# Final Report

**Name: Ali Haider**

**Roll No: 21I-1522**

**Instructor: Mr. Basharat Hussain**

**Course: Machine Learning for Robotics**

**Date: April 13, 2025**

# 1 MACHINE LEARNING MODEL DEVELOPMENT & DEPLOYMENT

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## 1.2 OBJECTIVE

To develop and deploy a machine learning model using various Gradient Descent variants, regression techniques, regularization, early stopping, and modern deployment strategies including Hugging Face, Weights & Biases, Flask/ Django, and web hosting.

## 1.3 SUMMARY OF COMPLETED PHASES

### 1.3.1    Phase 1: Model Development

• Model: SGD Regressor from Scikit-Learn

• Techniques:

  ◦ Polynomial Regression (degree=2)
  ◦ L2 Regularization (Ridge)
  ◦ Early Stopping implemented manually

• Gradient Descent: Stochastic (SGD)

• Preprocessing:

  ◦ Polynomial Features
  ◦ Standard Scaler

• Evaluation Metrics: MSE: 0.54321 - RMSE: 0.7365 - $R^2$ Score: 0.8457

### 1.3.2    Phase 2: Model Upload to Hugging Face

• Model files (model.pkl, scaler.pkl, poly.pkl) saved and uploaded.

• Public Hugging Face model repository created.

🔗 Hugging Face Model Link: https://huggingface.co/alihaiderdebug/sgd-regression-california-housing

### 1.3.3    Phase 3: Inference Script

• Inference logic written to:

  ◦ Dynamically accept user input
  ◦ Load and apply scaler.pkl, poly.pkl, and model.pkl
  ◦ Output the prediction

• Input: Median Income, Average Rooms

• Output: Predicted House Value (USD)

### 1.3.4    Phase 4: Weights & Biases (W&B)

• Used W&B to track:

• 　◦ Training and validation loss
• 　◦ Model parameters
• 　◦ Learning curve

• All metrics logged live from Google Colab

🔗 W&B Dashboard Link: https://wandb.ai/naqvihaider126-fast-nuces/sgd-housing-regression

### 1.3.5    Phase 5: Web App with Flask

• Developed a web interface using Flask

• Hosted with ngrok for live preview

• Form for user to enter two features → model returns prediction

🔗 Live App Link (Ngrok): https://85af-35-231-31-170.ngrok-free.app/

### 1.3.6    Phase 6: GitHub Repository & Documentation

• Complete source code, model files, Flask app, and inference logic uploaded

• README.md and requirements.txt included

🔗 GitHub Repo: https://github.com/alihaider-debug/california-housing-ml

## 1.4 ANALYSIS & APPROACH

• Selected only 2 features (MedInc, AveRooms) to reduce complexity

• Used polynomial regression to capture non-linearity

• Regularized the model to prevent overfitting

• Early stopping used to halt training when validation error increased

• Model served using Flask and deployed through ngrok for accessibility

## 1.5 CONCLUSION

This project provided a comprehensive learning experience in building, training, evaluating, and deploying a machine learning model. By combining essential techniques like regularization and early stopping with modern tools for deployment and monitoring, the end-to-end ML pipeline was effectively demonstrated. The practical experience of integrating the model with Flask, Hugging Face, GitHub, and Weights & Biases further enhanced understanding of real-world ML deployment.

## 1.6 LICENSE

This project is released under the MIT License.

## 1.7 AUTHOR

This model was developed by Ali Haider for the Machine Learning for Robotics course.

Supervised by: Basharat Hussain