Phase 5d: Neural Network Model

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1 Introduction

This document presents Phase 5d: Neural Network Model. We build a feedforward neural network model, analyze its architecture, and evaluate model performance.

2 Load Data

```
Dataset:  24996  observations,  18  variables
```

3 Train/Test Split

```
Training set:  17498  observations (70%)
```

```
Testing set:  7498  observations (30%)
```

4 Data Preparation for Neural Network

```
Data prepared for Neural Network:

  Training features:  33

  Training samples:  17498

  Test samples:  7498

  Features scaled: Yes
```

5 Build Neural Network Model

```
# Train neural network
model_nn <- nnet(
  x = X_train_nn_scaled,
  y = y_train_nn,
  size = 10,         # Number of hidden units
  decay = 0.1,       # Weight decay (L2 regularization)
  maxit = 200,       # Maximum iterations
  trace = TRUE       # Print progress
)
```

```
# weights:  351
initial  value 4479.476496
iter  10 value 4065.213341
iter  20 value 4010.497263
iter  30 value 3960.042273
iter  40 value 3924.733026
iter  50 value 3912.111873
iter  60 value 3905.725090
iter  70 value 3899.420142
iter  80 value 3894.688928
iter  90 value 3890.891156
iter 100 value 3887.085348
iter 110 value 3884.827366
iter 120 value 3883.270910
iter 130 value 3881.716492
iter 140 value 3879.818379
iter 150 value 3878.193662
iter 160 value 3877.341468
iter 170 value 3876.060515
iter 180 value 3875.166473
iter 190 value 3874.610741
iter 200 value 3873.801876
final  value 3873.801876
stopped after 200 iterations
```

```r
cat("\nNeural Network model fitted successfully!\n")
```

```
Neural Network model fitted successfully!
```

```r
cat("Architecture: ", model_nn$n[1], " input units -> ", model_nn$n[2],
    " hidden units -> ", model_nn$n[3], " output unit\n", sep = "")
```

```
Architecture: 33 input units -> 10 hidden units -> 1 output unit
```

```r
cat("Total weights: ", length(model_nn$wts), "\n")
```

```
Total weights:  351
```

```r
cat("Convergence: ", ifelse(model_nn$convergence == 0, "Yes", "No"), "\n")
```

```
Convergence:  No
```

6 Model Architecture

Table 1: Neural Network Architecture

Layer	Units	Activation
Input	33	Linear
Hidden	10	Sigmoid
Output	1	Sigmoid

```
Model Parameters:
```

```
- Hidden units:  10
```

```
- Weight decay: 0.1
```

```
- Maximum iterations: 200
```

```
- Actual iterations:
```

7 Model Evaluation

Table 2: Neural Network: Confusion Matrix

	Not_Readmitted	Readmitted
Not_Readmitted	2813	1785
Readmitted	1160	1740

Table 3: Neural Network: Performance Metrics

Metric	Value	Percentage
Accuracy	0.61	60.72
Precision	0.60	60.00
Recall (Sensitivity)	0.49	49.36
Specificity	0.71	70.80
F1-Score	0.54	54.16

8 ROC Curve

```
Area Under the Curve (AUC):  0.6416
```

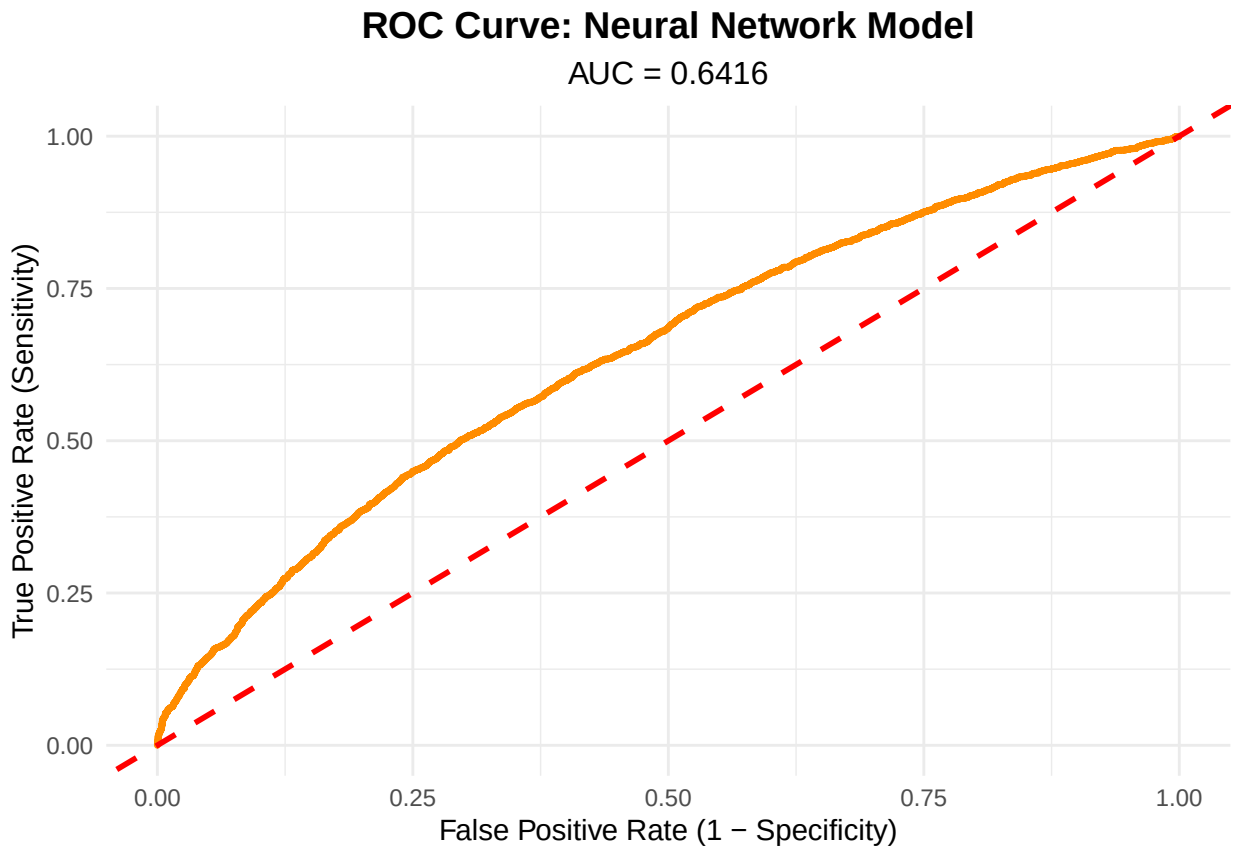

Figure 1: ROC Curve: Neural Network Model

9 Summary

This phase successfully built and evaluated the Neural Network model:

- **Accuracy**: 60.72%
- **AUC**: 0.642
- **Architecture**: 33 input -> 10 hidden -> 1 output
- **Hidden units**: 10
- **Weight decay**: 0.1
- **Total weights**: 351
- **Convergence**: No
- **Interpretability**: Very low (black box model)