Fitness.ai

objectives :

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2. Project idea
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4. Methodology
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Introduction:

- Good afternoon, [DR : MOHAMED EL-SAEED] and esteemed members of the evaluation committee. I am delighted to have this opportunity to present my graduation project, which focuses on the development of an AI application that classifies human exercises, specifically targeting fitness and physical therapy routines.
- Throughout the presentation, I will provide a detailed overview of the development process, including the methodology, implementation, and evaluation of the AI application. I will also showcase the practical applications and potential impact of this technology in the fields of fitness tracking and physical therapy

- I am truly excited to share my progress and findings with you today, and I am grateful for the guidance and support provided by my supervisor and the committee. Without further ado, let us delve into the intricate details of this innovative project that aims to revolutionize exercise classification and tracking using AI-based human pose detection.

- The primary motivation behind my project was to address the limitations of existing pose recognition methods and create a more robust and versatile system for exercise classification. By combining pose detection and a multinomial logistic regression algorithm, my application achieves remarkable accuracy in distinguishing between different exercises and tracking the user's performance.

Project idea

- The idea of our project revolves around creating an AI application that classifies human exercises and tracks the user's performance. This application holds great importance for users in the realm of fitness and physical therapy. Here's an explanation of the core concept and its significance:

1. Exercise Classification:

- our AI application utilizes pose detection and classification techniques to recognize and categorize various human exercises.
- By analyzing the relative positions of different body parts, the application can accurately identify the exercise being performed.
- This classification capability allows users to receive real-time feedback on their exercise form and ensure they are performing the correct movements.

2. Repetition Tracking:

- In addition to exercise classification, our application also tracks the user's performance by counting the number of repetitions completed for each exercise.
- By accurately monitoring repetition counts, users can track their progress, set goals, and ensure consistency in their exercise routines.
- This feature is particularly valuable for individuals undergoing physical therapy or those looking to improve their fitness levels.

3. Personalized Exercise Monitoring:

- Our application offers personalized exercise monitoring by tailoring the feedback and tracking to individual users.
- By analyzing and comparing the user's performance over time, the application can provide insights into progress, areas for improvement, and recommended modifications or variations of exercises.
- This personalized approach enhances the user's exercise experience, increases motivation, and maximizes the effectiveness of their fitness or therapy regimen

4. Accessibility and Convenience:

- The AI application is designed to be user-friendly and accessible, allowing individuals to perform exercises in their preferred environment, whether at home or in a gym.
- Users can access the application on various devices, such as smartphones, tablets, or computers, making it convenient and adaptable to their lifestyle.
- This accessibility enables users to maintain a consistent exercise routine, even in situations where they may not have access to a fitness professional or physical therapist.
- Overall, our project's significance lies in its ability to empower users to effectively perform exercises, track their progress, and optimize their fitness or therapy routines. By providing accurate exercise classification, repetition counting, personalized monitoring, and convenient accessibility, our AI application aims to enhance the exercise experience, promote better technique, and ultimately improve users' overall fitness and well-being.

[Pose classification options | ML Kit | Google for Developers]

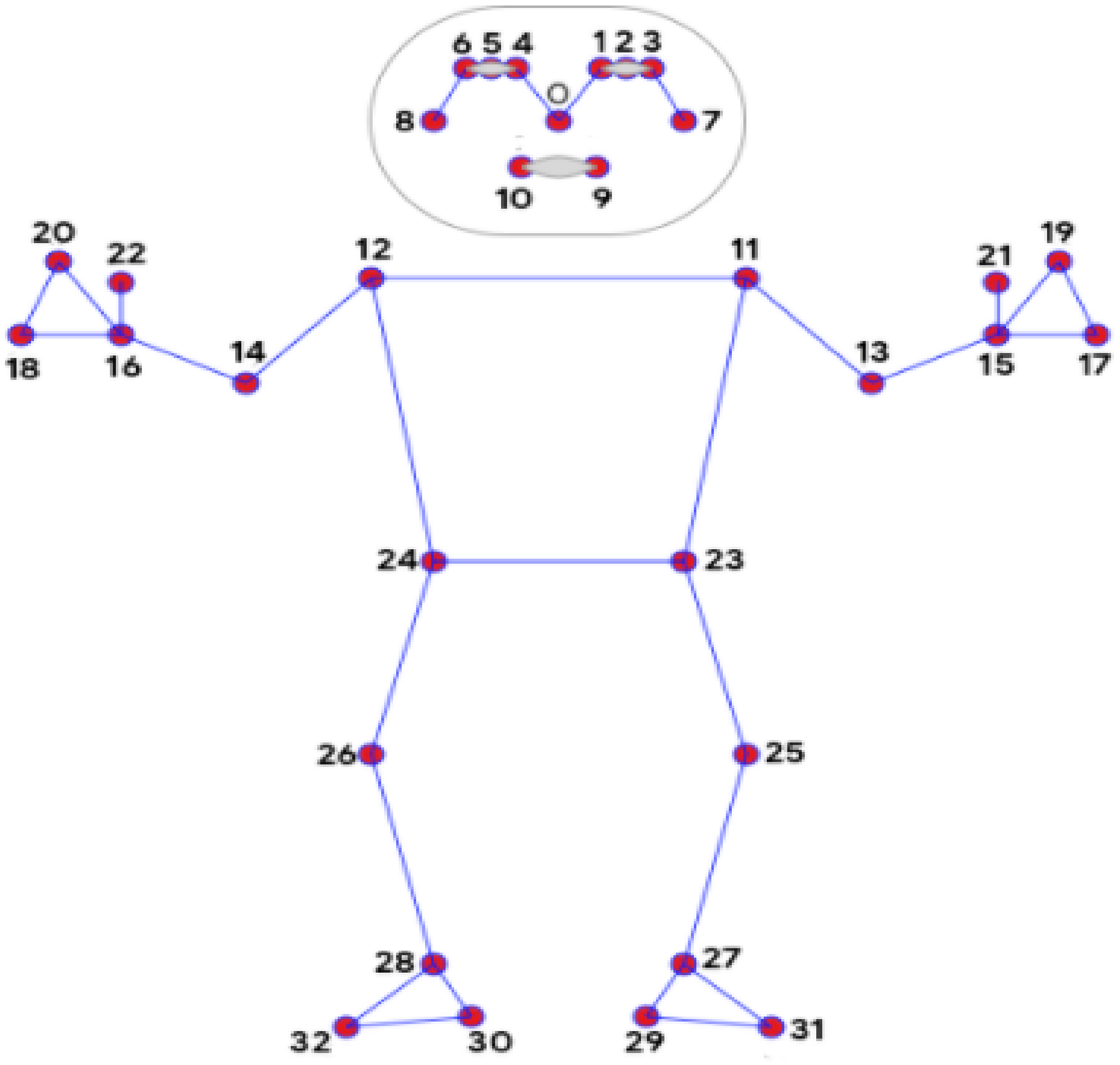
- Before delving into the details of my project, I would like to highlight the key differentiating factor that sets my approach apart from other existing methods. This approach was recommended by my supervisor, Dr. Mohammed Al-Saeed, who emphasized the importance of utilizing the powerful capabilities of the MediaPipe framework.

- Recognizing the value and potential of the MediaPipe framework, my project offers a superior solution that leverages advanced machine learning algorithms. By incorporating MediaPipe, my application benefits from its accurate and efficient pose detection capabilities.

- Rather than relying solely on angle measurements, my project utilizes pose classification based on human pose detection, which enables more accurate and comprehensive exercise recognition. This approach provides a more robust and reliable solution compared to traditional angle-based methods.

- With the guidance of Dr. Mohammed Al-Saeed and the utilization of MediaPipe, my application is capable of detecting and classifying a wide range of exercises, extending beyond yoga poses alone. This expansion enhances the utility and versatility of the application, catering to a broader range of fitness and physical therapy exercises.

MEDIAPIPE



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32. right_foot_index

Problem Statement and Efforts:

1. **Recording Videos and Exercise Selection:**

- The first task involved recording videos for each exercise. To ensure a diverse dataset,
  I utilized multiple sources such as physitrack.com, and collaborated with the Physiotherapy Center, who recommended specific exercises for the program.
- Explanation: The collection of exercise videos was crucial for building a comprehensive dataset that encompasses a wide range of poses and variations. By collaborating with professionals and using established platforms, the project ensured access to reliable and diverse exercise content.

2. Video Processing and Landmark Extraction:

- To extract relevant information from the videos, the project employed OpenCV and MediaPipe libraries for video processing and human pose estimation.
- Explanation: By utilizing OpenCV and MediaPipe, the project was able to detect 33 coordinates corresponding to various body landmarks in the human pose. The project coded a function to read video files, export the landmarks' data, and save it into a CSV file. This CSV file served as a structured dataset to be used for subsequent processing and modeling.

3. User Interaction and Class Labeling:

- The project implemented a user interaction mechanism to label the extracted landmarks with their corresponding exercise class.
- Explanation: By incorporating user interaction, the project allowed for the manual labeling of each exercise's landmarks. This involved pressing specific keys (such as 'u' or 'd') to associate the landmarks with the corresponding exercise class (e.g., 'kegel_up' or 'kegel_down'). This step facilitated the creation of a labeled dataset for training and validation purposes.

4. Machine Learning Model Evaluation:

- In order to assess the quality and quantity of the collected data, a small ML model was developed and evaluated using the CSV dataset.
- Explanation: The project constructed a pipeline with two models: Logistic Regression and K-nearest Neighbors (KNN). The Logistic Regression model was chosen for its accuracy and the availability of the predict_proba method. This allowed for assessing the data quality and quantity by analyzing the model's predictions and probabilities. If any deficiencies or flaws were identified, the project could repeat the data collection and labeling steps to ensure a robust dataset.

- Through these efforts, the project tackled various challenges associated with collecting, processing, and evaluating the exercise dataset. The rigorous process of video recording, landmark extraction, manual labeling, and model evaluation demonstrates the project's commitment to ensuring high-quality and reliable data for accurate exercise classification.

Methodology:

1. Model Selection:

- In the methodology, different machine learning algorithms were explored for the exercise classification task.
- Initially, models such as Artificial Neural Network (ANN), Random Forest Classifier, and Gradient Boosting Classifier were experimented with.

2. Generalization Issues:

- Despite achieving high accuracy, the aforementioned models faced generalization issues.
- Explanation: Generalization refers to the ability of a model to perform well on unseen or new data. If a model is overfitting the training data, it may struggle to generalize to new instances, resulting in poor performance on unseen data. Although these models provided high accuracy during training, their performance on unseen data was suboptimal.

3. Multinomial Logistic Regression:

- To address the generalization problem, the project turned to multinomial logistic regression as an alternative model.
- The logistic regression model was configured to handle multiple classes (exercises) using the 'multinomial' option, and the 'lbfgs' solver was chosen for optimization.
- Additionally, class weights were incorporated to handle any class imbalance present in the dataset.
- The maximum number of iterations for convergence was set to 1000 to ensure sufficient training.

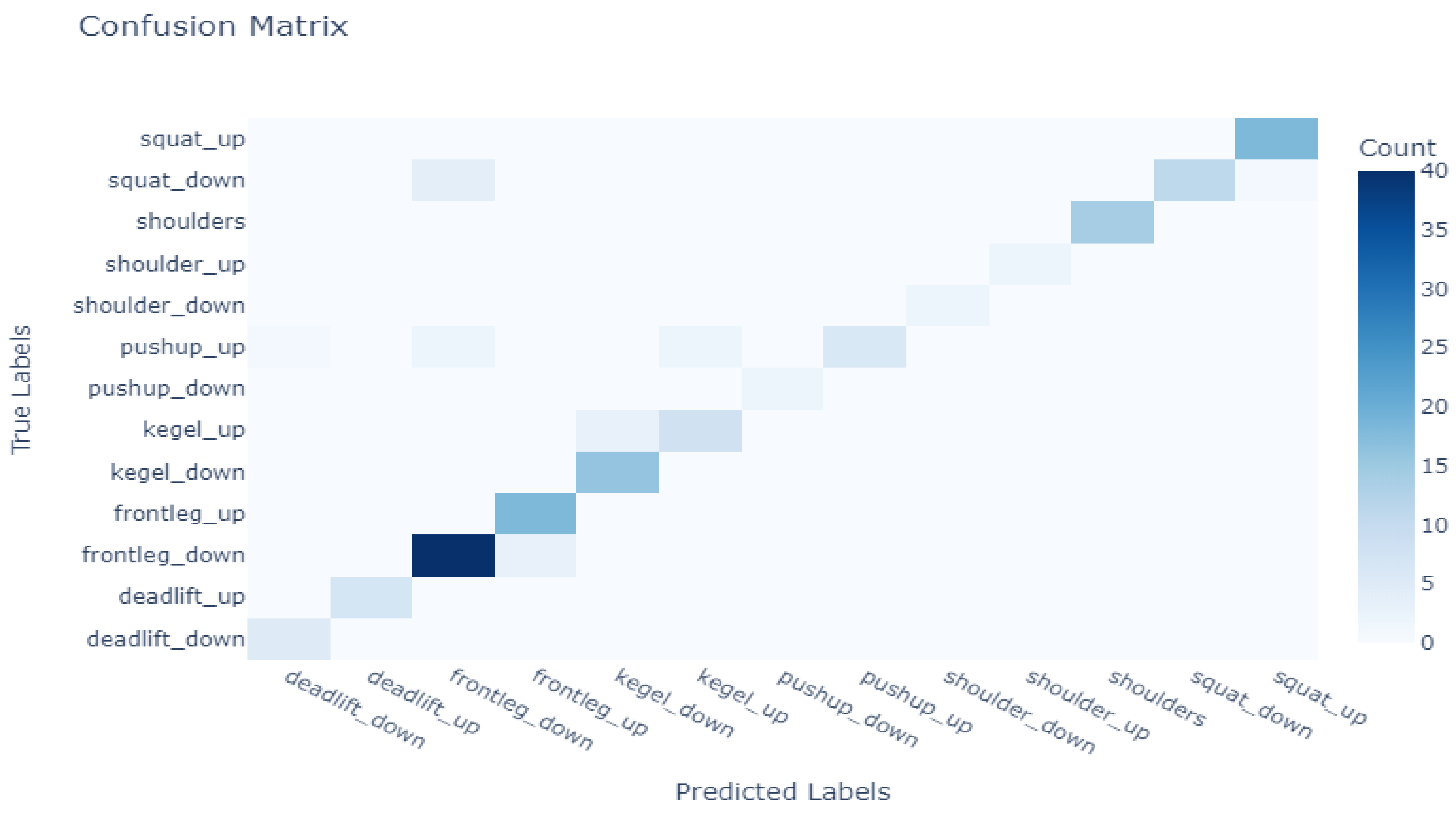
4. Evaluation Metrics:

- The performance of the multinomial logistic regression model was evaluated using accuracy, precision, recall, and F1 score.

5. Model Performance:

- The multinomial logistic regression model demonstrated good accuracy, achieving a score of 0.90 (90%).
- Precision, recall, and F1 score were also calculated to assess the model's performance.
- Precision represents the proportion of correctly classified positive instances, recall measures the proportion of actual positives correctly identified, and F1 score combines both precision and recall into a single metric.

- Overall, the multinomial logistic regression model showed promising results, both in terms of accuracy and generalization. It outperformed the other models considered in the methodology and proved to be the most suitable choice for the exercise classification task in this project.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frontleg_down
deadlift_up
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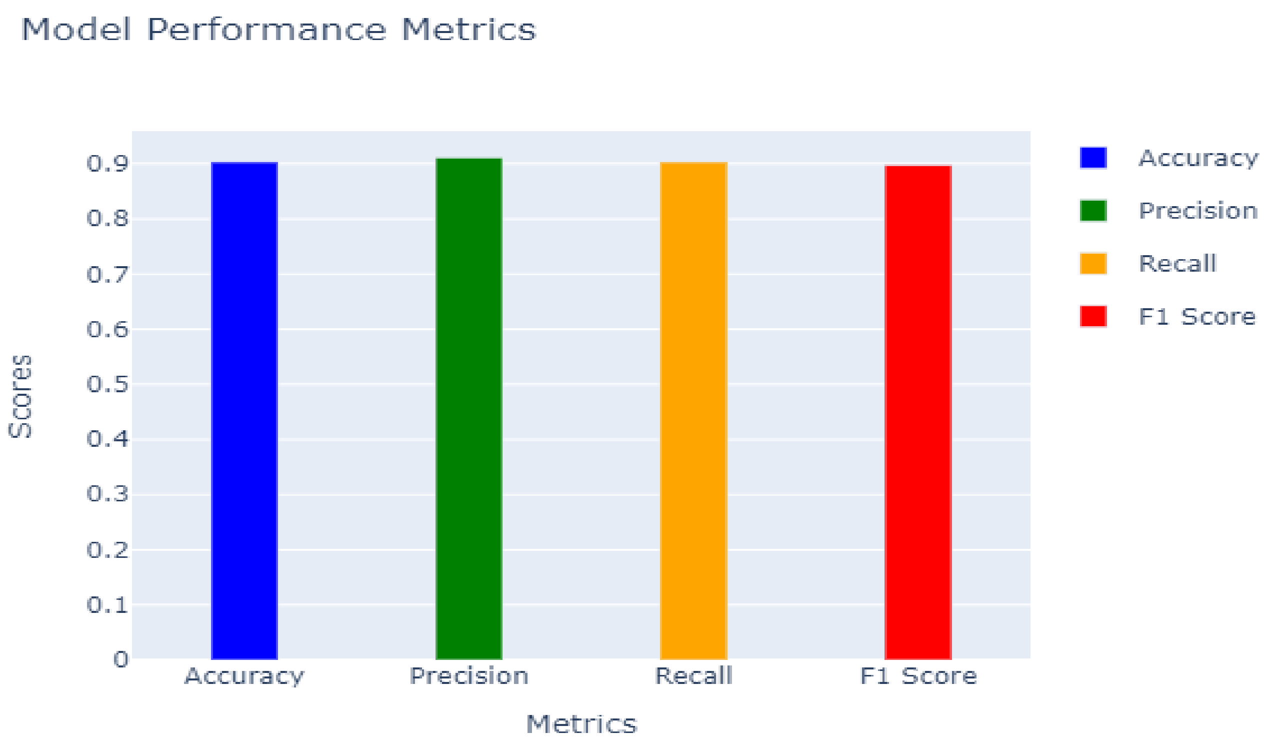
Model Performance Metrics
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0.7
0.6
0.5
0.4
0.3
0.2
0.1
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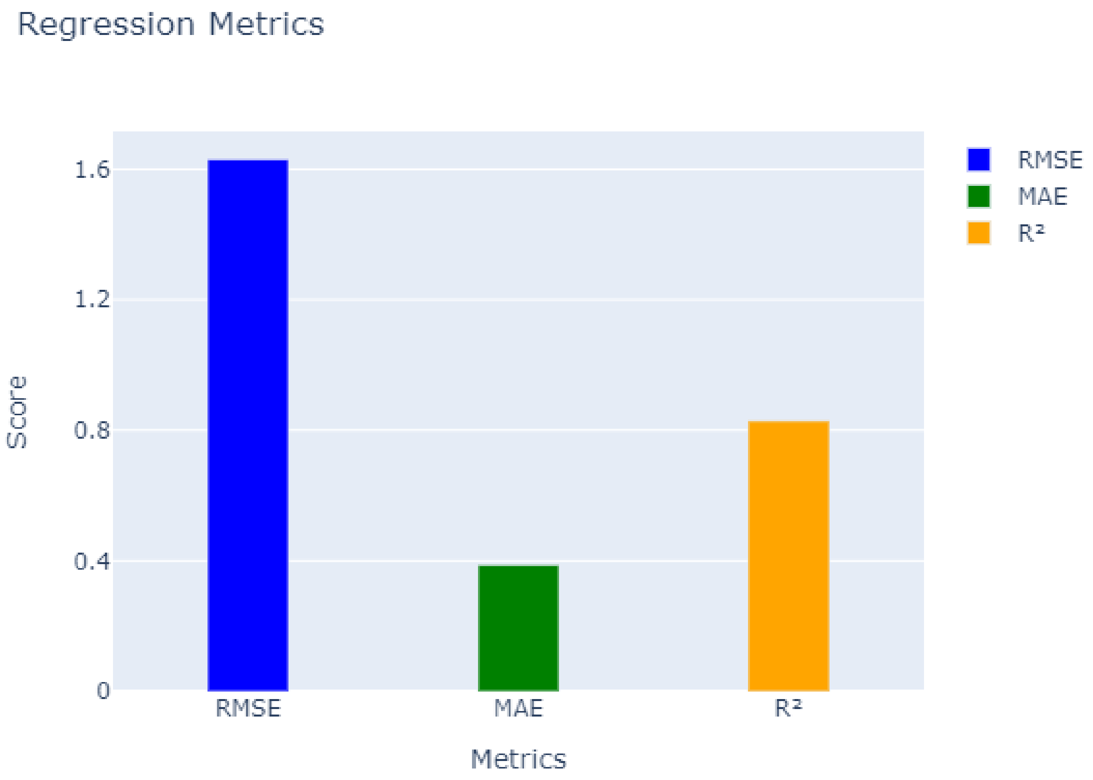
Accuracy
Precision
Recall
F1 Score


Regression Metrics
1.6
1.2
0.8
0.4
0
Score
RMSE
MAE
R²
Metrics
RMSE
MAE
R²

Application Features:

1. Playlist of Exercise Videos:

- The mobile application presents a playlist of exercise videos to the user.
- Users can browse through the available exercises in the program and access instructional videos for each exercise.
- This feature provides users with a visual reference and guidance on how to correctly perform the exercises.

2. Exercise Identification and Monitoring:

- Users can open the camera within the application to perform exercises.
- The application utilizes pose detection and classification techniques to identify the exercise being performed in real-time.
- As the user follows along with the exercise, the application monitors and provides feedback on the user's form and technique.
- This real-time monitoring ensures that users are performing the exercises correctly and can make necessary adjustments for optimal results and safety.

3. Time-Based Fitness Exercise Detection:

- During the exercise session, the application tracks the duration of each exercise.
- Users can receive feedback on the time spent on each exercise, enabling them to adhere to prescribed workout durations or track their progress.
- This feature helps users maintain consistency and ensure they meet their fitness goals within the specified time frames.

4. Video Upload Functionality:

- The application allows users to upload exercise videos by browsing their device's storage.
- Users may have pre-recorded videos or prefer to follow exercises from external sources.
- By providing the option to upload videos, the application accommodates users who want to incorporate exercises beyond the predefined playlist.

5. Exercise Counters:

- Each exercise in the program is assigned a dedicated exercise counter, except for the "shoulders" exercise.
- The logic behind the exercise counters is as follows:
- For exercises like deadlift, push-up, and squat, the counter increments when the labels transition from "down" to "up" (e.g., "deadlift_down" to "deadlift_up").
- On the other hand, exercises like front leg lift, kegel, and shoulder exercises have counters that increment when the labels transition from "up" to "down" (e.g., "frontleg_up" to "frontleg_down").
- The counter increment signifies one completed repetition of the respective exercise.

6. Real-time Display of Exercise Counts:

- The application provides real-time feedback to the user by displaying the number of counts for each exercise performed.
- As the user performs the exercises and the labels transition accordingly, the corresponding exercise counters are incremented.
- The updated exercise counts are then shown on the screen, allowing the user to track their progress and ensure they achieve the desired number of repetitions for each exercise.

7. Special Case: Shoulders Exercise Counter:

- Unlike other exercises, the "shoulders" exercise counter is only incremented when the model detects the "shoulders" exercise.
- This implies that the counter for the shoulders exercise will only increment once the model identifies the specific exercise, regardless of label transitions.

- These features collectively provide users with real-time exercise detection, accurate exercise tracking, and immediate feedback on their exercise counts. The application's user interface and intuitive functionality contribute to a seamless exercise experience, helping users stay on track with their fitness goals.

8. User-Friendly Interface:

- The mobile application is developed using the Flutter framework, which offers a user-friendly and intuitive interface.
- The app design focuses on simplicity and ease of navigation, ensuring a smooth user experience.
- Users can easily access the playlist, video playback, camera, and video upload functions without any technical barriers.
- Overall, these application features enhance the user's experience by providing a comprehensive exercise library, real-time exercise identification and monitoring, time-based tracking, and the flexibility to upload custom exercise videos. The combination of these features promotes accurate exercise execution, customization, and progress tracking, contributing to the user's overall fitness journey.

Conclusion:

- Overall, this project holds great significance in the field of fitness and physical therapy. It offers an intelligent solution for classifying and monitoring exercises, ensuring correct form and technique, and providing users with real-time feedback on their progress. The application has the potential to positively impact the lives of individuals seeking to improve their fitness and engage in effective physical therapy.
- I would like to express my sincere gratitude to my supervisor for their guidance and support throughout the project. Additionally, I would like to thank the Physiotherapy Center for their collaboration and recommendation of exercises for the program. Their assistance and expertise were invaluable in the successful completion of this project.

- In conclusion, this project represents a significant step towards leveraging AI technology for exercise classification and tracking, contributing to the advancement of fitness and physical therapy practices.

The official sponsor of the project

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Thank you