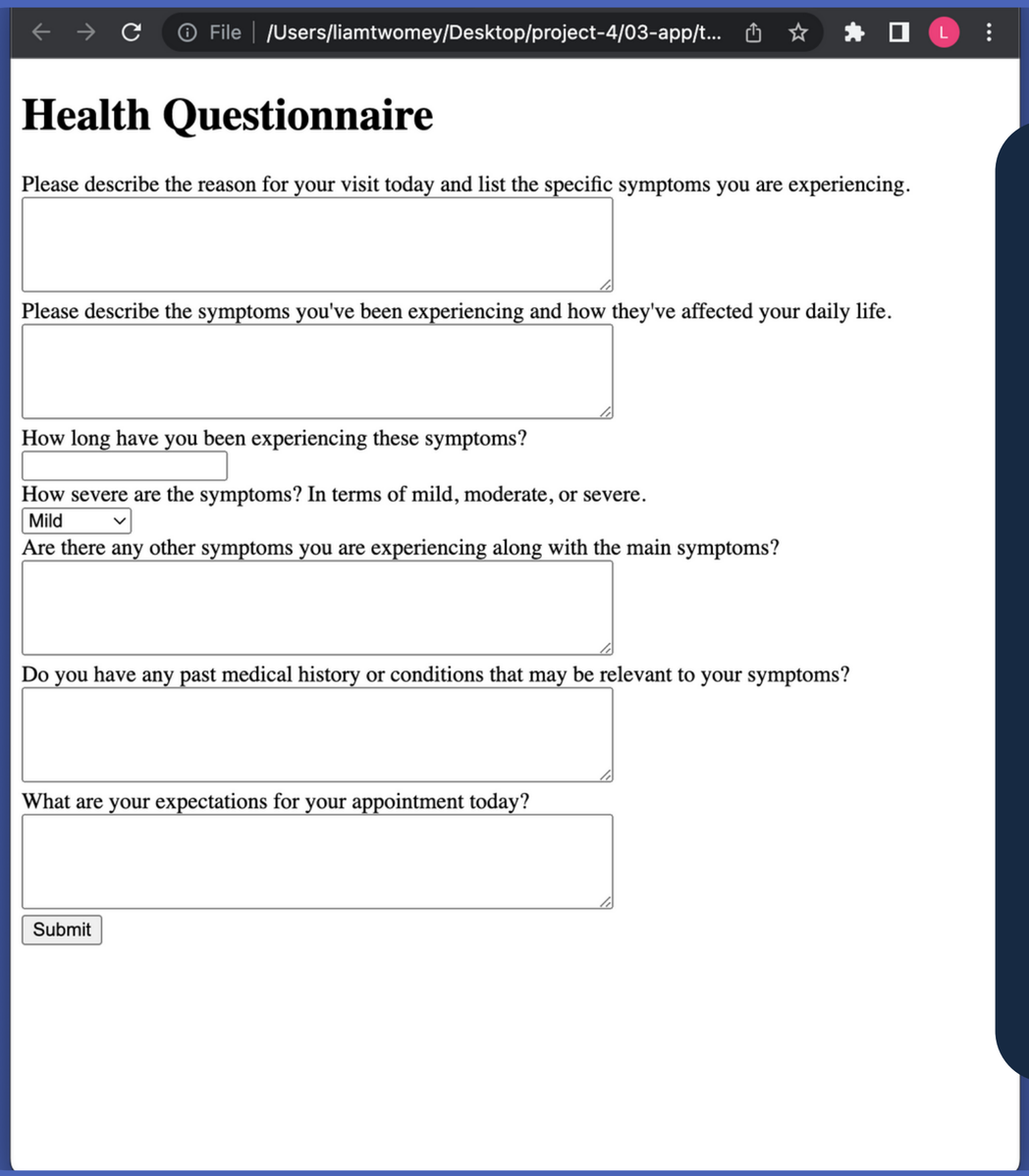
Model Optimisation: Evaluating Algorithms, Metrics, and Hyperparameters.

The Python script incorporates model optimisation and performance testing to ensure optimal results. It evaluates and compares multiple machine learning algorithms, including Logistic Regression, Support Vector Machine (SVM), and Random Forest Classifier.

To assess model performance on unseen data and mitigate overfitting or under-fitting, the script employs a train-test split. Feature scaling using StandardScaler is applied to normalise the input data, enhancing the performance of the algorithms.

Essential evaluation metrics, such as train accuracy, test accuracy, precision, recall, and F1 score, are calculated and displayed for a thorough assessment. The script provides detailed insights into the model's predictions and performance by utilising the confusion matrix and heatmap visualisation. Throughout the process, hyperparameter tuning techniques may be utilised to further optimize model performance.

At the conclusion of the script, the overall model performance is printed or displayed, facilitating clear assessment and comparison of different models. Furthermore, the trained Random Forest Classifier model is saved for future use and deployment.



Web App Aspirations

The web-based Health Questionnaire offers a Minimal Viable Product for patients to provide crucial health information before appointments.

Capturing essential data on symptoms, duration, and medical history, the platform sets the foundation for further enhancements and integration with machine learning models for personalised healthcare insights.

Please note that the web-based Health Questionnaire displayed is not functional.

Challenge's and Reflections

Navigating Challenges, Embracing Growth: Reflecting on the Project Journey

During this project, I faced several challenges that tested my skills and problem-solving abilities. Falling behind in the fast-paced course created a knowledge gap, making Project 4 more challenging than anticipated. However, I remained determined and dedicated extra effort to bridge the gap.

Selecting a subject and purpose for the project was another significant challenge. I sought a topic aligning with my interests and showcasing learned concepts, requiring careful consideration and exploration of possibilities.
Finding appropriate data proved challenging due to time constraints and limited resources. Resorting to creating fictitious data presented difficulties in ensuring its accuracy and integrity.

Despite the challenges, I viewed each obstacle as an opportunity for growth. Leveraging natural language processing and machine learning techniques, I simulated diverse patient responses and developed a functional model for symptom classification and prioritization.

This project provided valuable insights into machine learning integration and meticulous data preparation. Overcoming challenges strengthened my problem-solving skills and commitment to continuous improvement in machine learning.
Though limited in scope, the project serves as a foundation for future advancements in primary care and machine learning integration. It has been a valuable learning experience, and I'm proud of the progress made. Moving forward, I will carry these lessons, seeking innovative solutions to complex healthcare challenges.

Thank You

UWA Data Analytics Bootcamp Team