🧠 Hypertension Risk Classification — Deep Neural Network Summary

📌 Objective

This project developed a deep feedforward 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 sampling to assign 37,500 patients to the training dataset; 11,250 patients to the validation dataset; and 11,250 patients to the testing dataset. Each input vector is cross-sectional, with no temporal sequence.

🧱 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 (BCEWithLogitsLoss used)

🔧 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

Two models were retained:

- 🌟 Best Validation Loss Model
- 🌟 Best ROC AUC Model

📊 Training Curves — Best Validation Loss Model

Loss

Loss plot

Accuracy

Accuracy plot

Precision

Precision plot

Recall

Recall plot

ROC AUC

ROC AUC plot

PR AUC

PR AUC plot

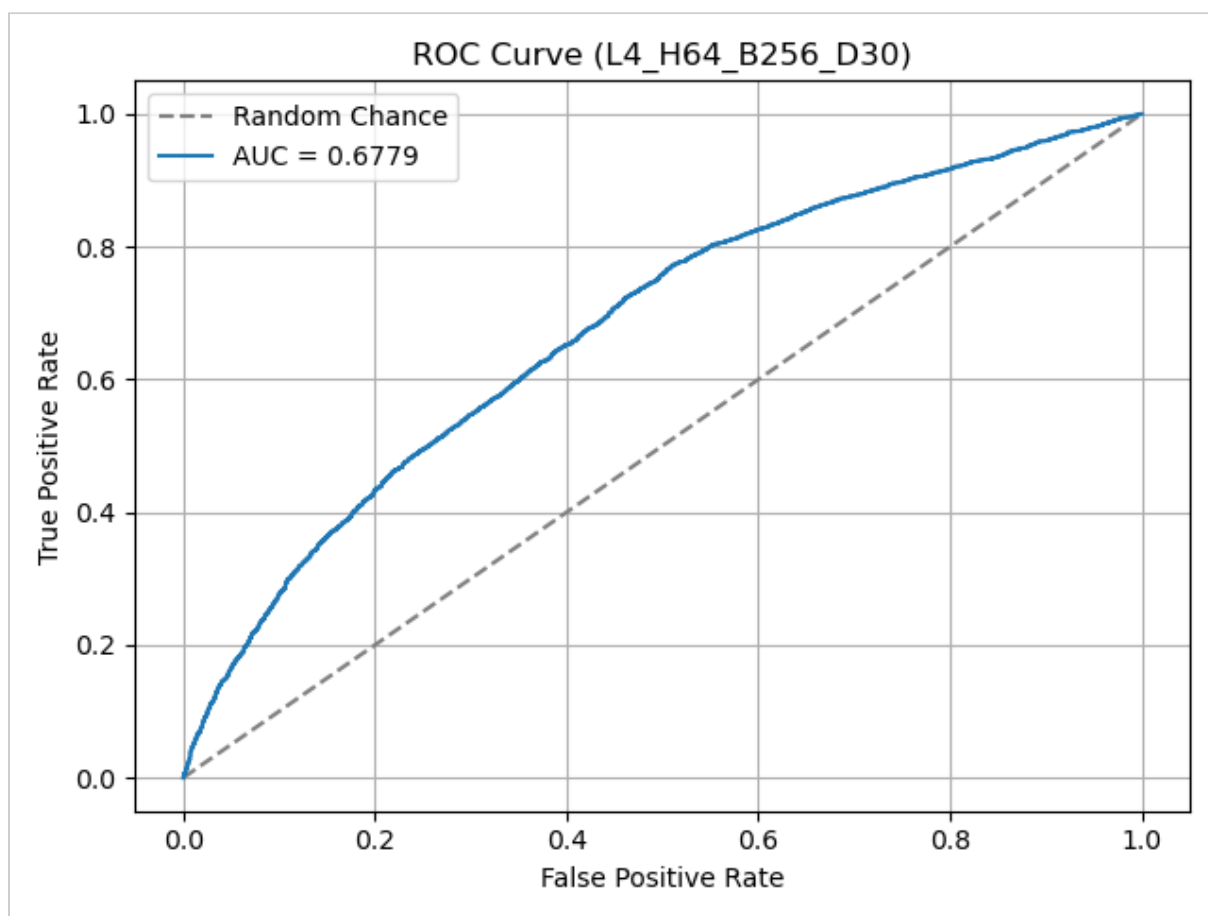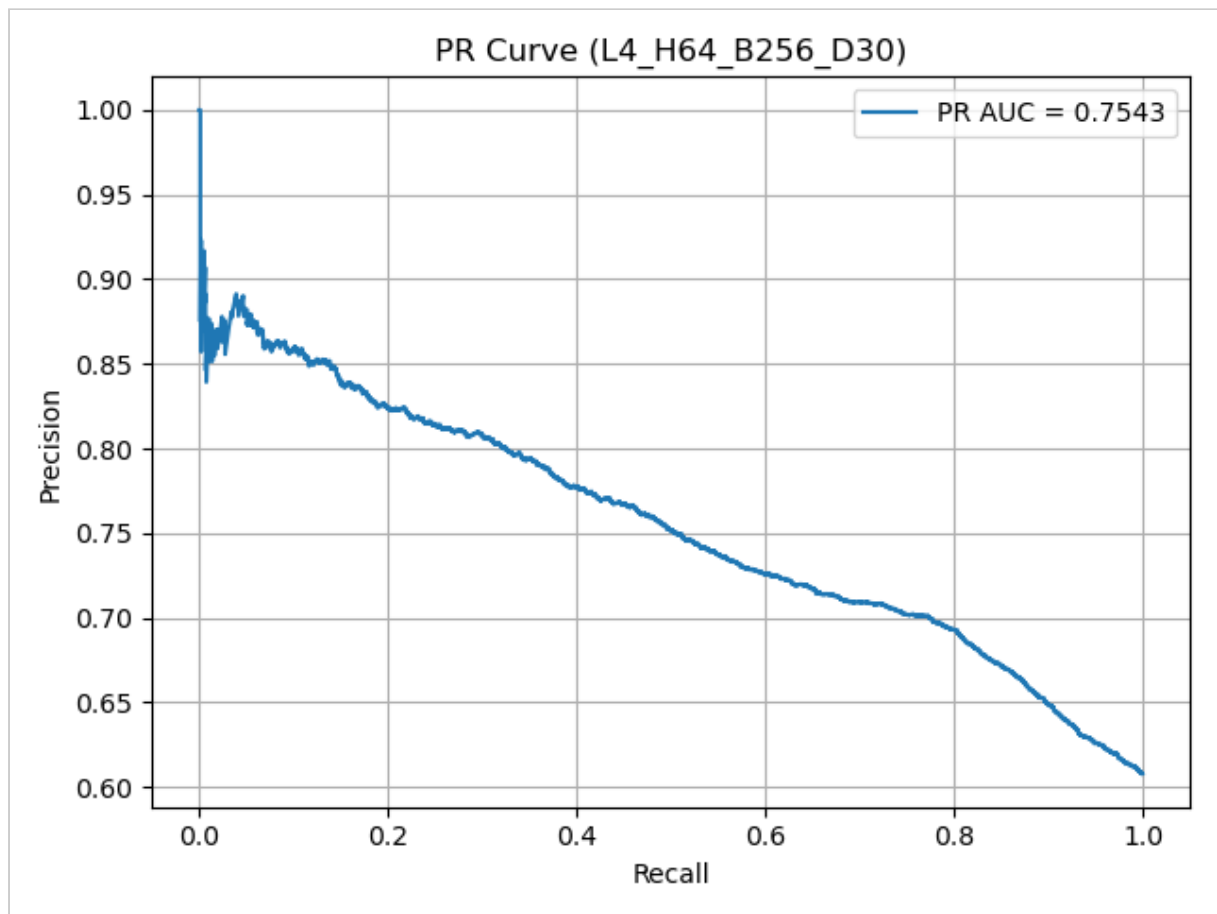## 🧪 Test Evaluation — Best ROC AUC Model

Final performance of the optimized neural net model was evaluated on a held-out test dataset (n=20,000 observations). Below are the evaluation curves:

ROC AUC

ROC Curve (L4_H64_B256_D30)

**PR AUC**

PR Curve (L4_H64_B256_D30)

## 🤖 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.
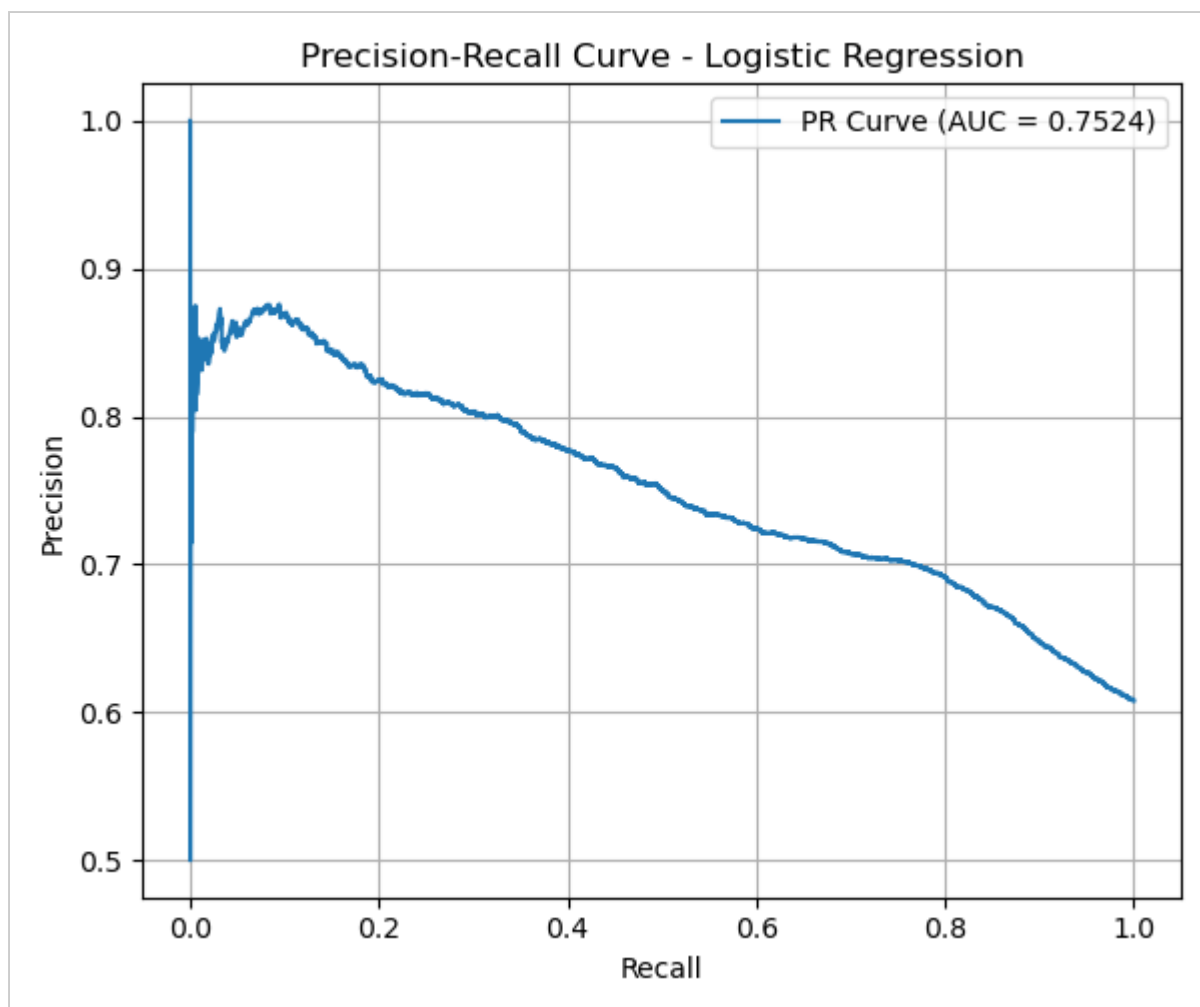
ROC Curve Comparison (Neural Net vs Logistic Regression)

ROC Curve (L4_H64_B256_D30)

ROC Curve - Logistic Regression

ROC Curve (AUC = 0.6767)
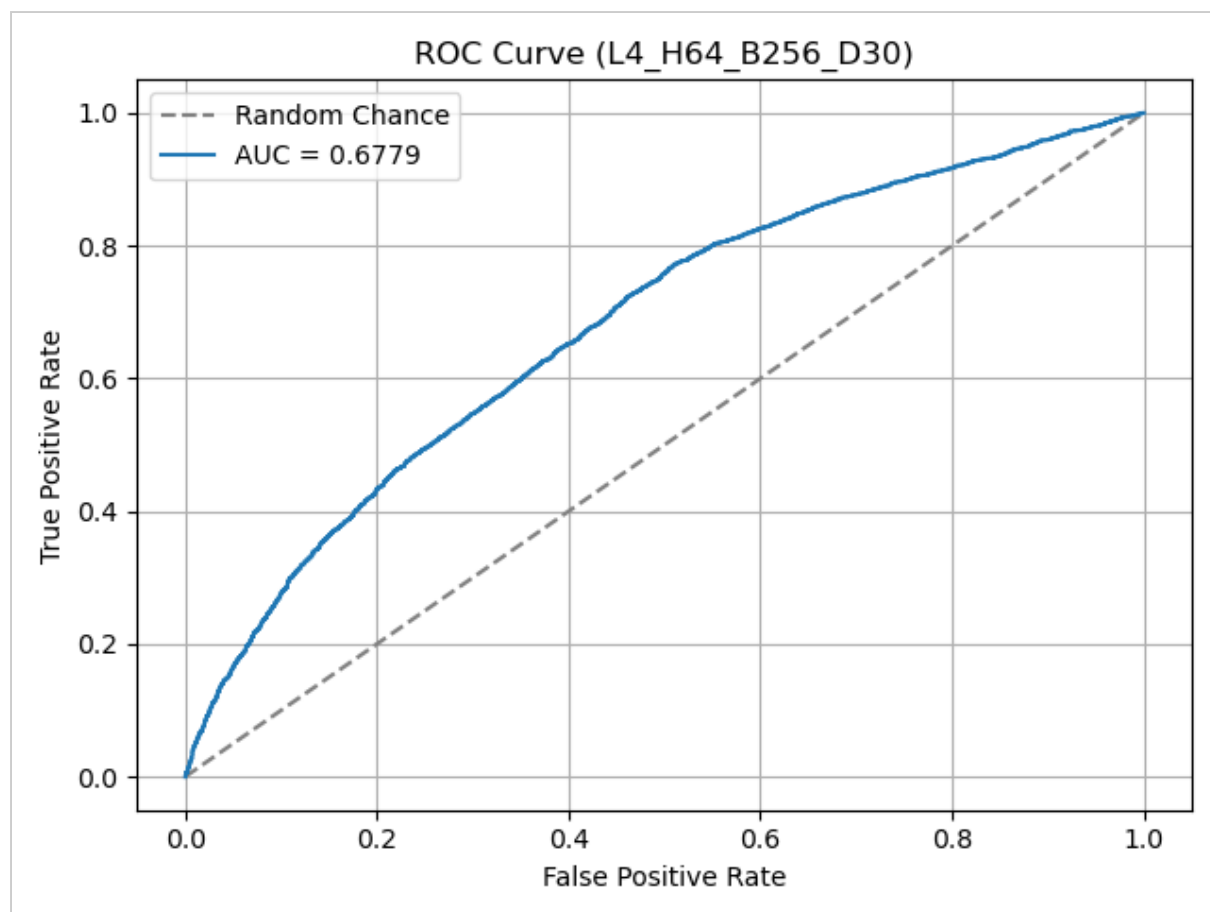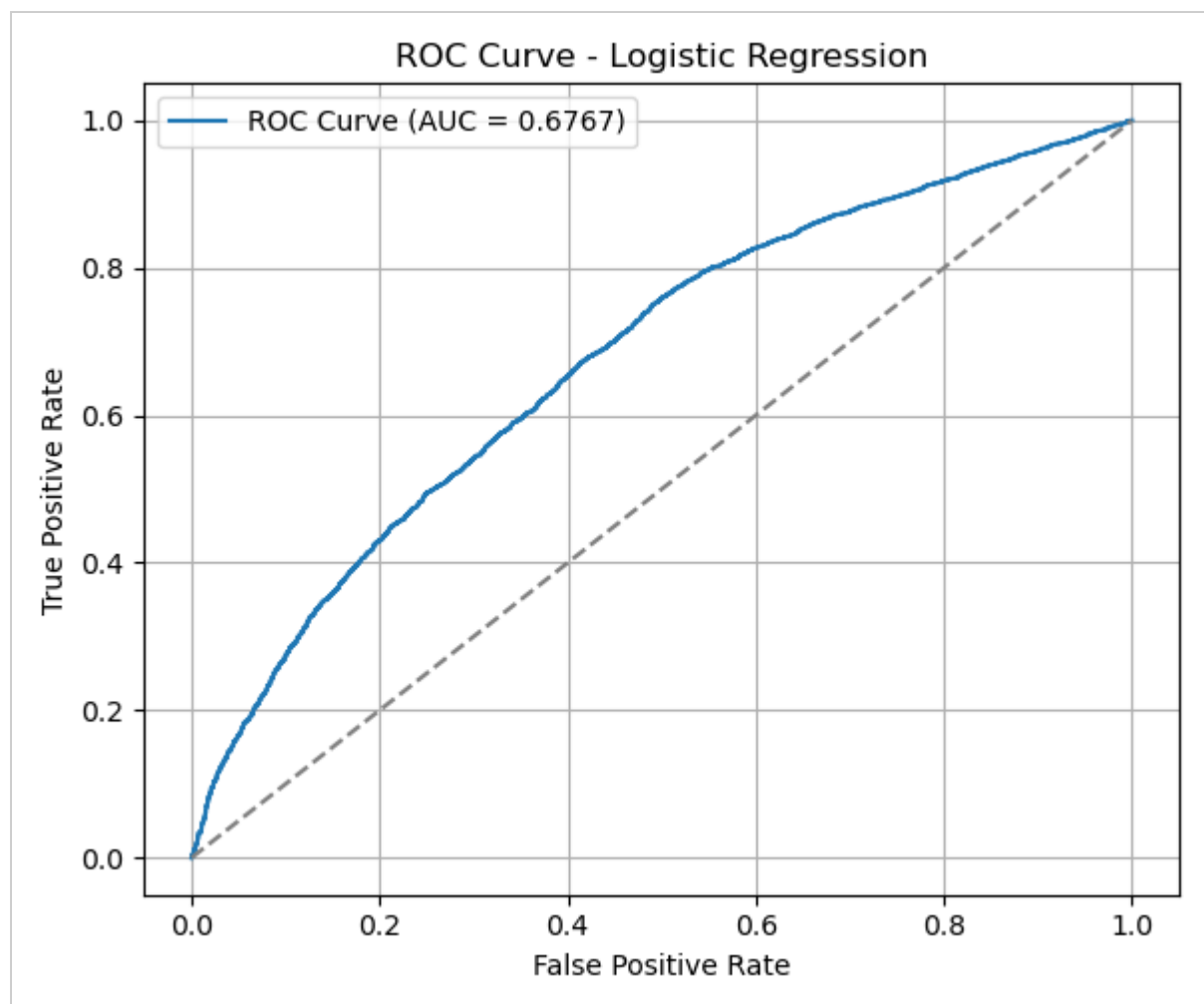
Precision-Recall Curve Comparison (Neural Net vs Logistic Regression)

PR Curve (L4_H64_B256_D30)

PR AUC = 0.7543

Precision-Recall Curve - Logistic Regression
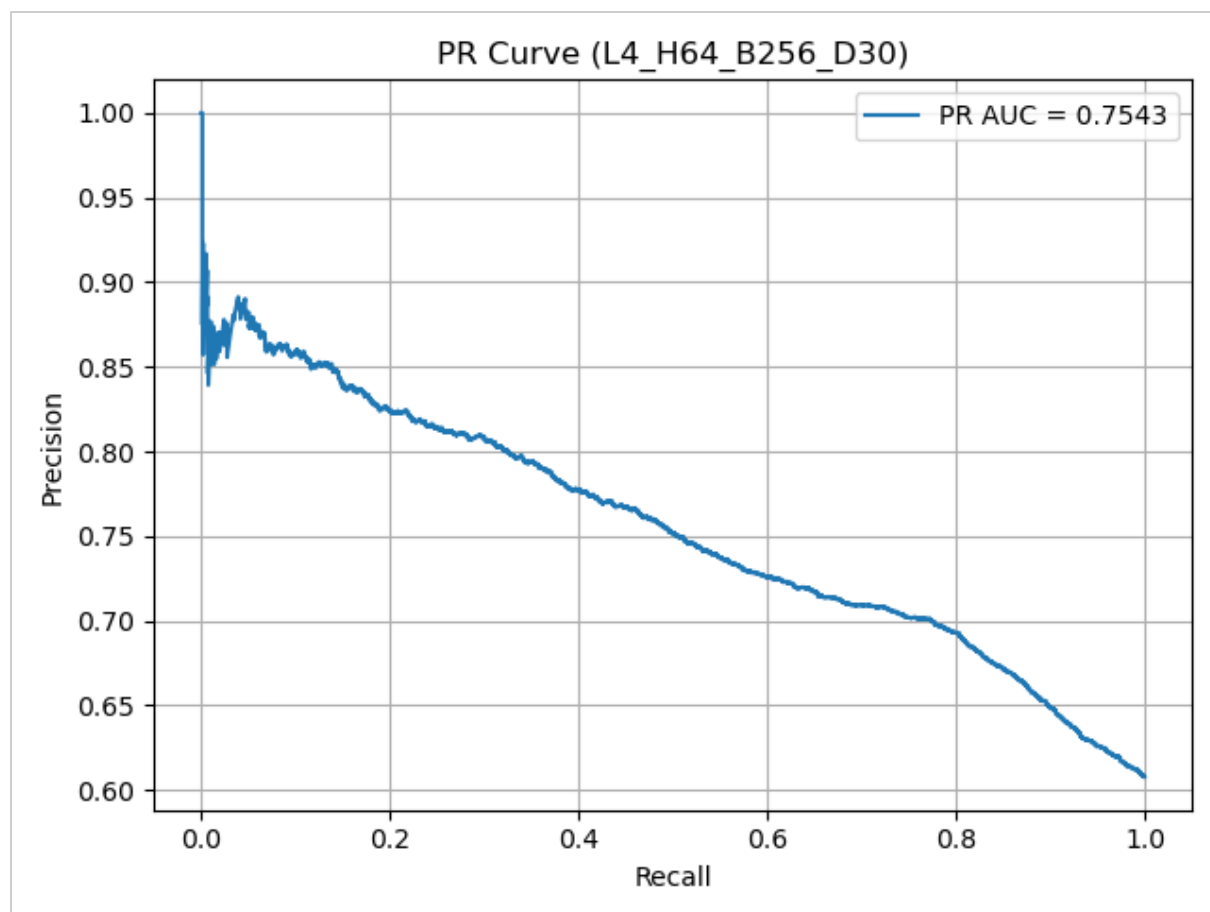
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