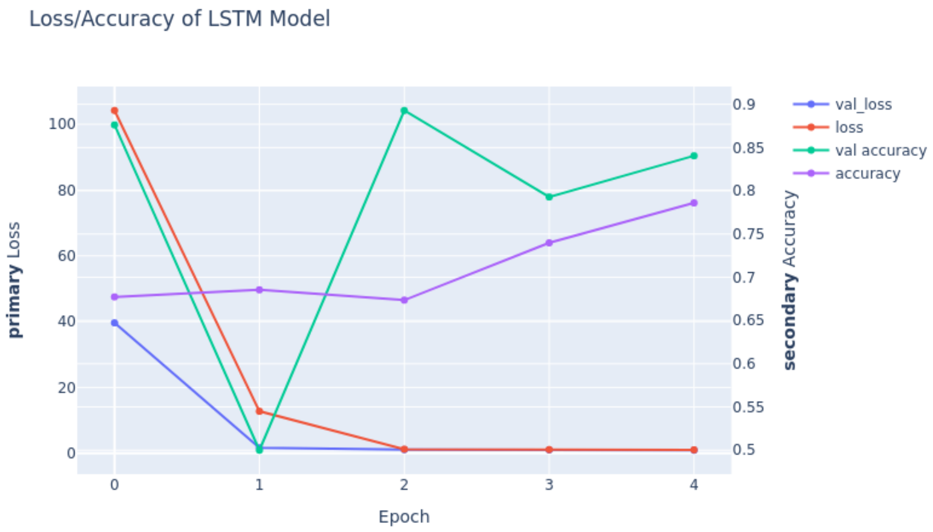
TEST A – starting point

INPUT

```
batch_size= 16
image_shape=(256,256,3)

===========================================================
  model = Sequential()

  model.add(Conv2D(32, (3, 3), input_shape=image_shape, activation='relu'))
  model.add(MaxPooling2D(pool_size=(2, 2)))

  model.add(Conv2D(32, (3, 3), activation='relu'))
  model.add(MaxPooling2D(pool_size=(2, 2)))
  model.add(Conv2D(64, (3, 3), activation='relu'))
  model.add(MaxPooling2D(pool_size=(2, 2)))
  model.add(Flatten())
  model.add(Dense(64, activation='relu'))
  model.add(Dropout(.2))

  model.add(Dense(2, activation='softmax'))

  model.compile(loss='categorical_crossentropy',
            optimizer='adagrad',
            metrics=['accuracy'])

===========================================================
early_stop = EarlyStopping(monitor='val_accuracy,mode=max,verbose=1, patience=2)
```

OUTPUT



```
=================================================================
Total params: 3,715,234
Trainable params: 3,715,234
Non-trainable params: 0

=================================================================
Classification Report:
----------------------
               precision    recall  f1-score   support
      healthy       0.82      0.92      0.87       422
powdery_mildew       0.91      0.80      0.85       422

     accuracy                           0.86       844
    macro avg       0.87      0.86      0.86       844
  weighted avg       0.87      0.86      0.86       844
=================================================================
Model accuracy: 86.26%
Model Loss:  1.1209170818328857

=================================================================
Confusion Matrix:
[[389   33]
 [83 339]]
```

OBSERVATIONS

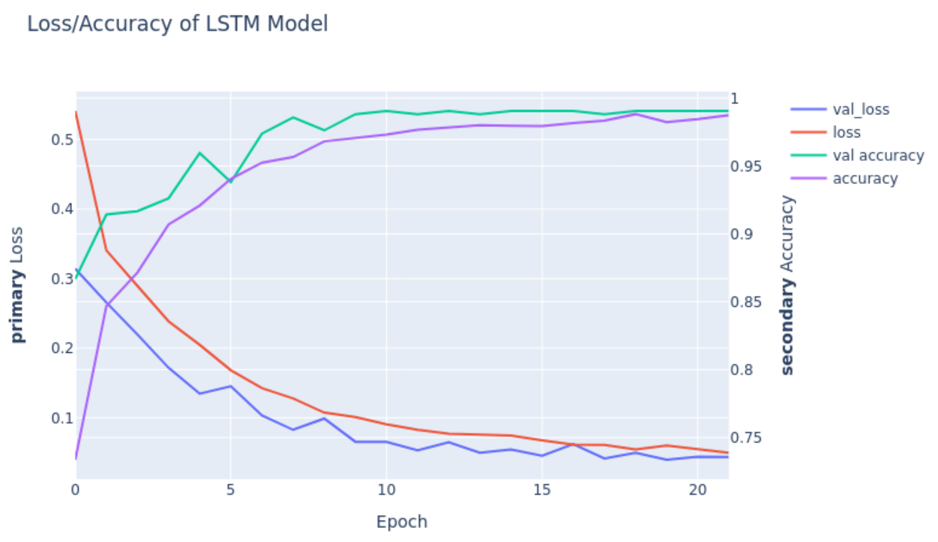
The model stopped training after 5 Epochs. The loss is high as confirmed by the confusion matrix which makes the model accuracy not satisfying despite the ‘high’ percentage. The model is likely **underfitting**.

TEST B – monitor loss on validation set

INPUT

```
 batch_size= 16
 image_shape=(256,256,3)

============================================================
  model = Sequential()

  model.add(Conv2D(32, (3, 3), input_shape=image_shape, activation='relu'))
  model.add(MaxPooling2D(pool_size=(2, 2)))

  model.add(Conv2D(32, (3, 3), activation='relu'))
  model.add(MaxPooling2D(pool_size=(2, 2)))
  model.add(Conv2D(64, (3, 3), activation='relu'))
  model.add(MaxPooling2D(pool_size=(2, 2)))
  model.add(Flatten())
  model.add(Dense(64, activation='relu'))
  model.add(Dropout(.2))

  model.add(Dense(2, activation='softmax'))

  model.compile(loss='categorical_crossentropy',
          optimizer='adagrad',
          metrics=['accuracy'])

============================================================
early_stop = EarlyStopping(monitor='val_loss',mode='min',verbose=1, patience=2)
```

OUTPUT



```
=================================================================
Total params: 3,715,234
Trainable params: 3,715,234
Non-trainable params: 0

=================================================================
Classification Report:
----------------------
                precision    recall  f1-score   support

       healthy       0.98      1.00      0.99       422
powdery_mildew       1.00      0.98      0.99       422

      accuracy                           0.99       844
     macro avg       0.99      0.99      0.99       844
  weighted avg       0.99      0.99      0.99       844
=================================================================
Model accuracy: 98.82%
Model Loss:  0.04888060688972473

=================================================================
Confusion Matrix:
[[422   0]
 [10 412]]
```

OBSERVATIONS

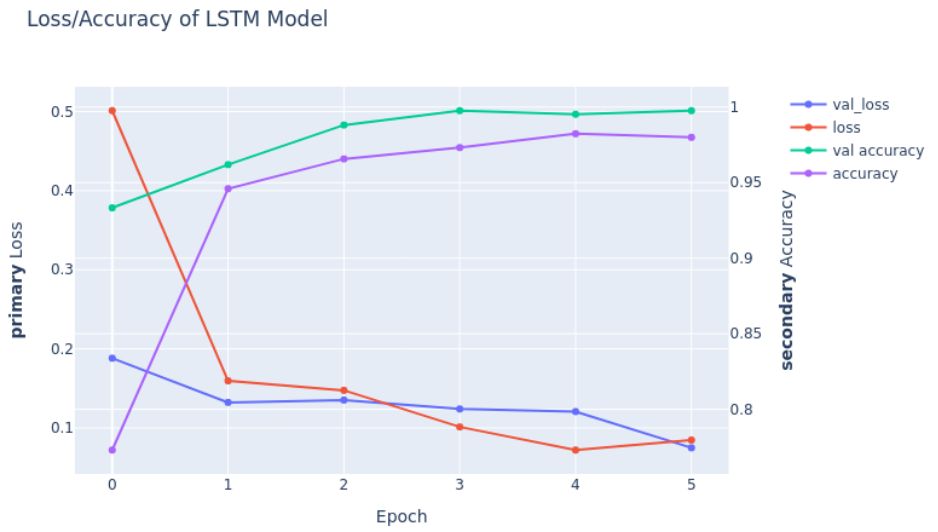
The model stopped training after 22 Epochs. Considering the number of epochs, the model accuracy and the confusion matrix, the model tends to **overfit**.

TEST C – change optimizer (rmsprop)

INPUT

```
batch_size= 16
image_shape=(256,256,3)

==============================================================
   model = Sequential()

   model.add(Conv2D(32, (3, 3), input_shape=image_shape, activation='relu'))
   model.add(MaxPooling2D(pool_size=(2, 2)))

   model.add(Conv2D(32, (3, 3), activation='relu'))
   model.add(MaxPooling2D(pool_size=(2, 2)))
   model.add(Conv2D(64, (3, 3), activation='relu'))
   model.add(MaxPooling2D(pool_size=(2, 2)))
   model.add(Flatten())
   model.add(Dense(64, activation='relu'))
   model.add(Dropout(.2))

   model.add(Dense(2, activation='softmax'))

   model.compile(loss='categorical_crossentropy',
             optimizer='rmsprop',
             metrics=['accuracy'])

==============================================================
early_stop = EarlyStopping(monitor='val_accuracy,mode=max,verbose=1, patience=2)
```

OUTPUT



```
=================================================================
Total params: 3,715,234
Trainable params: 3,715,234
Non-trainable params: 0

=================================================================
Classification Report:
----------------------
               precision    recall  f1-score   support

      healthy       0.99      1.00      1.00       422
powdery_mildew       1.00      0.99      1.00       422

     accuracy                           1.00       844
    macro avg       1.00      1.00      1.00       844
 weighted avg       1.00      1.00      1.00       844
=================================================================
Model accuracy: 99.64%
Model Loss:  0.013791169971227646
=================================================================
Confusion Matrix:
[[422   0]
 [3 419]]
```

OBSERVATIONS

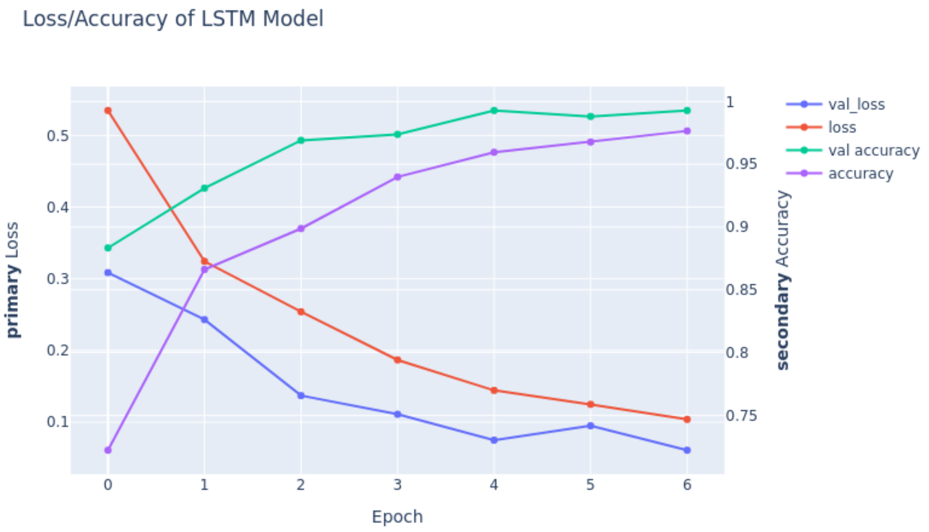
The model stopped training after 6 Epochs. Considering the unrealistic accuracy after just 6 Epochs, the loss on the train set even higher than the loss on the validation set, the accuracy which is not converging and that no healthy leaves were mistakenly predicted as infected, the model is **overfitting**.

TEST D – remove one Convolutional Layer

INPUT

```
batch_size= 16
image_shape=(256,256,3)

==============================================================
  model = Sequential()

  model.add(Conv2D(32, (3, 3), input_shape=image_shape, activation='relu'))
  model.add(MaxPooling2D(pool_size=(2, 2)))

  model.add(Conv2D(32, (3, 3), activation='relu'))
  model.add(MaxPooling2D(pool_size=(2, 2)))
  model.add(Conv2D(64, (3, 3), activation='relu'))
  model.add(MaxPooling2D(pool_size=(2, 2)))
  model.add(Flatten())
  model.add(Dense(64, activation='relu'))
  model.add(Dropout(.2))

  model.add(Dense(2, activation='softmax'))

  model.compile(loss='categorical_crossentropy',
            optimizer='adagrad',
            metrics=['accuracy'])

==============================================================
early_stop = EarlyStopping(monitor='val_accuracy',mode='max',verbose=1, patience=2)
```

OUTPUT



```
=================================================================
Total params: 15,764,610
Trainable params: 15,764,610
Non-trainable params: 0
=================================================================
Classification Report:
----------------------
                precision    recall  f1-score   support

       healthy       0.97      1.00      0.98       422
powdery_mildew       1.00      0.97      0.98       422

      accuracy                           0.98       844
     macro avg       0.98      0.98      0.98       844
  weighted avg       0.98      0.98      0.98       844
=================================================================
Model accuracy: 98.10%
Model Loss:  0.10587086528539658
=================================================================
Confusion Matrix:
[[420   2]
 [14 408]]
```

OBSERVATIONS

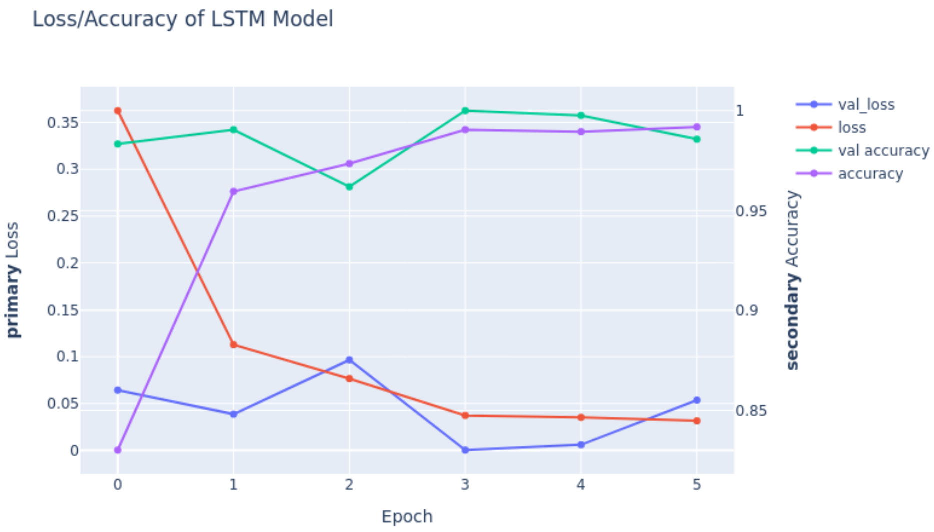
The model stopped training after 7 Epochs. The number of parameters increased reducing the model training speed, the accuracy seems unrealistic after just 7 Epochs. The model is likely **overfitting**.

TEST E – change optimizer (adam)

INPUT

```
 batch_size= 16
 image_shape=(256,256,3)

============================================================
  model = Sequential()

  model.add(Conv2D(32, (3, 3), input_shape=image_shape, activation='relu'))
  model.add(MaxPooling2D(pool_size=(2, 2)))

  model.add(Conv2D(32, (3, 3), activation='relu'))
  model.add(MaxPooling2D(pool_size=(2, 2)))
  model.add(Conv2D(64, (3, 3), activation='relu'))
  model.add(MaxPooling2D(pool_size=(2, 2)))
  model.add(Flatten())
  model.add(Dense(64, activation='relu'))
  model.add(Dropout(.2))

  model.add(Dense(2, activation='softmax'))

  model.compile(loss='categorical_crossentropy',
            optimizer='adam',
            metrics=['accuracy'])

============================================================
early_stop = EarlyStopping(monitor='val_accuracy',mode='max',verbose=1, patience=2)
```

OUTPUT



```
=================================================================
Total params: 3,715,234
Trainable params: 3,715,234
Non-trainable params: 0
=================================================================
Classification Report:
----------------------
               precision    recall  f1-score   support

      healthy       0.99      1.00      1.00       422
powdery_mildew       1.00      0.99      1.00       422

     accuracy                           1.00       844
    macro avg       1.00      1.00      1.00       844
 weighted avg       1.00      1.00      1.00       844
=================================================================
Model accuracy: 99.64%
Model Loss:  0.008717085234820843
=================================================================
Confusion Matrix:
[[422   0]
 [3 419]]
```

OBSERVATIONS

The model stopped training after 6 Epochs. The validation accuracy is lower than the training accuracy while the validation loss is increasing compared to training loss. Hence, the model is doing well on the training set but it’s not able to generalize. The model is **overfitting**.