

Movie Recommendation System

Final Model Performance Report

Executive Summary

This report summarizes the evaluation of four collaborative filtering models for the MovieLens dataset. The hyperparameter-tuned **SVD++** algorithm was the definitive best-performing model, demonstrating superior predictive accuracy (RMSE) and recommendation ranking quality (NDCG). It is the recommended model for deployment.

Methodology and Evaluated Models

Models were trained on 80% of the data and evaluated on the remaining 20% using RMSE, Precision@10, and NDCG@10.

- **Matrix Factorization (MF):** A baseline model learning user and item embeddings.
- **Matrix Factorization with Bias (MF-Bias):** An enhanced model that adds user and item bias terms.
- **Neural Collaborative Filtering:** A deep learning model using a neural network on concatenated embeddings.
- **SVD++:** An advanced matrix factorization model that incorporates implicit user feedback.

Performance Results

Table 1: Comprehensive Model Performance Comparison (k=10)

Model	Val. RMSE / Loss ↓	Precision@10 ↑	NDCG@10 ↑
SVD++ (Tuned)	0.863	0.579	0.807
MF-Bias (Tuned)	0.976	0.571	0.799
MF (PyTorch)	1.069	0.527	0.734
Neural Network	1.215	0.480	0.661

Note: Lower RMSE/Loss is better. Higher Precision and NDCG are better.

Analysis and Conclusion: Why SVD++ Worked Best

The tuned SVD++ model is the superior choice for three key reasons:

1. **Superior Predictive Accuracy:** It achieved the lowest validation RMSE of **0.863**, indicating the most accurate rating predictions.

2. **Highest Ranking Quality:** It scored the highest on NDCG@10 with **0.807**, confirming it is best at ranking the most relevant movies at the top of the list.
3. **Leverages Implicit Feedback:** Unlike other models, SVD++ uses the entire set of movies a user has rated (implicit feedback), not just the rating scores. This creates a richer user profile and leads to more accurate recommendations.

Final Recommendation

Based on its superior performance and robust tuning, the **SVD++ model is the recommended choice for deployment.**