

AI Personalized Fitness And Nutrition Coach Using ML

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Abstract

In an era where health and wellness are increasingly prioritized, the demand for personalized fitness and nutrition guidance continues to grow. This project presents the development of an AI-powered personalized fitness and nutrition coach designed to deliver customized workout plans, dietary recommendations, and real-time progress tracking tailored to individual goals, preferences, and physiological parameters. Leveraging machine learning algorithms, computer vision, and data analytics, the system dynamically adapts to users' evolving fitness levels, dietary responses, and lifestyle patterns. The AI coach incorporates data from wearable devices, user input, and external health databases to refine its recommendations continuously. Through intuitive user interfaces, virtual assistant capabilities, and evidence-based methodologies, this solution aims to bridge the gap between expert human coaching and scalable, accessible health technology. The proposed platform not only empowers users to make informed health decisions but also supports long-term engagement and behavioral change, contributing to improved overall well-being.

Keywords: *AI fitness coach, personalized nutrition, customized workout plans, machine learning in health, computer vision fitness tracking, real-time progress monitoring, wearable device integration, health data analytics, dietary recommendations, fitness app, virtual health assistant, behavioral change support, scalable health solution, user-centered health technology, evidence-based coaching, lifestyle adaptation, health and wellness AI, intelligent diet planning, fitness level adaptation, and digital health engagement.*

Introduction

The "AI Personalized Fitness and Nutrition Coach" is an innovative web application designed to provide a comprehensive and individualized approach to health and wellness. Recognizing the limitations of generic solutions, this project focuses on delivering personalized weekly diet plans, tailored workout regimens, and critical health metric calculations (BMI, BMR, TDEE) based on each user's unique profile, preferences, and specific fitness objectives. A central component is the real-time pose detection feature, which utilizes MediaPipe to offer immediate feedback on exercise form, promoting safer and more effective workouts.

Beyond its current data-driven personalization, the system is architected with the intent to integrate machine learning algorithms. This future enhancement will enable the coach to learn from user activity, feedback, and outcomes, leading to increasingly refined and adaptive diet and workout suggestions. The project thus aims to create not just a static advisor, but an evolving AI partner that intelligently guides users towards their health goals, making personalized

coaching more dynamic and accessible.

Proposed System:

To overcome the limitations of existing digital health solutions, this project proposes the "AI Personalized Fitness and Nutrition Coach," an intelligent web application designed to offer a comprehensive, interactive, and highly personalized approach to fitness and dietary management. The system aims to act as a virtual coach, empowering users with tailored guidance and real-time feedback to achieve their health and wellness objectives effectively and safely.

Related Work

Survey:

The landscape of digital health and fitness solutions reveals a strong trend towards leveraging Artificial Intelligence for personalized user experiences. Existing research extensively covers AI-driven recommendation engines for both diet and exercise, utilizing techniques from collaborative filtering to content-based analysis based on user profiles and

historical data. Simultaneously, the field of computer vision has made significant strides in human pose estimation, with tools like Media Pipe offering robust real-time capabilities for analyzing movement from standard camera feeds. However, a distinct opportunity remains in holistically integrating these advanced AI-driven personalization techniques with accessible, real-time, interactive exercise form correction within a unified web platform, thereby addressing the limitations of generic plans and the absence of immediate guidance found in many current systems.

Key Research Areas

This project delves into several key research areas to achieve its objectives. Firstly, it explores personalized recommendation algorithms for generating diet and workout plans by effectively utilizing a multi-dimensional user profile that includes physiological metrics, lifestyle factors, specific dietary preferences (including cuisine choices), and distinct fitness goals. Secondly, it investigates the application of real-time computer vision and pose estimation (specifically Google's Media Pipe) for exercise form analysis, focusing on translating detected body landmark data into actionable, corrective feedback for common exercises. Finally, the research touches upon user engagement strategies within a digital health context, by integrating features like progress tracking and task management to support adherence and motivation.

The development of AI-driven health and fitness systems builds upon a rich body of existing research. Studies have explored creating AI yoga trainers that simplify home practice using MediaPipe for pose analysis and video streaming to guide users. Other work has focused on advanced exercise monitoring within smart gym environments, utilizing fused sensor data like RFID and computer vision to track activities more deeply than simple presence detection. The broader field of human pose estimation has seen extensive surveys, cataloging the progress and systems have also been a traditional approach for diet recommendation, codifying nutritional expertise into rule-sets. More broadly, surveys on AI nutrition recommender systems highlight the diverse AI techniques used to personalize dietary advice. Finally, deep neural networks have been specifically applied to rehabilitation contexts for posture correction, demonstrating the power of AI in therapeutic movement analysis.

Design

Architecture:

System Architecture:

taxonomy of 2D models, which are fundamental to understanding how current exercise analysis tools function.

Real-time workout analysis using machine learning and computer vision has been a key area, enabling systems to interpret indoor exercise movements and potentially offer immediate insights. Researchers have also investigated sophisticated exercise recommendation techniques, such as using interconnected recurrent neural networks to predict exercise success and tailor suggestions based on individual progress and characteristics. The core task of human exercise posture analysis itself, based on accurately estimating pose landmarks, forms the foundation for many corrective feedback systems, allowing for detailed interpretation of movement patterns during physical activity.

AI-powered recommender systems have been specifically developed for fitness assistance, aiming to provide intelligent guidance and support. Beyond just exercise, comprehensive fitness and health recommendation systems have been designed to offer a more holistic approach to well-being, integrating various data points. Machine learning methods are also directly applied to generate exercise recommendations by learning from user data and activity patterns to suggest suitable physical activities. Furthermore, some systems, like PostureCheck, have utilized technologies such as the Microsoft Kinect for detailed posture modeling and assessment during exercises, providing a basis for corrective feedback.

In online learning environments, concepts like deep knowledge tracing have been combined with exercise recommendations to create more adaptive and effective learning and physical training systems. The application of deep learning for physical activity recommendation extends to preventative health, with systems designed to suggest activities that can help mitigate respiratory diseases by promoting an active lifestyle. Knowledge-based expert

The "AI Personalized Fitness and Nutrition Coach" uses a scalable multi-tier client-server architecture. The frontend is a dynamic Single Page Application (SPA) built with HTML, CSS, and Vanilla JavaScript, providing a smooth and responsive user experience. It communicates with the backend through RESTful APIs and includes a real-time pose detection module using Google's MediaPipe, which runs in the browser to deliver instant feedback on exercise form without relying on the server.

The backend is powered by a Python Flask API that handles authentication, processes user data to calculate BMI, BMR, TDEE, and generates personalized diet and workout plans. It leverages Pandas for filtering structured food datasets and SQLAlchemy ORM to manage user profiles, logs, and data interactions with

an SQLite database. This structure ensures efficient logic processing, secure data handling, and clear

separation between frontend and backend operations.

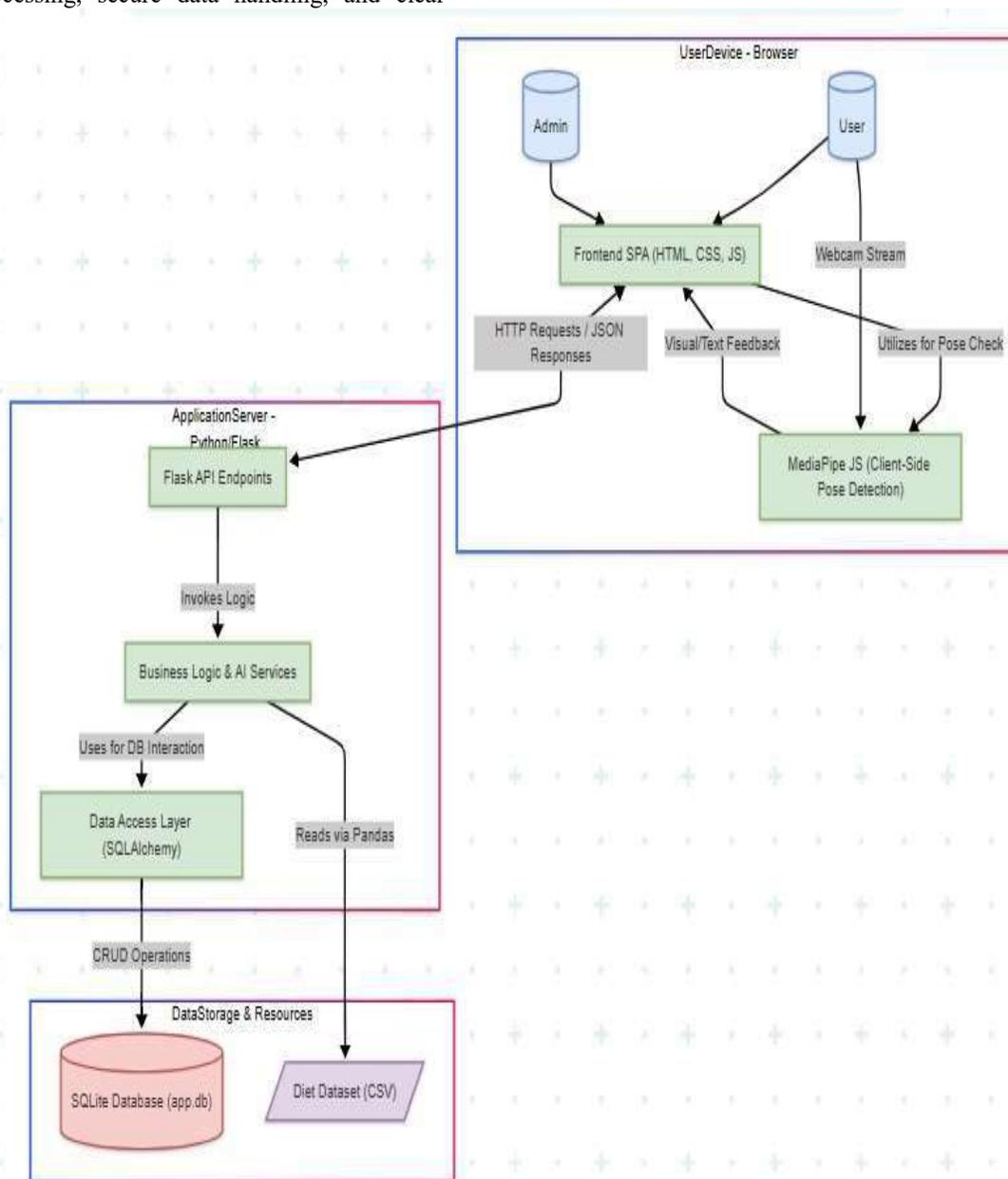


Fig. 1 Technical Architecture

Methodology:

The development of the "AI Personalized Fitness and Nutrition Coach" followed an iterative and agile-inspired methodology, blending structured design with flexible implementation to accommodate evolving insights and technical requirements. The initial phase involved comprehensive requirement analysis, defining both functional (user registration, personalized plan generation, pose feedback, logging,

admin access) and non-functional (usability, performance, security) needs based on identified gaps in existing systems. This was followed by a design phase where the system architecture was outlined, detailing a client-server model with a frontend Single Page Application (SPA) built using HTML, CSS, and Vanilla JavaScript, and a backend API developed with Python and Flask. Key UML diagrams, including use case, class, sequence, and activity diagrams, were

conceptualized to model system behavior and structure. For data persistence, SQLite was chosen with SQLAlchemy as the ORM. The "AI" components for diet and workout recommendations were initially designed using a rule-based and data-driven approach, leveraging a food dataset (processed with Pandas) and predefined exercise logic, while the real-time pose correction feature was designed around the integration of Google's MediaPipe library on the client-side. Implementation proceeded in an iterative fashion, with frontend and backend components developed in parallel, focusing on core functionalities first (authentication, profile management, basic plan generation) and then layering on more advanced features like pose detection and detailed logging. Testing was an ongoing process, involving unit tests for backend logic, integration tests for API communication, and qualitative user acceptance testing (UAT) to gather feedback on usability, the relevance of recommendations, and the effectiveness of the pose feedback module. This iterative approach allowed for continuous refinement and adaptation throughout the project lifecycle.

Implementation

Libraries

- **Flask (Python Backend Framework):**
Flask serves as the backbone of our server-side application. It's a lightweight and flexible Python micro web framework used to build the RESTful API endpoints. These endpoints handle incoming requests from the frontend for user authentication, profile
- **Flask-Login (Python Backend - User Sessions):**
This Flask extension handles user session management within our backend API. It provides functionalities for logging users in, logging them out, remembering their sessions across requests, and protecting certain API endpoints (using `@login_required`) to ensure only authenticated users can access their personal data and features.
- **Flask-Bcrypt (Python Backend - Password Security):**
To ensure user credential security, Flask-Bcrypt is used for password hashing. When a user registers or changes their password, this library generates a secure

management, data retrieval (like workout logs and todos), and triggering the generation of personalized diet and workout plans.

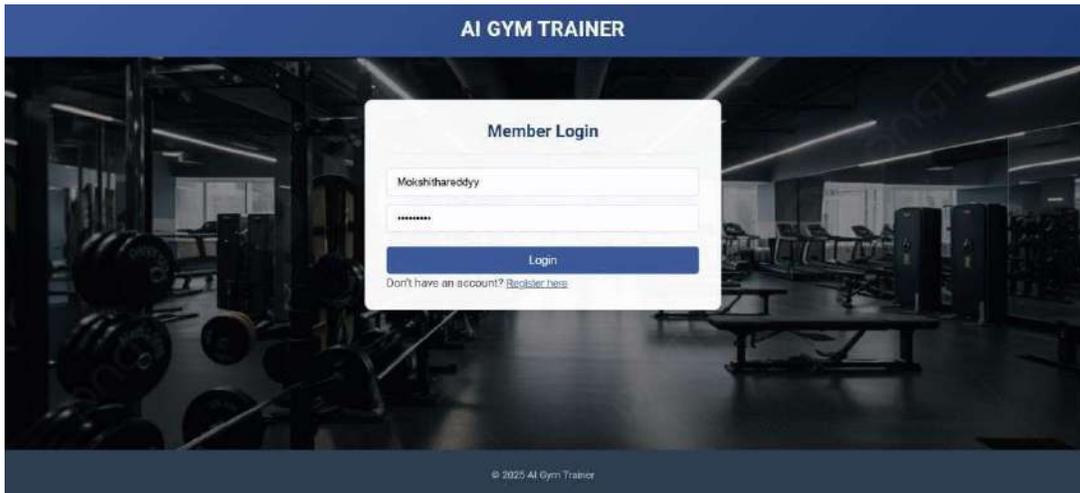
- **SQLAlchemy (Python Backend ORM):**
For database interaction, SQLAlchemy is employed as an Object-Relational Mapper (ORM). It allows our Python backend code to interact with the SQLite database using Python objects and classes (our defined User, WorkoutLog, Todo models) instead of writing raw SQL queries. This simplifies data persistence, querying, and management of user profiles and activity logs.
- **Pandas (Python Backend Data Analysis):**
The Pandas library is crucial for the diet plan generation module in our backend. It is used to efficiently load, manipulate, and filter the `diet_dataset_1000.csv` which contains nutritional information and food item characteristics. Pandas DataFrames enable complex querying and selection logic needed to find suitable food items based on user preferences and calculated caloric needs.
- **MediaPipe (JavaScript Frontend - Pose Detection):**
Google's MediaPipe (specifically `@mediapipe/pose`, `@mediapipe/camera_utils`, and `@mediapipe/drawing_utils`) is a critical frontend JavaScript library. It enables real-time human pose estimation directly in the browser by processing the user's webcam feed. We utilize its ability to detect 33 body landmarks to analyze exercise form and provide immediate corrective feedback to the user.

hash of the password, which is then stored in the database instead of the plain-text password. During login, it compares the hash of the entered password with the stored hash.
- **Flask-CORS (Python Backend - API Accessibility):**
Flask-CORS (Cross-Origin Resource Sharing) is a Flask extension essential for allowing our frontend application (running on a different origin/port, e.g., `localhost:8000`) to make requests to our backend API (e.g., `localhost:5000`). Browsers, by default, block such requests for security reasons, and Flask-CORS helps configure the necessary headers to permit this communication.

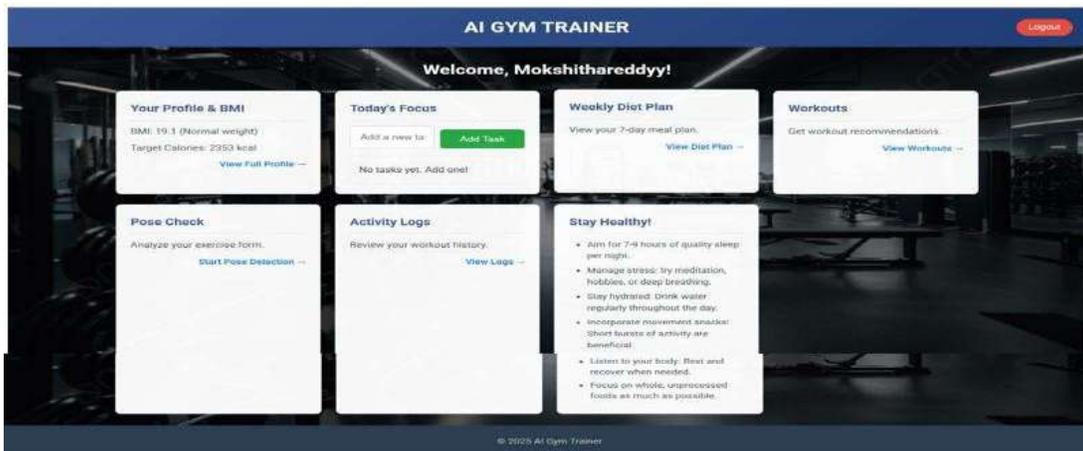
Results



Screenshot 1: Register page



Screenshot 2: Login page



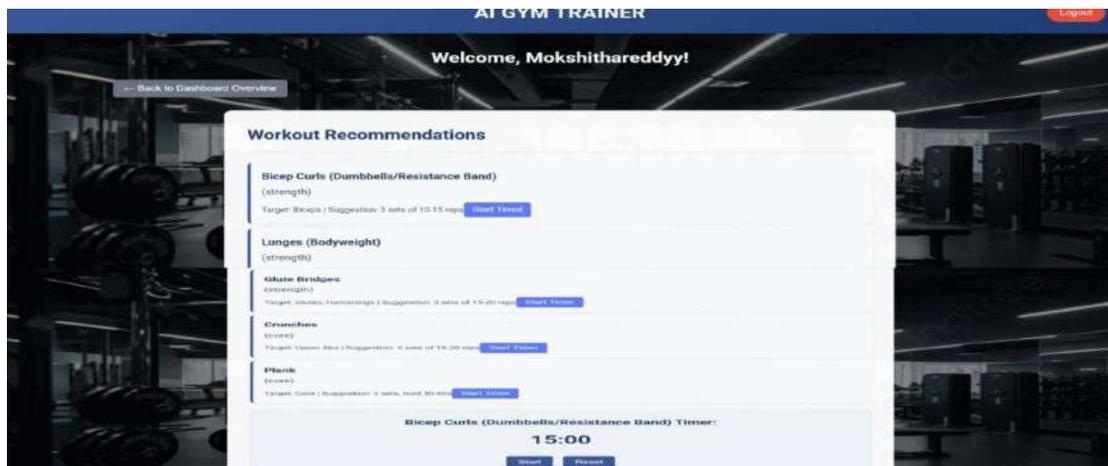
Screenshot 3: Home Page



Screenshot 4: User Profile page



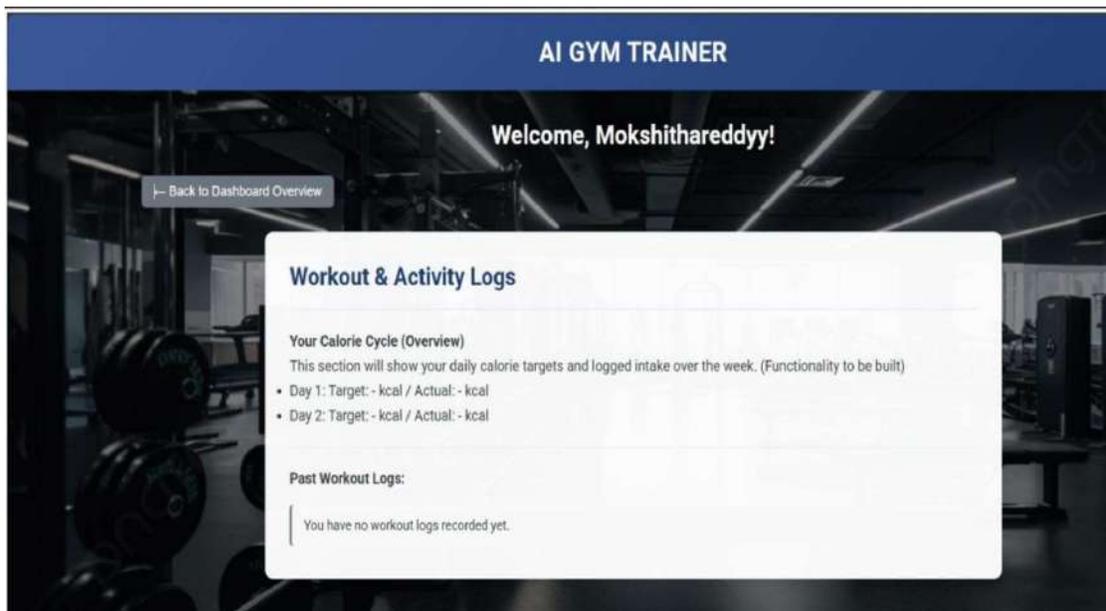
Screenshot 5: Diet Plan



Screenshot 6: Workout Recommendation



Screenshot 7:Real Time Pose Detection



Screenshot 8: Result

Conclusion

The "AI Personalized Fitness and Nutrition Coach" project has successfully culminated in the development of a comprehensive web application that serves as an intelligent and interactive guide for personal health and wellness. By meticulously processing detailed user profiles—encompassing physical metrics, lifestyle factors, dietary preferences, and specific fitness goals—the system effectively generates customized 7-day diet plans and tailored workout regimens. This personalization, currently driven by sophisticated rule-based algorithms and data analysis (analogous to foundational machine learning pattern recognition), ensures that recommendations are

relevant and aligned with individual needs. Furthermore, the integration of MediaPipe for real-time pose detection provides an invaluable AI-powered feedback mechanism, offering users immediate guidance on their exercise form to enhance safety and efficacy, a feature that truly elevates the user experience beyond traditional fitness applications.

This project not only delivers a functional platform with core features like secure authentication, activity logging, and task management but also strategically lays the groundwork for more advanced machine learning integration. The current architecture is designed to readily incorporate future ML models that could enable adaptive learning, where diet and

workout plans dynamically adjust based on logged user progress, feedback, and evolving biometric data. Such enhancements would transform the system into a truly intelligent coaching companion, capable of learning individual user responses and optimizing strategies over time. In essence, this work successfully demonstrates the significant potential of combining data-driven personalization with computer vision and sets a clear path towards a future where machine learning plays an even more central role in delivering highly effective and responsive personal fitness and nutrition coaching.

Future Scope

While the "AI Personalized Fitness and Nutrition Coach" provides a robust foundation, several exciting avenues exist for future development to further enhance its capabilities and user experience. A primary focus would be the integration of true machine learning models for diet and workout recommendations, allowing the system to learn from user feedback, logged progress, and even broader anonymized data patterns to provide increasingly adaptive and optimized plans over time. Expanding the exercise library for pose detection to include more complex movements and yoga asanas, along with more nuanced feedback, would significantly broaden its utility. Incorporating food logging capabilities to track actual nutrient intake against planned meals, and integrating with wearable fitness devices for automatic activity and biometric data synchronization, would offer a more complete picture of the user's health. Furthermore, developing a full-fledged admin panel for user management, content updates (diet/workout datasets), and system analytics, alongside potential community features like challenges or progress sharing (with user consent), could transform the application into an even more dynamic and supportive wellness ecosystem. Finally, creating native mobile applications (iOS and Android) would improve accessibility and user convenience on the go.

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