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Proposed title of the Thesis Project

Developing a Personalized fitness Assistant Web application using Analytics and AI for Obese and Sedentary Individuals

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## Introduction

## Background of the Study

The rise of sedentary lives and obesity has become a major global health concern in recent years(Papry et al., 2024). According to the World Health Organization (WHO), there has been a roughly threefold increase in obesity rate since 1975. In 2016, over 1.9 billion persons were classified as overweight, and 650 million of them were obese. This worrying trend is not limited to adults; childhood obesity has also sharply increased, with dire consequences for coming generations(*2018 13th International Workshop on Semantic and Social Media Adaptation and Personalization (SMAP)*, 2018). Long stretches of inactivity are a hallmark of sedentary lifestyles, which worsen this problem. Because of urbanization and technological improvements, the modern sedentary lifestyle has resulted in a decline in physical activity levels across all age groups. Overeating coupled with a lack of physical activity creates a powerful recipe for obesity and related health complications(Gaikwad et al., 2023).

Sedentary lifestyles and obesity have numerous detrimental effects on general well-being. A number of chronic ailments, such as heart disease, type 2 diabetes, several cancers, and musculoskeletal conditions are significant exacerbated by obesity(Gaikwad et al., 2023). Furthermore, it has a strong connection to mental health problems like anxiety and sadness. Because obesity causes earlier death, lower productivity and higher healthcare costs, it also has a significant financial impact. On the other hand, regardless of other health determinants, sedentary behaviour is linked to an increased risk in diabetes, cardiovascular disease, and early mortality(Gaikwad et al., 2023). Obesity and sedentary lifestyles combine to produce a vicious cycle in which being overweight makes it harder and less likely to engage in physical activity, and physical inactivity causes weight increase(Sathya et al., 2024).

Given that effective programs that encourage healthy habits are desperately needed, as obese and inactive lifestyles carry major health risks as well as financial expenses. It has been difficult to reverse these trends with conventional methods like therapeutic interventions and public health initiatives(Mardiana & Baizal, 2023). Personalized health management approaches have demonstrated potential in tackling these intricate problems because they consider individual variance in health status, preferences, and behaviours. More focused and efficient solutions can be obtained through personalized intervention, raising the possibility of long-lasting behaviour change and better health results(Muhd Hafeez Khan et al., 2023).

Technology has created new opportunities for health intervention. To track health indicators, provide interventions, and encourage behaviour change, wearable technology, mobile health apps and telehealth services are being used more and more. Among these, smartwatches have become more popular as wearable health monitoring gadgets that track heart rate, exercise, sleep habits, and other parameters. These gadgets are useful instruments for health monitoring and intervention since they have the capacity to other comprehensive and ongoing health data(Sathya et al., 2024). Furthermore, pathological data obtained through testing or wearable technology can provide more in-depth understanding of a person’s health status. Example of this type of data include body composition, medical history, and metabolic profiles. It is feasible to create more through and individualized health advice by combining these many data sources(Gaikwad et al., 2023).

## Statement of the Problem

Traditional diet and exercise plans use a one-size-fits-all approach, they frequently fall short of meeting individual needs. Subpar results result from these systems’ failure to take into account individual differences in metabolism, physical capabilities, medical histories, and preference(Papry et al., 2024). John, a 45 years old officer worker who leads a sedentary lifestyle, is recommended to adhere to a standard diet and exercise regimen. But he has an history of hypertension, because of his knees discomfort, he prefers low-impact workouts. The particular demands are not met by the generalized plan which results in low adherence and little improvement in health. This emphasizes the need for tailored health therapies that can accommodate individual variances and advance improved health outcomes.

Current recommendation systems have many drawbacks, especially the ones that use collaborative filtering algorithms. For example, the cold start issue occurs when the system is unable to accurately deliver recommendations due to insufficient or no knowledge about new users or things. This problem is made more complex by sparse data, since less interaction data makes collaborative filtering methods less effective(Yue et al., 2021). Another major obstacle is the computing difficulty involved in processing massive datasets to produce recommendations in real time. Maria, a new user of a diet advice software, finds it difficult to get precise meal recommendations because the app can’t handle fresh user well. Due to this cold start issues, she receives irrelevant recommendation that don’t meet her demands in terms of nutrition or health. Resolving these issues is essential to enhancing the improving recommendation systems.

Smartwatches and other wearables devices have become popular tools for health monitoring, capable of collecting continuous and rich health data. However, many current health intervention systems do not effectively utilize this data to provide, personalized recommendations. Ahmed, 30-year old professional, uses a smartwatch to track his daily physical activity and heart rate. Despite the rich data collected, his health app only provides generic advice, failing to tailor recommendations based on his actual activity levels and heart rate variability. This underutilization of continuous health data limits the potential benefits of personalized health interventions and underscores the need for systems that can effectively integrate and analyze this data.

Medical history, body composition, and metabolic profiles are examples of pathological data that offer comprehensive insights into a person’s state of health. But a lot of the current systems don’t incorporate this important data, which makes the health advice less useful.

Using pathology data in conjunction with continuous health monitoring, this research seeks to close significant gaps in the present health intervention systems. The recommendation system has the potential to help people like John, Maria, Ahmed and Ravi lead healthier lives and improve their health by offering highly tailored and context-aware health suggestions. This research sets the stage for further development in individualized health management while simultaneously addressing a critical public health issue. This research hold promising substantially influencing public health by endowing people with the ability to make knowledgeable choices and take proactive measures towards improved health.

## Purpose of the Research

The goal of this research is to create and assess a web application for a personalized fitness assistant that is intended specifically for obese and sedentary people. The purpose of this research is to deliver personalized nutrition and exercise recommendations utilizing cutting edge technology. This research aims to overcome the drawbacks of conventional recommendation algorithms and fill significant gaps in current health intervention systems by merging pathological information with data from continuous health monitoring.

## Research Aims

This research aims to:

1. To develop a user interface that is easy to navigate and accessible for all users.
2. To ensure the web application is inclusive by integrating necessary accessibility features.
3. To identity and implement features that effectively engage users
4. To access the effectiveness of the fitness assistance web application in increasing physical activity levels among obese and sedentary individuals.

## Research Questions

This research aims to answer the following questions:

1. How can the user interface be optimized for ease of use and accessibility?
2. What accessibility features are necessary to ensure inclusivity for all potential users?
3. How user friendly is the web application for individuals with varying levels of tech-savviness?
4. What features of the application are most effective in engaging and retaining users?
5. How effective is the recommendation fitness assistant web application in improving physical activity levels among obese and sedentary individuals?

## Research Objectives

1. Conduct user testing to gather feedback on the current interface and identify areas of improvement.
2. Review and integrate best practices for web accessibility standards.
3. Continuously monitor user feedback and make adjustment to improve usability for all users
4. Analyse user engagement data to identify which features are most frequently used and highly rated by users.
5. Use self-reported and objective measures to access changes in physical activity.

## Relevance and Important of the study

The significance of this study lies in its potential to revolutionized health management for obese and sedentary individuals through the development and implementation of sophisticated recommendation fitness assistant web application. Obesity and Sedentary lifestyles are leading contributors to various chronic diseases, including cardiovascular diseases, diabetes, and certain cancers. This research will not only mitigate these health risks, it will also improve overall well-being as these innovations can be applied beyond health management to other domains requiring personalized recommendations which can inform future research and development effort aimed at enhancing personalized health interventions and other applications of recommender systems.

## Scope of the Study

The scope of the study encompasses the primary focus on obese and sedentary individuals who can benefit significantly from personalized diet and exercise recommendations using advanced algorithms that enhances accuracy and relevance. This study will focus on developing an intuitive and accessible user interface. This web accessibility standards, and continuously improving the interface based on user feedback.

## Key concepts, Theories and Studies

In the context of health recommendation systems, several key concepts and theories underpin the development and implementation of these systems(Varshney et al., 2023). Content-based filtering and collaborative filtering are the primary methodologies that will be utilized in these systems. Content-based relies on the similarity of item content, recommending items that share characteristics with those the user previously interacted with(Zahiruddin & Musa, n.d.). This approach, while effective in many context, can suffer from issues as limited content analysis and over-specialization.

Collaborative filtering, on the other hand focus on leveraging user behavior data to generate recommendations(Zahiruddin & Musa, n.d.). This technique can be divided into memory-based and model-based approaches. Memory-based collaborative filtering, including user-based and item-methods, identifies similar users or items and makes recommendations based on shared preferences. Model-based approaches utilize machine learning techniques to predict preferences, providing a robust alternative to memory-based methods.

Recent advancements have seen the integration of knowledge graphs with collaborative filtering algorithms to enhance recommendation accuracy(Elahi et al., 2024). Knowledge graphs help in capturing relationships between entities, thereby improving the contextual relevance of recommendations. Studies have demonstrated the efficacy of combining user-based collaborative filtering with knowledge graphs in improving recommendation quality for health-related applications.

## Key Debates and Controversies

One of the primary debates in the field of health recommendation systems revolves around the balance between personalization and generalization. While highly personalized recommendations are beneficial, they can sometimes lead to privacy concerns and require extensive data collection, which may not always be feasible. On the other hand, generalized recommendations may not be as effective in meeting individual user needs (Elahi et al., 2024).

Zahiruddin states that another critical issue is the reliability and accuracy of health recommendations. Given the potential impact on user health, ensuring that the recommendations are evidence-based and scientifically valid is crucial(Zahiruddin & Musa, n.d.). This brings into question the sources of data used and the algorithms employed in generating these recommendations. The integration of medical records, user inputs can enhance accuracy but also raise concerns about data security and user privacy.

## Gaps in Existing Knowledge

Despite significant advancements, there are still notable gaps in the existing literature. One of the main gaps is the limited exploration of hybrid models that effectively integrate multiple data sources, such as user inputs to generate comprehensive health recommendations. Additionally, while there is considerable research on the technical aspects of recommendation systems in real-world settings(Varshney et al., 2023). Most studies are conducted in controlled environments, which may not accurately reflect the challenges and complexities encountered in everyday use. Addressing these gaps will require interdisciplinary research that combines expertise in health sciences, data analytics, and user-centered design Muhd stated (Muhd Hafeez Khan et al., 2023).

Research Design

Historical Data on Health

Data Cleansing

Feature Selection

Splitting Data set

Test

,

User Input

Predict

Machine Learning

Recommended Dietary Plans and Exercise

## fig 1: The process flowchart

The figure above shows the flow chart of the web application

Historical Data on Health: the first step involves gathering historical health data, which includes various datasets such as medical records. These datasets contains valuable information about patient’s health metrics, dietary habits, physical activity levels, etc. This data is crucial for building a robust recommendation system as it helps in understanding patterns and correlations between different health factors.

Data Cleansing: this phase is essential to ensure the quality and reliability of the dataset. This process involves removing duplicate entries, handling missing values through imputation or removal, correcting errors in data entries, standardizing data formats. This phase provides a solid foundation for accurate analysis and model training.

Feature Selection: feature selection involves identifying the most relevant variable that significantly impact health outcomes and dietary recommendations. This step includes statistical analysis to determine feature importance, correlation analysis to remove redundant features, domain knowledge to select clinical relevant features. The effective feature selection improves model performance and reduces computational complexity.

Split data set: the cleaned and selected data is split into training and testing datasets. Typically, a common split is 80% train and 20% test. This step ensures that the model is trained on one subset of data and validated on another to assess its performance and generalizability.

Train: the training phase involves using machine learning algorithms to learn patterns from the training dataset. Various algorithms like decision trees, random forest, or neural networks can be used. The model is trained iteratively, adjusting parameters to minimize prediction errors and improve accuracy.

Test: testing the model involves evaluating its performance on the testing dataset. Key metrics such as accuracy, precision, recall, and F1-score are calculated to determine how well the model predicts outcomes on unseen data. This step helps in validating the model’s effectiveness and identifying any overfitting or underfitting issues.

Machine learning: machine learning techniques are employed to build predictive models that can analyze user data and historical health information. These models are designed to predict health outcomes and provide personalized dietary and exercise recommendations. Machine learning enhances the ability of the system to adapt and improve over time as more data becomes available.

Predict: using the trained mode, predictions are made on new user data. The system analyses the user’s current health metrics and dietary habits to forecast potential risks and recommend preventive measures. This predictive capability is central to providing timely and personalized health advice.

User input: user provide their personal health care, including weight, height, age, dietary preferences, physical activity levels, and any medical conditons. This input is crucial for tailoring the recommendations to the individual’s specific needs and health goals.

Recommended Dietary Plans and Exercise: based on the user’s input and the model’s predictions, the system generates personalized dietary plans and exercise routines. These recommendations aim to improve the user’s health outcomes by promoting balanced nutrition and regular physical activity. The system would also offer educational resources to help users understand the benefits of the recommended lifestyle changes.

## Research Methodology

The methodology section outlines the systematic approach that will be employed in the development of this recommendation fitness assistant web application which will be specifically designed for obese and sedentary individuals. The development process will leverage Python Django for the backend and HTML and CSS for the frontend. This section will detail the steps, tools and techniques that will be used, including user data collection, algorithm selection and system architecture design.

## Research Design

Type of Research

Quantitative and Qualitative Research: this research will incorporate both quantitative and qualitative methods. Quantitative data will include metrics such as BMI, calorie intake, blood pressure readings. Qualitative data will be gathered from user feedback on the usability and effectiveness of the recommendations.

Descriptive and Correlation: the research will be descriptive in terms of documenting user interactions and health outcomes, and correlational in analyzing the relationships between dietary habits, physical activity and health metrics.

## Data Collection

Primary Data Collection: Data will be collected directly from users through the web application interface.

Secondary Data Sources: Existing health datasets will be used to build the initial model and validate the system’s recommendations.

## Methods and Sources

## Data Sources

User Inputs: Personal health metrics like weight, health, age , for dietary preferences, and activity levels will be collected directly from users.

Tools and Procedures

Backend Development: Python Django

Python Django will be utilized for backend development due to its robust features, scalability and ease of use. Django will handle the following aspects:

User Authentication: managing user registration, login, and profile management.

Data Management: Storing and processing user data, including health metrics and preferences.

Recommendation Engine: implementing the collaborative filtering algorithm and knowledge graph integration to generate personalized fitness and diet recommendations.

Frontend Development: HTML and CSS

HTML and CSS will be used for the frontend development to create a user-friendly and accessible interface. The frontend will ensure:

Responsive Design: Ensuring the application is accessible on various devices, including desktops, tablets and smartphones.

Participants

Target Population: the primary users of the system will be individuals with hypertension seeking dietary and fitness recommendations to manage their condition.

Sample Size: An initial pilot will involve 50-100 users to gather preliminary data and feedback. Based on the results, the sample size may be expanded.

Data Analysis

Quantitative Analysis: Statistical methods will be used to analyze health metrics and assess the effectiveness of the recommendations.

Qualitative Analysis: User feedback will be analyzed to identify common themes and areas of improvement.

Practical Considerations

Potential obstacles

Data Privacy: ensuring the confidentiality and security of user data will be top priority. Measures such as data encryption and secure authentication will be implemented.

User Engagement: Encouraging users to consistently input their health data and follow recommendations may be challenging. Strategies such as reminders and rewards will enhance engagement.

Limitations

Sample Size: a small initial sample size may limit the generalizability of the findings. Efforts will be made to increase the size over time.

Ethical Considerations

Informed Consent: users will be informed about the purpose of the study, the typs of data collected, and how their data will be used. Informed consent will be obtained from all participants.

Data Anonymization: Person identifiers will be removed from the dataset to protect user privacy.

Ethical Consideration

Practical Implications

The proposed project holds significant practical implications for individuals with sedentary and obese lifestyle. By developing a web-based diet recommendation system, the research aims to provide personalized dietary and fitness guidance to help individuals better manage their condition. The findings of this study can potentially improve the overall health outcomes of hypertensive individuals by promoting healthier lifestyle choices.

Furthermore, the insights gained from user interactions and feedback can inform the design of future health-related interventions and digital health tools. The web application’s user-friendly and personalized recommendations have the potential to empower individuals to take proactive steps towards health management.

Theoretical Implications

From a theoretical perspective, this project contributes to the growing body of literature on personalized health interventions and recommendation systems. By integrating collaborative filtering algorithms and knowledge graphs, the research advances out understanding of how machine learning techniques can be applied to address complex health challenges.

Moreover, this study may contribute to the refinement and validation of existing health behaviour model and theories, such as the health Belief Model and the Transtheoretical Model. By analysing user engagement and behaviour change patterns, the research may challenge current assumptions and provide insights into the mechanisms underlying successful health interventions.

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