

ML Model Optimization and Results

Logistic Regression Model

```
precision recall f1-score support
0 0.90 0.96 0.93 195
1 0.94 0.84 0.89 132
accuracy 0.91 327
macro avg 0.92 0.90 0.91 327
weighted avg 0.92 0.91 0.91 327
```

Logistic Regression Optimized

**** Best Model Overall (outperforms Neural Network)****

Methods: Increased max number of iterations to 1000 (to correct error received in original notebook), changed solver to newton-cg from default

Results: Increased performance, all metrics improved and accuracy increased from 91% to 94%

```
precision recall f1-score support
0 0.91 0.99 0.95 200
1 0.99 0.85 0.92 127

accuracy 0.94 327
macro avg 0.95 0.92 0.93 327
weighted avg 0.94 0.94 0.94 327
```

NN Model 1

```
11/11 - 0s - loss: 4.3789e-04 - accuracy: 1.0000 - precision: 1.0000 - recall: 1.0000 -
266ms/epoch - 24ms/step
Loss: 0.00043788834591396153, Accuracy: 1.0, Precision: 1.0, Recall: 1.0
```

```
11/11 [=====] - 0s 901us/step
Confusion Matrix:
[[205 0]
```

```
[ 0 122]]
Classification Report:
precision recall f1-score support
0 1.00 1.00 1.00 205
1 1.00 1.00 1.00 122
accuracy 1.00 327
macro avg 1.00 1.00 1.00 327
weighted avg 1.00 1.00 1.00 327
```

NN model 1 optimization 1a

Goal: **remove overfitting**

Methods: Kept model the same but added L2 regularization, early callback, and dropout layer to reduce risk of overfitting

Result: still overfit

```
11/11 - 0s - loss: 0.0045 - accuracy: 1.0000 - precision: 1.0000 - recall: 1.0000 -
234ms/epoch - 21ms/step
Loss: 0.004514823667705059, Accuracy: 1.0, Precision: 1.0, Recall: 1.0
```

```
11/11 [=====] - 0s 801us/step
Confusion Matrix:
[[205 0]
 [ 0 122]]
Classification Report:
precision recall f1-score support
0 1.00 1.00 1.00 205
1 1.00 1.00 1.00 122
accuracy 1.00 327
macro avg 1.00 1.00 1.00 327
weighted avg 1.00 1.00 1.00 327
```

NN model 1 optimization 1b

Goal: **remove overfitting**

Methods: Retained L2 regularization, early callback, and dropout layer but also dropped 'body number' column

Result: No longer overfit

```
11/11 - 0s - loss: 0.4832 - accuracy: 0.7859 - precision: 0.8095 - recall: 0.5574 -
25ms/epoch - 2ms/step
Loss: 0.4831599295139313, Accuracy: 0.785932719707489, Precision: 0.8095238208770752,
Recall: 0.5573770403862
```

```
11/11 [=====] - 0s 801us/step
```

```
Confusion Matrix:
```

```
[[189 16]
```

```
[ 54 68]]
```

```
Classification Report:
```

```
precision recall f1-score support
```

```
0 0.78 0.92 0.84 205
```

```
1 0.81 0.56 0.66 122
```

```
accuracy 0.79 327
```

```
macro avg 0.79 0.74 0.75 327
```

```
weighted avg 0.79 0.79 0.78 327
```

NN Model 1 Optimization 2

Goal: Improve performance now that overfitting is corrected

Methods: Removed L2 regularization

Result: Slight improvement overall

```
11/11 - 0s - loss: 0.4734 - accuracy: 0.7982 - precision: 0.7979 - recall: 0.6148 -  
229ms/epoch - 21ms/step
```

```
Loss: 0.4734460711479187, Accuracy: 0.7981651425361633, Precision: 0.7978723645210266,  
Recall: 0.6147540807723999
```

```
11/11 [=====] - 0s 901us/step
```

```
Confusion Matrix:
```

```
[[186 19]
```

```
[ 47 75]]
```

```
Classification Report:
```

```
precision recall f1-score support
```

```
0 0.80 0.91 0.85 205
```

```
1 0.80 0.61 0.69 122
```

```
accuracy 0.80 327
```

```
macro avg 0.80 0.76 0.77 327
```

```
weighted avg 0.80 0.80 0.79 327
```

NN model 1 Optimization 3

Goal: Improve performance

Methods: Retained removal of L2 regularization and also removed dropout layer

Result: Slightly worse overall

```
11/11 - 0s - loss: 0.4716 - accuracy: 0.7645 - precision: 0.7473 - recall: 0.5574 -  
234ms/epoch - 21ms/step  
Loss: 0.4715633690357208, Accuracy: 0.7645260095596313, Precision: 0.7472527623176575,  
Recall: 0.5573770403862
```

```
11/11 [=====] - 0s 901us/step  
Confusion Matrix:  
[[182 23]  
 [ 54 68]]  
Classification Report:  
precision recall f1-score support  
  
0 0.77 0.89 0.83 205  
1 0.75 0.56 0.64 122  
  
accuracy 0.76 327  
macro avg 0.76 0.72 0.73 327  
weighted avg 0.76 0.76 0.76 327
```

Tried model 2, then came back to model 1 with another optimization

NN Model 1 Optimization 4

Kept body number out, removed L2 and dropout, removed early stopping, increased max epochs to 40

Result: Slightly better than optimization 3, but still worse than optimization 2

```
11/11 - 0s - loss: 0.4669 - accuracy: 0.7737 - precision: 0.7609 - recall: 0.5738 -  
232ms/epoch - 21ms/step  
Loss: 0.46693500876426697, Accuracy: 0.7737002968788147, Precision: 0.760869562625885,  
Recall: 0.5737704634666443
```

```
11/11 [=====] - 0s 901us/step  
Confusion Matrix:  
[[183 22]  
 [ 52 70]]  
Classification Report:  
precision recall f1-score support
```

```
0 0.78 0.89 0.83 205
1 0.76 0.57 0.65 122
accuracy 0.77 327
macro avg 0.77 0.73 0.74 327
weighted avg 0.77 0.77 0.77 327
```

NN Model 1 - reprocessed

Methods: Used different CSV and preprocessed data differently

Results: Roughly equivalent to optimization attempt 1b

```
11/11 - 0s - loss: 0.5010 - accuracy: 0.7768 - precision: 0.7426 - recall: 0.6148 -
229ms/epoch - 21ms/step
Loss: 0.5009827017784119, Accuracy: 0.7767584323883057, Precision: 0.7425742745399475,
Recall: 0.6147540807723999
```

```
11/11 [=====] - 0s 901us/step
```

Confusion Matrix:

```
[[179 26]
```

```
[ 47 75]]
```

Classification Report:

```
precision recall f1-score support
```

```
0 0.79 0.87 0.83 205
```

```
1 0.74 0.61 0.67 122
```

```
accuracy 0.78 327
```

```
macro avg 0.77 0.74 0.75 327
```

```
weighted avg 0.77 0.78 0.77 327
```

NN model 1 - reprocessed and optimized

Methods: oversampled minority class in target column (survived) to balance dataset

Results: Significant improvements across the board!

```
13/13 - 0s - loss: 0.4673 - accuracy: 0.8020 - precision: 0.8389 - recall: 0.7475 -
228ms/epoch - 18ms/step
Loss: 0.4673449695110321, Accuracy: 0.801980197429657, Precision: 0.8388888835906982,
Recall: 0.7475247383117676
```

```
13/13 [=====] - 0s 834us/step
```

Confusion Matrix:

```
[[173 29]
```

```
[ 51 151]]
Classification Report:
precision recall f1-score support

0 0.77 0.86 0.81 202
1 0.84 0.75 0.79 202

accuracy 0.80 404
macro avg 0.81 0.80 0.80 404
weighted avg 0.81 0.80 0.80 404
```

NN Model 2

Methods: Used more complex model, option for extra hidden layer and allowed kerastuner to determine number of neurons in each. Included dropout layer but not L2, maintained removal of 'body number' feature

Results: some measures were better than the first model (precision for 1, recall for 0) but overall performed worse

```
11/11 - 0s - loss: 0.5585 - accuracy: 0.7401 - precision: 0.9744 - recall: 0.3115 -
236ms/epoch - 21ms/step
Loss: 0.5585038065910339, Accuracy: 0.7400611639022827, Precision: 0.9743589758872986,
Recall: 0.31147539615631104
```

```
11/11 [=====] - 0s 901us/step
Confusion Matrix:
[[204 1]
 [ 84 38]]
Classification Report:
precision recall f1-score support

0 0.71 1.00 0.83 205
1 0.97 0.31 0.47 122

accuracy 0.74 327
macro avg 0.84 0.65 0.65 327
weighted avg 0.81 0.74 0.69 327
```

NN model 2 optimization 1

Methods: Removed dropout layer

Results: some metrics improved, others worsened. Still not as good as first model.

```
11/11 - 0s - loss: 0.4722 - accuracy: 0.7768 - precision: 0.7692 - recall: 0.5738 -  
227ms/epoch - 21ms/step  
Loss: 0.4721972644329071, Accuracy: 0.7767584323883057, Precision: 0.7692307829856873,  
Recall: 0.5737704634666443
```

```
11/11 [=====] - 0s 801us/step
```

Confusion Matrix:

```
[[184 21]
```

```
[ 52 70]]
```

Classification Report:

```
precision recall f1-score support
```

```
0 0.78 0.90 0.83 205
```

```
1 0.77 0.57 0.66 122
```

```
accuracy 0.78 327
```

```
macro avg 0.77 0.74 0.75 327
```

```
weighted avg 0.78 0.78 0.77 327
```

NN model 2 - reprocessed

Methods: Used different CSV and preprocessed data differently

Results: Slight changes but not really an improvement

```
11/11 - 0s - loss: 0.4936 - accuracy: 0.7706 - precision: 0.7582 - recall: 0.5656 -  
236ms/epoch - 21ms/step  
Loss: 0.49361488223075867, Accuracy: 0.7706422209739685, Precision: 0.7582417726516724,  
Recall: 0.5655737519264221
```

```
11/11 [=====] - 0s 1ms/step
```

Confusion Matrix:

```
[[183 22]
```

```
[ 53 69]]
```

Classification Report:

```
precision recall f1-score support
```

```
0 0.78 0.89 0.83 205
```

```
1 0.76 0.57 0.65 122
```

```
accuracy 0.77 327
```

```
macro avg 0.77 0.73 0.74 327
```

```
weighted avg 0.77 0.77 0.76 327
```

NN model 2 - reprocessed and optimized 1

Methods: oversampled minority class in target column (survived) to balance dataset

Results: Significant improvements across the board! Outperformed model 1's performance after reprocessing and optimization

```
13/13 - 0s - loss: 0.4279 - accuracy: 0.8243 - precision: 0.8708 - recall: 0.7635 -  
237ms/epoch - 18ms/step  
Loss: 0.4279337525367737, Accuracy: 0.8242574334144592, Precision: 0.8707864880561829,  
Recall: 0.7635468244552612
```

```
13/13 [=====] - 0s 917us/step
```

Confusion Matrix:

```
[[178 23]
```

```
[ 48 155]]
```

Classification Report:

```
precision recall f1-score support
```

```
0 0.79 0.89 0.83 201
```

```
1 0.87 0.76 0.81 203
```

```
accuracy 0.82 404
```

```
macro avg 0.83 0.82 0.82 404
```

```
weighted avg 0.83 0.82 0.82 404
```

NN model 2 reprocessed and optimized 2

**** Second best model****

Methods: changed encoding from labelencoder to get dummies, dropped last name column

Results: improve in performance

```
13/13 - 0s - loss: 0.4255 - accuracy: 0.8317 - precision: 0.8771 - recall: 0.7734 -  
243ms/epoch - 19ms/step  
Loss: 0.42546987533569336, Accuracy: 0.8316831588745117, Precision: 0.8770949840545654,  
Recall: 0.7733989953994751
```

```
13/13 [=====] - 0s 917us/step
```

Confusion Matrix:

```
[[179 22]
```

```
[ 46 157]]
```

Classification Report:

```
precision recall f1-score support
```



```
0 0.80 0.89 0.84 201
1 0.88 0.77 0.82 203

accuracy 0.83 404
macro avg 0.84 0.83 0.83 404
weighted avg 0.84 0.83 0.83 404
```

NN model 2 reprocessed and optimized 3

**** Best model****

Methods: continued with get dummies encoding but also applied it to last name column instead of dropping

Results: further improvement in performance

```
13/13 - 0s - loss: 0.4827 - accuracy: 0.8589 - precision: 0.8380 - recall: 0.8916 -
244ms/epoch - 19ms/step
Loss: 0.48270294070243835, Accuracy: 0.8589109182357788, Precision: 0.8379629850387573,
Recall: 0.8916256427764893
```

```
13/13 [=====] - 0s 1ms/step
Confusion Matrix:
[[166 35]
 [ 22 181]]
Classification Report:
precision recall f1-score support

0 0.88 0.83 0.85 201
1 0.84 0.89 0.86 203

accuracy 0.86 404
macro avg 0.86 0.86 0.86 404
weighted avg 0.86 0.86 0.86 404
```