Downloading the data

```
!curl -O https://ai.stanford.edu/~amaas/data/sentiment/aclImdb_v1.tar.gz
!tar -xf aclImdb_v1.tar.gz
!rm -r aclImdb/train/unsup
```

```
  % Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left  Speed
100 80.2M  100 80.2M    0     0  48.4M      0  0:00:01  0:00:01 --:--:-- 48.4M
```

Preparing the data

```
import os, pathlib, shutil, random
from tensorflow import keras
batchSize = 32
base_dir= pathlib.Path("/content/aclImdb")
val_dir = base_dir/ "val"
train_dir = base_dir / "train"
for category in ("neg", "pos"):
    os.makedirs(val_dir / category, exist_ok=True )

    files = os.listdir(train_dir / category)
    random.Random(1496).shuffle(files)
    num_val_samples = 10000
    validation_files = files[-num_val_samples:]
    for fname in validation_files:
        shutil.move(train_dir / category / fname,
                    val_dir / category / fname)

raw_train_dataset = keras.utils.text_dataset_from_directory(
    "aclImdb/train", batch_size=batchSize
).take(100)  # Restrict training samples to 100

raw_validation_dataset = keras.utils.text_dataset_from_directory(
    "/content/aclImdb/val", batch_size=batchSize
)
raw_test_dataset = keras.utils.text_dataset_from_directory(
    "aclImdb/test", batch_size=batchSize
)
te_only_raw_train_dataset = raw_train_dataset.map(lambda x, y: x)
```

```
Found 5000 files belonging to 2 classes.
Found 20000 files belonging to 2 classes.
Found 25000 files belonging to 2 classes.
```

Setting up datasets for numeric sequences

A sequence sentiment_classifier built on one-hot encoded vector sequences

```
from tensorflow.keras import layers

MAX_SEQUENCE_LENGTH = 150   # Cutoff reviews after 150 words
MAX_VOCAB_SIZE = 10000      # Consider only the top 10,000 words

# Define TextVectorization layer
text_vectorizer_layer = layers.TextVectorization(
    max_tokens=MAX_VOCAB_SIZE,
    output_mode="int",
    output_sequence_length=MAX_SEQUENCE_LENGTH,
)

# Extract texts only from raw_train_dataset for vectorization adaptation
train_texts_only = raw_train_dataset.map(lambda x, y: x)
text_vectorizer_layer.adapt(train_texts_only)

# Vectorize the train, validation, and test datasets
raw_train_dataset_vectorized = raw_train_dataset.map(
    lambda x, y: (text_vectorizer_layer(x), y),
    num_parallel_calls=4
)
val_dataset_vectorized = raw_validation_dataset.map(
```

```
    lambda x, y: (text_vectorizer_layer(x), y),
    num_parallel_calls=4
)
raw_test_dataset_vectorized = raw_test_dataset.map(
    lambda x, y: (text_vectorizer_layer(x), y),
    num_parallel_calls=4
)
```

```
import tensorflow as tf  # sentiment_classifier with embedding layer

input_tokens = keras.Input(shape=(None,), dtype="int64")
trainable_embedding_layer_output = layers.Embedding(input_dim=MAX_VOCAB_SIZE, output_dim=256, mask_zero=True)(input_t
x = layers.Bidirectional(layers.LSTM(32))(trainable_embedding_layer_output)
x = layers.Dropout(0.5)(x)
prediction_layer = layers.Dense(1, activation="sigmoid")(x)

sentiment_classifier = keras.Model(input_tokens, prediction_layer)
sentiment_classifier.compile(optimizer="rmsprop",
             loss="binary_crossentropy",
             metrics=["accuracy"])

sentiment_classifier.summary()
```

Model: "functional"

Layer (type)	Output Shape	Param #	Connected to
input_layer (InputLayer)	(None, None)	0	–
embedding (Embedding)	(None, None, 256)	2,560,000	input_layer[0][0]
not_equal (NotEqual)	(None, None)	0	input_layer[0][0]
bidirectional (Bidirectional)	(None, 64)	73,984	embedding[0][0], not_equal[0][0]
dropout (Dropout)	(None, 64)	0	bidirectional[0]…
dense (Dense)	(None, 1)	65	dropout[0][0]

Total params: 2,634,049 (10.05 MB)
Trainable params: 2,634,049 (10.05 MB)
Non-trainable params: 0 (0.00 B)

Developing a fundamental sequencing concept initially

```
model_checkpoint_callback = [
    keras.callbacks.ModelCheckpoint("one_hot_bidir_lstm.keras", save_best_only=True)
]

history = sentiment_classifier.fit(
    raw_train_dataset_vectorized,
    validation_data=val_dataset_vectorized,
    epochs=15,
    callbacks=model_checkpoint_callback
)
```

```
Epoch 1/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 11s 69ms/step - accuracy: 0.5234 - loss: 0.6907 - val_accuracy: 0.6611 - val_loss: 0
Epoch 2/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 13s 127ms/step - accuracy: 0.6969 - loss: 0.5928 - val_accuracy: 0.7649 - val_loss:
Epoch 3/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 20s 121ms/step - accuracy: 0.7965 - loss: 0.4388 - val_accuracy: 0.7950 - val_loss:
Epoch 4/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 15s 63ms/step - accuracy: 0.8663 - loss: 0.3259 - val_accuracy: 0.7834 - val_loss: 0
Epoch 5/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 10s 64ms/step - accuracy: 0.9035 - loss: 0.2396 - val_accuracy: 0.7685 - val_loss: 0
Epoch 6/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 11s 69ms/step - accuracy: 0.9414 - loss: 0.1497 - val_accuracy: 0.7665 - val_loss: 0
Epoch 7/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 12s 121ms/step - accuracy: 0.9620 - loss: 0.1183 - val_accuracy: 0.7254 - val_loss:
Epoch 8/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 20s 120ms/step - accuracy: 0.9750 - loss: 0.0713 - val_accuracy: 0.7666 - val_loss:
```

```
Epoch 9/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 15s 64ms/step - accuracy: 0.9791 - loss: 0.0607 - val_accuracy: 0.7534 - val_loss: 0
Epoch 10/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 12s 122ms/step - accuracy: 0.9895 - loss: 0.0418 - val_accuracy: 0.7657 - val_loss:
Epoch 11/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 20s 120ms/step - accuracy: 0.9918 - loss: 0.0320 - val_accuracy: 0.7753 - val_loss:
Epoch 12/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 12s 120ms/step - accuracy: 0.9959 - loss: 0.0188 - val_accuracy: 0.7734 - val_loss:
Epoch 13/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 7s 70ms/step - accuracy: 0.9890 - loss: 0.0395 - val_accuracy: 0.7500 - val_loss: 0.
Epoch 14/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 7s 67ms/step - accuracy: 0.9970 - loss: 0.0145 - val_accuracy: 0.7792 - val_loss: 0.
Epoch 15/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 10s 65ms/step - accuracy: 0.9891 - loss: 0.0351 - val_accuracy: 0.7141 - val_loss: 1
```

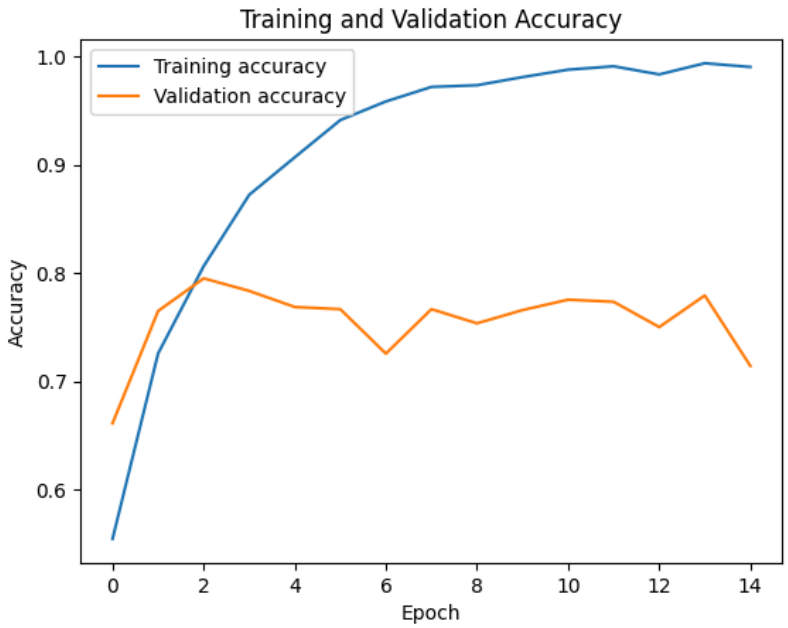
```
sentiment_classifier = keras.models.load_model('one_hot_bidir_lstm.keras')
print(f"Test acc: {sentiment_classifier.evaluate(raw_test_dataset_vectorized)[1]:.3f}")
```

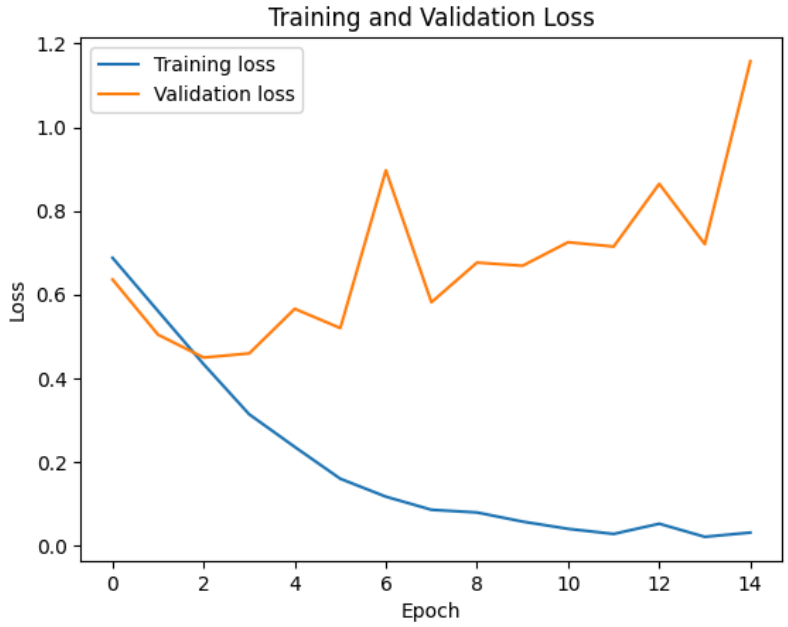
```
782/782 ━━━━━━━━━━━━━━━━━━━━ 8s 9ms/step - accuracy: 0.7966 - loss: 0.4466
Test acc: 0.790
```

```
import matplotlib.pyplot as plt

# Plot training and validation accuracy
plt.plot(history.history['accuracy'], label='Training accuracy')
plt.plot(history.history['val_accuracy'], label='Validation accuracy')
plt.title('Training and Validation Accuracy')
plt.xlabel('Epoch')
plt.ylabel('Accuracy')
plt.legend()
plt.show()

# Plot training and validation loss
plt.plot(history.history['loss'], label='Training loss')
plt.plot(history.history['val_loss'], label='Validation loss')
plt.title('Training and Validation Loss')
plt.xlabel('Epoch')
plt.ylabel('Loss')
plt.legend()
plt.show()
```





Using the Embedded level to acquire embedded words

Putting an Anchoring level into Action

```
em_layer = layers.Embedding(input_dim=MAX_VOCAB_SIZE, output_dim=256)
```

Anchor layer system which was developed form start

```
# Define the model
in1 = keras.Input(shape=(None,), dtype="int64")
em1 = layers.Embedding(input_dim=MAX_VOCAB_SIZE, output_dim=256)(in1)
x = layers.Bidirectional(layers.LSTM(32))(em1)
x = layers.Dropout(0.5)(x)
prediction_layer1 = layers.Dense(1, activation="sigmoid")(x)

# Build the model correctly
sentiment_classifier = keras.Model(in1, prediction_layer1)

# Compile correctly
sentiment_classifier.compile(
    optimizer="rmsprop",
    loss="binary_crossentropy",
    metrics=["accuracy"]
)
```

```
# Model summary
sentiment_classifier.summary()
```

Model: "functional_1"

Layer (type)	Output Shape	Param #
input_layer_1 (InputLayer)	(None, None)	0
embedding_2 (Embedding)	(None, None, 256)	2,560,000
bidirectional_1 (Bidirectional)	(None, 64)	73,984
dropout_1 (Dropout)	(None, 64)	0
dense_1 (Dense)	(None, 1)	65

Total params: 2,634,049 (10.05 MB)
Trainable params: 2,634,049 (10.05 MB)
Non-trainable params: 0 (0.00 B)

```
# Correct ModelCheckpoint
model_checkpoint_callback1 = [
    keras.callbacks.ModelCheckpoint("embeddings_bidir_gru.keras", save_best_only=True)
]

# Correct model fitting
history1 = sentiment_classifier.fit(
    raw_train_dataset_vectorized,
    validation_data=val_dataset_vectorized,
    epochs=15,
    callbacks=model_checkpoint_callback1
)

# Correct way to load the best saved model
sentiment_classifier = keras.models.load_model("embeddings_bidir_gru.keras")

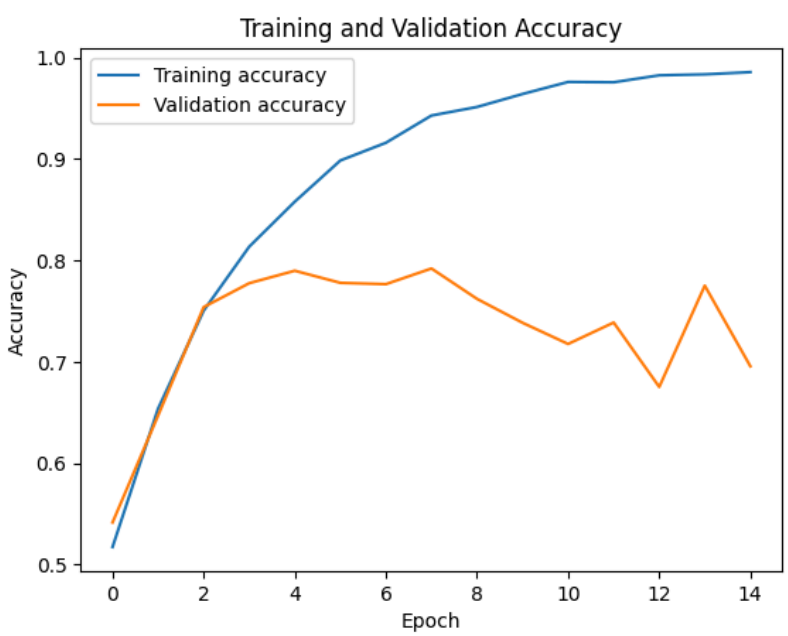
# Evaluate the loaded model
print(f"Test acc: {sentiment_classifier.evaluate(raw_test_dataset_vectorized)[1]:.3f}")
```

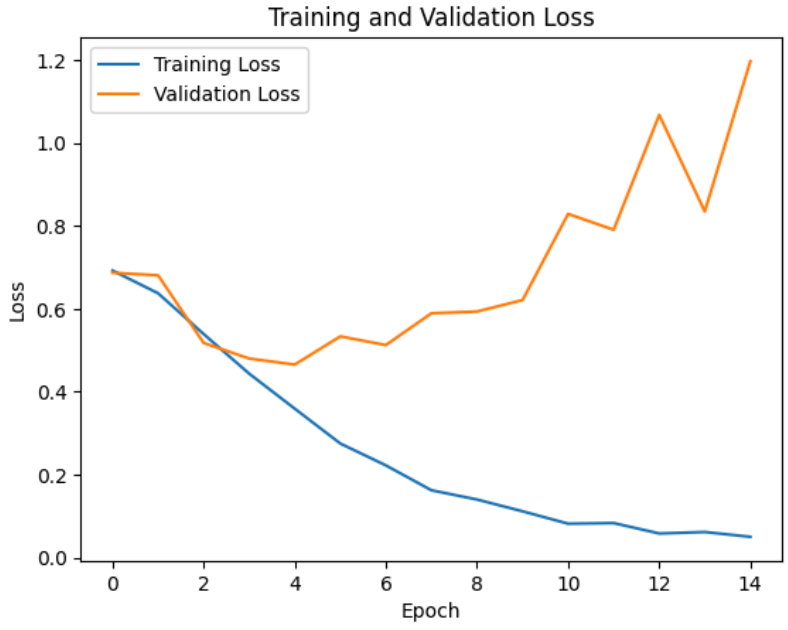
```
Epoch 1/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 10s 71ms/step - accuracy: 0.5015 - loss: 0.6938 - val_accuracy: 0.5414 - val_loss: 0
Epoch 2/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 7s 68ms/step - accuracy: 0.6283 - loss: 0.6607 - val_accuracy: 0.6469 - val_loss: 0.
Epoch 3/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 7s 68ms/step - accuracy: 0.7256 - loss: 0.5694 - val_accuracy: 0.7538 - val_loss: 0.
Epoch 4/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 10s 69ms/step - accuracy: 0.8136 - loss: 0.4495 - val_accuracy: 0.7774 - val_loss: 0
Epoch 5/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 7s 68ms/step - accuracy: 0.8556 - loss: 0.3628 - val_accuracy: 0.7897 - val_loss: 0.
Epoch 6/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 15s 119ms/step - accuracy: 0.8898 - loss: 0.2873 - val_accuracy: 0.7778 - val_loss:
Epoch 7/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 7s 68ms/step - accuracy: 0.9186 - loss: 0.2208 - val_accuracy: 0.7764 - val_loss: 0.
Epoch 8/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 6s 59ms/step - accuracy: 0.9455 - loss: 0.1564 - val_accuracy: 0.7919 - val_loss: 0.
Epoch 9/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 7s 67ms/step - accuracy: 0.9517 - loss: 0.1328 - val_accuracy: 0.7620 - val_loss: 0.
Epoch 10/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 6s 60ms/step - accuracy: 0.9649 - loss: 0.1077 - val_accuracy: 0.7383 - val_loss: 0.
Epoch 11/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 12s 118ms/step - accuracy: 0.9814 - loss: 0.0761 - val_accuracy: 0.7175 - val_loss:
Epoch 12/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 7s 68ms/step - accuracy: 0.9787 - loss: 0.0802 - val_accuracy: 0.7386 - val_loss: 0.
Epoch 13/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 10s 62ms/step - accuracy: 0.9896 - loss: 0.0417 - val_accuracy: 0.6751 - val_loss: 1
Epoch 14/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 10s 60ms/step - accuracy: 0.9792 - loss: 0.0711 - val_accuracy: 0.7750 - val_loss: 0
Epoch 15/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 7s 66ms/step - accuracy: 0.9882 - loss: 0.0399 - val_accuracy: 0.6955 - val_loss: 1.
782/782 ━━━━━━━━━━━━━━━━━━━━ 7s 8ms/step - accuracy: 0.7817 - loss: 0.4742
Test acc: 0.779
```

```
# Plot training and validation accuracy
plt.plot(history1.history['accuracy'], label='Training accuracy')
plt.plot(history1.history['val_accuracy'], label='Validation accuracy')
plt.title('Training and Validation Accuracy')
```

```
plt.xlabel('Epoch')
plt.ylabel('Accuracy')
plt.legend()
plt.show()

# Plot training and validation loss
plt.plot(history1.history['loss'], label='Training Loss')
plt.plot(history1.history['val_loss'], label='Validation Loss')
plt.title('Training and Validation Loss')
plt.xlabel('Epoch')
plt.ylabel('Loss')
plt.legend()
plt.show()
```





Recognizing blurring and filling

Applying filtering to an Anchoring level

```
in2 = keras.Input(shape=(None,), dtype="int64")
em2 = layers.Embedding(input_dim=MAX_VOCAB_SIZE, output_dim=256, mask_zero=True)(in2)
x = layers.Bidirectional(layers.LSTM(32))(em2)
x = layers.Dropout(0.5)(x)
prediction_layer2 = layers.Dense(1, activation="sigmoid")(x)

# ❗ Correct way to create the model
sentiment_classifier = keras.Model(in2, prediction_layer2)
```

```
# ! Correct way to compile the model
sentiment_classifier.compile(
    optimizer="rmsprop",
    loss="binary_crossentropy",
    metrics=["accuracy"]
)

# ! Correct way to print model summary
sentiment_classifier.summary()
```

Model: "functional_2"

Layer (type)	Output Shape	Param #	Connected to
input_layer_2 (InputLayer)	(None, None)	0	–
embedding_4 (Embedding)	(None, None, 256)	2,560,000	input_layer_2[0]…
not_equal_2 (NotEqual)	(None, None)	0	input_layer_2[0]…
bidirectional_2 (Bidirectional)	(None, 64)	73,984	embedding_4[0][0]… not_equal_2[0][0]
dropout_2 (Dropout)	(None, 64)	0	bidirectional_2[…
dense_2 (Dense)	(None, 1)	65	dropout_2[0][0]

Total params: 2,634,049 (10.05 MB)
Trainable params: 2,634,049 (10.05 MB)
Non-trainable params: 0 (0.00 B)

```
model_checkpoint_callback2 = [
    keras.callbacks.ModelCheckpoint("embeddings_bidir_gru_with_masking.keras", save_best_only=True)
]

history2 = sentiment_classifier.fit(
    raw_train_dataset_vectorized,
    validation_data=val_dataset_vectorized,
    epochs=15,
    callbacks=model_checkpoint_callback2
)
```

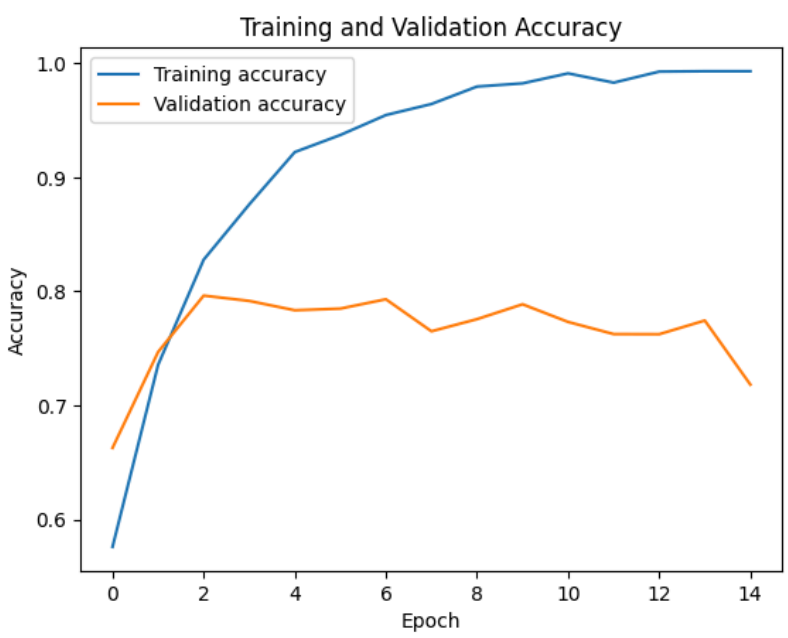
```
Epoch 1/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 14s 124ms/step - accuracy: 0.5439 - loss: 0.6893 - val_accuracy: 0.6628 - val_loss:
Epoch 2/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 15s 70ms/step - accuracy: 0.7106 - loss: 0.5763 - val_accuracy: 0.7469 - val_loss: 0
Epoch 3/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 10s 64ms/step - accuracy: 0.8084 - loss: 0.4293 - val_accuracy: 0.7963 - val_loss: 0
Epoch 4/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 12s 119ms/step - accuracy: 0.8675 - loss: 0.3163 - val_accuracy: 0.7916 - val_loss:
Epoch 5/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 12s 121ms/step - accuracy: 0.9181 - loss: 0.2216 - val_accuracy: 0.7835 - val_loss:
Epoch 6/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 20s 120ms/step - accuracy: 0.9415 - loss: 0.1533 - val_accuracy: 0.7849 - val_loss:
Epoch 7/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 12s 120ms/step - accuracy: 0.9516 - loss: 0.1314 - val_accuracy: 0.7931 - val_loss:
Epoch 8/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 12s 120ms/step - accuracy: 0.9730 - loss: 0.0745 - val_accuracy: 0.7650 - val_loss:
Epoch 9/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 7s 71ms/step - accuracy: 0.9835 - loss: 0.0534 - val_accuracy: 0.7757 - val_loss: 0.
Epoch 10/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 10s 68ms/step - accuracy: 0.9848 - loss: 0.0492 - val_accuracy: 0.7887 - val_loss: 0
Epoch 11/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 7s 73ms/step - accuracy: 0.9935 - loss: 0.0271 - val_accuracy: 0.7732 - val_loss: 0.
Epoch 12/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 12s 119ms/step - accuracy: 0.9895 - loss: 0.0372 - val_accuracy: 0.7625 - val_loss:
Epoch 13/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 15s 62ms/step - accuracy: 0.9960 - loss: 0.0211 - val_accuracy: 0.7624 - val_loss: 0
Epoch 14/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 10s 63ms/step - accuracy: 0.9977 - loss: 0.0156 - val_accuracy: 0.7745 - val_loss: 0
Epoch 15/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 10s 63ms/step - accuracy: 0.9959 - loss: 0.0125 - val_accuracy: 0.7182 - val_loss: 1
```

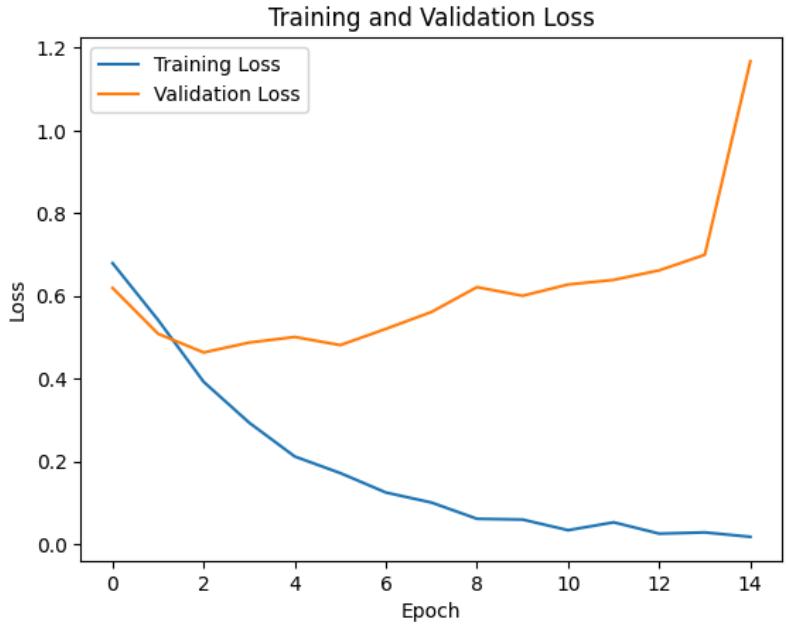
```
sentiment_classifier = keras.models.load_model("embeddings_bidir_gru_with_masking.keras")
print(f"Test acc: {sentiment_classifier.evaluate(raw_test_dataset_vectorized)[1]:.3f}")
```

```
782/782 ━━━━━━━━━━━━━━━━━━━━ 8s 9ms/step - accuracy: 0.8000 - loss: 0.4544
Test acc: 0.794
```

```
# Plot training and validation accuracy
plt.plot(history2.history['accuracy'], label='Training accuracy')
plt.plot(history2.history['val_accuracy'], label='Validation accuracy')
plt.title('Training and Validation Accuracy')
plt.xlabel('Epoch')
plt.ylabel('Accuracy')
plt.legend()
plt.show()

# Plot training and validation loss
plt.plot(history2.history['loss'], label='Training Loss')
plt.plot(history2.history['val_loss'], label='Validation Loss')
plt.title('Training and Validation Loss')
plt.xlabel('Epoch')
plt.ylabel('Loss')
plt.legend()
plt.show()
```





Preconditioned word embeds are used

```
!wget http://nlp.stanford.edu/data/glove.6B.zip
!unzip -q glove.6B.zip
```

```
!unzip -q glove.6B.zip
```

```
--2025-04-18 18:09:31--  http://nlp.stanford.edu/data/glove.6B.zip
Resolving nlp.stanford.edu (nlp.stanford.edu)... 171.64.67.140
Connecting to nlp.stanford.edu (nlp.stanford.edu)|171.64.67.140|:80... connected.
HTTP request sent, awaiting response... 302 Found
Location: https://nlp.stanford.edu/data/glove.6B.zip [following]
--2025-04-18 18:09:31--  https://nlp.stanford.edu/data/glove.6B.zip
Connecting to nlp.stanford.edu (nlp.stanford.edu)|171.64.67.140|:443... connected.
HTTP request sent, awaiting response... 301 Moved Permanently
Location: https://downloads.cs.stanford.edu/nlp/data/glove.6B.zip [following]
--2025-04-18 18:09:31--  https://downloads.cs.stanford.edu/nlp/data/glove.6B.zip
Resolving downloads.cs.stanford.edu (downloads.cs.stanford.edu)... 171.64.64.22
Connecting to downloads.cs.stanford.edu (downloads.cs.stanford.edu)|171.64.64.22|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 862182613 (822M) [application/zip]
Saving to: 'glove.6B.zip'

glove.6B.zip        100%[===================>] 822.24M  5.02MB/s    in 2m 39s

2025-04-18 18:12:10 (5.18 MB/s) - 'glove.6B.zip' saved [862182613/862182613]
```

Interpreting the word-embeddings package for One

```
import numpy as np
GLOVE_FILE_PATH = "glove.6B.100d.txt"

glove_embeddings = {}
with open(GLOVE_FILE_PATH) as f:
    for line in f:
        word, coefs = line.split(maxsplit=1)
        coefs = np.fromstring(coefs, "f", sep=" ")
        glove_embeddings[word] = coefs

print(f"Found {len(glove_embeddings)} word vectors.")
```

```
Found 400000 word vectors.
```

Setting up the matrix for the GloVe website embedded words

```
embedding_dimension = 100

vocab = text_vectorizer_layer.get_vocabulary()
vocab_to_index = dict(zip(vocab, range(len(vocab))))

glove_embedding_matrix = np.zeros((MAX_VOCAB_SIZE, embedding_dimension))
for word, i in vocab_to_index.items():
    if i < MAX_VOCAB_SIZE:
        em_vector = glove_embeddings.get(word)
    if em_vector is not None:
        glove_embedding_matrix[i] = em_vector


em_layer = layers.Embedding(
    MAX_VOCAB_SIZE,
    embedding_dimension,
    embeddings_initializer=keras.initializers.Constant(glove_embedding_matrix),
    trainable=False,
    mask_zero=True,
)
```

Architecture with an embedded level which has been trained

```
from tensorflow import keras
from tensorflow.keras import layers

# Define the model input
in4 = keras.Input(shape=(None,), dtype="int64")

# Apply the embedding layer
em4 = em_layer(in4)

# Define the LSTM layer with bidirectional wrapper
x = layers.Bidirectional(layers.LSTM(32))(em4)
```

```
# Apply dropout for regularization
x = layers.Dropout(0.5)(x)

# Define the output layer with sigmoid activation
prediction_layer4 = layers.Dense(1, activation="sigmoid")(x)

# Create the model
sentiment_classifier = keras.Model(inputs=in4, outputs=prediction_layer4)

# Compile the model
sentiment_classifier.compile(optimizer="rmsprop",
                        loss="binary_crossentropy",
                        metrics=["accuracy"])

# Display the model summary
sentiment_classifier.summary()
```

Model: "functional_5"

Layer (type)	Output Shape	Param #	Connected to
input_layer_5 (InputLayer)	(None, None)	0	–
embedding_6 (Embedding)	(None, None, 100)	1,000,000	input_layer_5[0]…
not_equal_6 (NotEqual)	(None, None)	0	input_layer_5[0]…
bidirectional_5 (Bidirectional)	(None, 64)	34,048	embedding_6[2][0]… not_equal_6[0][0]
dropout_5 (Dropout)	(None, 64)	0	bidirectional_5[…
dense_5 (Dense)	(None, 1)	65	dropout_5[0][0]

Total params: 1,034,113 (3.94 MB)
Trainable params: 34,113 (133.25 KB)
Non-trainable params: 1,000,000 (3.81 MB)

```
from tensorflow.keras.callbacks import ModelCheckpoint
from tensorflow import keras

# Define the ModelCheckpoint callback correctly
model_checkpoint_callback4 = [
    ModelCheckpoint("glove_embeddings_sequence_sentiment_classifier.keras",
                    save_best_only=True)
]

# Train the model
history4 = sentiment_classifier.fit(raw_train_dataset_vectorized,
                                validation_data=val_dataset_vectorized,
                                epochs=15,
                                callbacks=model_checkpoint_callback4)

# Load the best model saved during training
sentiment_classifier = keras.models.load_model("glove_embeddings_sequence_sentiment_classifier.keras")

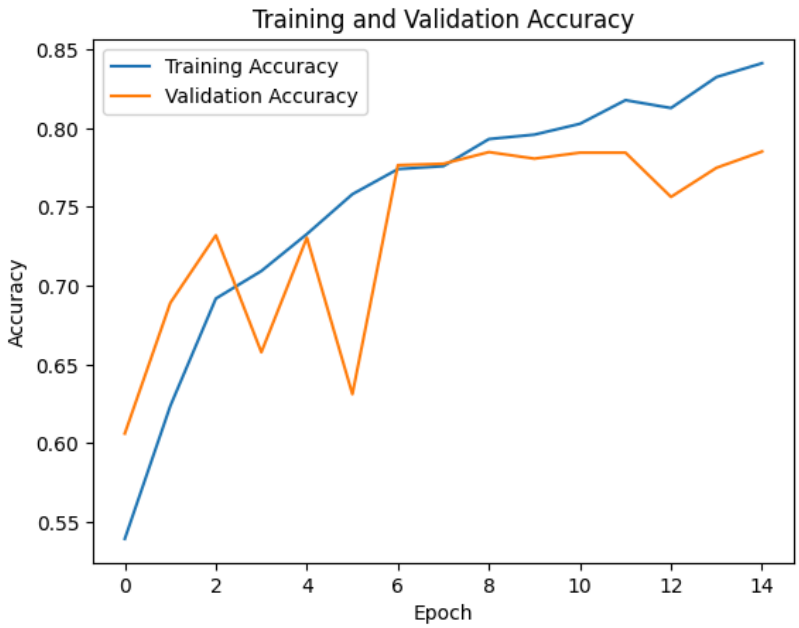
# Evaluate the model on the test dataset
test_accuracy = sentiment_classifier.evaluate(raw_test_dataset_vectorized)[1]
print(f"Test sentiment_classifier_accuracy: {test_accuracy:.3f}")
```

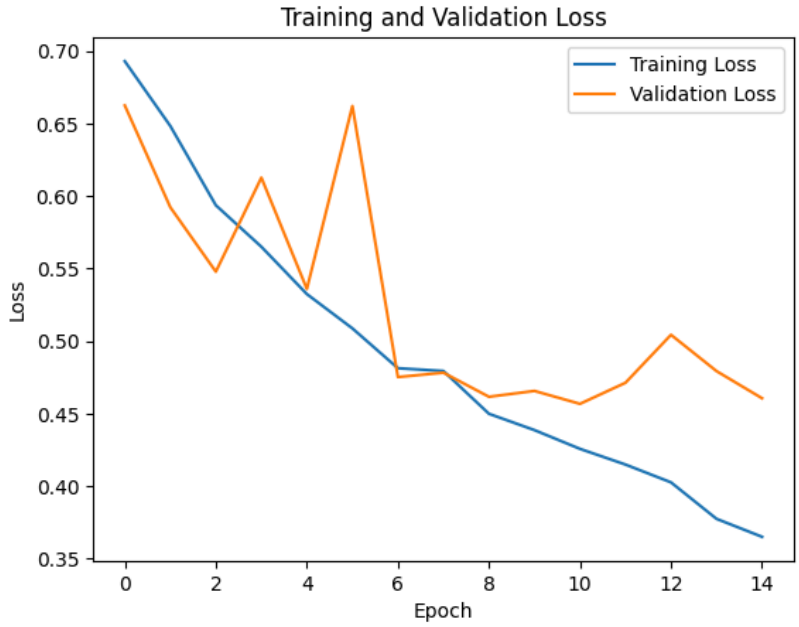
```
Epoch 1/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 10s 81ms/step - accuracy: 0.5017 - loss: 0.7095 - val_accuracy: 0.6062 - val_loss: 0
Epoch 2/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 11s 88ms/step - accuracy: 0.6079 - loss: 0.6574 - val_accuracy: 0.6891 - val_loss: 0
Epoch 3/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 13s 134ms/step - accuracy: 0.6857 - loss: 0.5952 - val_accuracy: 0.7321 - val_loss:
Epoch 4/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 13s 63ms/step - accuracy: 0.7155 - loss: 0.5604 - val_accuracy: 0.6578 - val_loss: 0
Epoch 5/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 12s 81ms/step - accuracy: 0.7431 - loss: 0.5194 - val_accuracy: 0.7305 - val_loss: 0
Epoch 6/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 15s 125ms/step - accuracy: 0.7752 - loss: 0.4868 - val_accuracy: 0.6312 - val_loss:
Epoch 7/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 17s 94ms/step - accuracy: 0.7836 - loss: 0.4712 - val_accuracy: 0.7765 - val_loss: 0
Epoch 8/15
```

```
100/100 ━━━━━━━━━━━━━━━━━━━━ 8s 67ms/step - accuracy: 0.7896 - loss: 0.4535 - val_accuracy: 0.7775 - val_loss: 0.
Epoch 9/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 12s 81ms/step - accuracy: 0.8068 - loss: 0.4335 - val_accuracy: 0.7849 - val_loss: 0
Epoch 10/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 10s 75ms/step - accuracy: 0.8109 - loss: 0.4180 - val_accuracy: 0.7807 - val_loss: 0
Epoch 11/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 16s 135ms/step - accuracy: 0.8173 - loss: 0.4090 - val_accuracy: 0.7845 - val_loss:
Epoch 12/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 7s 75ms/step - accuracy: 0.8245 - loss: 0.4026 - val_accuracy: 0.7845 - val_loss: 0.
Epoch 13/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 9s 62ms/step - accuracy: 0.8202 - loss: 0.3928 - val_accuracy: 0.7564 - val_loss: 0.
Epoch 14/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 7s 73ms/step - accuracy: 0.8423 - loss: 0.3674 - val_accuracy: 0.7749 - val_loss: 0.
Epoch 15/15
100/100 ━━━━━━━━━━━━━━━━━━━━ 6s 61ms/step - accuracy: 0.8488 - loss: 0.3612 - val_accuracy: 0.7852 - val_loss: 0.
782/782 ━━━━━━━━━━━━━━━━━━━━ 7s 8ms/step - accuracy: 0.7818 - loss: 0.4566
Test sentiment_classifier_accuracy: 0.780
```

```
# Plot training and validation accuracy
plt.plot(history4.history['accuracy'], label='Training Accuracy')
plt.plot(history4.history['val_accuracy'], label='Validation Accuracy')
plt.title('Training and Validation Accuracy')
plt.xlabel('Epoch')
plt.ylabel('Accuracy')
plt.legend()
plt.show()

# Plot training and validation loss
plt.plot(history4.history['loss'], label='Training Loss')
plt.plot(history4.history['val_loss'], label='Validation Loss')
plt.title('Training and Validation Loss')
plt.xlabel('Epoch')
plt.ylabel('Loss')
plt.legend()
plt.show()
```






```
from tensorflow.keras.callbacks import ModelCheckpoint
from tensorflow import keras
from tensorflow.keras import layers
import matplotlib.pyplot as plt

train_sample_sizes = [100, 500, 1000, 5000, 10000, 20000]

for train_size in train_sample_sizes:
    raw_train_dataset = keras.utils.text_dataset_from_directory(
        "aclImdb/train", batch_size=batchSize
    ).take(train_size)

    raw_train_dataset_vectorized = raw_train_dataset.map(
        lambda x, y: (text_vectorizer_layer(x), y),
        num_parallel_calls=4
    )
    int_raw_validation_dataset = raw_validation_dataset.map(
        lambda x, y: (text_vectorizer_layer(x), y),
        num_parallel_calls=4
    )
    raw_test_dataset_vectorized = raw_test_dataset.map(
        lambda x, y: (text_vectorizer_layer(x), y),
        num_parallel_calls=4
    )

    # Train and evaluate the sentiment_classifier with the embedding layer
    trainable_embedding_layer = layers.Embedding(MAX_VOCAB_SIZE, embedding_dimension)
```

```
inputs = keras.Input(shape=(None,), dtype="int64")
embedded = trainable_embedding_layer(inputs)
x = layers.Bidirectional(layers.LSTM(32))(embedded)
x = layers.Dropout(0.5)(x)
output_logits = layers.Dense(1, activation="sigmoid")(x)

sentiment_classifier = keras.Model(inputs=inputs, outputs=output_logits)
sentiment_classifier.compile(optimizer="rmsprop",
                         loss="binary_crossentropy",
                         metrics=["accuracy"])

callbacks = [
    ModelCheckpoint("embeddings_sentiment_classifier.keras", save_best_only=True)
]
history = sentiment_classifier.fit(raw_train_dataset_vectorized,
                               validation_data=int_raw_validation_dataset,
                               epochs=10,
                               callbacks=callbacks)

sentiment_classifier = keras.models.load_model("embeddings_sentiment_classifier.keras")
trainable_embedding_layer_test_acc = sentiment_classifier.evaluate(raw_test_dataset_vectorized)[1]

loss = history.history["accuracy"]
val_loss = history.history["val_accuracy"]
epochs = range(1, len(loss) + 1)

plt.figure()
plt.plot(epochs, loss, "r", label="Training Accuracy")
plt.plot(epochs, val_loss, "b", label="Validation Accuracy")
plt.title("Training and Validation Accuracy")
plt.legend()
plt.show()

# Train and evaluate the sentiment_classifier with the pretrained word embeddings
trainable_embedding_layer = layers.Embedding(
    MAX_VOCAB_SIZE,
    embedding_dimension,
    embeddings_initializer=keras.initializers.Constant(glove_embedding_matrix),
    trainable=False,
    mask_zero=True,
)

inputs = keras.Input(shape=(None,), dtype="int64")
embedded = trainable_embedding_layer(inputs)
x = layers.Bidirectional(layers.LSTM(32))(embedded)
x = layers.Dropout(0.5)(x)
output_logits = layers.Dense(1, activation="sigmoid")(x)

sentiment_classifier = keras.Model(inputs=inputs, outputs=output_logits)
sentiment_classifier.compile(optimizer="rmsprop",
                         loss="binary_crossentropy",
                         metrics=["accuracy"])

callbacks = [
    ModelCheckpoint("pretrained_embeddings_sentiment_classifier.keras", save_best_only=True)
]
history = sentiment_classifier.fit(raw_train_dataset_vectorized,
                               validation_data=int_raw_validation_dataset,
                               epochs=10,
                               callbacks=callbacks)

sentiment_classifier = keras.models.load_model("pretrained_embeddings_sentiment_classifier.keras")
pretrained_embeddings_test_acc = sentiment_classifier.evaluate(raw_test_dataset_vectorized)[1]

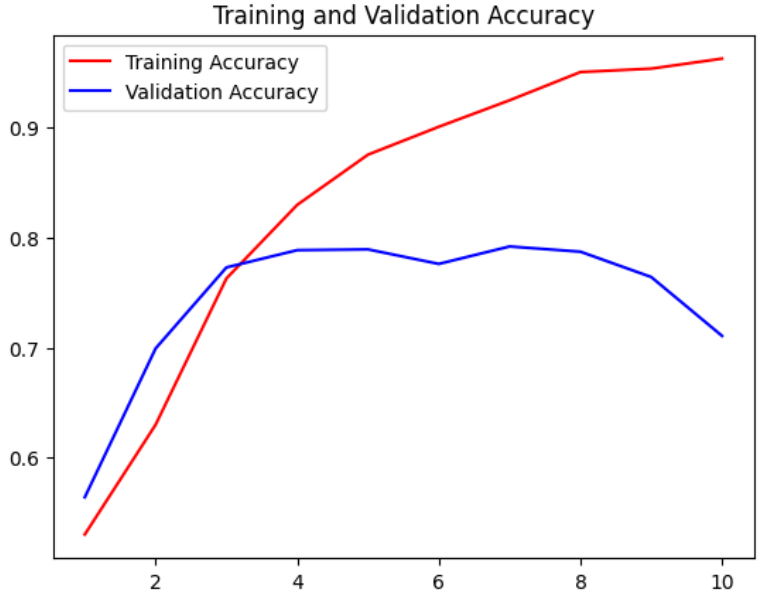
loss = history.history["accuracy"]
val_loss = history.history["val_accuracy"]
epochs = range(1, len(loss) + 1)

plt.figure()
plt.plot(epochs, loss, "r", label="Training Accuracy")
plt.plot(epochs, val_loss, "b", label="Validation Accuracy")
plt.title("Training and Validation Accuracy")
plt.legend()
plt.show()

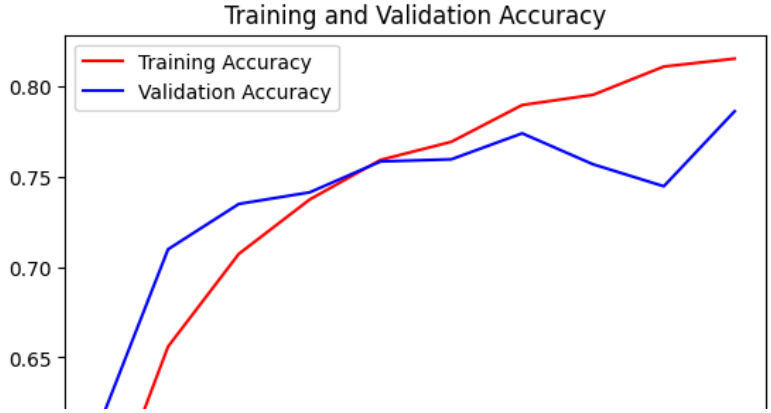
# Compare the performance and store the results
print(f"Training samples: {train_size}")
print(f"Embedding layer test accuracy: {trainable_embedding_layer_test_acc:.3f}")
```

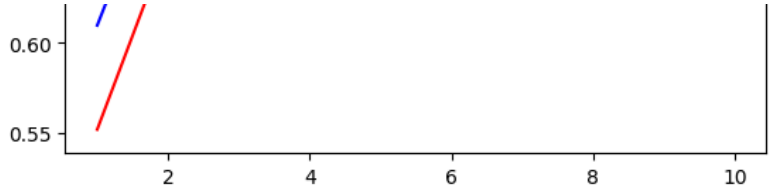
```
    print(f"Pretrained embeddings test accuracy: {pretrained_embeddings_test_acc:.3f}")
    print("-" * 50)
```

```
Found 5000 files belonging to 2 classes.
Epoch 1/10
100/100 ━━━━━━━━━━━━━━━━━━━━ 9s 72ms/step - accuracy: 0.5225 - loss: 0.6920 - val_accuracy: 0.5641 - val_loss: 0.
Epoch 2/10
100/100 ━━━━━━━━━━━━━━━━━━━━ 9s 61ms/step - accuracy: 0.6133 - loss: 0.6708 - val_accuracy: 0.6992 - val_loss: 0.
Epoch 3/10
100/100 ━━━━━━━━━━━━━━━━━━━━ 12s 118ms/step - accuracy: 0.7579 - loss: 0.5327 - val_accuracy: 0.7728 - val_loss:
Epoch 4/10
100/100 ━━━━━━━━━━━━━━━━━━━━ 7s 74ms/step - accuracy: 0.8219 - loss: 0.4189 - val_accuracy: 0.7886 - val_loss: 0.
Epoch 5/10
100/100 ━━━━━━━━━━━━━━━━━━━━ 6s 59ms/step - accuracy: 0.8701 - loss: 0.3415 - val_accuracy: 0.7893 - val_loss: 0.
Epoch 6/10
100/100 ━━━━━━━━━━━━━━━━━━━━ 11s 68ms/step - accuracy: 0.8998 - loss: 0.2705 - val_accuracy: 0.7760 - val_loss: 0
Epoch 7/10
100/100 ━━━━━━━━━━━━━━━━━━━━ 12s 87ms/step - accuracy: 0.9313 - loss: 0.1941 - val_accuracy: 0.7919 - val_loss: 0
Epoch 8/10
100/100 ━━━━━━━━━━━━━━━━━━━━ 8s 67ms/step - accuracy: 0.9513 - loss: 0.1503 - val_accuracy: 0.7872 - val_loss: 0.
Epoch 9/10
100/100 ━━━━━━━━━━━━━━━━━━━━ 10s 60ms/step - accuracy: 0.9549 - loss: 0.1515 - val_accuracy: 0.7642 - val_loss: 0
Epoch 10/10
100/100 ━━━━━━━━━━━━━━━━━━━━ 12s 118ms/step - accuracy: 0.9722 - loss: 0.1001 - val_accuracy: 0.7107 - val_loss:
782/782 ━━━━━━━━━━━━━━━━━━━━ 8s 9ms/step - accuracy: 0.7839 - loss: 0.4708
```

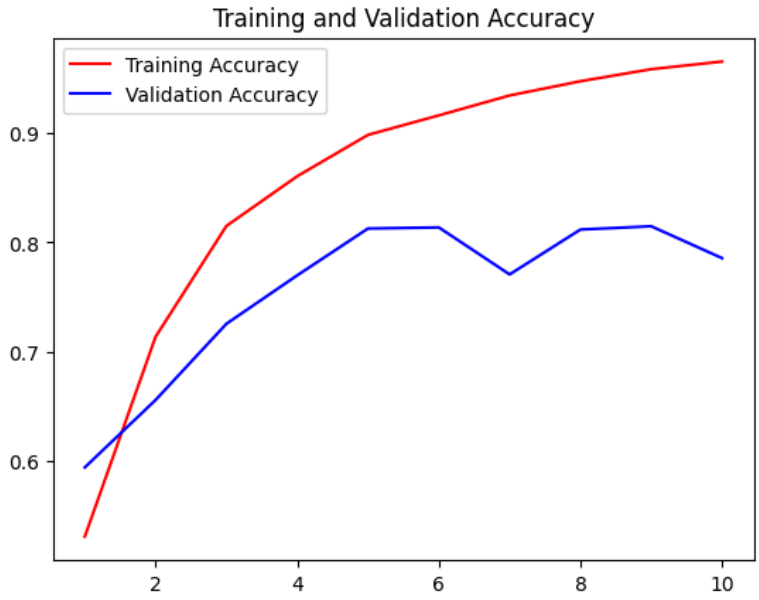



```
Epoch 1/10
100/100 ━━━━━━━━━━━━━━━━━━━━ 11s 94ms/step - accuracy: 0.5372 - loss: 0.7041 - val_accuracy: 0.6097 - val_loss: 0
Epoch 2/10
100/100 ━━━━━━━━━━━━━━━━━━━━ 8s 77ms/step - accuracy: 0.6378 - loss: 0.6414 - val_accuracy: 0.7097 - val_loss: 0.
Epoch 3/10
100/100 ━━━━━━━━━━━━━━━━━━━━ 11s 81ms/step - accuracy: 0.7088 - loss: 0.5763 - val_accuracy: 0.7347 - val_loss: 0
Epoch 4/10
100/100 ━━━━━━━━━━━━━━━━━━━━ 9s 92ms/step - accuracy: 0.7369 - loss: 0.5285 - val_accuracy: 0.7412 - val_loss: 0.
Epoch 5/10
100/100 ━━━━━━━━━━━━━━━━━━━━ 9s 94ms/step - accuracy: 0.7665 - loss: 0.4938 - val_accuracy: 0.7582 - val_loss: 0.
Epoch 6/10
100/100 ━━━━━━━━━━━━━━━━━━━━ 9s 78ms/step - accuracy: 0.7686 - loss: 0.4851 - val_accuracy: 0.7594 - val_loss: 0.
Epoch 7/10
100/100 ━━━━━━━━━━━━━━━━━━━━ 9s 93ms/step - accuracy: 0.7944 - loss: 0.4515 - val_accuracy: 0.7738 - val_loss: 0.
Epoch 8/10
100/100 ━━━━━━━━━━━━━━━━━━━━ 8s 73ms/step - accuracy: 0.8003 - loss: 0.4357 - val_accuracy: 0.7566 - val_loss: 0.
Epoch 9/10
100/100 ━━━━━━━━━━━━━━━━━━━━ 7s 68ms/step - accuracy: 0.8099 - loss: 0.4168 - val_accuracy: 0.7445 - val_loss: 0.
Epoch 10/10
100/100 ━━━━━━━━━━━━━━━━━━━━ 11s 74ms/step - accuracy: 0.8156 - loss: 0.4098 - val_accuracy: 0.7860 - val_loss: 0
782/782 ━━━━━━━━━━━━━━━━━━━━ 8s 9ms/step - accuracy: 0.7697 - loss: 0.4815
```

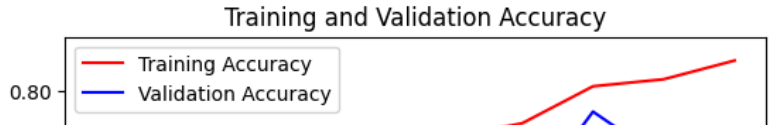


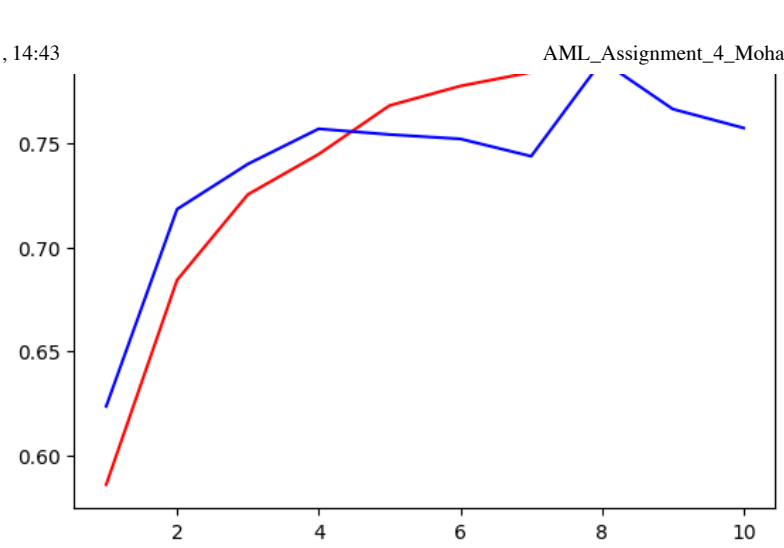



```
Training samples: 100
Embedding layer test accuracy: 0.785
Pretrained embeddings test accuracy: 0.769
--------------------------------------------------
Found 5000 files belonging to 2 classes.
Epoch 1/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 10s 52ms/step - accuracy: 0.5151 - loss: 0.6922 - val_accuracy: 0.5944 - val_loss: 0
Epoch 2/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 8s 49ms/step - accuracy: 0.6881 - loss: 0.6038 - val_accuracy: 0.6560 - val_loss: 0.
Epoch 3/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 8s 51ms/step - accuracy: 0.8049 - loss: 0.4501 - val_accuracy: 0.7256 - val_loss: 0.
Epoch 4/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 7s 47ms/step - accuracy: 0.8556 - loss: 0.3567 - val_accuracy: 0.7699 - val_loss: 0.
Epoch 5/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 8s 51ms/step - accuracy: 0.9057 - loss: 0.2677 - val_accuracy: 0.8127 - val_loss: 0.
Epoch 6/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 7s 45ms/step - accuracy: 0.9152 - loss: 0.2400 - val_accuracy: 0.8137 - val_loss: 0.
Epoch 7/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 8s 52ms/step - accuracy: 0.9358 - loss: 0.1881 - val_accuracy: 0.7707 - val_loss: 0.
Epoch 8/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 10s 52ms/step - accuracy: 0.9414 - loss: 0.1714 - val_accuracy: 0.8117 - val_loss: 0
Epoch 9/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 7s 44ms/step - accuracy: 0.9625 - loss: 0.1146 - val_accuracy: 0.8147 - val_loss: 0.
Epoch 10/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 9s 58ms/step - accuracy: 0.9637 - loss: 0.1166 - val_accuracy: 0.7856 - val_loss: 0.
782/782 ━━━━━━━━━━━━━━━━━━━━ 8s 9ms/step - accuracy: 0.8081 - loss: 0.4711
```

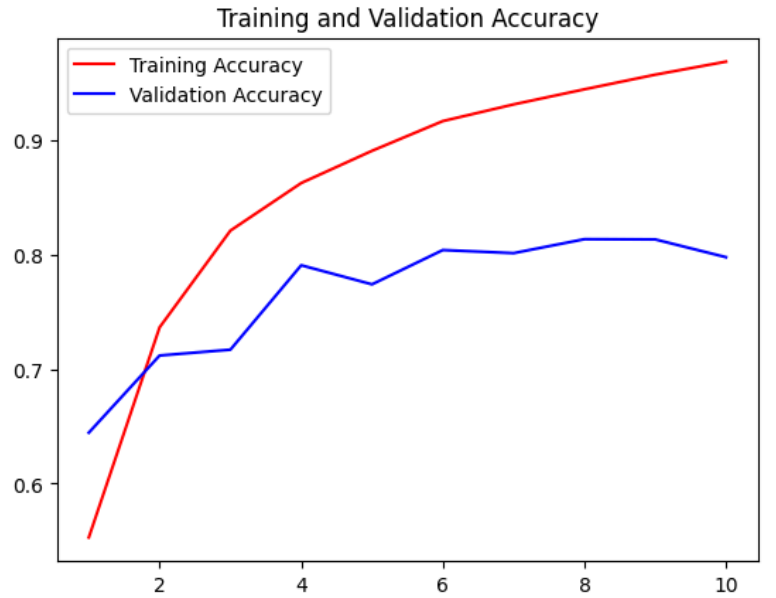



```
Epoch 1/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 10s 56ms/step - accuracy: 0.5530 - loss: 0.6921 - val_accuracy: 0.6234 - val_loss: 0
Epoch 2/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 10s 64ms/step - accuracy: 0.6641 - loss: 0.6120 - val_accuracy: 0.7183 - val_loss: 0
Epoch 3/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 10s 64ms/step - accuracy: 0.7303 - loss: 0.5543 - val_accuracy: 0.7401 - val_loss: 0
Epoch 4/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 10s 63ms/step - accuracy: 0.7427 - loss: 0.5265 - val_accuracy: 0.7570 - val_loss: 0
Epoch 5/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 7s 45ms/step - accuracy: 0.7670 - loss: 0.4880 - val_accuracy: 0.7542 - val_loss: 0.
Epoch 6/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 13s 62ms/step - accuracy: 0.7793 - loss: 0.4764 - val_accuracy: 0.7521 - val_loss: 0
Epoch 7/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 9s 53ms/step - accuracy: 0.7864 - loss: 0.4570 - val_accuracy: 0.7438 - val_loss: 0.
Epoch 8/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 16s 91ms/step - accuracy: 0.7953 - loss: 0.4370 - val_accuracy: 0.7898 - val_loss: 0
Epoch 9/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 13s 80ms/step - accuracy: 0.8084 - loss: 0.4103 - val_accuracy: 0.7665 - val_loss: 0
Epoch 10/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 13s 80ms/step - accuracy: 0.8133 - loss: 0.4072 - val_accuracy: 0.7574 - val_loss: 0
782/782 ━━━━━━━━━━━━━━━━━━━━ 8s 10ms/step - accuracy: 0.7906 - loss: 0.4522
```



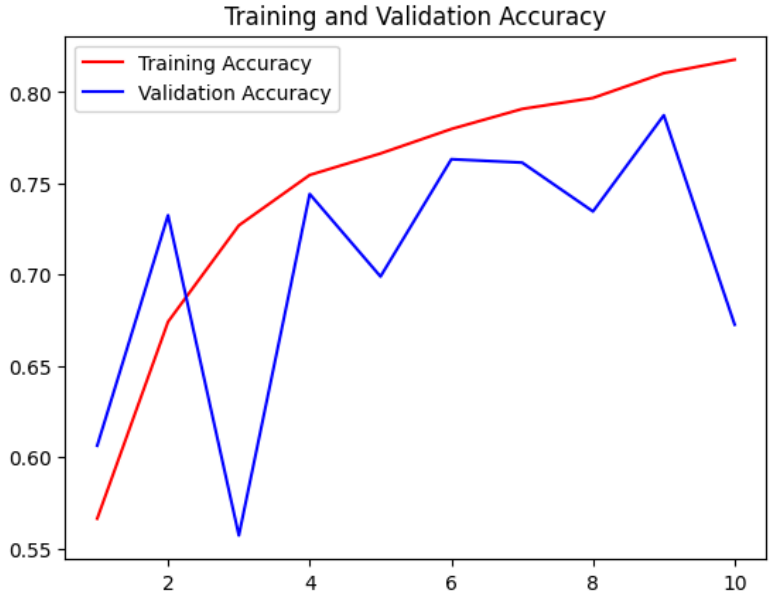



```
Training samples: 500
Embedding layer test accuracy: 0.806
Pretrained embeddings test accuracy: 0.788
--------------------------------------------------
Found 5000 files belonging to 2 classes.
Epoch 1/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 10s 52ms/step - accuracy: 0.5049 - loss: 0.6919 - val_accuracy: 0.6445 - val_loss: 0
Epoch 2/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 8s 49ms/step - accuracy: 0.7129 - loss: 0.5774 - val_accuracy: 0.7120 - val_loss: 0.
Epoch 3/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 8s 51ms/step - accuracy: 0.8091 - loss: 0.4544 - val_accuracy: 0.7171 - val_loss: 0.
Epoch 4/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 7s 47ms/step - accuracy: 0.8544 - loss: 0.3620 - val_accuracy: 0.7909 - val_loss: 0.
Epoch 5/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 8s 51ms/step - accuracy: 0.8804 - loss: 0.3071 - val_accuracy: 0.7742 - val_loss: 0.
Epoch 6/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 10s 53ms/step - accuracy: 0.9094 - loss: 0.2621 - val_accuracy: 0.8042 - val_loss: 0
Epoch 7/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 7s 47ms/step - accuracy: 0.9284 - loss: 0.1977 - val_accuracy: 0.8015 - val_loss: 0.
Epoch 8/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 11s 50ms/step - accuracy: 0.9446 - loss: 0.1724 - val_accuracy: 0.8137 - val_loss: 0
Epoch 9/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 8s 51ms/step - accuracy: 0.9551 - loss: 0.1384 - val_accuracy: 0.8135 - val_loss: 0.
Epoch 10/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 11s 57ms/step - accuracy: 0.9683 - loss: 0.1071 - val_accuracy: 0.7980 - val_loss: 0
782/782 ━━━━━━━━━━━━━━━━━━━━ 7s 8ms/step - accuracy: 0.7956 - loss: 0.4806
```

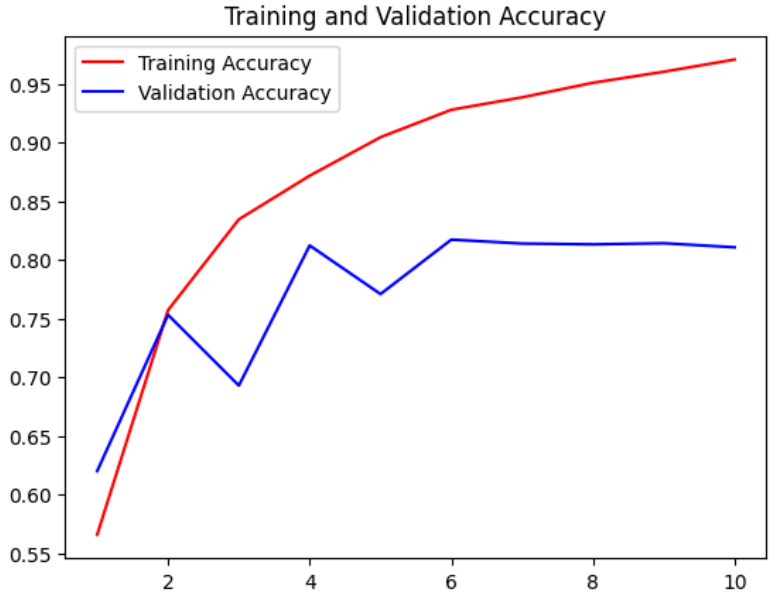



```
Epoch 1/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 10s 56ms/step - accuracy: 0.5366 - loss: 0.6952 - val_accuracy: 0.6064 - val_loss: 0
Epoch 2/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 11s 59ms/step - accuracy: 0.6583 - loss: 0.6219 - val_accuracy: 0.7326 - val_loss: 0
Epoch 3/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 13s 82ms/step - accuracy: 0.7212 - loss: 0.5556 - val_accuracy: 0.5572 - val_loss: 0
Epoch 4/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 10s 63ms/step - accuracy: 0.7488 - loss: 0.5205 - val_accuracy: 0.7442 - val_loss: 0
Epoch 5/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 8s 51ms/step - accuracy: 0.7746 - loss: 0.4879 - val_accuracy: 0.6990 - val_loss: 0.
Epoch 6/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 9s 59ms/step - accuracy: 0.7815 - loss: 0.4779 - val_accuracy: 0.7632 - val_loss: 0.
Epoch 7/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 8s 52ms/step - accuracy: 0.8008 - loss: 0.4417 - val_accuracy: 0.7614 - val_loss: 0.
Epoch 8/10
```

```
157/157 ━━━━━━━━━━━━━━━━━━━━ 15s 81ms/step - accuracy: 0.7960 - loss: 0.4392 - val_accuracy: 0.7347 - val_loss: 0
Epoch 9/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 10s 65ms/step - accuracy: 0.8128 - loss: 0.4268 - val_accuracy: 0.7873 - val_loss: 0
Epoch 10/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 7s 44ms/step - accuracy: 0.8283 - loss: 0.3904 - val_accuracy: 0.6726 - val_loss: 0.
782/782 ━━━━━━━━━━━━━━━━━━━━ 7s 8ms/step - accuracy: 0.7866 - loss: 0.4601
```

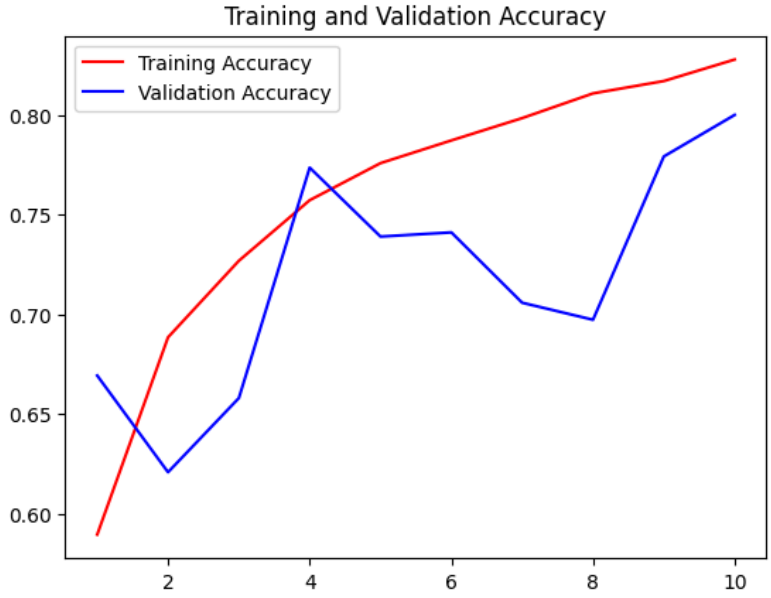



```
Training samples: 1000
Embedding layer test accuracy: 0.788
Pretrained embeddings test accuracy: 0.784
--------------------------------------------------
Found 5000 files belonging to 2 classes.
Epoch 1/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 9s 45ms/step - accuracy: 0.5283 - loss: 0.6902 - val_accuracy: 0.6202 - val_loss: 0.
Epoch 2/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 8s 51ms/step - accuracy: 0.7350 - loss: 0.5580 - val_accuracy: 0.7533 - val_loss: 0.
Epoch 3/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 15s 81ms/step - accuracy: 0.8266 - loss: 0.4157 - val_accuracy: 0.6930 - val_loss: 0
Epoch 4/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 8s 51ms/step - accuracy: 0.8630 - loss: 0.3403 - val_accuracy: 0.8123 - val_loss: 0.
Epoch 5/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 9s 43ms/step - accuracy: 0.9024 - loss: 0.2646 - val_accuracy: 0.7710 - val_loss: 0.
Epoch 6/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 10s 42ms/step - accuracy: 0.9237 - loss: 0.2231 - val_accuracy: 0.8173 - val_loss: 0
Epoch 7/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 8s 51ms/step - accuracy: 0.9321 - loss: 0.1888 - val_accuracy: 0.8140 - val_loss: 0.
Epoch 8/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 7s 42ms/step - accuracy: 0.9481 - loss: 0.1587 - val_accuracy: 0.8133 - val_loss: 0.
Epoch 9/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 8s 51ms/step - accuracy: 0.9561 - loss: 0.1218 - val_accuracy: 0.8142 - val_loss: 0.
Epoch 10/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 8s 53ms/step - accuracy: 0.9702 - loss: 0.0907 - val_accuracy: 0.8108 - val_loss: 0.
782/782 ━━━━━━━━━━━━━━━━━━━━ 7s 8ms/step - accuracy: 0.8067 - loss: 0.4284
```

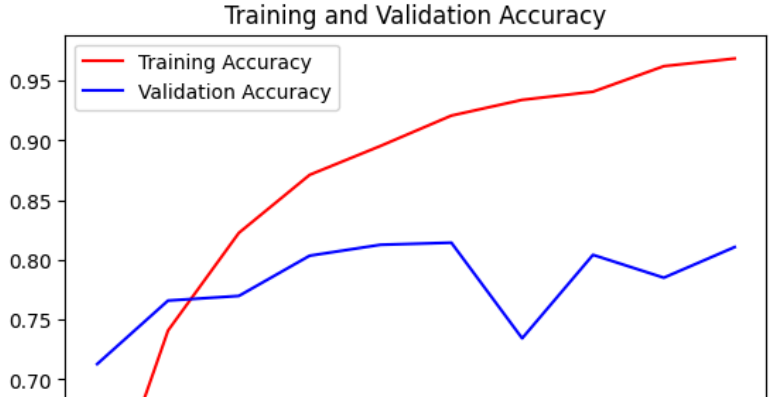


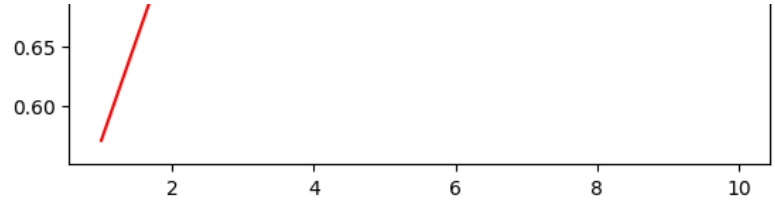

```
Epoch 1/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 12s 62ms/step - accuracy: 0.5507 - loss: 0.6924 - val_accuracy: 0.6692 - val_loss: 0
Epoch 2/10
```

```
157/157 ━━━━━━━━━━━━━━━━━━━━ 8s 52ms/step - accuracy: 0.6827 - loss: 0.6015 - val_accuracy: 0.6207 - val_loss: 0.
Epoch 3/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 9s 47ms/step - accuracy: 0.7208 - loss: 0.5494 - val_accuracy: 0.6579 - val_loss: 0.
Epoch 4/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 12s 59ms/step - accuracy: 0.7483 - loss: 0.5251 - val_accuracy: 0.7735 - val_loss: 0
Epoch 5/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 8s 51ms/step - accuracy: 0.7666 - loss: 0.4917 - val_accuracy: 0.7390 - val_loss: 0.
Epoch 6/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 13s 80ms/step - accuracy: 0.7792 - loss: 0.4708 - val_accuracy: 0.7411 - val_loss: 0
Epoch 7/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 13s 81ms/step - accuracy: 0.7854 - loss: 0.4607 - val_accuracy: 0.7057 - val_loss: 0
Epoch 8/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 16s 50ms/step - accuracy: 0.8064 - loss: 0.4281 - val_accuracy: 0.6972 - val_loss: 0
Epoch 9/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 12s 63ms/step - accuracy: 0.8016 - loss: 0.4342 - val_accuracy: 0.7792 - val_loss: 0
Epoch 10/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 14s 91ms/step - accuracy: 0.8226 - loss: 0.3960 - val_accuracy: 0.8000 - val_loss: 0
782/782 ━━━━━━━━━━━━━━━━━━━━ 9s 10ms/step - accuracy: 0.8016 - loss: 0.4414
```

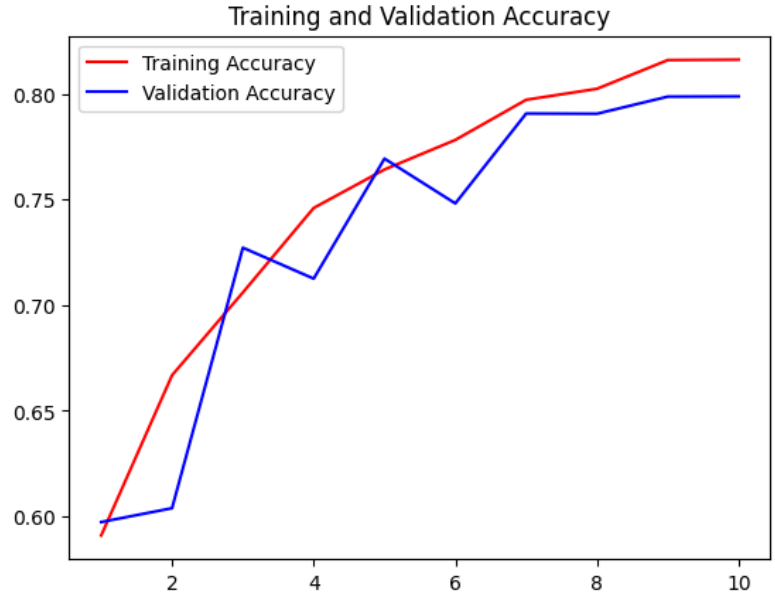



```
Training samples: 5000
Embedding layer test accuracy: 0.802
Pretrained embeddings test accuracy: 0.797
--------------------------------------------------
Found 5000 files belonging to 2 classes.
Epoch 1/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 15s 83ms/step - accuracy: 0.5194 - loss: 0.6899 - val_accuracy: 0.7128 - val_loss: 0
Epoch 2/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 8s 48ms/step - accuracy: 0.7126 - loss: 0.5677 - val_accuracy: 0.7659 - val_loss: 0.
Epoch 3/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 7s 47ms/step - accuracy: 0.8107 - loss: 0.4467 - val_accuracy: 0.7698 - val_loss: 0.
Epoch 4/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 11s 51ms/step - accuracy: 0.8683 - loss: 0.3491 - val_accuracy: 0.8035 - val_loss: 0
Epoch 5/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 10s 52ms/step - accuracy: 0.8935 - loss: 0.2873 - val_accuracy: 0.8127 - val_loss: 0
Epoch 6/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 9s 44ms/step - accuracy: 0.9193 - loss: 0.2292 - val_accuracy: 0.8144 - val_loss: 0.
Epoch 7/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 8s 51ms/step - accuracy: 0.9322 - loss: 0.1881 - val_accuracy: 0.7343 - val_loss: 1.
Epoch 8/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 8s 50ms/step - accuracy: 0.9402 - loss: 0.2030 - val_accuracy: 0.8042 - val_loss: 0.
Epoch 9/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 9s 57ms/step - accuracy: 0.9626 - loss: 0.1103 - val_accuracy: 0.7850 - val_loss: 0.
Epoch 10/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 8s 52ms/step - accuracy: 0.9699 - loss: 0.0919 - val_accuracy: 0.8107 - val_loss: 0.
782/782 ━━━━━━━━━━━━━━━━━━━━ 7s 8ms/step - accuracy: 0.8093 - loss: 0.4520
```

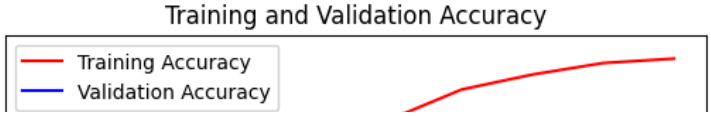


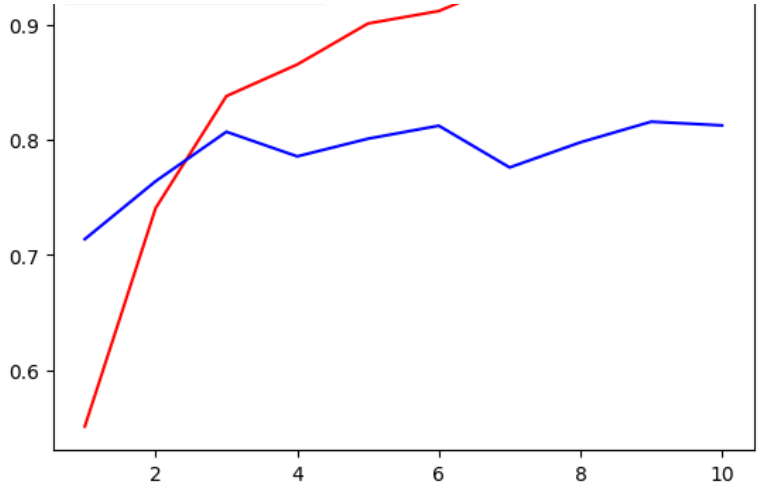



```
Epoch 1/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 12s 66ms/step - accuracy: 0.5601 - loss: 0.6874 - val_accuracy: 0.5974 - val_loss: 0
Epoch 2/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 10s 63ms/step - accuracy: 0.6568 - loss: 0.6200 - val_accuracy: 0.6039 - val_loss: 0
Epoch 3/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 14s 91ms/step - accuracy: 0.6859 - loss: 0.5812 - val_accuracy: 0.7272 - val_loss: 0
Epoch 4/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 10s 66ms/step - accuracy: 0.7359 - loss: 0.5420 - val_accuracy: 0.7125 - val_loss: 0
Epoch 5/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 10s 63ms/step - accuracy: 0.7693 - loss: 0.5036 - val_accuracy: 0.7693 - val_loss: 0
Epoch 6/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 7s 45ms/step - accuracy: 0.7731 - loss: 0.4798 - val_accuracy: 0.7481 - val_loss: 0.
Epoch 7/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 10s 63ms/step - accuracy: 0.7926 - loss: 0.4587 - val_accuracy: 0.7907 - val_loss: 0
Epoch 8/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 13s 81ms/step - accuracy: 0.8062 - loss: 0.4339 - val_accuracy: 0.7906 - val_loss: 0
Epoch 9/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 10s 63ms/step - accuracy: 0.8152 - loss: 0.4200 - val_accuracy: 0.7987 - val_loss: 0
Epoch 10/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 9s 57ms/step - accuracy: 0.8162 - loss: 0.4000 - val_accuracy: 0.7988 - val_loss: 0.
782/782 ━━━━━━━━━━━━━━━━━━━━ 7s 8ms/step - accuracy: 0.7993 - loss: 0.4325
```

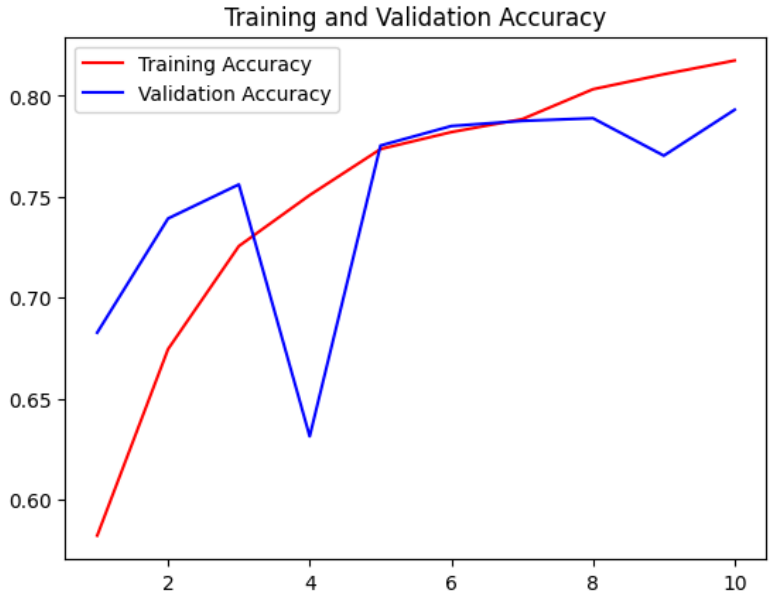



```
Training samples: 10000
Embedding layer test accuracy: 0.806
Pretrained embeddings test accuracy: 0.795
--------------------------------------------------
Found 5000 files belonging to 2 classes.
Epoch 1/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 10s 53ms/step - accuracy: 0.5099 - loss: 0.6911 - val_accuracy: 0.7137 - val_loss: 0
Epoch 2/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 13s 81ms/step - accuracy: 0.7046 - loss: 0.5822 - val_accuracy: 0.7639 - val_loss: 0
Epoch 3/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 15s 45ms/step - accuracy: 0.8248 - loss: 0.4245 - val_accuracy: 0.8069 - val_loss: 0
Epoch 4/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 12s 55ms/step - accuracy: 0.8503 - loss: 0.3623 - val_accuracy: 0.7855 - val_loss: 0
Epoch 5/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 8s 49ms/step - accuracy: 0.8956 - loss: 0.2808 - val_accuracy: 0.8008 - val_loss: 0.
Epoch 6/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 7s 46ms/step - accuracy: 0.9135 - loss: 0.2489 - val_accuracy: 0.8121 - val_loss: 0.
Epoch 7/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 13s 80ms/step - accuracy: 0.9386 - loss: 0.1811 - val_accuracy: 0.7759 - val_loss: 0
Epoch 8/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 15s 48ms/step - accuracy: 0.9452 - loss: 0.1536 - val_accuracy: 0.7977 - val_loss: 0
Epoch 9/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 8s 51ms/step - accuracy: 0.9509 - loss: 0.1370 - val_accuracy: 0.8156 - val_loss: 0.
Epoch 10/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 15s 81ms/step - accuracy: 0.9631 - loss: 0.0995 - val_accuracy: 0.8124 - val_loss: 0
782/782 ━━━━━━━━━━━━━━━━━━━━ 7s 8ms/step - accuracy: 0.8103 - loss: 0.4641
```






```
Epoch 1/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 11s 61ms/step - accuracy: 0.5387 - loss: 0.6933 - val_accuracy: 0.6828 - val_loss: 0
Epoch 2/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 10s 61ms/step - accuracy: 0.6718 - loss: 0.6095 - val_accuracy: 0.7393 - val_loss: 0
Epoch 3/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 10s 66ms/step - accuracy: 0.7270 - loss: 0.5503 - val_accuracy: 0.7561 - val_loss: 0
Epoch 4/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 8s 48ms/step - accuracy: 0.7533 - loss: 0.5140 - val_accuracy: 0.6315 - val_loss: 0.
Epoch 5/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 12s 59ms/step - accuracy: 0.7652 - loss: 0.5026 - val_accuracy: 0.7753 - val_loss: 0
Epoch 6/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 10s 61ms/step - accuracy: 0.7819 - loss: 0.4706 - val_accuracy: 0.7850 - val_loss: 0
Epoch 7/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 10s 66ms/step - accuracy: 0.7845 - loss: 0.4492 - val_accuracy: 0.7875 - val_loss: 0
Epoch 8/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 19s 56ms/step - accuracy: 0.8069 - loss: 0.4293 - val_accuracy: 0.7889 - val_loss: 0
Epoch 9/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 9s 50ms/step - accuracy: 0.8076 - loss: 0.4150 - val_accuracy: 0.7703 - val_loss: 0.
Epoch 10/10
157/157 ━━━━━━━━━━━━━━━━━━━━ 12s 64ms/step - accuracy: 0.8175 - loss: 0.3970 - val_accuracy: 0.7930 - val_loss: 0
782/782 ━━━━━━━━━━━━━━━━━━━━ 9s 10ms/step - accuracy: 0.7978 - loss: 0.4306
```




```
Training samples: 20000
Embedding layer test accuracy: 0.806
Pretrained embeddings test accuracy: 0.795
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