🧠 Hypertension Risk Classification — Deep Neural Network Summary

📌 Objective

This project developed a deep feed-forward binary classifier in PyTorch to predict whether a patient developed hypertension within a 24-month observation window. The total dataset contained 60,000 simulated human patients that were matched with appropriate measures for individual and community confounding. The pre-training split used class-stratified random sampling with a 70/30 split between training and validation. The breakdown of sampling assignment was as follows: 37,500 patients in training, 11,250 patients in validation, and 11,250 in testing. All input vectors were temporally stationary (i.e. cross-sectional).

🧱 Model Architecture

The model architecture is defined by a dynamic PyTorch class `DynamicBinaryClassifier`, which flexibly builds a stack of hidden layers using:

- He (Kaiming) initialization
- LeakyReLU activations
- Batch normalization
- Dropout regularization
- Output layer: raw logits
- Loss function: Binary crossentropy with logits loss
- Early Stopping: patience 15 | MinDelta (val loss) 0.001 | Reset Weights

🔧 Architecture Calibration

We conducted a full grid search over combinations of:

- Hidden layers: 2, 3, 4
- Hidden units per layer: 64, 128, 256, 512, 1024
- Dropout rates: 0.2, 0.3
- Batch sizes: 128, 256, 512, 1024, 2048

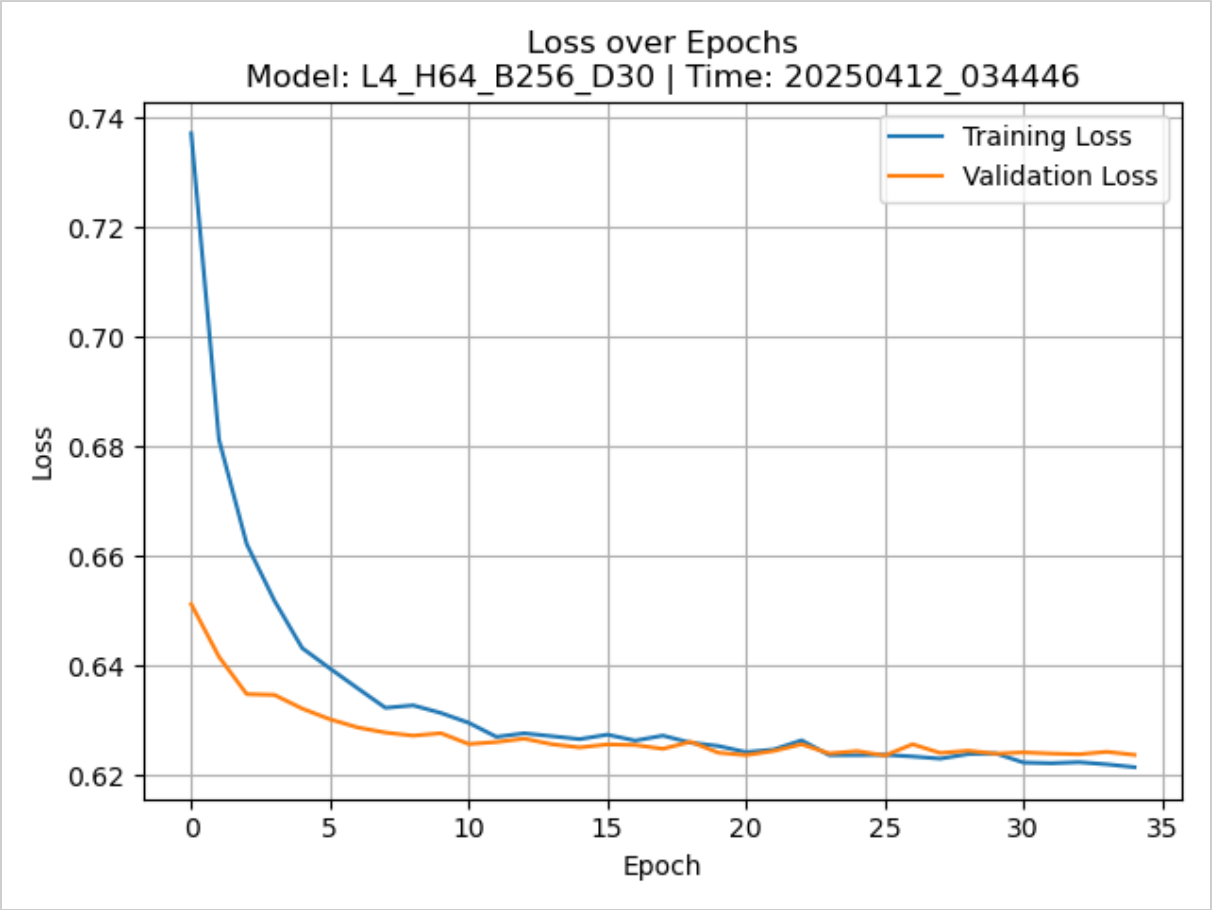
Best performant model was determined according to:

- 🌟 Best ROC AUC Model (defined by the mean ROC AUC value of the five epochs prior to early stop)

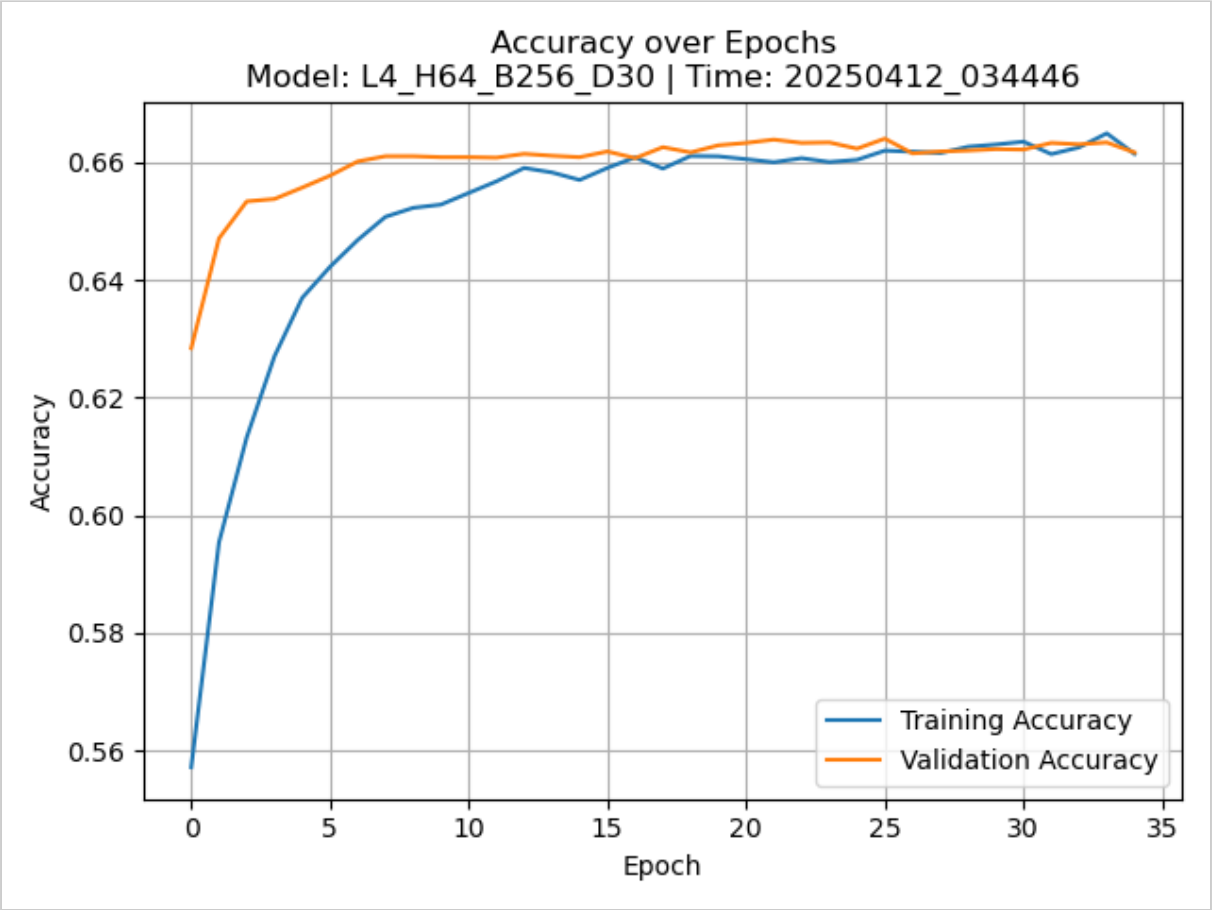
  Optimal Architecture: 4 Dense Layers | 64 Units | Batch Size 265 | Dropout 0.30

📊 Training Curves

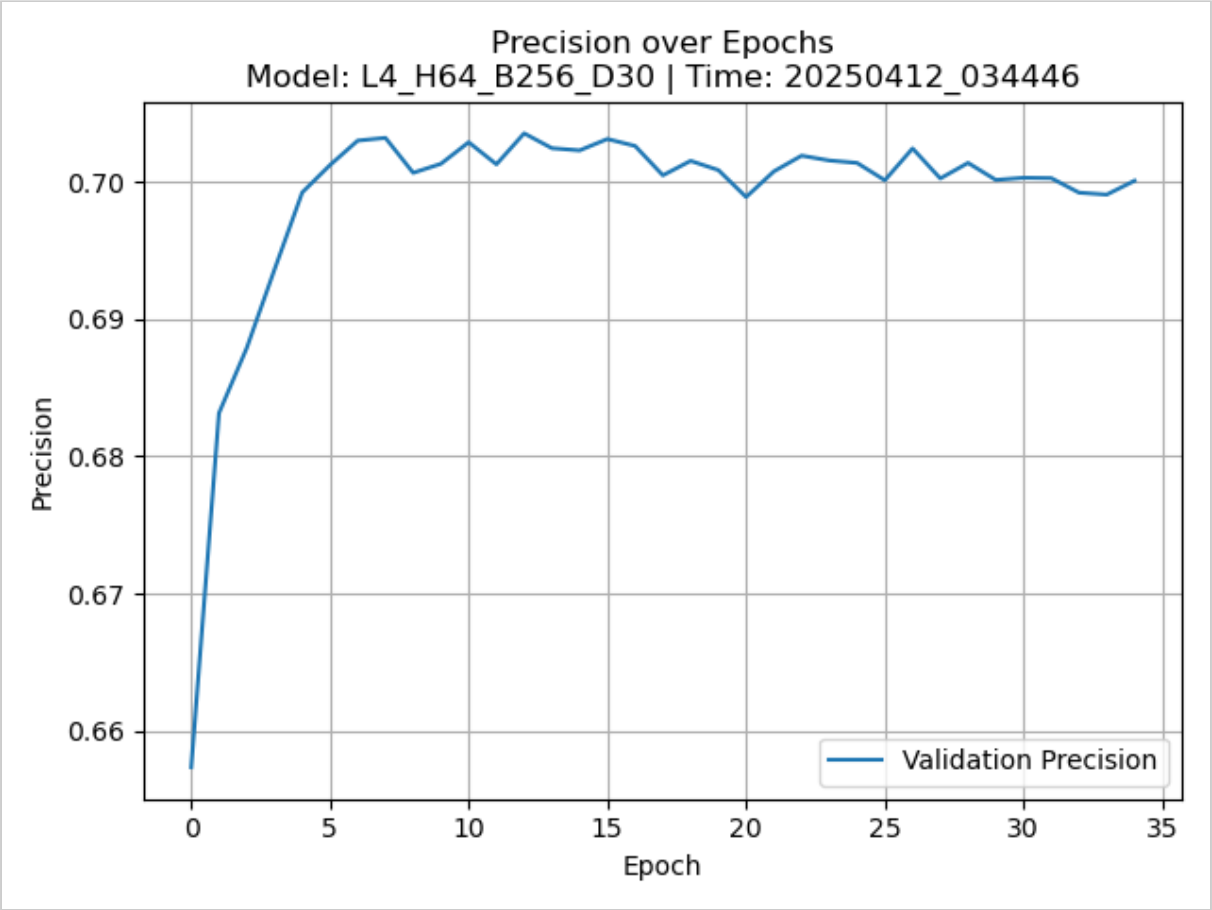
Loss



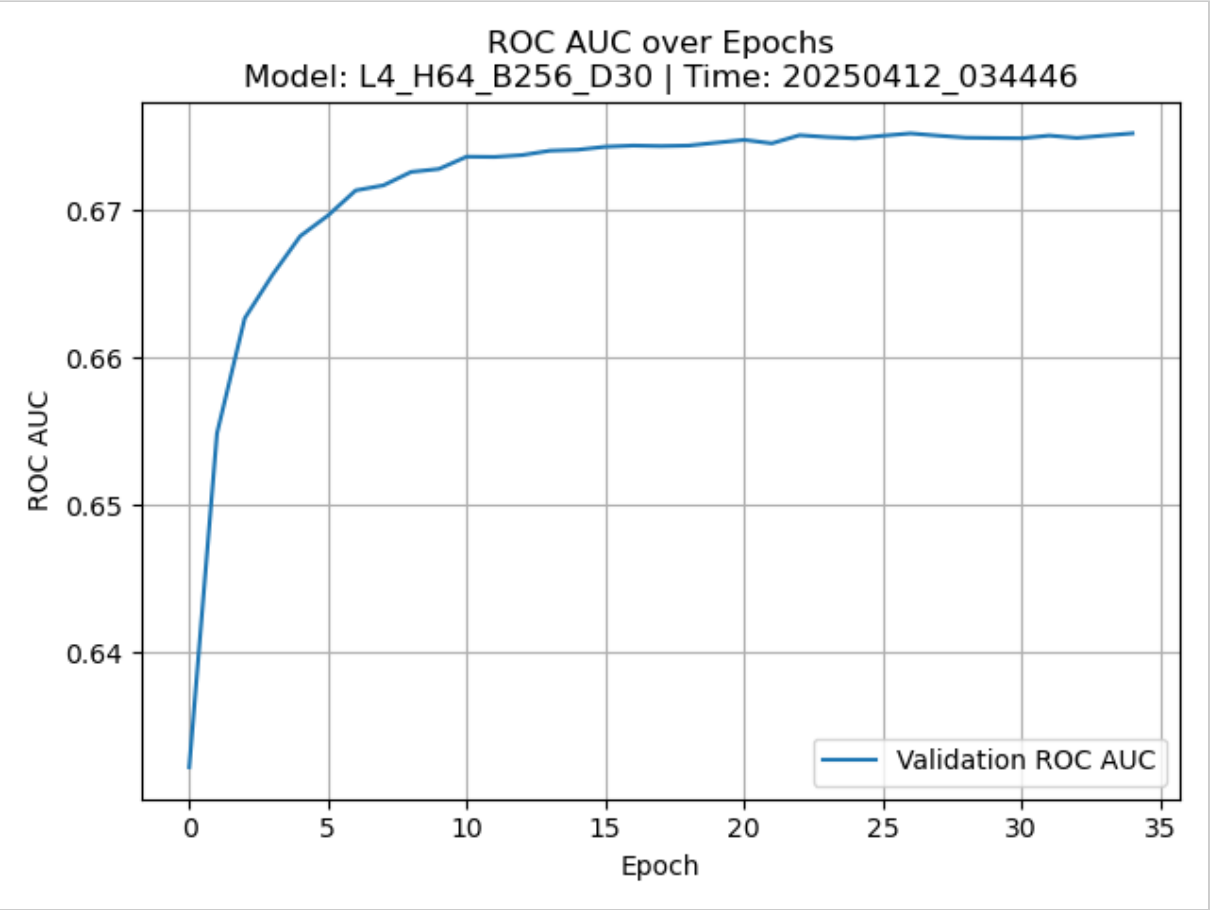
Accuracy


Accuracy over Epochs
Model: L4_H64_B256_D30 | Time: 20250412_034446
Accuracy
Epoch
0.56
0.58
0.60
0.62
0.64
0.66
0
5
10
15
20
25
30
35
Training Accuracy
Validation Accuracy

Precision


Precision over Epochs
Model: L4_H64_B256_D30 | Time: 20250412_034446
Precision
Epoch
Validation Precision
0.66
0.67
0.68
0.69
0.70
0
5
10
15
20
25
30
35

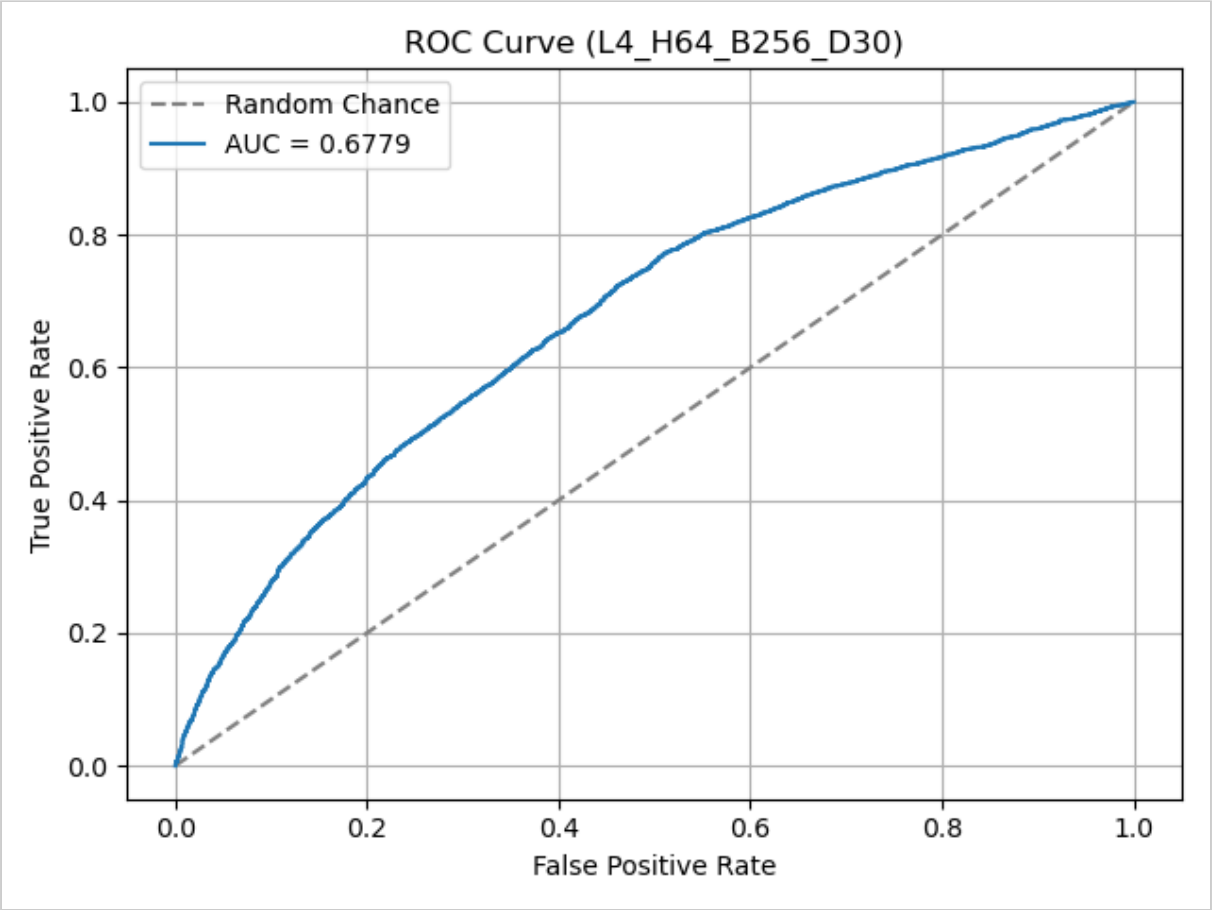
ROC AUC



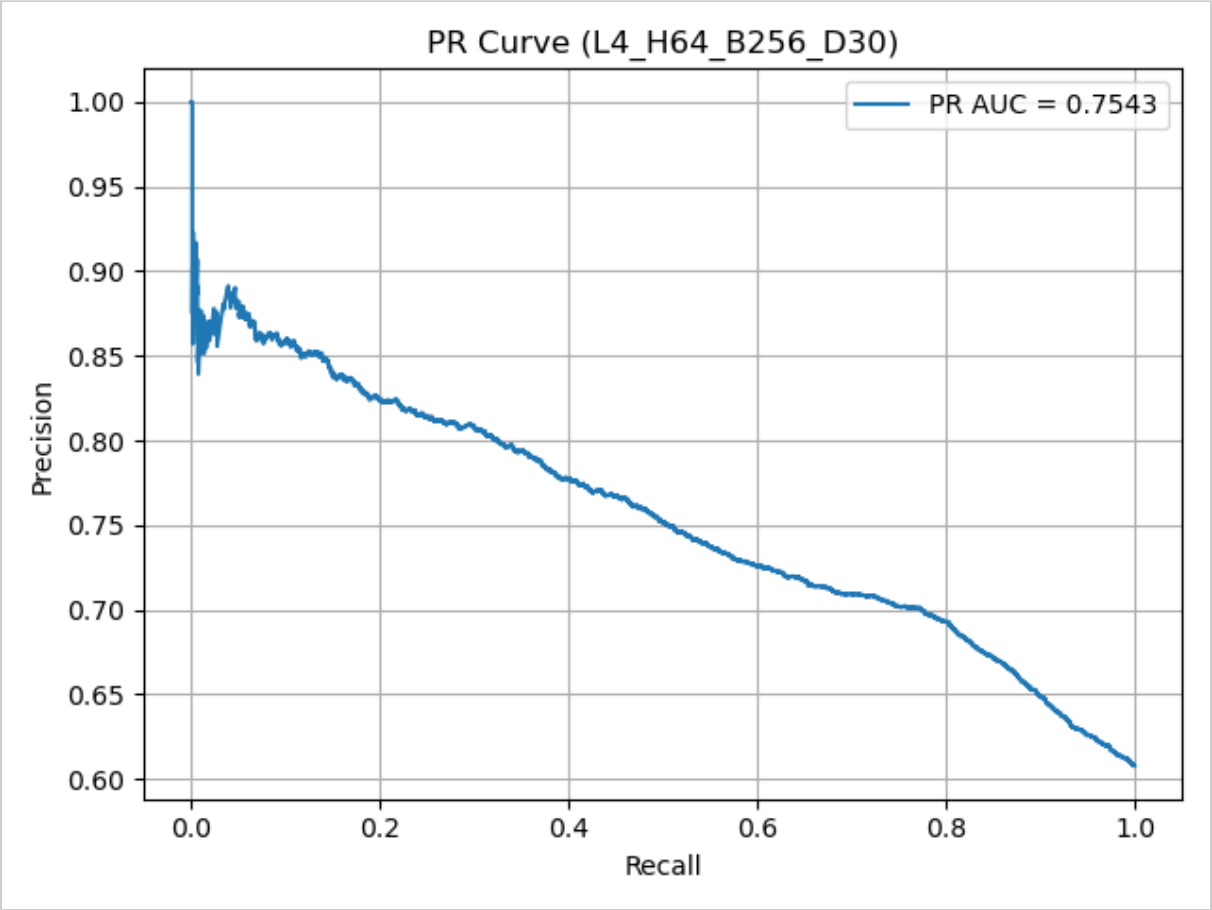
🧪 Network Test Evaluation — Best ROC AUC Model

Final performance of the optimized neural net model was evaluated on a held-out test dataset (n=11,250 observations). Below are the evaluation curves:

ROC AUC of Optimized Model



PR AUC of Optimized Model

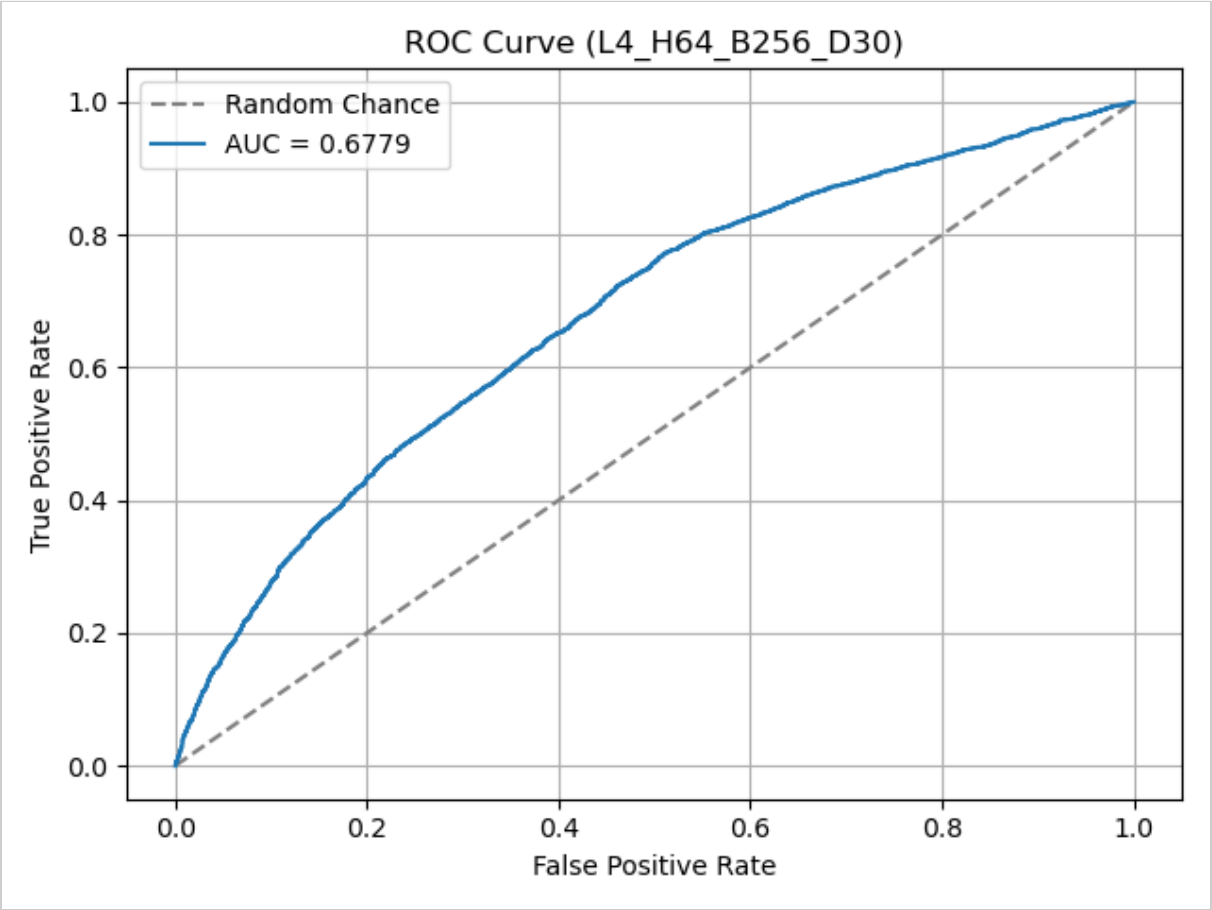


🤖 Neural Net vs. Logistic Regression

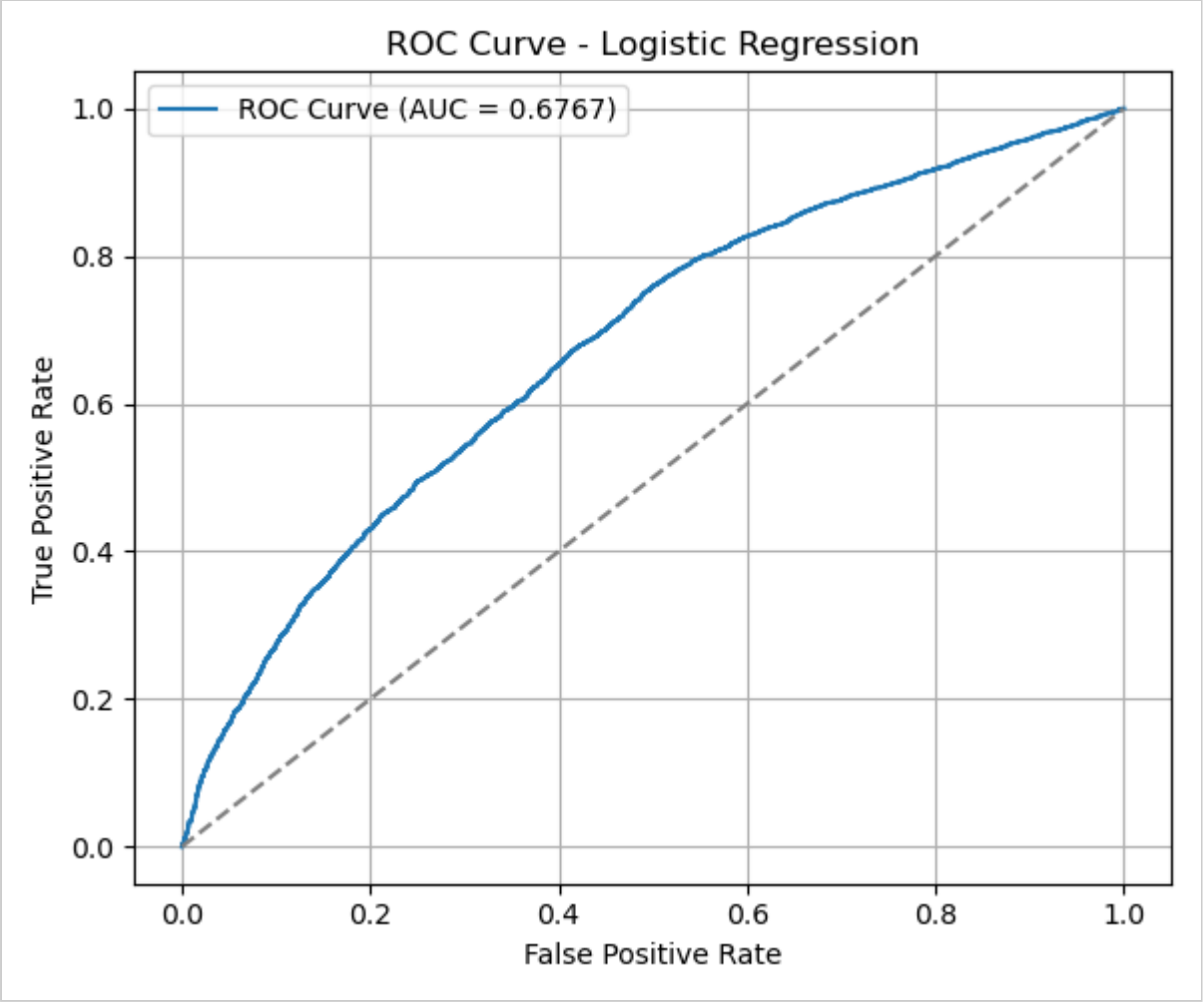
The final ROC AUC score for the neural network model was **0.6779**, compared to **0.6767** for logistic regression. Similarly, the PR AUC was **0.7543** for the neural net and **0.7524** for logistic regression.

ROC Curve Comparison

Optimized Neural Net

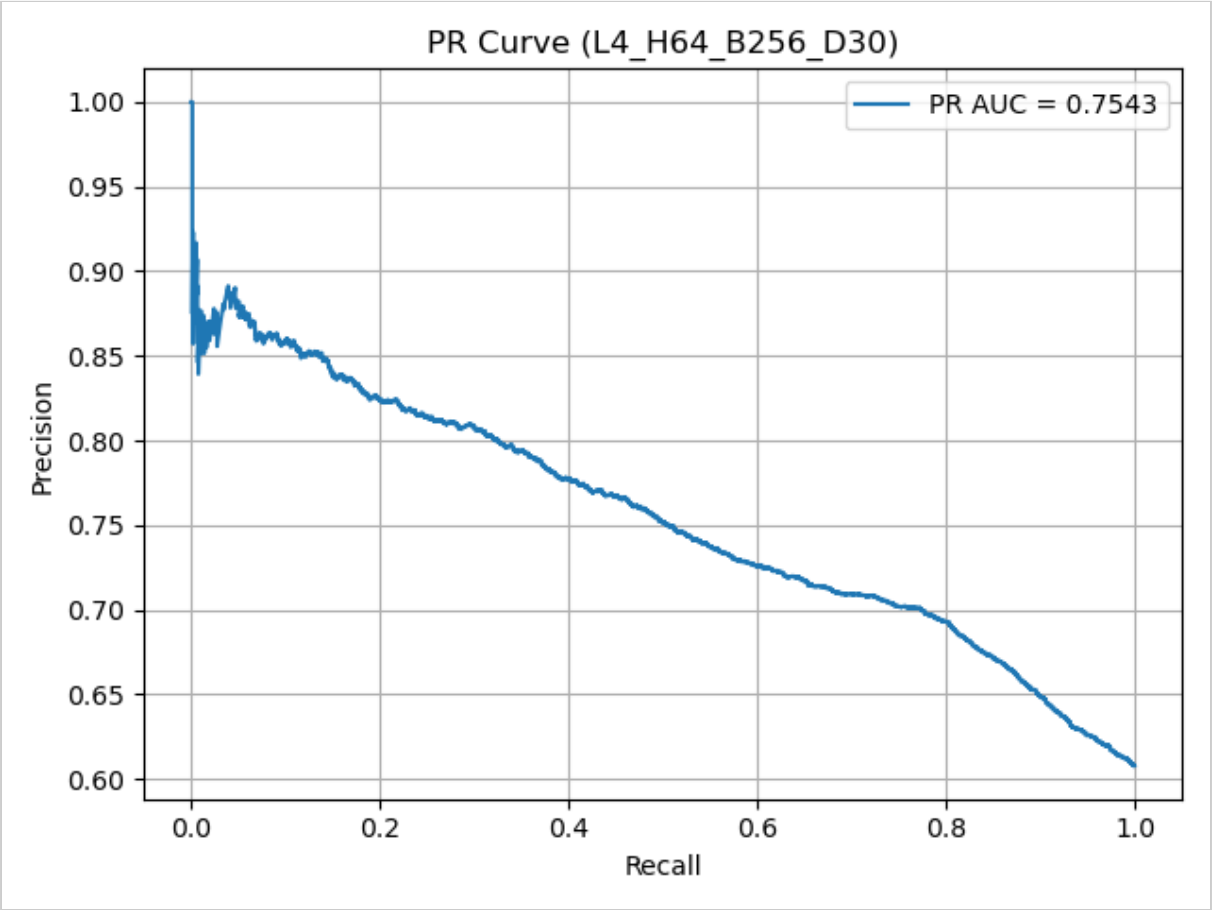


Logistic Regression

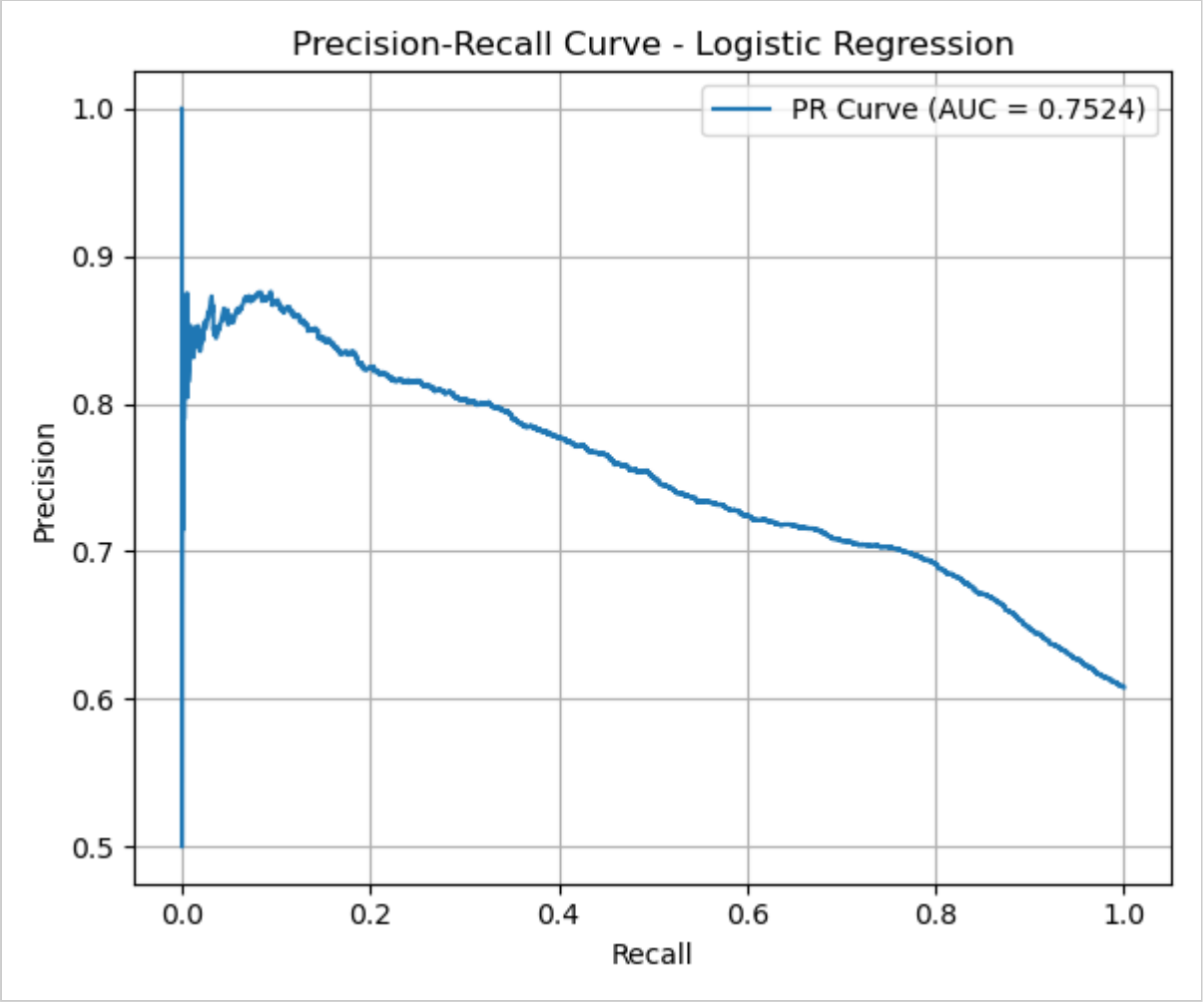


Precision-Recall Curve Comparison

Optimized Neural Net



Logistic Regression



Report Timestamp: 20250412_034446

Report generated automatically using PyTorch experiment logs.