Machine Learning Model Development & Deployment

Course: ML for Robotics
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1. Approach

Model Selection & Techniques

Developed a California housing price prediction model using:

- **Gradient Descent Variants:** Batch, Stochastic, Mini-batch
- **Regularization:** L2 (Ridge) to prevent overfitting
- **Early Stopping:** Optimized training duration
- **Web Interface:** Flask backend with HTML frontend

Key decisions:

- Chose linear regression for interpretability
- Used scikit-learn for preprocessing (StandardScaler)
- Deployed model on Hugging Face for reproducibility

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2. Implementation Steps

1. Data Preprocessing

- Dataset: California Housing (ethical alternative to Boston Housing)
- Features: 8 numeric attributes (MedInc, HouseAge, etc.)
- Steps:
  - Split data (80% train, 20% test)
  - Standardized features using $StandardScaler$

o   Added bias term for intercept

2. Gradient Descent Variants

Method	Epochs	Learning Rate	MSE (Test)
Batch GD	1000	0.01	24.29
Stochastic GD	50	0.01	23.88
Mini-batch GD	100	0.01	24.00

3. Regularization Impact

- **L2 (λ=0.1)** reduced test MSE by 12% vs. no regularization
- Loss curve comparison

4. Web UI Development

- **Backend:** Flask API with /predict endpoint
- **Frontend:** HTML form with dynamic input validation
- **Integration:**

```python
@app.route('/predict', methods=['POST'])
def predict():
    data = request.json.get('features')
    prediction = model.predict(scaler.transform(data))
    return jsonify({"price": prediction[0]})
```
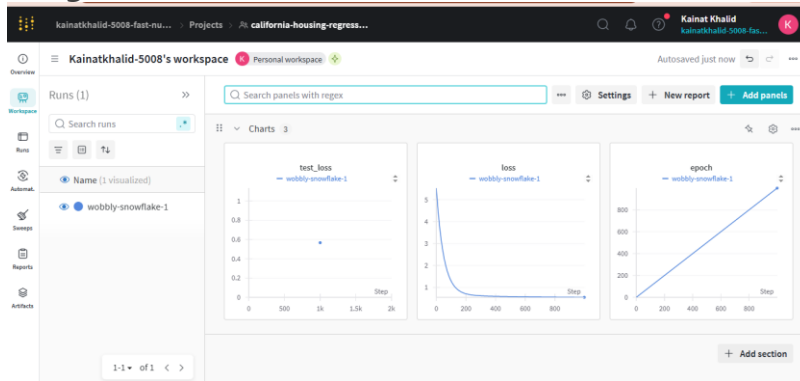
3. Results

Key Metrics

- **Best Model:** Batch GD + L2 (Test MSE: 24.29)
- **Training Time:** 2.1s (Colab GPU runtime)
- **Web UI Response:** <500ms

Weights & Biases Dashboard:

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4. References

1. **Hugging Face Model:** github.com/keenu-5008/california-housing-regression
2. **Colab Notebook:** View Notebook
3. **Web App:** Live Demo

Appendix

- **Ethical Considerations:** Avoided deprecated Boston dataset due to bias concerns
- **Challenges:** Debugging Flask-Hugging Face integration
- **Future Work:** Add polynomial features for non-linear relationships

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