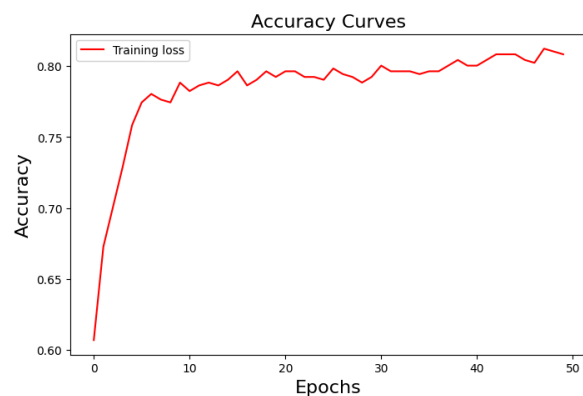


Variasi percobaan:

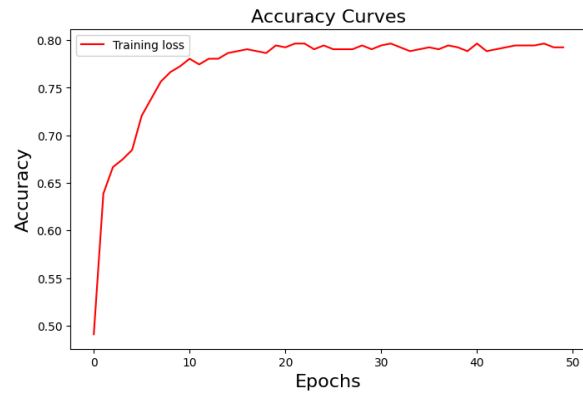
Jumlah Layer	Simple Model: 1-2 hidden layers with 8-16 units each. Moderate Model: 2-3 hidden layers with 16-32 units each. Complex Model: 3-4 hidden layers with 32-64 units each.
Fungsi Aktivasi	ReLU: Common choice, works well with most architectures. Leaky ReLU: Can help with the dying ReLU problem. Sigmoid/Tanh: May be suitable for specific layers, especially for binary classification tasks.
Batch Size	Small: 16, 32 Medium: 64 Large: 128, 256
Epoch	Low: 50-100 epochs Medium: 100-200 epochs High: 200-300 epochs
Optimizer	Adam: Default choice for many tasks. SGD with Momentum: Sometimes better for very large datasets or when tuning learning rates. RMSprop: Often used for RNNs, but can work well here too.
Loss function	Binary Cross-Entropy: The standard for binary classification tasks. Focal Loss: Can be useful if the dataset is imbalanced.
Regularization	Dropout: Add dropout layers with rates between 0.2 and 0.5. L2 Regularization: Apply to Dense layers.
Callback	EarlyStopping: Already implemented. Learning Rate Scheduler: Reduce learning rate on plateau.

Layer : 2 hidden layer (12,8,1)
Activation : ReLU
Batch Size : 8
Epoch : 50
Optimizer : Adam
Loss : binary cross-entropy



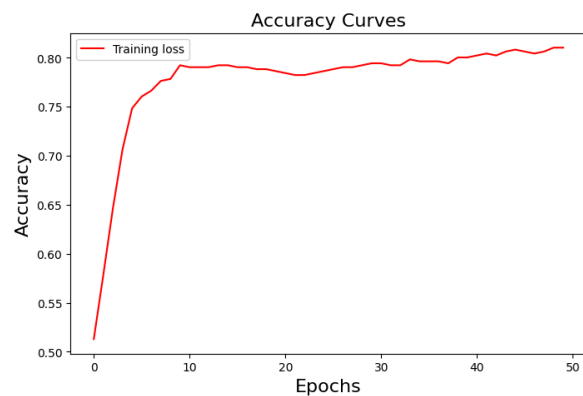
Accuracy: 73.81

Layer : 2 hidden layer (12,8,1)
Activation : ReLU
Batch Size : **16**
Epoch : 50
Optimizer : Adam
Loss : binary cross-entropy



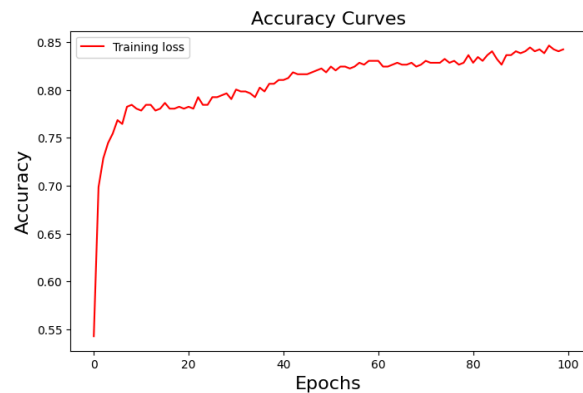
Accuracy: 76.19

Layer : 2 hidden layer (12,8,1)
Activation : ReLU
Batch Size : **32**
Epoch : 50
Optimizer : Adam
Loss : binary cross-entropy



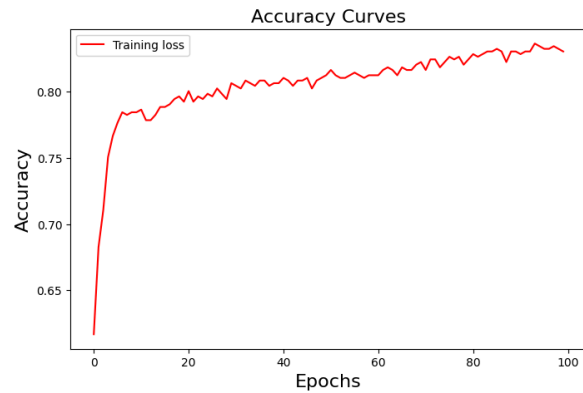
Accuracy: 74.60

Layer : 2 hidden layer (12,8,1)
Activation : ReLU
Batch Size : **8**
Epoch : **100**
Optimizer : Adam
Loss : binary cross-entropy



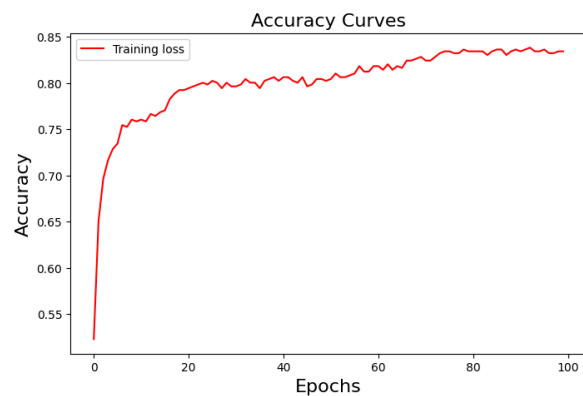
Accuracy: 76.19

Layer : 2 hidden layer (12,8,1)
Activation : ReLU
Batch Size : **16**
Epoch : **100**
Optimizer : Adam
Loss : binary cross-entropy



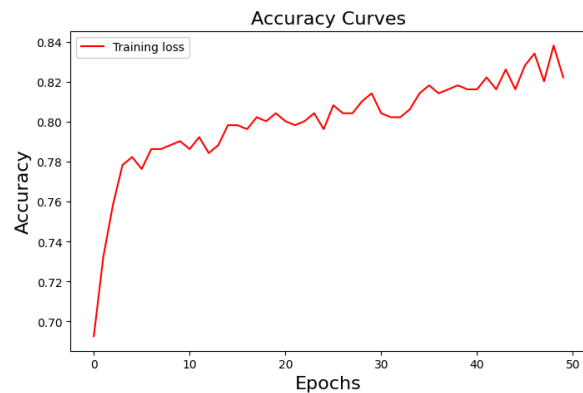
Accuracy: 74.60

Layer : 2 hidden layer (12,8,1)
Activation : ReLU
Batch Size : **32**
Epoch : **100**
Optimizer : Adam
Loss : binary cross-entropy



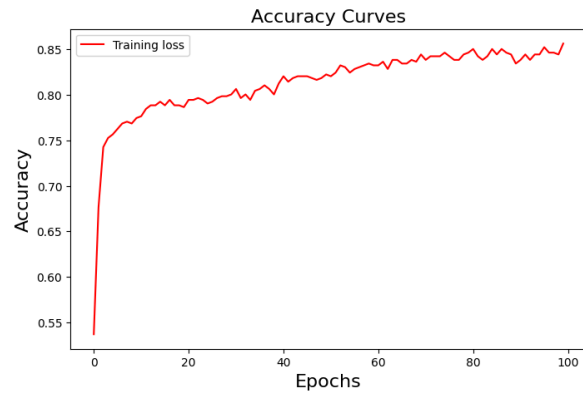
Accuracy: 73.02

Layer : 2 hidden layer (**24,12,1**)
Activation : ReLU
Batch Size : **8**
Epoch : **50**
Optimizer : Adam
Loss : binary cross-entropy



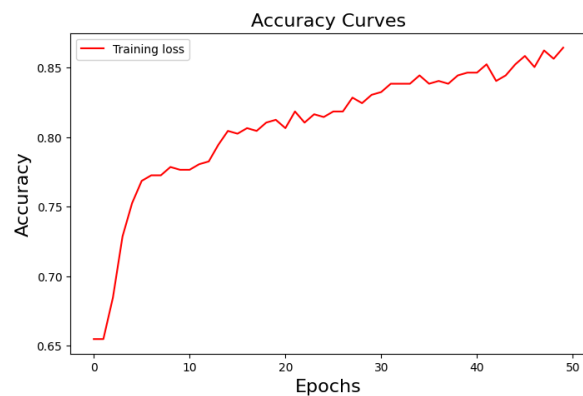
Accuracy: 73.81

Layer : 2 hidden layer **(24,12,1)**
Activation : ReLU
Batch Size : **16**
Epoch : **100**
Optimizer : Adam
Loss : binary cross-entropy



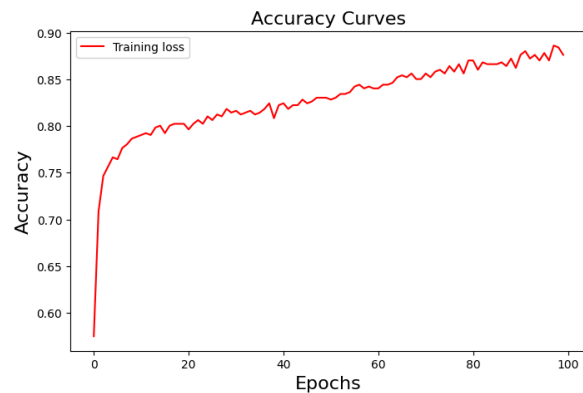
Accuracy: 74.60

Layer : 3 hidden layer **(24,12,8,1)**
Activation : ReLU
Batch Size : **8**
Epoch : **50**
Optimizer : Adam
Loss : binary cross-entropy



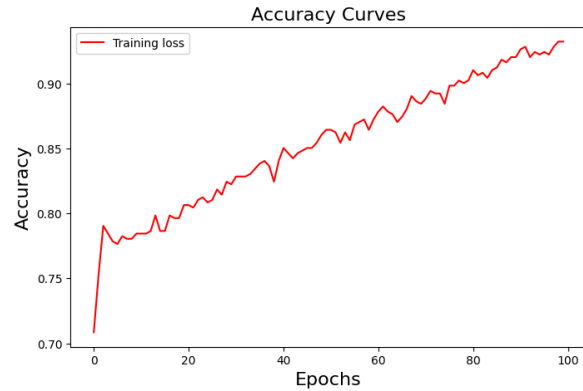
Accuracy: 74.60

Layer : 3 hidden layer **(24,12,8,1)**
Activation : ReLU
Batch Size : **16**
Epoch : **100**
Optimizer : Adam
Loss : binary cross-entropy



Accuracy: 75.40

Layer : 3 hidden layer **(32,16,8,1)**
 Activation : ReLU
 Batch Size : **16**
 Epoch : **100**
 Optimizer : Adam
 Loss : binary cross-entropy

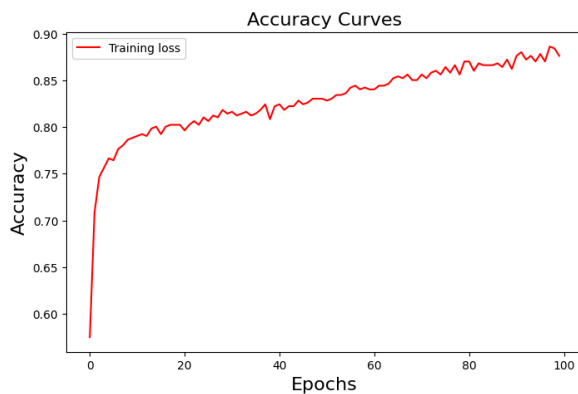


Accuracy: 69.84

Top-3 best result based on batch size, epoch, and layer (left side of the table)

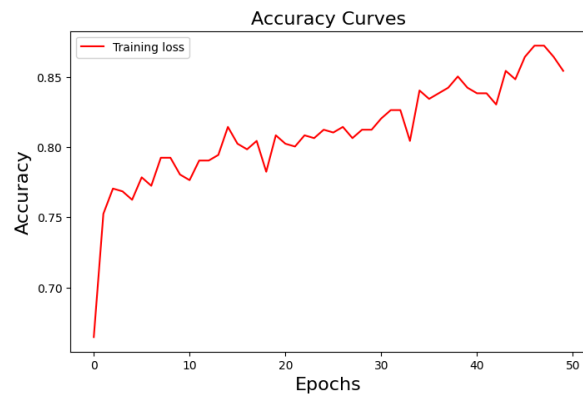
Layer : 3 hidden layer **(24,12,8,1)**
 Activation : ReLU
 Batch Size : **16**
 Epoch : **100**
 Optimizer : Adam
 Loss : binary cross-entropy

Acc before : **75.40**



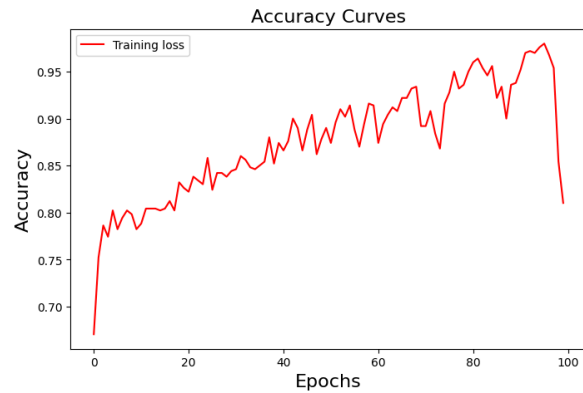
Change the optimizer:

Layer : 3 hidden layer **(24,12,8,1)**
 Activation : ReLU
 Batch Size : **8**
 Epoch : **50**
 Optimizer : **SGD**
 Loss : binary cross-entropy



Accuracy: 69.84

Layer : 3 hidden layer **(24,12,8,1)**
 Activation : ReLU
 Batch Size : **8**
 Epoch : **100**
 Optimizer : **SGD**
 Loss : binary cross-entropy



Accuracy: 72.22

Layer : 3 hidden layer (24,12,8,1)

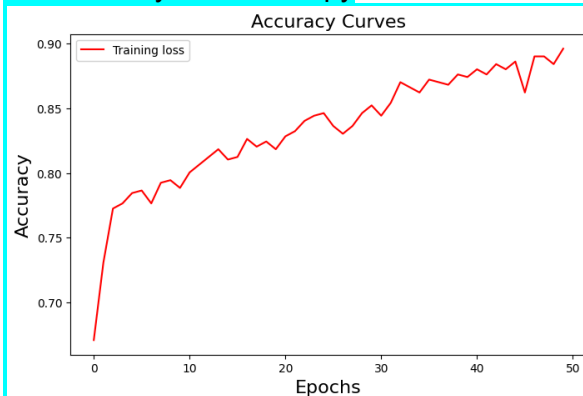
Activation : ReLU

Batch Size : 16

Epoch : 50

Optimizer : SGD

Loss : binary cross-entropy



Accuracy: 75.40

Layer : 3 hidden layer (24,12,8,1)

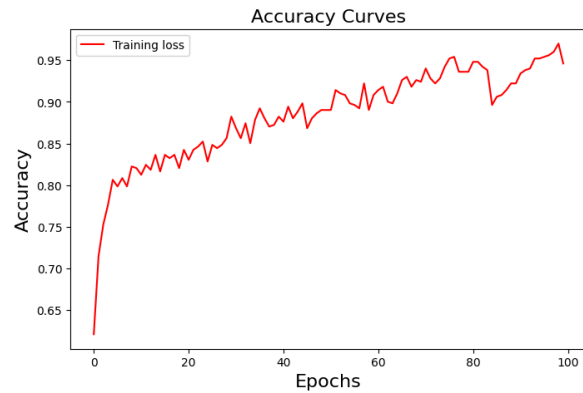
Activation : ReLU

Batch Size : 16

Epoch : 100

Optimizer : SGD

Loss : binary cross-entropy



Accuracy: 65.87

Layer : 3 hidden layer **(24,12,8,1)**

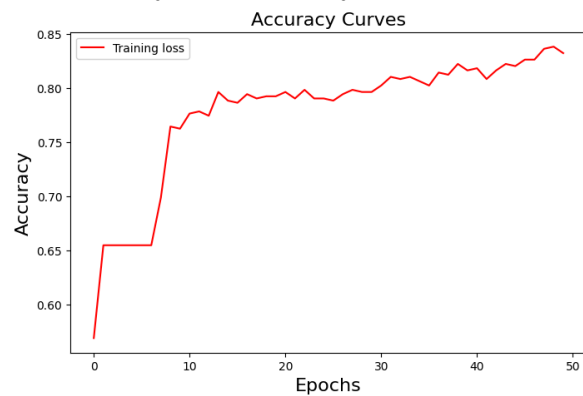
Activation : ReLU

Batch Size : **32**

Epoch : **50**

Optimizer : **SGD**

Loss : binary cross-entropy



Accuracy: 74.60

Layer : 2 hidden layer (12,8,1)

Activation : ReLU

Batch Size : **16**

Epoch : 50

Optimizer : Adam

Loss : binary cross-entropy

Acc before : **76.19**

Change the optimizer:

Layer : 2 hidden layer **(12,8,1)**

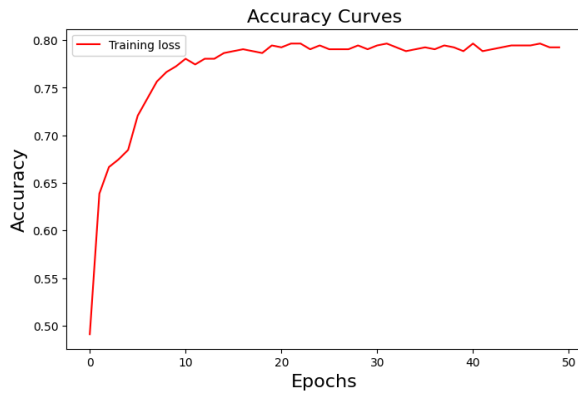
Activation : ReLU

Batch Size : **8**

Epoch : **50**

Optimizer : **SGD**

Loss : binary cross-entropy



Layer : 2 hidden layer (12,8,1)

Activation : ReLU

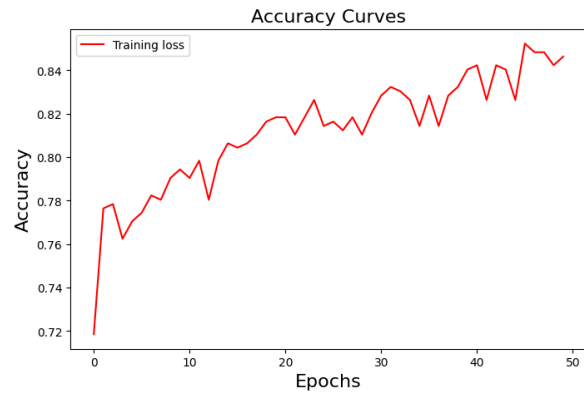
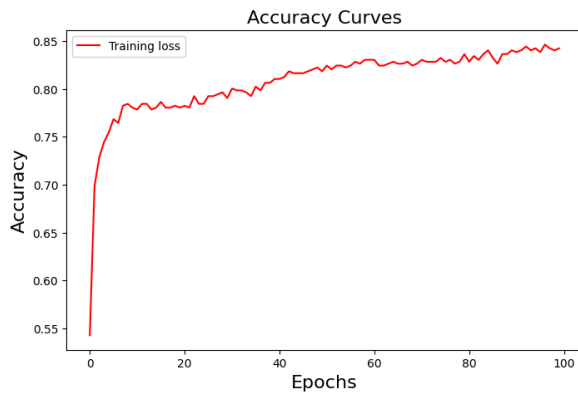
Batch Size : 8

Epoch : 100

Optimizer : Adam

Loss : binary cross-entropy

Acc before: 76.19



Accuracy: 72.22

Layer : 2 hidden layer (12,8,1)

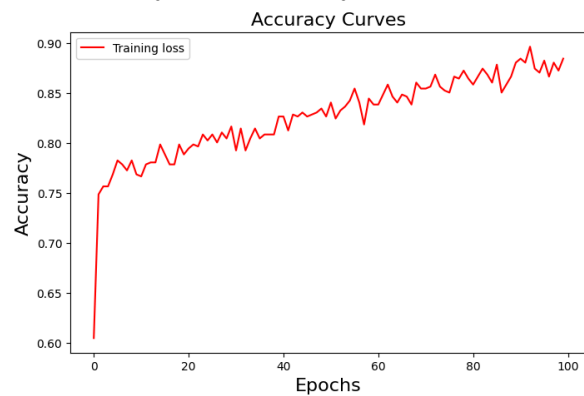
Activation : ReLU

Batch Size : 8

Epoch : 100

Optimizer : SGD

Loss : binary cross-entropy



Accuracy: 73.81

Layer : 2 hidden layer (12,8,1)

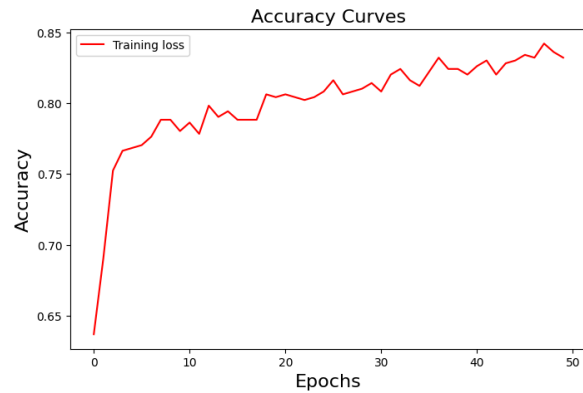
Activation : ReLU

Batch Size : 16

Epoch : 50

Optimizer : SGD

Loss : binary cross-entropy



Accuracy: 73.81

Layer : 2 hidden layer (12,8,1)

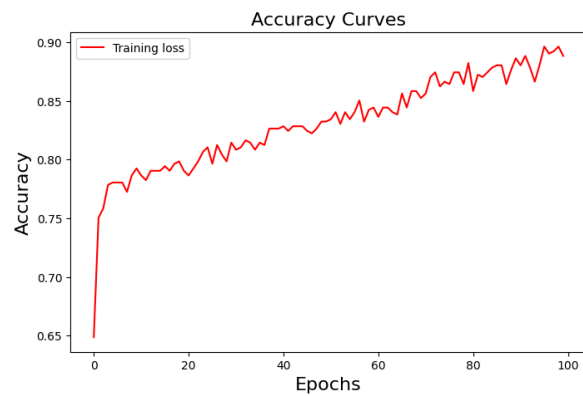
Activation : ReLU

Batch Size : 16

Epoch : 100

Optimizer : **SGD**

Loss : binary cross-entropy



Accuracy: 69.84

Layer : 2 hidden layer (12,8,1)

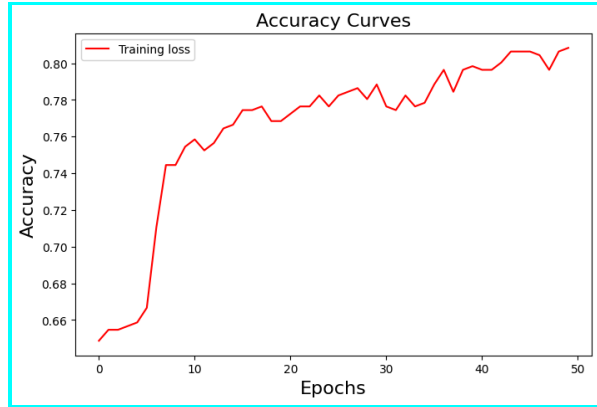
Activation : ReLU

Batch Size : 32

Epoch : 50

Optimizer : **SGD**

Loss : binary cross-entropy



Accuracy: 75.40

Optimizer Adam vs SGD : **Adam**

Batch Size : **8, 16** (32 sudah menurun akurasi)

Hidden layer : **2** (akurasi dengan 3 hidden layer, tidak lebih besar dari yang 2 layer)

Next, uji dengan epoch 100-200, pada 2 set parameter dengan akurasi tertinggi, yaitu:

Layer : 2 hidden layer (12,8,1)

Activation : ReLU

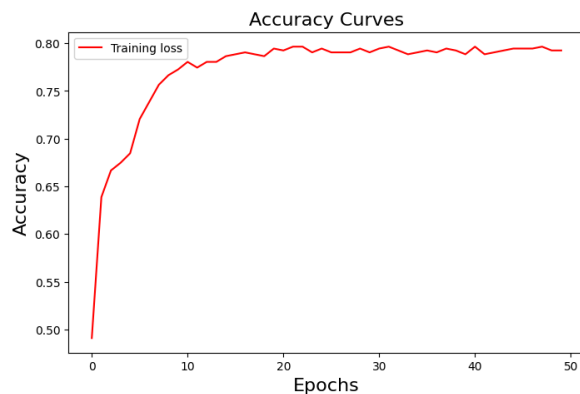
Batch Size : **16**

Epoch : **50**

Optimizer : Adam

Loss : binary cross-entropy

Acc before : **76.19**



Ubah nilai epoch:

Epoch = 200

Layer : 2 hidden layer (12,8,1)

Activation : ReLU

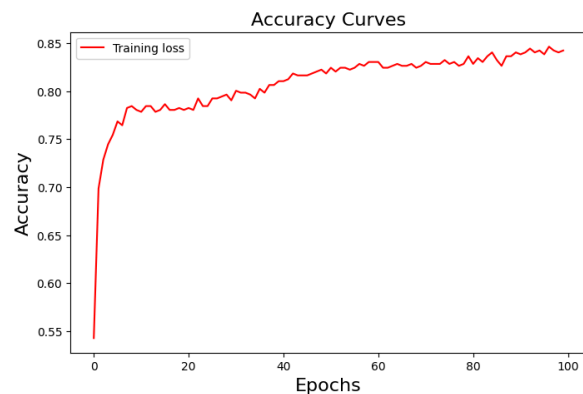
Batch Size : **8**

Epoch : **100**

Optimizer : Adam

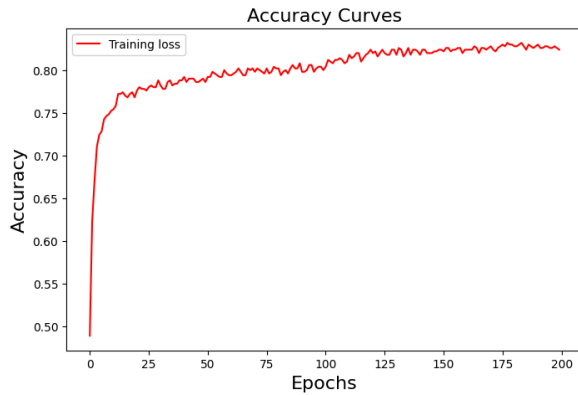
Loss : binary cross-entropy

Acc before: **76.19**



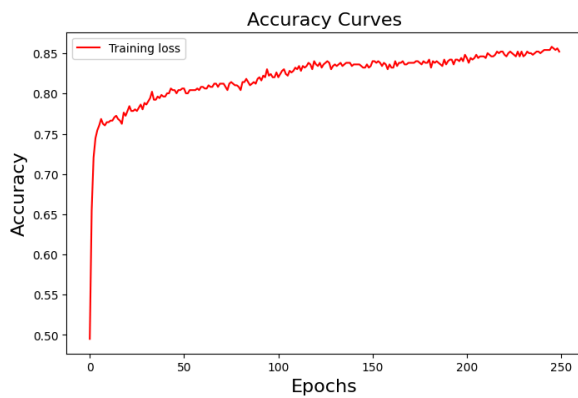
Ubah nilai epoch:

Epoch = 150

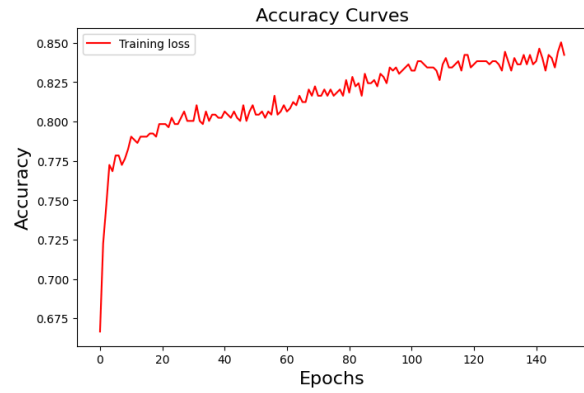


Accuracy: 77.78 (best result)

Ubah nilai epoch:
Epoch = 250

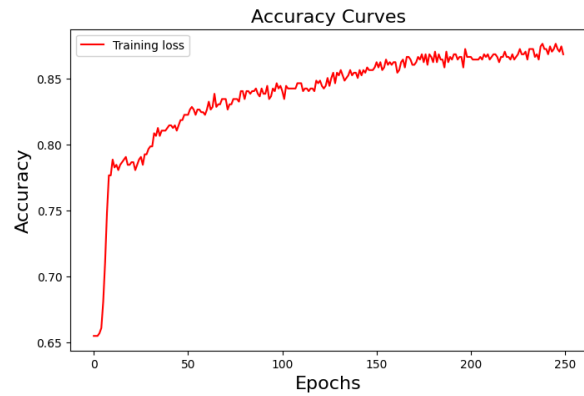


Accuracy: 72.22 (menurun)



Accuracy: 76.19 (stuck)

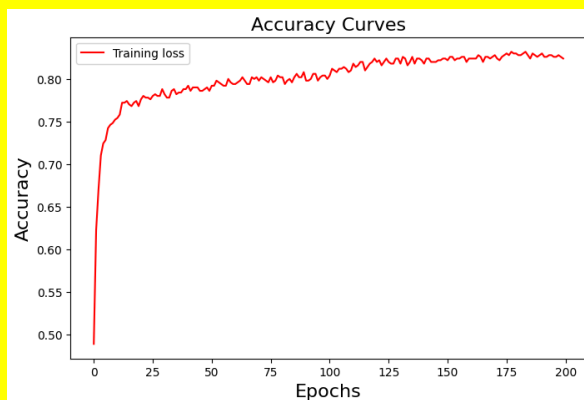
Ubah nilai epoch:
Epoch = 250



Accuracy: 73.81 (menurun)

Best parameter based on the manual experiment:

Layer : 2 hidden layer (12,8,1)
Activation : ReLU
Batch Size : **16**
Epoch : **200**
Optimizer : Adam
Loss : binary cross-entropy



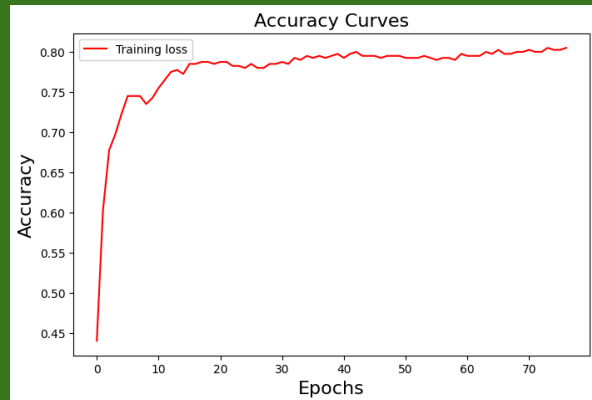
Accuracy: 77.78 (best result)

Note : result bisa saja berubah ketika dirunning ulang

Testing with **early stopping** (to reduce overfitting)

Layer : 2 hidden layer (12,8,1)
Activation : ReLU
Batch Size : **16**
Epoch : **200**
Optimizer : Adam
Loss : binary cross-entropy

Result : **stopped at epoch-77**



Accuracy: 80.16 (Best result with early stopping)

Note : result bisa saja berubah ketika dirunning ulang

AFTER hyperparameter tuning:

Best val_accuracy So Far: 0.8118811845779419
Test Accuracy: 0.76

Recommendation:

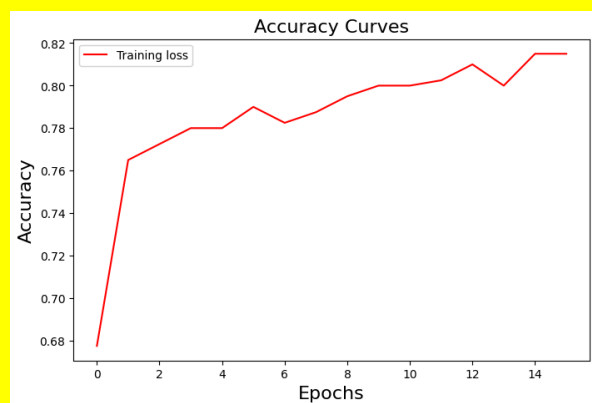
Best units for the first dense layer: 64
Best activation function: relu
Best optimizer: rmsprop
Best learning rate: 0.01

Experiment 1:

Layer : 2 hidden layer (64,32,1)
Activation : ReLU
Batch Size : **16**
Epoch : **200**
Optimizer : rmsprop
Loss : binary cross-entropy

Result : **stopped at epoch-16**

```
25/25 ----- 0s 3ms/step - accuracy: 0.8290 - loss: 0.3632 - val_accuracy: 0.7228 - val_loss: 0.4294
Epoch 11/200
25/25 ----- 0s 3ms/step - accuracy: 0.7771 - loss: 0.4472 - val_accuracy: 0.7327 - val_loss: 0.4257
Epoch 12/200
25/25 ----- 0s 3ms/step - accuracy: 0.7812 - loss: 0.4132 - val_accuracy: 0.7426 - val_loss: 0.4312
Epoch 13/200
25/25 ----- 0s 3ms/step - accuracy: 0.8096 - loss: 0.3989 - val_accuracy: 0.7228 - val_loss: 0.4263
Epoch 14/200
25/25 ----- 0s 3ms/step - accuracy: 0.8120 - loss: 0.3768 - val_accuracy: 0.7327 - val_loss: 0.4319
Epoch 15/200
25/25 ----- 0s 4ms/step - accuracy: 0.8205 - loss: 0.3880 - val_accuracy: 0.7228 - val_loss: 0.4268
Epoch 16/200
25/25 ----- 0s 3ms/step - accuracy: 0.8323 - loss: 0.3680 - val_accuracy: 0.7426 - val_loss: 0.4313
(keras.src.callbacks.history.history at 0x7eb8163420eb)
```



Accuracy: 78.57

Experiment 2:

Layer : 2 hidden layer (64,8,1)

Activation : ReLU

Batch Size : 16

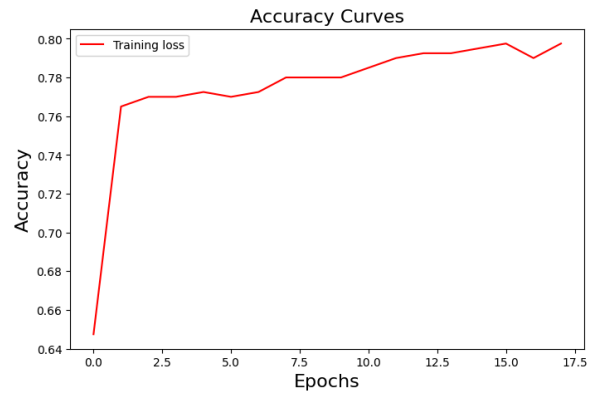
Epoch : 200

Optimizer : rmsprop

Loss : binary cross-entropy

Result : **stopped at epoch-18**

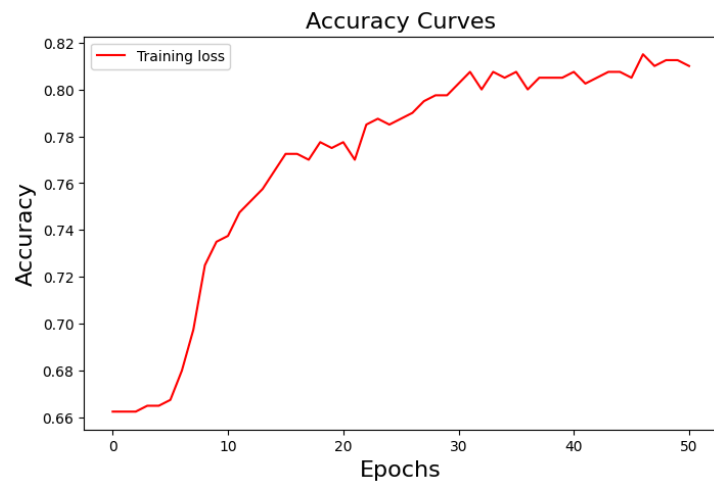
```
Epoch 15/200      0s 3ms/step - accuracy: 0.7776 - loss: 0.4271 - val_accuracy: 0.7426 - val_loss: 0.4411
Epoch 16/200      0s 3ms/step - accuracy: 0.7697 - loss: 0.4365 - val_accuracy: 0.7426 - val_loss: 0.4415
Epoch 17/200      0s 4ms/step - accuracy: 0.7941 - loss: 0.3835 - val_accuracy: 0.7327 - val_loss: 0.4421
Epoch 18/200      0s 3ms/step - accuracy: 0.7908 - loss: 0.4038 - val_accuracy: 0.7426 - val_loss: 0.4421
keras.src.callbacks.history.history at 0x7eb888ebcd80
```



Accuracy: 76.19

Contoh early stopping

```
Epoch 39/400      25/25      0s 3ms/step - accuracy: 0.8186 - loss: 0.4085 - val_accuracy: 0.7525 - val_loss: 0.4281
Epoch 40/400      25/25      0s 3ms/step - accuracy: 0.8224 - loss: 0.3962 - val_accuracy: 0.7624 - val_loss: 0.4274
Epoch 41/400      25/25      0s 3ms/step - accuracy: 0.7999 - loss: 0.4297 - val_accuracy: 0.7624 - val_loss: 0.4279
Epoch 42/400      25/25      0s 3ms/step - accuracy: 0.7764 - loss: 0.4556 - val_accuracy: 0.7525 - val_loss: 0.4294
Epoch 43/400      25/25      0s 3ms/step - accuracy: 0.7884 - loss: 0.4396 - val_accuracy: 0.7525 - val_loss: 0.4301
Epoch 44/400      25/25      0s 3ms/step - accuracy: 0.8113 - loss: 0.3890 - val_accuracy: 0.7624 - val_loss: 0.4294
Epoch 45/400      25/25      0s 3ms/step - accuracy: 0.7819 - loss: 0.4288 - val_accuracy: 0.7525 - val_loss: 0.4306
Epoch 46/400      25/25      0s 3ms/step - accuracy: 0.8034 - loss: 0.4002 - val_accuracy: 0.7624 - val_loss: 0.4295
Epoch 47/400      25/25      0s 3ms/step - accuracy: 0.8336 - loss: 0.4008 - val_accuracy: 0.7624 - val_loss: 0.4295
Epoch 48/400      25/25      0s 3ms/step - accuracy: 0.8222 - loss: 0.3851 - val_accuracy: 0.7822 - val_loss: 0.4291
Epoch 49/400      25/25      0s 3ms/step - accuracy: 0.8034 - loss: 0.3863 - val_accuracy: 0.7624 - val_loss: 0.4310
Epoch 50/400      25/25      0s 4ms/step - accuracy: 0.8116 - loss: 0.3947 - val_accuracy: 0.7624 - val_loss: 0.4307
Epoch 51/400      25/25      0s 4ms/step - accuracy: 0.7843 - loss: 0.4205 - val_accuracy: 0.7723 - val_loss: 0.4304
keras.src.callbacks.history.history at 0x7eb8302bbe50>
```



Accuracy: 79.37