Bonus in Assignment 3

2. Provide a report that shows model summary of each model and the best hyperparameters for each model (splitting ratio, sequence padding length ...) with a table showing the accuracy against each parameter (i.e. 80% 20% Ratio, 70% 30% Ratio, and same for sequence padding length).

Show model summary of each model

- ## RNN

  1- Data Pre-processing:
  The input data, Amazon reviews, are pre-processed (Lowercase letters, remove stopwords, and special characters).
  Cleaned reviews are stored in the 'cleaned_review' column.
  2- Data Splitting:
  The dataset is split into training and testing sets using (80%-20%) split ratio.
  3- Word Embedding:
  Tokenization is applied to convert text data into sequences of indices.
  Padding is applied to sequences to make them uniform in length for model input.
  4- Model Architecture:
  Sequential model is initialized.
  Embedding layer: Converts word indices into dense vectors of fixed size.
  SimpleRNN layer: Recurrent layer with 100 units.
  Dense layer with softmax activation: Output layer with 3 units representing sentiment classes.
  5- Model Compilation:
  Adam optimizer is used with sparse categorical cross-entropy loss function.
  Accuracy metric is used to evaluate model performance.
  6- Training:
  Model is trained on the training data for 10 epochs.
  Validation data is used for model evaluation after each epoch.

- ## LSTM

  1- Data Pre-processing:
  Same as RNN, the input data is pre-processed to lowercase, remove stopwords, and special characters.
  2- Data Splitting:

Similar splitting of dataset into training and validation sets.

3- Word Embedding:

Tokenization and padding are applied to convert text data into sequences of indices with uniform length.

4- Model Architecture:

Sequential model is initialized.

Embedding layer: Same as in RNN.

LSTM layer: Long Short-Term Memory layer with 100 units.

Dense layer with softmax activation: Output layer with 3 units representing sentiment classes.

5- Model Compilation:

Same optimizer, loss function, and metrics are used as in RNN.

6-Training:

Model is trained on the training data for 10 epochs with evaluation on validation data.

Trial 1:

Splitting ratio: 80% 20%

Sequence padding length (max_length): 50

```
Epoch 1/10
434/434 - 8s - loss: 0.7811 - accuracy: 0.6633 - val_loss: 0.7502 - val_accuracy: 0.6926 - 8s/epoch - 19ms/step
Epoch 2/10
434/434 - 7s - loss: 0.6237 - accuracy: 0.7636 - val_loss: 0.6605 - val_accuracy: 0.7442 - 7s/epoch - 16ms/step
Epoch 3/10
434/434 - 7s - loss: 0.5265 - accuracy: 0.8068 - val_loss: 0.6963 - val_accuracy: 0.6949 - 7s/epoch - 16ms/step
Epoch 4/10
434/434 - 7s - loss: 0.4465 - accuracy: 0.8354 - val_loss: 0.5665 - val_accuracy: 0.7858 - 7s/epoch - 16ms/step
Epoch 5/10
434/434 - 7s - loss: 0.3568 - accuracy: 0.8669 - val_loss: 0.5507 - val_accuracy: 0.7961 - 7s/epoch - 16ms/step
Epoch 6/10
434/434 - 7s - loss: 0.6863 - accuracy: 0.7004 - val_loss: 0.8045 - val_accuracy: 0.6597 - 7s/epoch - 16ms/step
Epoch 7/10
434/434 - 7s - loss: 0.6849 - accuracy: 0.7302 - val_loss: 0.7981 - val_accuracy: 0.6675 - 7s/epoch - 16ms/step
Epoch 8/10
434/434 - 7s - loss: 0.5988 - accuracy: 0.7690 - val_loss: 0.6601 - val_accuracy: 0.7500 - 7s/epoch - 16ms/step
Epoch 9/10
434/434 - 7s - loss: 0.4137 - accuracy: 0.8483 - val_loss: 0.5637 - val_accuracy: 0.8062 - 7s/epoch - 16ms/step
Epoch 10/10
434/434 - 7s - loss: 0.3212 - accuracy: 0.8889 - val_loss: 0.5266 - val_accuracy: 0.8152 - 7s/epoch - 16ms/step
Epoch 1/10
434/434 - 21s - loss: 0.8669 - accuracy: 0.5877 - val_loss: 0.8450 - val_accuracy: 0.6116 - 21s/epoch - 48ms/step
Epoch 2/10
434/434 - 20s - loss: 0.6865 - accuracy: 0.7303 - val_loss: 0.5488 - val_accuracy: 0.7904 - 20s/epoch - 47ms/step
Epoch 3/10
434/434 - 20s - loss: 0.4449 - accuracy: 0.8326 - val_loss: 0.4449 - val_accuracy: 0.8206 - 20s/epoch - 45ms/step
Epoch 4/10
434/434 - 21s - loss: 0.3052 - accuracy: 0.8932 - val_loss: 0.3948 - val_accuracy: 0.8653 - 21s/epoch - 48ms/step
Epoch 5/10
434/434 - 20s - loss: 0.2224 - accuracy: 0.9309 - val_loss: 0.4109 - val_accuracy: 0.8578 - 20s/epoch - 46ms/step
Epoch 6/10
434/434 - 20s - loss: 0.1716 - accuracy: 0.9488 - val_loss: 0.4315 - val_accuracy: 0.8645 - 20s/epoch - 46ms/step
Epoch 7/10
434/434 - 19s - loss: 0.1340 - accuracy: 0.9626 - val_loss: 0.4958 - val_accuracy: 0.8676 - 19s/epoch - 45ms/step
Epoch 8/10
434/434 - 19s - loss: 0.1211 - accuracy: 0.9673 - val_loss: 0.4395 - val_accuracy: 0.8734 - 19s/epoch - 44ms/step
Epoch 9/10
434/434 - 19s - loss: 0.1092 - accuracy: 0.9709 - val_loss: 0.4493 - val_accuracy: 0.8749 - 19s/epoch - 44ms/step
Epoch 10/10
434/434 - 20s - loss: 0.0998 - accuracy: 0.9743 - val_loss: 0.4830 - val_accuracy: 0.8691 - 20s/epoch - 46ms/step
[1]: <keras.src.callbacks.History at 0x2163bfa4730>
```

Trial 2:

Splitting ratio: 80% 20%

Sequence padding length (max_length): 70

```
Epoch 1/10
434/434 - 9s - loss: 0.9163 - accuracy: 0.5450 - val_loss: 0.9311 - val_accuracy: 0.5435 - 9s/epoch - 21ms/step
Epoch 2/10
434/434 - 8s - loss: 0.9078 - accuracy: 0.5425 - val_loss: 0.9307 - val_accuracy: 0.5415 - 8s/epoch - 19ms/step
Epoch 3/10
434/434 - 8s - loss: 0.9067 - accuracy: 0.5491 - val_loss: 0.9248 - val_accuracy: 0.5415 - 8s/epoch - 20ms/step
Epoch 4/10
434/434 - 9s - loss: 0.8997 - accuracy: 0.5509 - val_loss: 0.9250 - val_accuracy: 0.5415 - 9s/epoch - 20ms/step
Epoch 5/10
434/434 - 9s - loss: 0.8948 - accuracy: 0.5549 - val_loss: 0.9236 - val_accuracy: 0.5392 - 9s/epoch - 20ms/step
Epoch 6/10
434/434 - 9s - loss: 0.8949 - accuracy: 0.5542 - val_loss: 0.9349 - val_accuracy: 0.5395 - 9s/epoch - 20ms/step
Epoch 7/10
434/434 - 9s - loss: 0.8952 - accuracy: 0.5507 - val_loss: 0.9257 - val_accuracy: 0.5401 - 9s/epoch - 20ms/step
Epoch 8/10
434/434 - 9s - loss: 0.8937 - accuracy: 0.5505 - val_loss: 0.9365 - val_accuracy: 0.5401 - 9s/epoch - 20ms/step
Epoch 9/10
434/434 - 9s - loss: 0.8961 - accuracy: 0.5501 - val_loss: 0.9319 - val_accuracy: 0.5395 - 9s/epoch - 20ms/step
Epoch 10/10
434/434 - 9s - loss: 0.8914 - accuracy: 0.5513 - val_loss: 0.9340 - val_accuracy: 0.5415 - 9s/epoch - 20ms/step
Epoch 1/10
434/434 - 29s - loss: 0.9147 - accuracy: 0.5490 - val_loss: 0.9253 - val_accuracy: 0.5421 - 29s/epoch - 66ms/step
Epoch 2/10
434/434 - 26s - loss: 0.8778 - accuracy: 0.5804 - val_loss: 0.9019 - val_accuracy: 0.5779 - 26s/epoch - 59ms/step
Epoch 3/10
434/434 - 26s - loss: 0.8751 - accuracy: 0.5812 - val_loss: 0.9220 - val_accuracy: 0.5424 - 26s/epoch - 60ms/step
Epoch 4/10
434/434 - 29s - loss: 0.8988 - accuracy: 0.5526 - val_loss: 0.9213 - val_accuracy: 0.5427 - 29s/epoch - 68ms/step
Epoch 5/10
434/434 - 26s - loss: 0.8978 - accuracy: 0.5534 - val_loss: 0.9241 - val_accuracy: 0.5430 - 26s/epoch - 61ms/step
Epoch 6/10
434/434 - 28s - loss: 0.8912 - accuracy: 0.5590 - val_loss: 0.8752 - val_accuracy: 0.6249 - 28s/epoch - 64ms/step
Epoch 7/10
434/434 - 28s - loss: 0.6100 - accuracy: 0.7660 - val_loss: 0.5762 - val_accuracy: 0.7739 - 28s/epoch - 64ms/step
Epoch 8/10
434/434 - 29s - loss: 0.4732 - accuracy: 0.8275 - val_loss: 0.5314 - val_accuracy: 0.8071 - 29s/epoch - 67ms/step
Epoch 9/10
434/434 - 29s - loss: 0.3918 - accuracy: 0.8581 - val_loss: 0.5130 - val_accuracy: 0.8163 - 29s/epoch - 66ms/step
Epoch 10/10
434/434 - 27s - loss: 0.3278 - accuracy: 0.8838 - val_loss: 0.4785 - val_accuracy: 0.8411 - 27s/epoch - 61ms/step
<keras.src.callbacks.History at 0x2677870e370>
```

Trial 3:

Splitting ratio: 80% 20%

Sequence padding length (max_length): 35

```
Epoch 1/10
434/434 - 7s - loss: 0.7042 - accuracy: 0.7114 - val_loss: 0.6189 - val_accuracy: 0.7670 - 7s/epoch - 16ms/step
Epoch 2/10
434/434 - 6s - loss: 0.4501 - accuracy: 0.8311 - val_loss: 0.4491 - val_accuracy: 0.8348 - 6s/epoch - 13ms/step
Epoch 3/10
434/434 - 6s - loss: 0.2673 - accuracy: 0.9123 - val_loss: 0.5004 - val_accuracy: 0.8097 - 6s/epoch - 13ms/step
Epoch 4/10
434/434 - 6s - loss: 0.1700 - accuracy: 0.9466 - val_loss: 0.5413 - val_accuracy: 0.8356 - 6s/epoch - 13ms/step
Epoch 5/10
434/434 - 6s - loss: 0.1413 - accuracy: 0.9544 - val_loss: 0.4900 - val_accuracy: 0.8506 - 6s/epoch - 13ms/step
Epoch 6/10
434/434 - 6s - loss: 0.1002 - accuracy: 0.9689 - val_loss: 0.5656 - val_accuracy: 0.8521 - 6s/epoch - 13ms/step
Epoch 7/10
434/434 - 6s - loss: 0.0948 - accuracy: 0.9694 - val_loss: 0.5860 - val_accuracy: 0.8414 - 6s/epoch - 13ms/step
Epoch 8/10
434/434 - 6s - loss: 0.0781 - accuracy: 0.9766 - val_loss: 0.6084 - val_accuracy: 0.8475 - 6s/epoch - 13ms/step
Epoch 9/10
434/434 - 6s - loss: 0.0780 - accuracy: 0.9737 - val_loss: 0.6510 - val_accuracy: 0.8359 - 6s/epoch - 13ms/step
Epoch 10/10
434/434 - 6s - loss: 0.0693 - accuracy: 0.9792 - val_loss: 0.6217 - val_accuracy: 0.8400 - 6s/epoch - 13ms/step
Epoch 1/10
434/434 - 16s - loss: 0.6631 - accuracy: 0.7150 - val_loss: 0.4608 - val_accuracy: 0.8106 - 16s/epoch - 37ms/step
Epoch 2/10
434/434 - 14s - loss: 0.3650 - accuracy: 0.8670 - val_loss: 0.3921 - val_accuracy: 0.8524 - 14s/epoch - 32ms/step
Epoch 3/10
434/434 - 14s - loss: 0.2716 - accuracy: 0.9079 - val_loss: 0.4125 - val_accuracy: 0.8475 - 14s/epoch - 33ms/step
Epoch 4/10
434/434 - 14s - loss: 0.2101 - accuracy: 0.9335 - val_loss: 0.4349 - val_accuracy: 0.8607 - 14s/epoch - 33ms/step
Epoch 5/10
434/434 - 14s - loss: 0.1750 - accuracy: 0.9481 - val_loss: 0.4231 - val_accuracy: 0.8633 - 14s/epoch - 32ms/step
Epoch 6/10
434/434 - 14s - loss: 0.1442 - accuracy: 0.9578 - val_loss: 0.4163 - val_accuracy: 0.8700 - 14s/epoch - 32ms/step
Epoch 7/10
434/434 - 14s - loss: 0.1219 - accuracy: 0.9674 - val_loss: 0.5459 - val_accuracy: 0.8662 - 14s/epoch - 32ms/step
Epoch 8/10
434/434 - 14s - loss: 0.1101 - accuracy: 0.9689 - val_loss: 0.4906 - val_accuracy: 0.8653 - 14s/epoch - 33ms/step
Epoch 9/10
434/434 - 14s - loss: 0.0899 - accuracy: 0.9752 - val_loss: 0.5509 - val_accuracy: 0.8607 - 14s/epoch - 33ms/step
Epoch 10/10
434/434 - 14s - loss: 0.0824 - accuracy: 0.9787 - val_loss: 0.5339 - val_accuracy: 0.8694 - 14s/epoch - 32ms/step
[9]: <keras.src.callbacks.History at 0x267330365b0>
```

Trial 4:

Splitting ratio: 70% 30%

Sequence padding length (max_length): 50

```
Epoch 1/10
380/380 - 7s - loss: 0.9011 - accuracy: 0.5537 - val_loss: 0.8502 - val_accuracy: 0.6021 - 7s/epoch - 19ms/step
Epoch 2/10
380/380 - 6s - loss: 0.8671 - accuracy: 0.5779 - val_loss: 0.8894 - val_accuracy: 0.5736 - 6s/epoch - 16ms/step
Epoch 3/10
380/380 - 6s - loss: 0.8613 - accuracy: 0.5801 - val_loss: 0.8910 - val_accuracy: 0.5429 - 6s/epoch - 16ms/step
Epoch 4/10
380/380 - 6s - loss: 0.8539 - accuracy: 0.5814 - val_loss: 0.8820 - val_accuracy: 0.5746 - 6s/epoch - 16ms/step
Epoch 5/10
380/380 - 6s - loss: 0.8541 - accuracy: 0.5849 - val_loss: 0.8845 - val_accuracy: 0.5433 - 6s/epoch - 16ms/step
Epoch 6/10
380/380 - 6s - loss: 0.8480 - accuracy: 0.5920 - val_loss: 0.8892 - val_accuracy: 0.5673 - 6s/epoch - 16ms/step
Epoch 7/10
380/380 - 6s - loss: 0.8574 - accuracy: 0.5802 - val_loss: 0.9110 - val_accuracy: 0.5306 - 6s/epoch - 16ms/step
Epoch 8/10
380/380 - 6s - loss: 0.8589 - accuracy: 0.5781 - val_loss: 0.9033 - val_accuracy: 0.5390 - 6s/epoch - 16ms/step
Epoch 9/10
380/380 - 6s - loss: 0.8757 - accuracy: 0.5610 - val_loss: 0.9281 - val_accuracy: 0.5334 - 6s/epoch - 16ms/step
Epoch 10/10
380/380 - 6s - loss: 0.8957 - accuracy: 0.5465 - val_loss: 0.9045 - val_accuracy: 0.5569 - 6s/epoch - 16ms/step
Epoch 1/10
380/380 - 20s - loss: 0.8692 - accuracy: 0.6006 - val_loss: 0.8139 - val_accuracy: 0.6603 - 20s/epoch - 52ms/step
Epoch 2/10
380/380 - 18s - loss: 0.7730 - accuracy: 0.6874 - val_loss: 0.7702 - val_accuracy: 0.7157 - 18s/epoch - 47ms/step
Epoch 3/10
380/380 - 18s - loss: 0.8431 - accuracy: 0.6069 - val_loss: 0.9325 - val_accuracy: 0.5719 - 18s/epoch - 47ms/step
Epoch 4/10
380/380 - 18s - loss: 0.8227 - accuracy: 0.6263 - val_loss: 0.9159 - val_accuracy: 0.5427 - 18s/epoch - 46ms/step
Epoch 5/10
380/380 - 19s - loss: 0.8957 - accuracy: 0.5521 - val_loss: 0.9087 - val_accuracy: 0.5442 - 19s/epoch - 49ms/step
Epoch 6/10
380/380 - 17s - loss: 0.8555 - accuracy: 0.5949 - val_loss: 0.7903 - val_accuracy: 0.6943 - 17s/epoch - 46ms/step
Epoch 7/10
380/380 - 17s - loss: 0.7608 - accuracy: 0.6852 - val_loss: 0.7690 - val_accuracy: 0.6963 - 17s/epoch - 45ms/step
Epoch 8/10
380/380 - 18s - loss: 0.6554 - accuracy: 0.7507 - val_loss: 0.7260 - val_accuracy: 0.7389 - 18s/epoch - 46ms/step
Epoch 9/10
380/380 - 18s - loss: 0.7680 - accuracy: 0.6365 - val_loss: 0.6956 - val_accuracy: 0.6717 - 18s/epoch - 48ms/step
Epoch 10/10
380/380 - 18s - loss: 0.6565 - accuracy: 0.7411 - val_loss: 0.6476 - val_accuracy: 0.7453 - 18s/epoch - 48ms/step

<keras.src.callbacks.History at 0x267427a43a0>
```

Trial 5:

Splitting ratio: 70% 30%

Sequence padding length (max_length): 70

```
Epoch 1/10
380/380 - 9s - loss: 0.9212 - accuracy: 0.5401 - val_loss: 0.9222 - val_accuracy: 0.5354 - 9s/epoch - 23ms/step
Epoch 2/10
380/380 - 8s - loss: 0.9092 - accuracy: 0.5484 - val_loss: 0.9156 - val_accuracy: 0.5423 - 8s/epoch - 21ms/step
Epoch 3/10
380/380 - 8s - loss: 0.9055 - accuracy: 0.5486 - val_loss: 0.9178 - val_accuracy: 0.5423 - 8s/epoch - 21ms/step
Epoch 4/10
380/380 - 8s - loss: 0.9023 - accuracy: 0.5516 - val_loss: 0.9265 - val_accuracy: 0.5390 - 8s/epoch - 20ms/step
Epoch 5/10
380/380 - 8s - loss: 0.9061 - accuracy: 0.5454 - val_loss: 0.9236 - val_accuracy: 0.5000 - 8s/epoch - 20ms/step
Epoch 6/10
380/380 - 8s - loss: 0.8680 - accuracy: 0.5746 - val_loss: 0.8390 - val_accuracy: 0.6078 - 8s/epoch - 20ms/step
Epoch 7/10
380/380 - 8s - loss: 0.8548 - accuracy: 0.5945 - val_loss: 0.8631 - val_accuracy: 0.6061 - 8s/epoch - 21ms/step
Epoch 8/10
380/380 - 8s - loss: 0.7661 - accuracy: 0.6731 - val_loss: 0.7984 - val_accuracy: 0.6499 - 8s/epoch - 22ms/step
Epoch 9/10
380/380 - 8s - loss: 0.7381 - accuracy: 0.7030 - val_loss: 0.8220 - val_accuracy: 0.6517 - 8s/epoch - 20ms/step
Epoch 10/10
380/380 - 8s - loss: 0.7254 - accuracy: 0.7078 - val_loss: 0.7925 - val_accuracy: 0.6634 - 8s/epoch - 20ms/step
Epoch 1/10
380/380 - 25s - loss: 0.9148 - accuracy: 0.5504 - val_loss: 0.9170 - val_accuracy: 0.5427 - 25s/epoch - 66ms/step
Epoch 2/10
380/380 - 23s - loss: 0.9085 - accuracy: 0.5511 - val_loss: 0.9189 - val_accuracy: 0.5434 - 23s/epoch - 61ms/step
Epoch 3/10
380/380 - 22s - loss: 0.8978 - accuracy: 0.5564 - val_loss: 0.9177 - val_accuracy: 0.5431 - 22s/epoch - 59ms/step
Epoch 4/10
380/380 - 22s - loss: 0.9051 - accuracy: 0.5531 - val_loss: 0.9192 - val_accuracy: 0.5438 - 22s/epoch - 59ms/step
Epoch 5/10
380/380 - 23s - loss: 0.8974 - accuracy: 0.5567 - val_loss: 0.9122 - val_accuracy: 0.5438 - 23s/epoch - 60ms/step
Epoch 6/10
380/380 - 23s - loss: 0.8740 - accuracy: 0.5704 - val_loss: 0.8693 - val_accuracy: 0.5973 - 23s/epoch - 60ms/step
Epoch 7/10
380/380 - 23s - loss: 0.7833 - accuracy: 0.6484 - val_loss: 0.7745 - val_accuracy: 0.6392 - 23s/epoch - 59ms/step
Epoch 8/10
380/380 - 23s - loss: 0.7454 - accuracy: 0.6601 - val_loss: 0.7811 - val_accuracy: 0.6409 - 23s/epoch - 61ms/step
Epoch 9/10
380/380 - 23s - loss: 0.7195 - accuracy: 0.6712 - val_loss: 0.7855 - val_accuracy: 0.6436 - 23s/epoch - 60ms/step
Epoch 10/10
380/380 - 23s - loss: 0.5528 - accuracy: 0.7738 - val_loss: 0.4821 - val_accuracy: 0.8201 - 23s/epoch - 60ms/step
<keras.src.callbacks.History at 0x267786dbf10>
```

Trial 6:

Splitting ratio: 70% 30%

Sequence padding length (max_length): 35

```
Epoch 1/10
380/380 - 6s - loss: 0.7577 - accuracy: 0.6667 - val_loss: 0.6172 - val_accuracy: 0.7528 - 6s/epoch - 17ms/step
Epoch 2/10
380/380 - 5s - loss: 0.4584 - accuracy: 0.8267 - val_loss: 0.6417 - val_accuracy: 0.7522 - 5s/epoch - 14ms/step
Epoch 3/10
380/380 - 5s - loss: 0.2851 - accuracy: 0.8993 - val_loss: 0.6071 - val_accuracy: 0.7524 - 5s/epoch - 13ms/step
Epoch 4/10
380/380 - 5s - loss: 0.1605 - accuracy: 0.9477 - val_loss: 0.5981 - val_accuracy: 0.8026 - 5s/epoch - 13ms/step
Epoch 5/10
380/380 - 5s - loss: 0.1195 - accuracy: 0.9616 - val_loss: 0.6445 - val_accuracy: 0.8001 - 5s/epoch - 13ms/step
Epoch 6/10
380/380 - 5s - loss: 0.0886 - accuracy: 0.9734 - val_loss: 0.6626 - val_accuracy: 0.8128 - 5s/epoch - 13ms/step
Epoch 7/10
380/380 - 5s - loss: 0.0800 - accuracy: 0.9747 - val_loss: 0.7201 - val_accuracy: 0.8018 - 5s/epoch - 14ms/step
Epoch 8/10
380/380 - 5s - loss: 0.0757 - accuracy: 0.9760 - val_loss: 0.6667 - val_accuracy: 0.8131 - 5s/epoch - 13ms/step
Epoch 9/10
380/380 - 5s - loss: 0.0507 - accuracy: 0.9853 - val_loss: 0.7506 - val_accuracy: 0.8072 - 5s/epoch - 14ms/step
Epoch 10/10
380/380 - 5s - loss: 0.0631 - accuracy: 0.9797 - val_loss: 0.8739 - val_accuracy: 0.7735 - 5s/epoch - 14ms/step
Epoch 1/10
380/380 - 16s - loss: 0.6477 - accuracy: 0.7147 - val_loss: 0.4811 - val_accuracy: 0.8137 - 16s/epoch - 42ms/step
Epoch 2/10
380/380 - 13s - loss: 0.3914 - accuracy: 0.8598 - val_loss: 0.4449 - val_accuracy: 0.8403 - 13s/epoch - 34ms/step
Epoch 3/10
380/380 - 13s - loss: 0.2782 - accuracy: 0.9076 - val_loss: 0.4165 - val_accuracy: 0.8599 - 13s/epoch - 34ms/step
Epoch 4/10
380/380 - 13s - loss: 0.2155 - accuracy: 0.9345 - val_loss: 0.4119 - val_accuracy: 0.8483 - 13s/epoch - 34ms/step
Epoch 5/10
380/380 - 13s - loss: 0.1775 - accuracy: 0.9475 - val_loss: 0.4758 - val_accuracy: 0.8583 - 13s/epoch - 34ms/step
Epoch 6/10
380/380 - 13s - loss: 0.1480 - accuracy: 0.9572 - val_loss: 0.4853 - val_accuracy: 0.8541 - 13s/epoch - 34ms/step
Epoch 7/10
380/380 - 13s - loss: 0.1233 - accuracy: 0.9682 - val_loss: 0.5345 - val_accuracy: 0.8591 - 13s/epoch - 34ms/step
Epoch 8/10
380/380 - 13s - loss: 0.1162 - accuracy: 0.9698 - val_loss: 0.5631 - val_accuracy: 0.8462 - 13s/epoch - 34ms/step
Epoch 9/10
380/380 - 13s - loss: 0.1019 - accuracy: 0.9742 - val_loss: 0.5365 - val_accuracy: 0.8526 - 13s/epoch - 33ms/step
Epoch 10/10
380/380 - 13s - loss: 0.0916 - accuracy: 0.9774 - val_loss: 0.5700 - val_accuracy: 0.8481 - 13s/epoch - 33ms/step

<keras.src.callbacks.History at 0x2673bb7b2b0>
```