SVM model Training Report
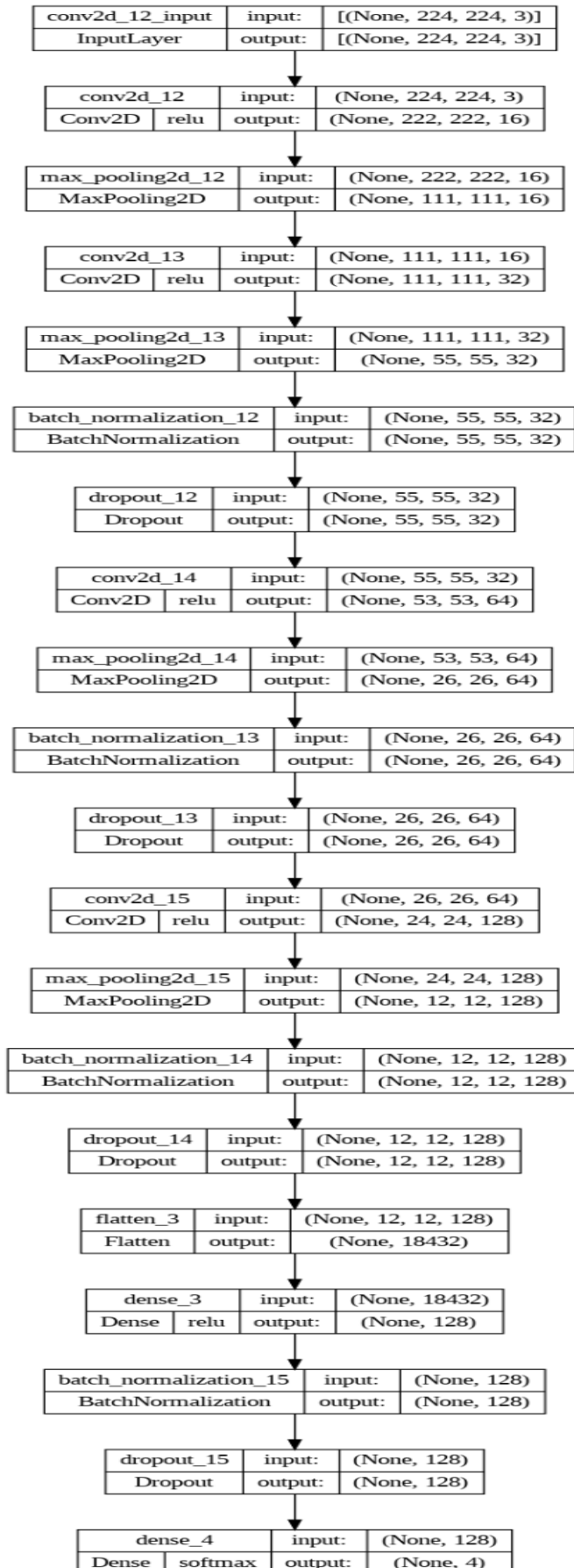
- Training set: dataset_new
- Image size: 224x224
- Model used: RCNN based SVM
- Model Architecture:

conv2d_12_input	input:	[(None, 224, 224, 3)]
InputLayer	output:	[(None, 224, 224, 3)]

conv2d_12		input:	(None, 224, 224, 3)
Conv2D	relu	output:	(None, 222, 222, 16)

max_pooling2d_12	input:	(None, 222, 222, 16)
MaxPooling2D	output:	(None, 111, 111, 16)

conv2d_13		input:	(None, 111, 111, 16)
Conv2D	relu	output:	(None, 111, 111, 32)

max_pooling2d_13	input:	(None, 111, 111, 32)
MaxPooling2D	output:	(None, 55, 55, 32)

batch_normalization_12	input:	(None, 55, 55, 32)
BatchNormalization	output:	(None, 55, 55, 32)

dropout_12	input:	(None, 55, 55, 32)
Dropout	output:	(None, 55, 55, 32)

conv2d_14		input:	(None, 55, 55, 32)
Conv2D	relu	output:	(None, 53, 53, 64)

max_pooling2d_14	input:	(None, 53, 53, 64)
MaxPooling2D	output:	(None, 26, 26, 64)

batch_normalization_13	input:	(None, 26, 26, 64)
BatchNormalization	output:	(None, 26, 26, 64)

dropout_13	input:	(None, 26, 26, 64)
Dropout	output:	(None, 26, 26, 64)

conv2d_15		input:	(None, 26, 26, 64)
Conv2D	relu	output:	(None, 24, 24, 128)

max_pooling2d_15	input:	(None, 24, 24, 128)
MaxPooling2D	output:	(None, 12, 12, 128)

batch_normalization_14	input:	(None, 12, 12, 128)
BatchNormalization	output:	(None, 12, 12, 128)

dropout_14	input:	(None, 12, 12, 128)
Dropout	output:	(None, 12, 12, 128)

flatten_3	input:	(None, 12, 12, 128)
Flatten	output:	(None, 18432)

dense_3		input:	(None, 18432)
Dense	relu	output:	(None, 128)

batch_normalization_15	input:	(None, 128)
BatchNormalization	output:	(None, 128)

dropout_15	input:	(None, 128)
Dropout	output:	(None, 128)

dense_4		input:	(None, 128)
Dense	softmax	output:	(None, 4)

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Model: "sequential_3"

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 Layer (type)                Output Shape              Param #
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 conv2d_12 (Conv2D)          (None, 222, 222, 16)      448

 max_pooling2d_12 (MaxPoolin  (None, 111, 111, 16)     0
 g2D)

 conv2d_13 (Conv2D)          (None, 111, 111, 32)      4640

 max_pooling2d_13 (MaxPoolin  (None, 55, 55, 32)       0
 g2D)

 batch_normalization_12 (Bat  (None, 55, 55, 32)       128
 chNormalization)

 dropout_12 (Dropout)        (None, 55, 55, 32)        0

 conv2d_14 (Conv2D)          (None, 53, 53, 64)        18496

 max_pooling2d_14 (MaxPoolin  (None, 26, 26, 64)       0
 g2D)

 batch_normalization_13 (Bat  (None, 26, 26, 64)       256
 chNormalization)

 dropout_13 (Dropout)        (None, 26, 26, 64)        0

 conv2d_15 (Conv2D)          (None, 24, 24, 128)       73856

 max_pooling2d_15 (MaxPoolin  (None, 12, 12, 128)      0
 g2D)

 batch_normalization_14 (Bat  (None, 12, 12, 128)      512
 chNormalization)

 dropout_14 (Dropout)        (None, 12, 12, 128)       0

 flatten_3 (Flatten)         (None, 18432)             0

 dense_3 (Dense)             (None, 128)               2359424

 batch_normalization_15 (Bat  (None, 128)              512
 chNormalization)

 dropout_15 (Dropout)        (None, 128)               0

 dense_4 (Dense)             (None, 4)                 516

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Total params: 2,458,788
Trainable params: 2,458,084
Non-trainable params: 704
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- No. of Epochs: 20
- Training History:

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Epoch 1/20
78/78 [==============================] - ETA: 0s - loss:
1.0567 - accuracy: 0.7511
Epoch 1: val_accuracy improved from -inf to 0.25173, saving
model to checkpoint/
78/78 [==============================] - 147s 2s/step -
loss: 1.0567 - accuracy: 0.7511 - val_loss: 1.5135 -
val_accuracy: 0.2517 - lr: 0.0010
Epoch 2/20
78/78 [==============================] - ETA: 0s - loss:
0.9876 - accuracy: 0.8087
Epoch 2: val_accuracy did not improve from 0.25173
78/78 [==============================] - 144s 2s/step -
loss: 0.9876 - accuracy: 0.8087 - val_loss: 1.4925 -
val_accuracy: 0.2517 - lr: 0.0010
Epoch 3/20
78/78 [==============================] - ETA: 0s - loss:
0.9605 - accuracy: 0.8318
Epoch 3: val_accuracy did not improve from 0.25173
78/78 [==============================] - 143s 2s/step -
loss: 0.9605 - accuracy: 0.8318 - val_loss: 1.5038 -
val_accuracy: 0.2517 - lr: 0.0010
Epoch 4/20
78/78 [==============================] - ETA: 0s - loss:
0.9139 - accuracy: 0.8707
Epoch 4: val_accuracy improved from 0.25173 to 0.25866,
saving model to checkpoint/
78/78 [==============================] - 135s 2s/step -
loss: 0.9139 - accuracy: 0.8707 - val_loss: 1.4934 -
val_accuracy: 0.2587 - lr: 0.0010
Epoch 5/20
78/78 [==============================] - ETA: 0s - loss:
0.8870 - accuracy: 0.8991
Epoch 5: val_accuracy improved from 0.25866 to 0.46189,
saving model to checkpoint/
78/78 [==============================] - 136s 2s/step -
loss: 0.8870 - accuracy: 0.8991 - val_loss: 1.2888 -
val_accuracy: 0.4619 - lr: 0.0010
Epoch 6/20
78/78 [==============================] - ETA: 0s - loss:
0.8778 - accuracy: 0.9080
Epoch 6: val_accuracy improved from 0.46189 to 0.57506,
saving model to checkpoint/
78/78 [==============================] - 142s 2s/step -
loss: 0.8778 - accuracy: 0.9080 - val_loss: 1.1310 -
val_accuracy: 0.5751 - lr: 0.0010
Epoch 7/20
78/78 [==============================] - ETA: 0s - loss:
0.8409 - accuracy: 0.9473
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Epoch 7: val_accuracy improved from 0.57506 to 0.63510,
saving model to checkpoint/
78/78 [==============================] - 138s 2s/step -
loss: 0.8409 - accuracy: 0.9473 - val_loss: 1.1013 -
val_accuracy: 0.6351 - lr: 0.0010
Epoch 8/20
78/78 [==============================] - ETA: 0s - loss:
0.8278 - accuracy: 0.9558
Epoch 8: val_accuracy improved from 0.63510 to 0.67206,
saving model to checkpoint/
78/78 [==============================] - 137s 2s/step -
loss: 0.8278 - accuracy: 0.9558 - val_loss: 1.0552 -
val_accuracy: 0.6721 - lr: 0.0010
Epoch 9/20
78/78 [==============================] - ETA: 0s - loss:
0.8157 - accuracy: 0.9647
Epoch 9: val_accuracy improved from 0.67206 to 0.74365,
saving model to checkpoint/
78/78 [==============================] - 138s 2s/step -
loss: 0.8157 - accuracy: 0.9647 - val_loss: 1.0047 -
val_accuracy: 0.7436 - lr: 0.0010
Epoch 10/20
78/78 [==============================] - ETA: 0s - loss:
0.8149 - accuracy: 0.9651
Epoch 10: val_accuracy improved from 0.74365 to 0.92379,
saving model to checkpoint/
78/78 [==============================] - 135s 2s/step -
loss: 0.8149 - accuracy: 0.9651 - val_loss: 0.8718 -
val_accuracy: 0.9238 - lr: 0.0010
Epoch 11/20
78/78 [==============================] - ETA: 0s - loss:
0.8218 - accuracy: 0.9530
Epoch 11: val_accuracy improved from 0.92379 to 0.94688,
saving model to checkpoint/
78/78 [==============================] - 139s 2s/step -
loss: 0.8218 - accuracy: 0.9530 - val_loss: 0.8193 -
val_accuracy: 0.9469 - lr: 0.0010
Epoch 12/20
78/78 [==============================] - ETA: 0s - loss:
0.8012 - accuracy: 0.9769
Epoch 12: val_accuracy improved from 0.94688 to 0.94919,
saving model to checkpoint/
78/78 [==============================] - 139s 2s/step -
loss: 0.8012 - accuracy: 0.9769 - val_loss: 0.8626 -
val_accuracy: 0.9492 - lr: 0.0010
Epoch 13/20
78/78 [==============================] - ETA: 0s - loss:
0.7963 - accuracy: 0.9797
Epoch 13: val_accuracy did not improve from 0.94919
78/78 [==============================] - 137s 2s/step -
loss: 0.7963 - accuracy: 0.9797 - val_loss: 0.8621 -
val_accuracy: 0.9353 - lr: 0.0010
Epoch 14/20
78/78 [==============================] - ETA: 0s - loss:
0.7962 - accuracy: 0.9781
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Epoch 14: val_accuracy improved from 0.94919 to 0.95150,
saving model to checkpoint/
78/78 [==============================] - 139s 2s/step -
loss: 0.7962 - accuracy: 0.9781 - val_loss: 0.8369 -
val_accuracy: 0.9515 - lr: 0.0010
Epoch 15/20
78/78 [==============================] - ETA: 0s - loss:
0.7891 - accuracy: 0.9850
Epoch 15: val_accuracy did not improve from 0.95150
78/78 [==============================] - 147s 2s/step -
loss: 0.7891 - accuracy: 0.9850 - val_loss: 0.8610 -
val_accuracy: 0.9423 - lr: 0.0010
Epoch 16/20
78/78 [==============================] - ETA: 0s - loss:
0.7888 - accuracy: 0.9854
Epoch 16: val_accuracy did not improve from 0.95150
78/78 [==============================] - 137s 2s/step -
loss: 0.7888 - accuracy: 0.9854 - val_loss: 0.8514 -
val_accuracy: 0.9261 - lr: 0.0010
Epoch 17/20
78/78 [==============================] - ETA: 0s - loss:
0.8374 - accuracy: 0.9360
Epoch 17: val_accuracy did not improve from 0.95150
78/78 [==============================] - 137s 2s/step -
loss: 0.8374 - accuracy: 0.9360 - val_loss: 0.9104 -
val_accuracy: 0.8430 - lr: 0.0010
Epoch 18/20
78/78 [==============================] - ETA: 0s - loss:
0.8146 - accuracy: 0.9558
Epoch 18: val_accuracy did not improve from 0.95150
78/78 [==============================] - 137s 2s/step -
loss: 0.8146 - accuracy: 0.9558 - val_loss: 0.8338 -
val_accuracy: 0.9423 - lr: 0.0010
Epoch 19/20
78/78 [==============================] - ETA: 0s - loss:
0.7994 - accuracy: 0.9753
Epoch 19: val_accuracy did not improve from 0.95150
78/78 [==============================] - 139s 2s/step -
loss: 0.7994 - accuracy: 0.9753 - val_loss: 0.8590 -
val_accuracy: 0.9400 - lr: 0.0010
Epoch 20/20
78/78 [==============================] - ETA: 0s - loss:
0.7899 - accuracy: 0.9818
Epoch 20: val_accuracy did not improve from 0.95150
78/78 [==============================] - 134s 2s/step -
loss: 0.7899 - accuracy: 0.9818 - val_loss: 0.8561 -
val_accuracy: 0.9376 - lr: 0.0010
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● Loss Curve:
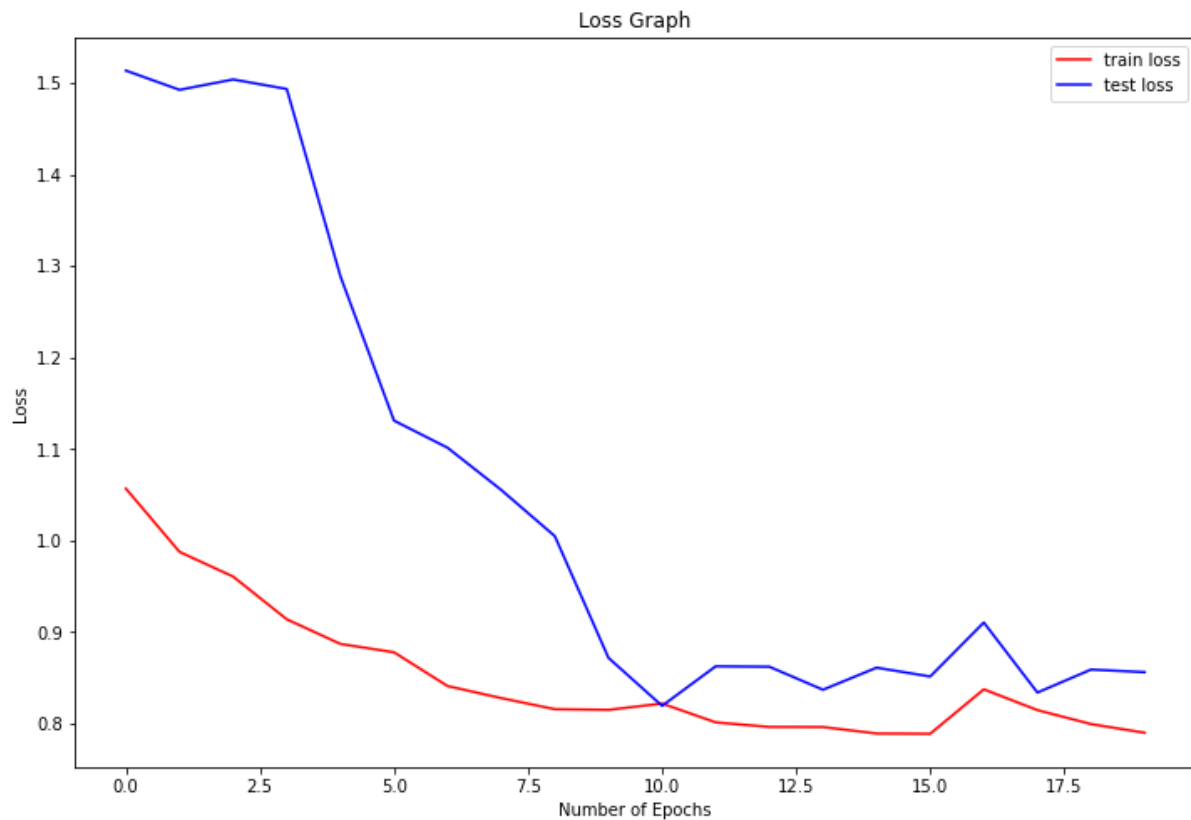
● Accuracy Curve

- Confusion Matrix:

Confusion Matrix

Actuals \ Predictions	0	1	2	3
0	108	1	0	0
1	10	99	0	0
2	0	0	109	0
3	0	1	15	90
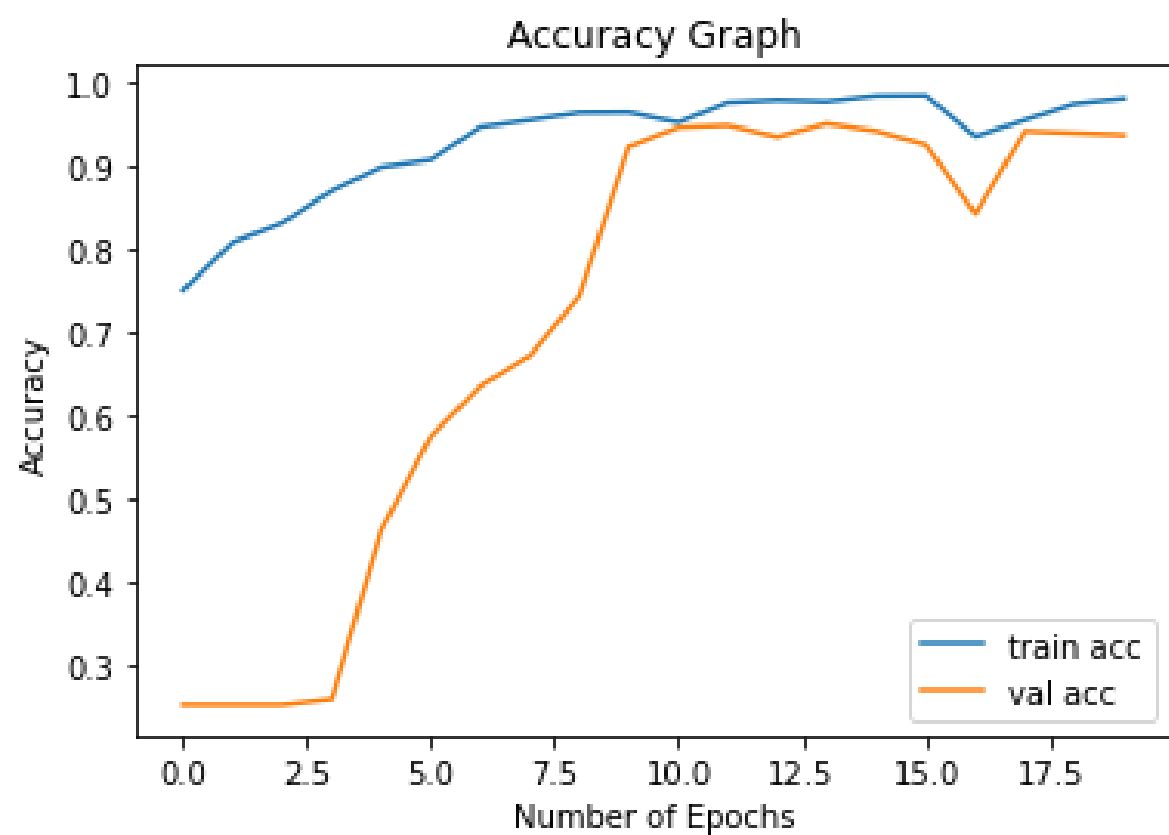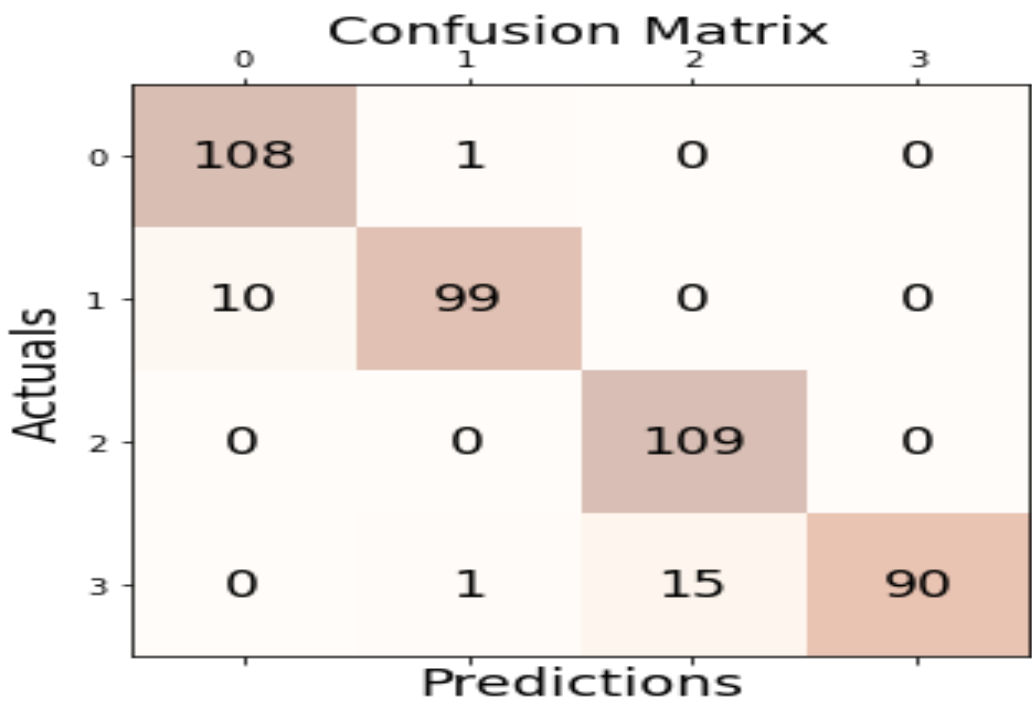
- Precision values:
  0.91525424 0.98019802 0.87903226 1.0000000

- Recall values:
  0.99082569 0.90825688 1.00000000 0.8490566

- F1 score values:
  0.95154185 0.94285714 0.93562232 0.91836735

- Accuracy values:
  0.9376443418013857