

# Project Overview

Project Overview: Human Activity Recognition using Sensor Data

## 1. Project Title

AI-Powered Physical Activity Monitoring with LSTM, GRU, and 3D CNN

## 2. Objective

The main objective of this project is to classify human physical activities (such as Walking, Sitting, Jogging, Upstairs, Downstairs) using time-series data collected from smartphone accelerometer and gyroscope sensors.

Applications:

- Fitness tracking
- Health monitoring
- Early detection of sedentary behavior risks
- Smart wearable applications

## 3. Datasets Used

- WISDM v1.1 Dataset (public dataset with sensor readings across multiple activities)

## 4. Methods and Models Implemented

- Data Preprocessing:
  - Download and clean raw data
  - Merge accelerometer and gyroscope data
  - Handle missing values

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- Normalize features (Min-Max Scaling)
- Encode labels
- Create sliding windows for sequential input
- Models Built:
  - LSTM (Original, Reduced, Bidirectional)
  - GRU
  - 3D CNN
- Model Improvements:
  - EarlyStopping and ReduceLROnPlateau callbacks
  - Balanced dataset
  - Hyperparameter tuning

## 5. Evaluation Metrics

- Accuracy
- Loss
- Classification Report
- Confusion Matrix
- True vs Predicted Activity Distributions

## 6. Key Results

- LSTM models captured sequential patterns effectively
- GRU models performed well with lower complexity
- 3D CNN showed moderate performance

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- Bidirectional LSTM achieved the highest accuracy

## 7. Final Outcome

Built an AI system capable of recognizing physical activities accurately across various models, with documentation for future students.

## 8. Future Work

- Explore Transformer models for time series
- Apply self-supervised learning methods
- Deploy models to mobile and wearable devices