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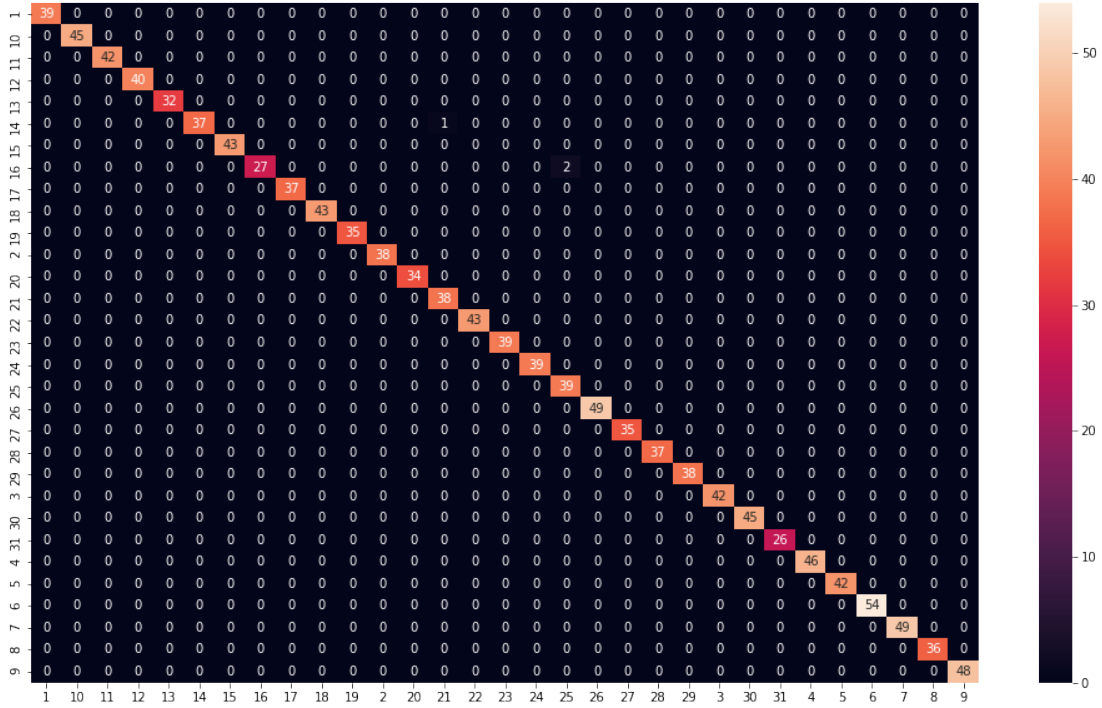
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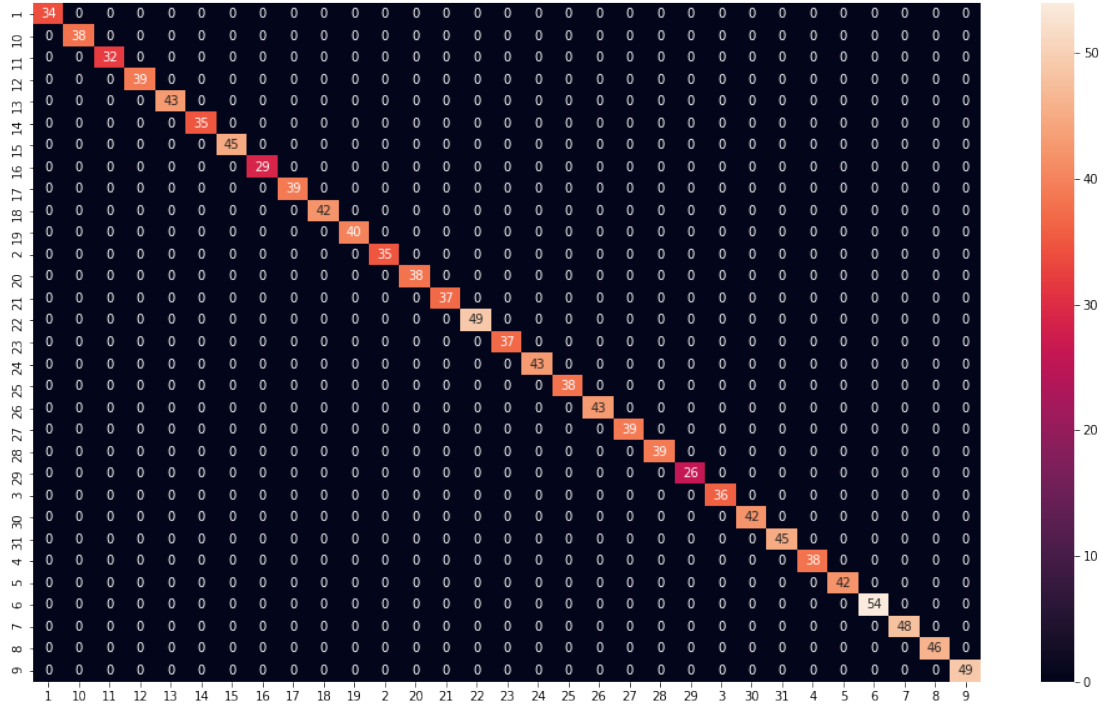
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LAMPIRAN

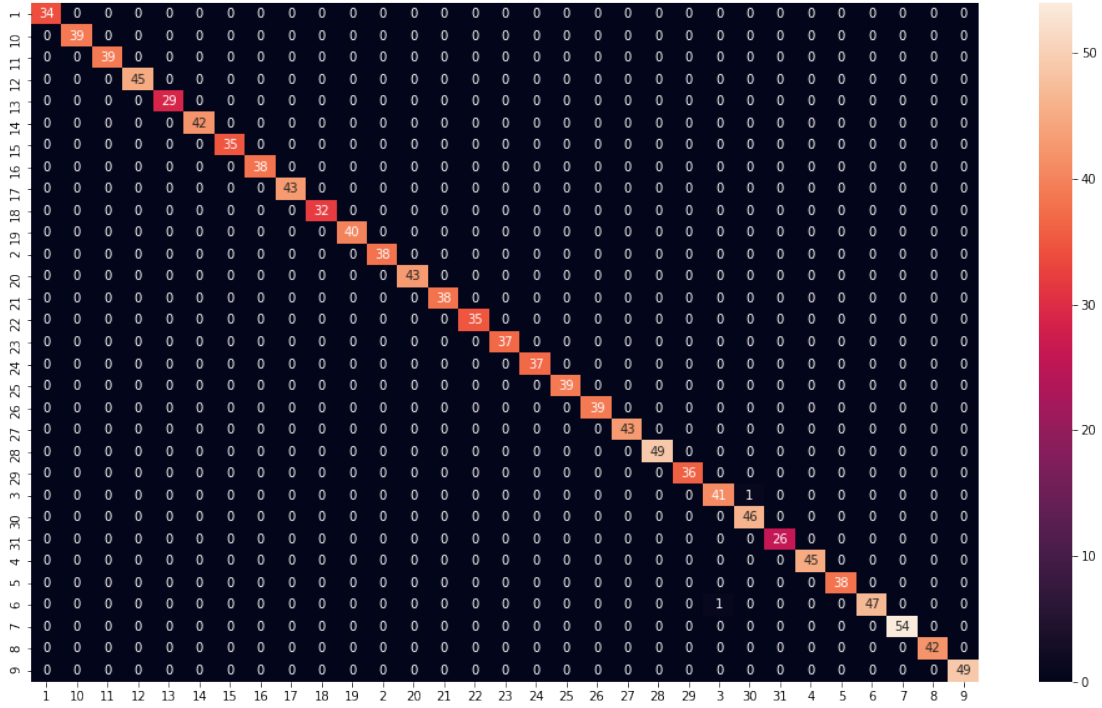
Lampiran 1 : Confusion Matrix Subjek 1



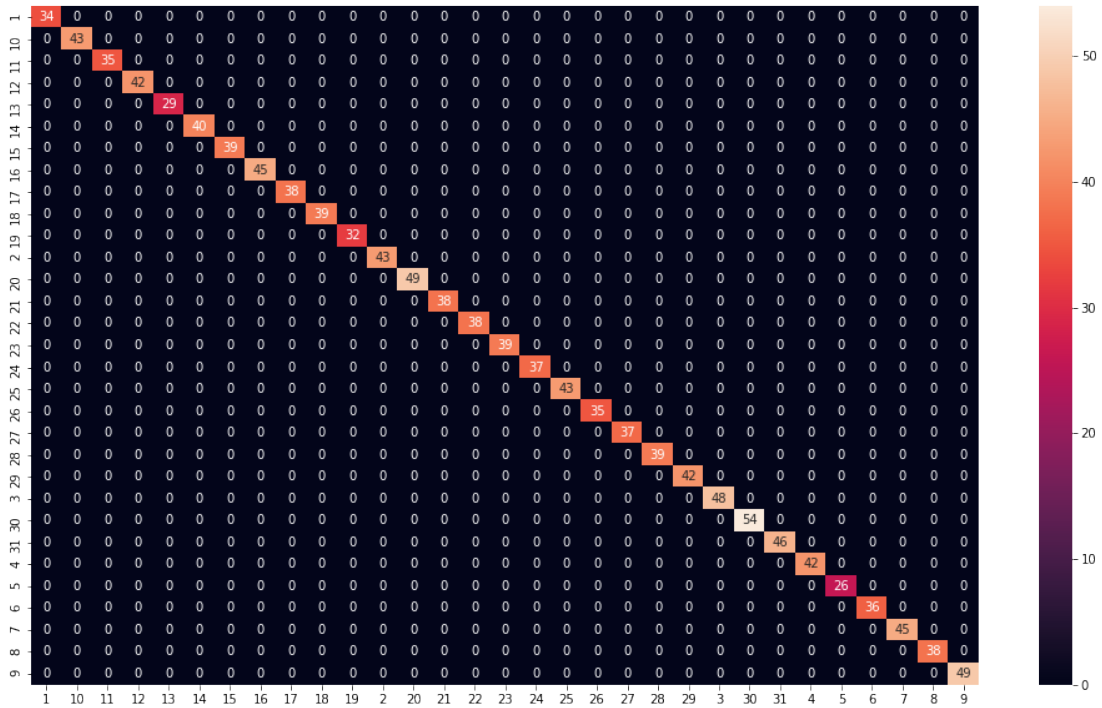
Lampiran 2 : Confusion Matrix Subjek 2



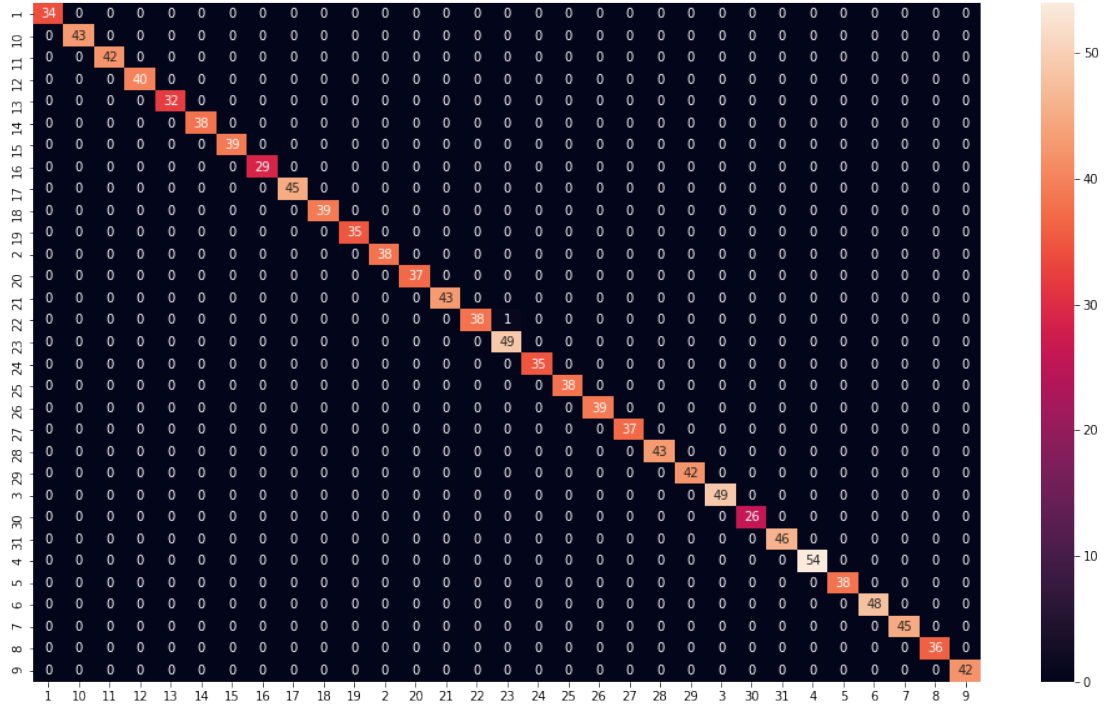
Lampiran 3 : Confusion Matrix Subjek 3



Lampiran 4 : Confusion Matrix Subjek 4



Lampiran 5 : Confusion Matrix Subjek 5



Lampiran 6 : Presisi , Recall , F1 setiap kelas Subjek 1

```
1240/1240 [=====] - 6s 5ms/step
precision recall f1-score support
0 1.00 1.00 1.00 39
1 1.00 1.00 1.00 45
2 1.00 1.00 1.00 42
3 1.00 1.00 1.00 40
4 1.00 1.00 1.00 32
5 1.00 0.97 0.99 38
6 1.00 1.00 1.00 43
7 1.00 0.93 0.96 29
8 1.00 1.00 1.00 37
9 1.00 1.00 1.00 43
10 1.00 1.00 1.00 35
11 1.00 1.00 1.00 38
12 1.00 1.00 1.00 34
13 0.97 1.00 0.99 38
14 1.00 1.00 1.00 43
15 1.00 1.00 1.00 39
16 1.00 1.00 1.00 39
17 0.95 1.00 0.97 39
18 1.00 1.00 1.00 49
19 1.00 1.00 1.00 35
20 1.00 1.00 1.00 37
21 1.00 1.00 1.00 38
22 1.00 1.00 1.00 42
23 1.00 1.00 1.00 45
24 1.00 1.00 1.00 26
25 1.00 1.00 1.00 46
26 1.00 1.00 1.00 42
27 1.00 1.00 1.00 54
28 1.00 1.00 1.00 49
29 1.00 1.00 1.00 36
30 1.00 1.00 1.00 48
```

Lampiran 7 : Presisi , Recall , F1 setiap kelas Subjek 2

1240/1240 [=====] - 6s 5ms/step

	precision	recall	f1-score	support
0	1.00	1.00	1.00	34
1	1.00	1.00	1.00	38
2	1.00	1.00	1.00	32
3	1.00	1.00	1.00	39
4	1.00	1.00	1.00	43
5	1.00	1.00	1.00	35
6	1.00	1.00	1.00	45
7	1.00	1.00	1.00	29
8	1.00	1.00	1.00	39
9	1.00	1.00	1.00	42
10	1.00	1.00	1.00	40
11	1.00	1.00	1.00	35
12	1.00	1.00	1.00	38
13	1.00	1.00	1.00	37
14	1.00	1.00	1.00	49
15	1.00	1.00	1.00	37
16	1.00	1.00	1.00	43
17	1.00	1.00	1.00	38
18	1.00	1.00	1.00	43
19	1.00	1.00	1.00	39
20	1.00	1.00	1.00	39
21	1.00	1.00	1.00	26
22	1.00	1.00	1.00	36
23	1.00	1.00	1.00	42
24	1.00	1.00	1.00	45
25	1.00	1.00	1.00	38
26	1.00	1.00	1.00	42
27	1.00	1.00	1.00	54
28	1.00	1.00	1.00	48
29	1.00	1.00	1.00	46
30	1.00	1.00	1.00	49

Lampiran 9 : Presisi , Recall , F1 setiap kelas Subjek 3

```
1240/1240 [=====] - 6s 5ms/step
precision  recall  f1-score  support
0          1.00    1.00    1.00     34
1          1.00    1.00    1.00     39
2          1.00    1.00    1.00     39
3          1.00    1.00    1.00     45
4          1.00    1.00    1.00     29
5          1.00    1.00    1.00     42
6          1.00    1.00    1.00     35
7          1.00    1.00    1.00     38
8          1.00    1.00    1.00     43
9          1.00    1.00    1.00     32
10         1.00    1.00    1.00     40
11         1.00    1.00    1.00     38
12         1.00    1.00    1.00     43
13         1.00    1.00    1.00     38
14         1.00    1.00    1.00     35
15         1.00    1.00    1.00     37
16         1.00    1.00    1.00     37
17         1.00    1.00    1.00     39
18         1.00    1.00    1.00     39
19         1.00    1.00    1.00     43
20         1.00    1.00    1.00     49
21         1.00    1.00    1.00     36
22         0.98    0.98    0.98     42
23         0.98    1.00    0.99     46
24         1.00    1.00    1.00     26
25         1.00    1.00    1.00     45
26         1.00    1.00    1.00     38
27         1.00    0.98    0.99     48
28         1.00    1.00    1.00     54
29         1.00    1.00    1.00     42
30         1.00    1.00    1.00     49
```

Lampiran 10 : Presisi , Recall , F1 setiap kelas Subjek 4

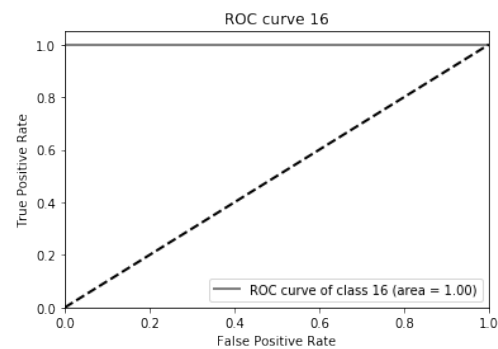
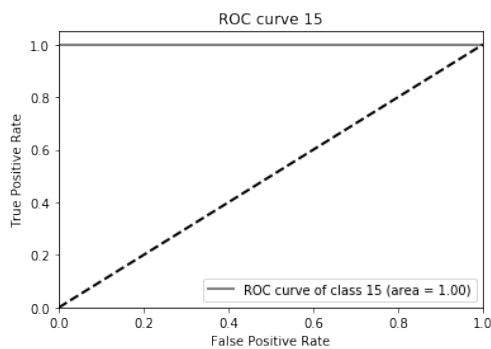
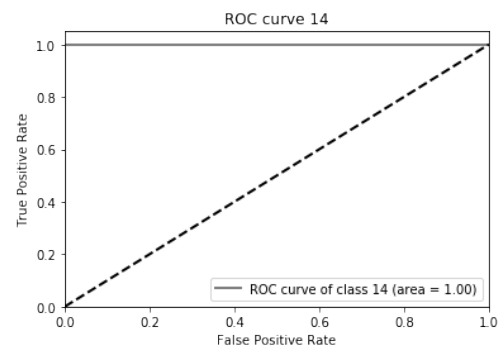
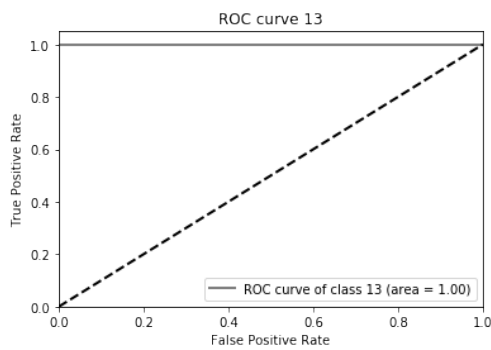
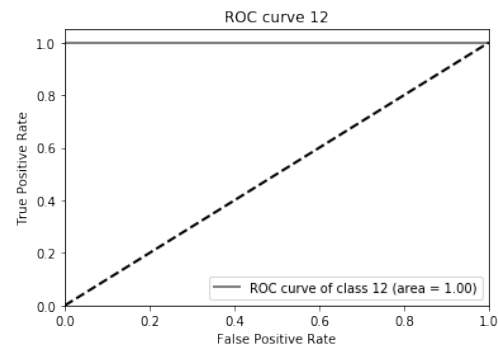
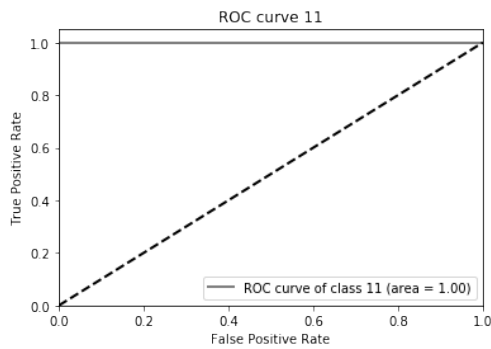
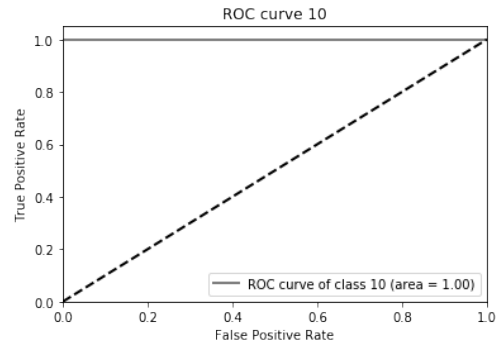
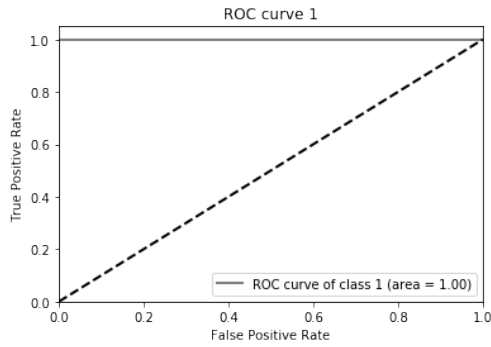
```
1240/1240 [=====] - 6s 5ms/step
precision    recall  f1-score   support

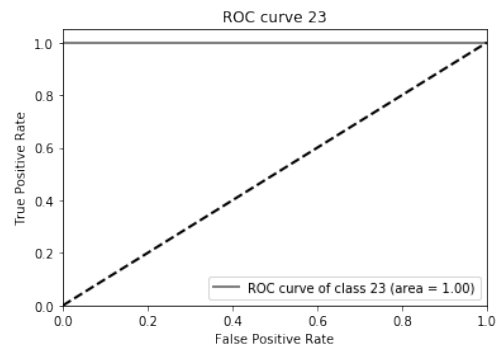
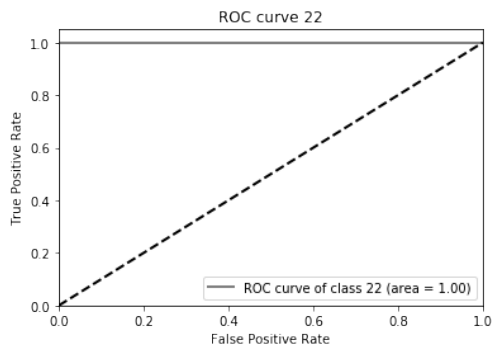
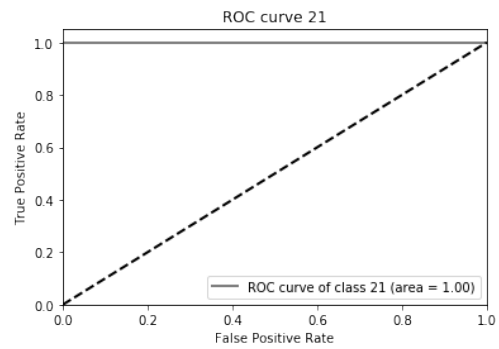
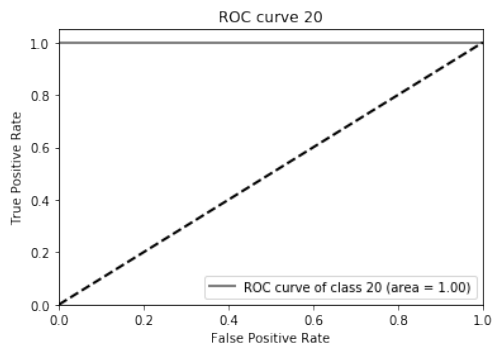
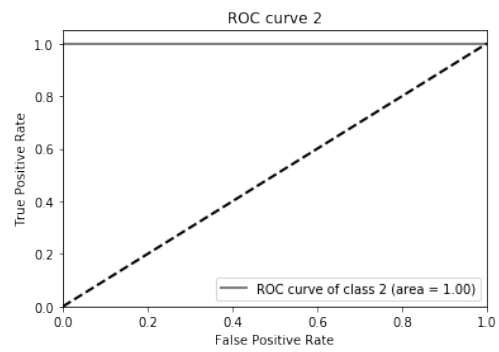
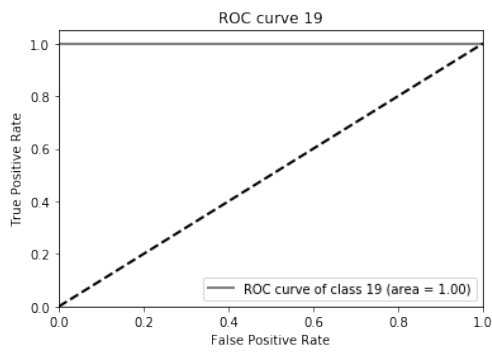
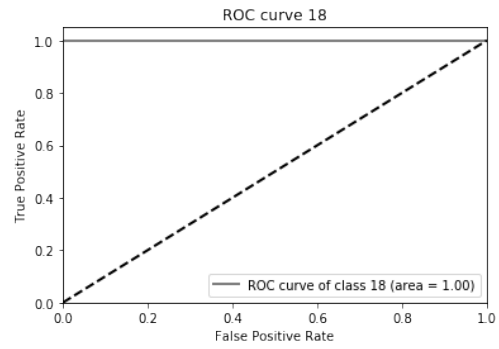
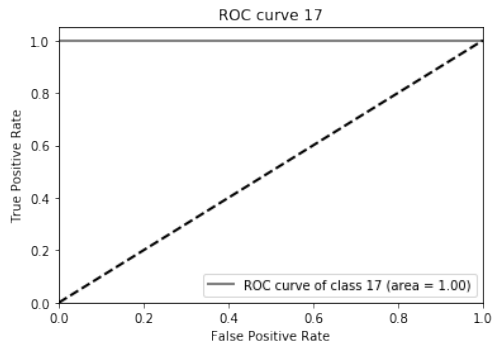
 0         1.00      1.00      1.00        34
 1         1.00      1.00      1.00        43
 2         1.00      1.00      1.00        35
 3         1.00      1.00      1.00        42
 4         1.00      1.00      1.00        29
 5         1.00      1.00      1.00        40
 6         1.00      1.00      1.00        39
 7         1.00      1.00      1.00        45
 8         1.00      1.00      1.00        38
 9         1.00      1.00      1.00        39
10         1.00      1.00      1.00        32
11         1.00      1.00      1.00        43
12         1.00      1.00      1.00        49
13         1.00      1.00      1.00        38
14         1.00      1.00      1.00        38
15         1.00      1.00      1.00        39
16         1.00      1.00      1.00        37
17         1.00      1.00      1.00        43
18         1.00      1.00      1.00        35
19         1.00      1.00      1.00        37
20         1.00      1.00      1.00        39
21         1.00      1.00      1.00        42
22         1.00      1.00      1.00        48
23         1.00      1.00      1.00        54
24         1.00      1.00      1.00        46
25         1.00      1.00      1.00        42
26         1.00      1.00      1.00        26
27         1.00      1.00      1.00        36
28         1.00      1.00      1.00        45
29         1.00      1.00      1.00        38
30         1.00      1.00      1.00        49
```

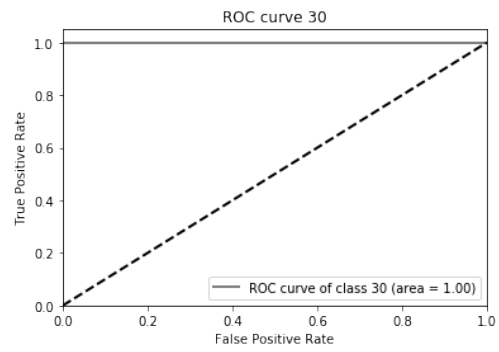
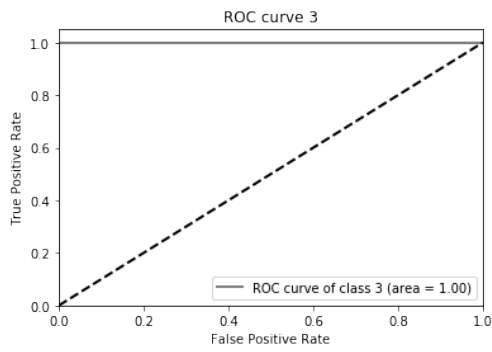
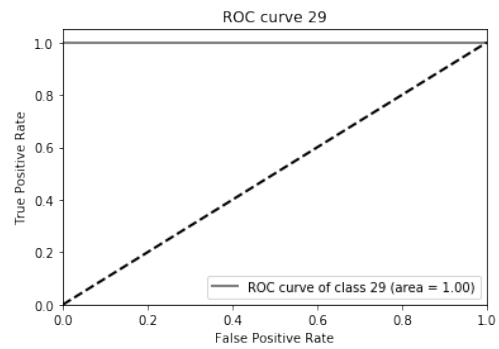
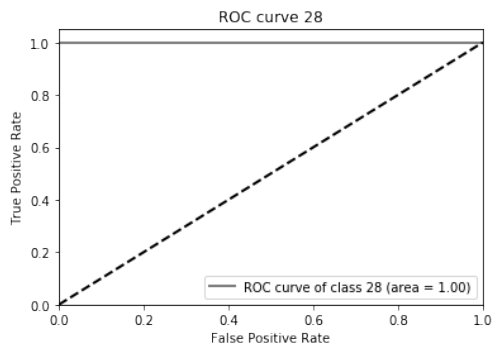
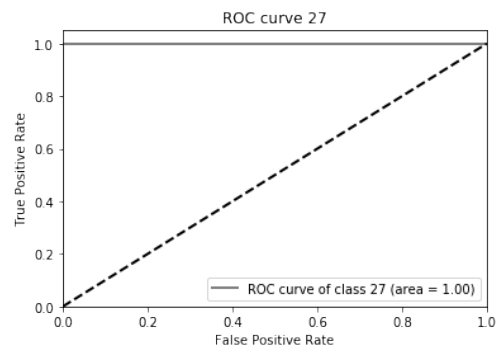
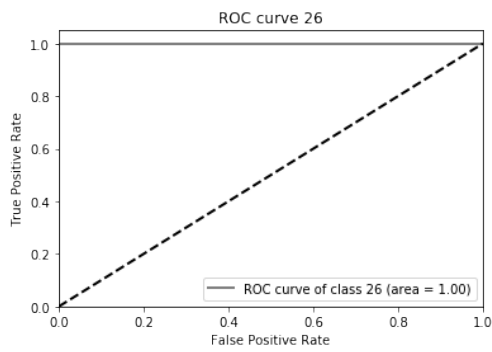
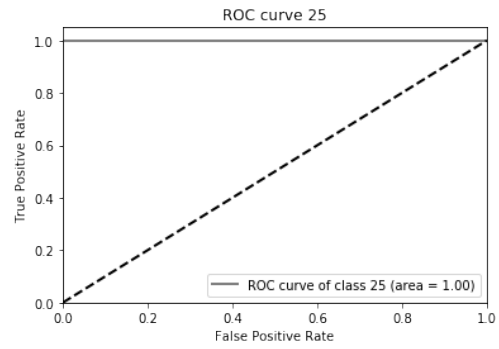
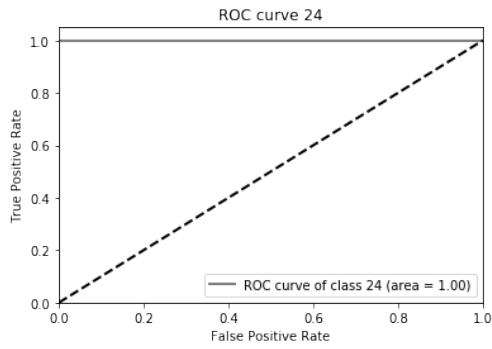
Lampiran 9 : Presisi , Recall , F1 setiap kelas Subjek 5

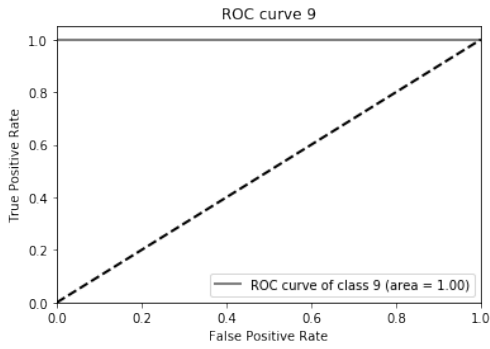
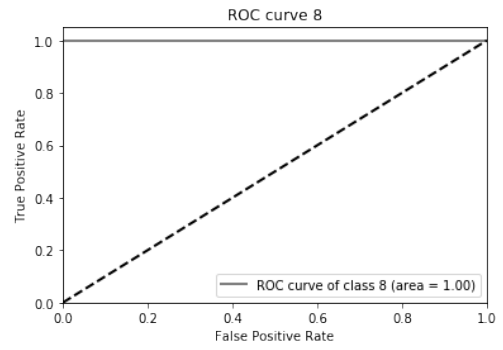
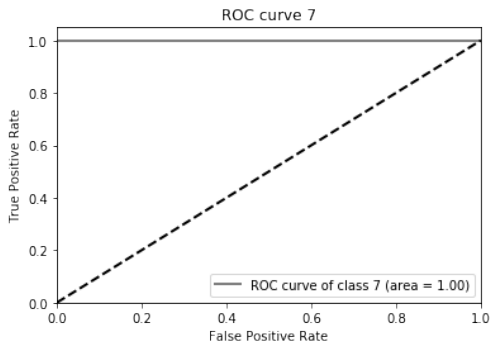
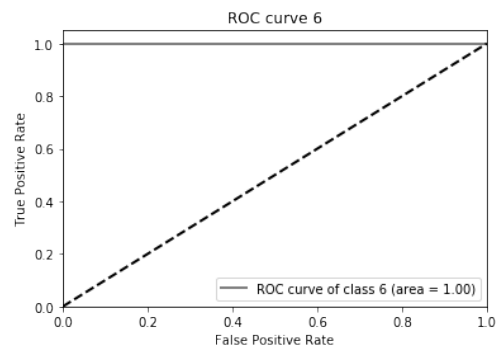
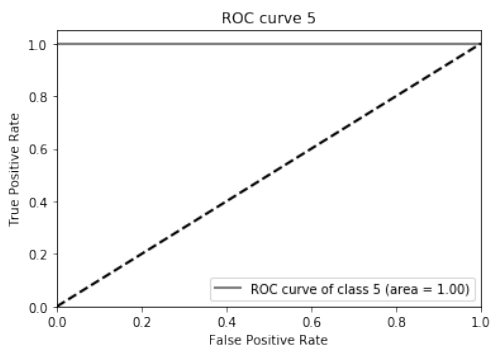
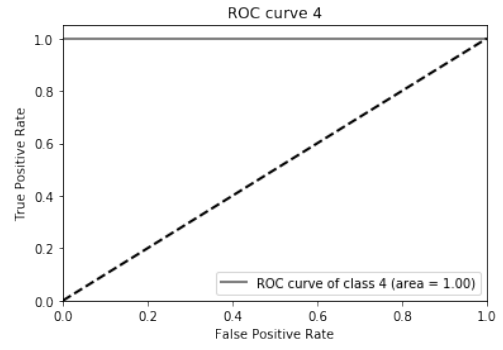
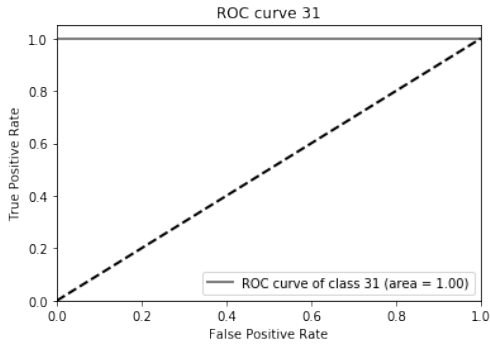
```
1240/1240 [=====] - 6s 5ms/step
precision  recall  f1-score  support
0          1.00    1.00     1.00     34
1          1.00    1.00     1.00     43
2          1.00    1.00     1.00     42
3          1.00    1.00     1.00     40
4          1.00    1.00     1.00     32
5          1.00    1.00     1.00     38
6          1.00    1.00     1.00     39
7          1.00    1.00     1.00     29
8          1.00    1.00     1.00     45
9          1.00    1.00     1.00     39
10         1.00    1.00     1.00     35
11         1.00    1.00     1.00     38
12         1.00    1.00     1.00     37
13         1.00    1.00     1.00     43
14         1.00    0.97     0.99     39
15         0.98    1.00     0.99     49
16         1.00    1.00     1.00     35
17         1.00    1.00     1.00     38
18         1.00    1.00     1.00     39
19         1.00    1.00     1.00     37
20         1.00    1.00     1.00     43
21         1.00    1.00     1.00     42
22         1.00    1.00     1.00     49
23         1.00    1.00     1.00     26
24         1.00    1.00     1.00     46
25         1.00    1.00     1.00     54
26         1.00    1.00     1.00     38
27         1.00    1.00     1.00     48
28         1.00    1.00     1.00     45
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30         1.00    1.00     1.00     42
```

Lampiran 11 : ROC Subjek 1

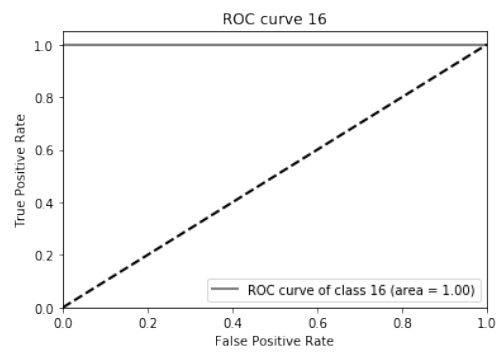
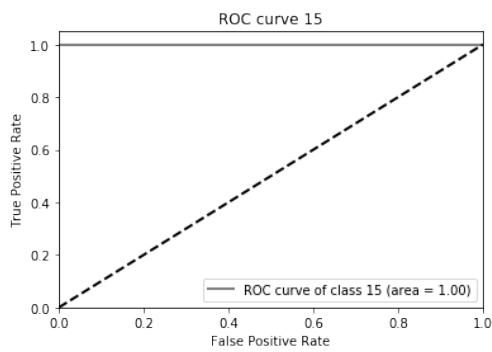
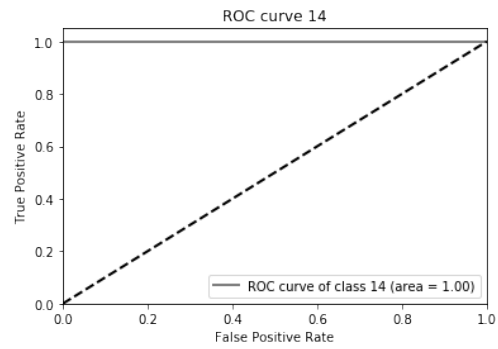
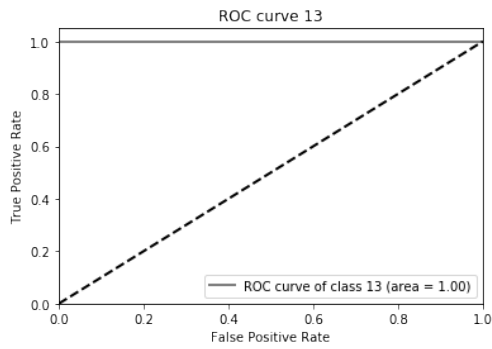
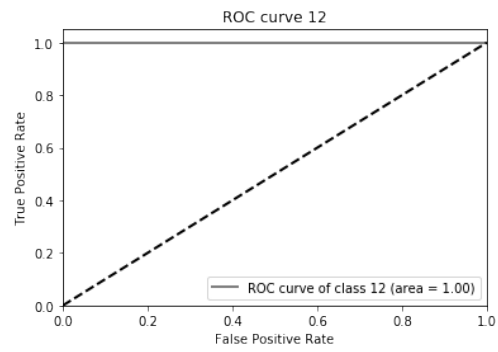
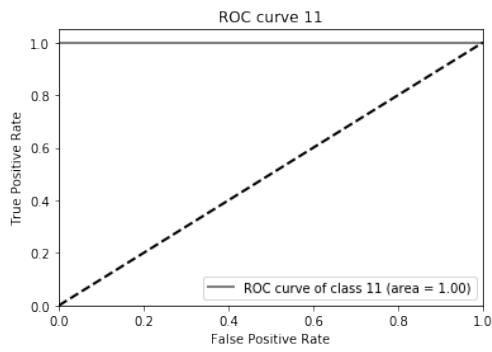
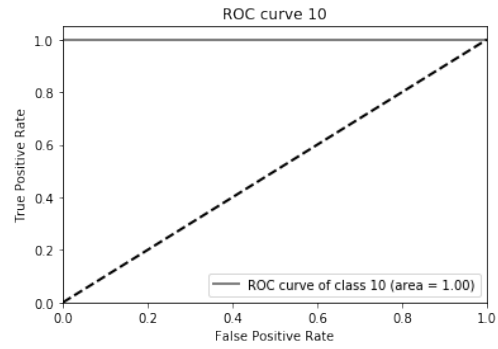
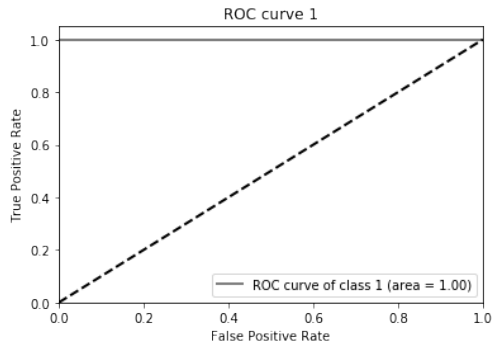


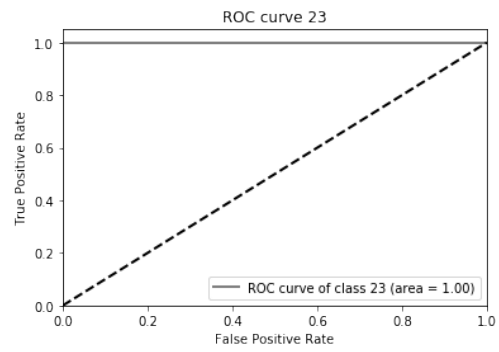
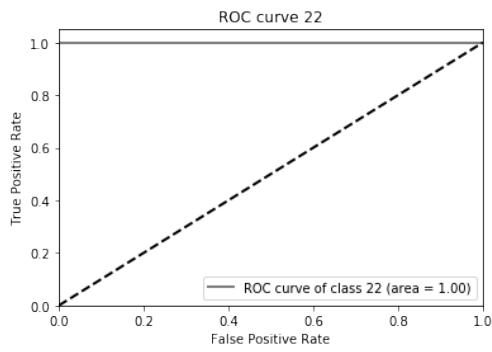
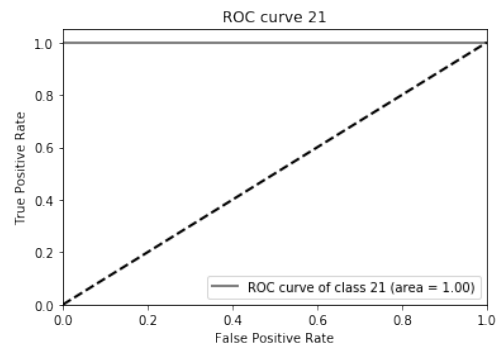
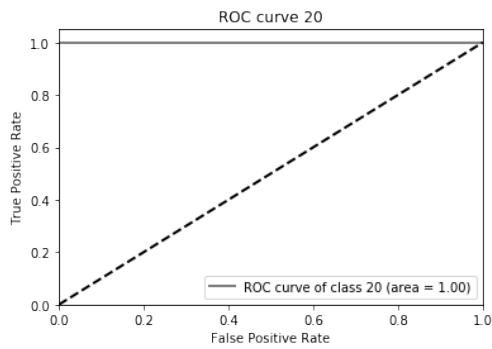
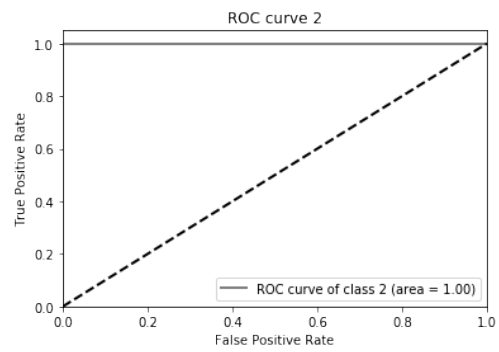
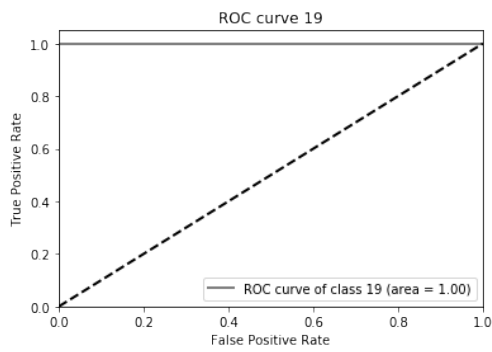
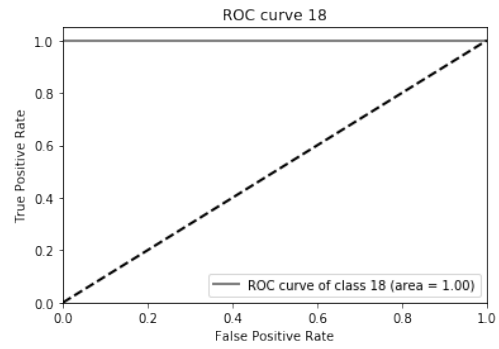
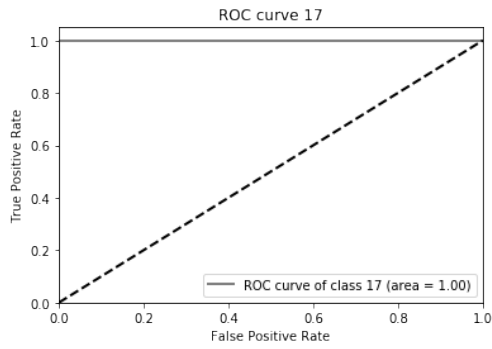


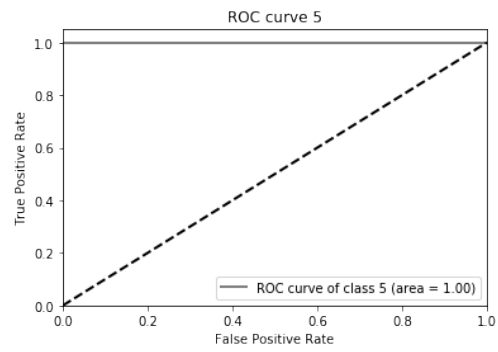
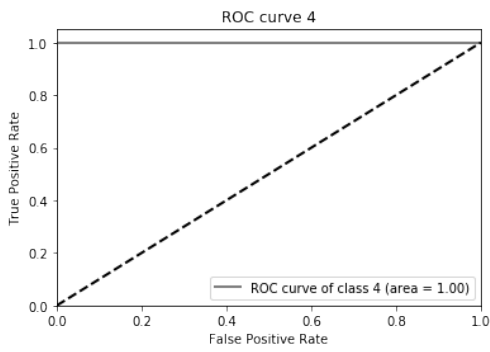
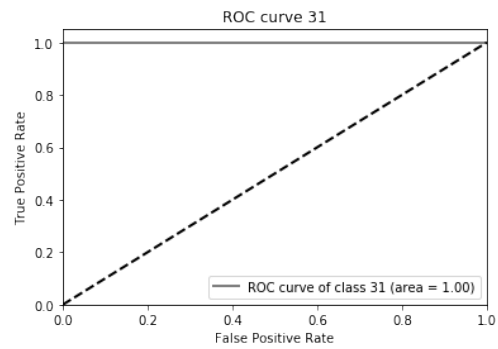
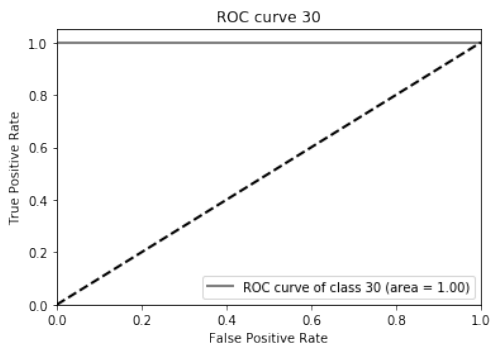
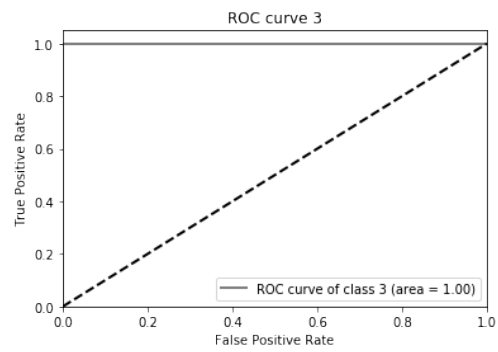
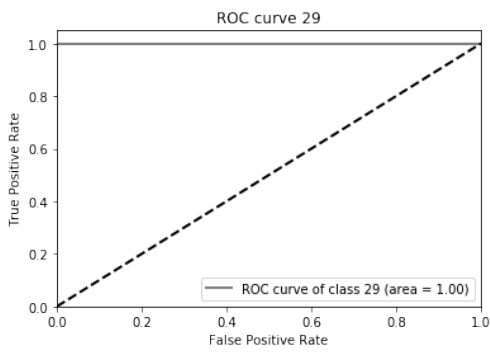
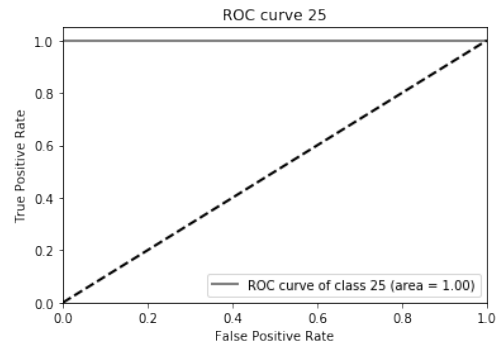
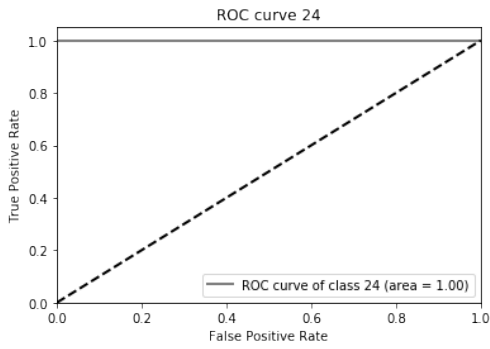


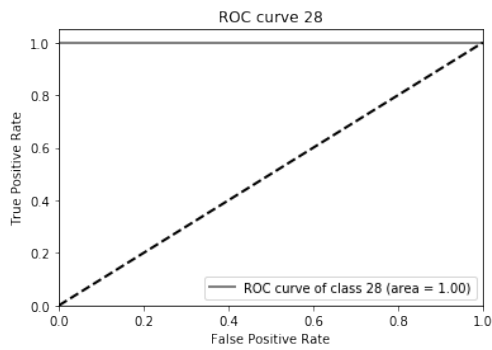
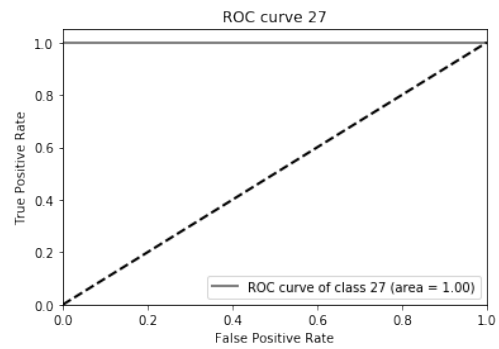
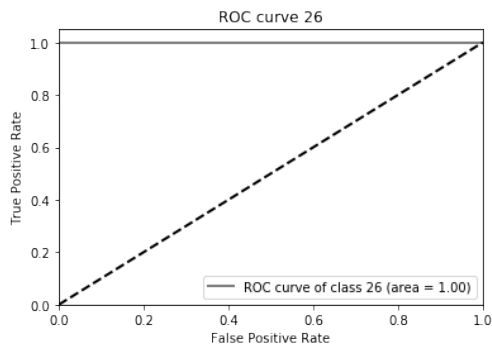
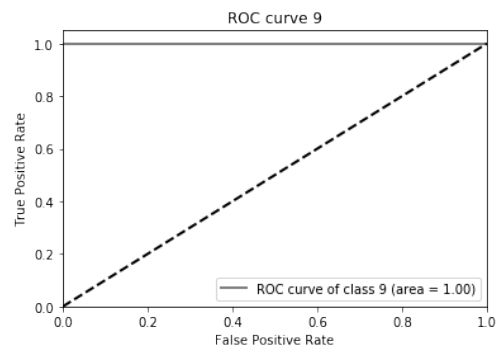
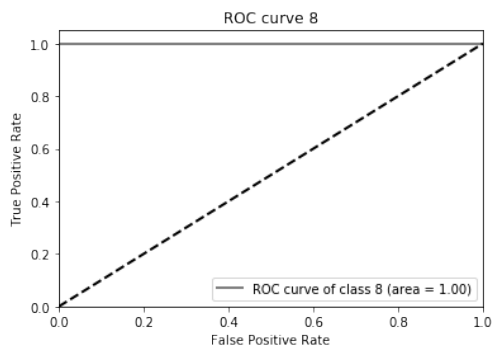
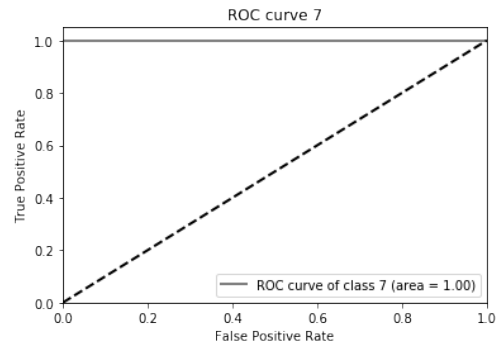
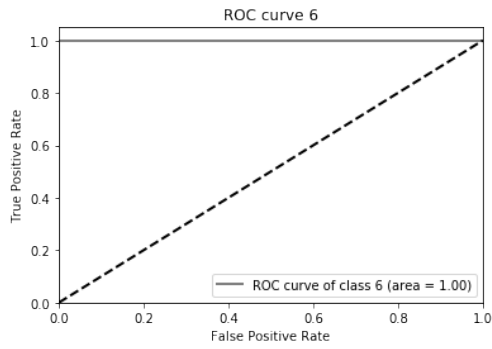


Lampiran 12 : ROC Subjek 2

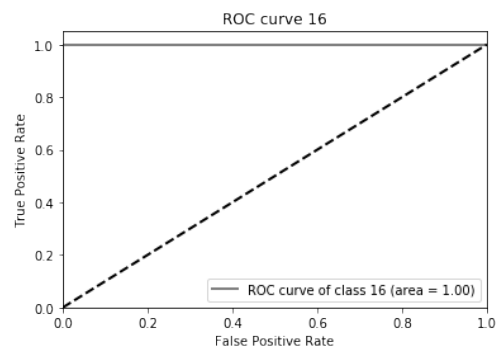
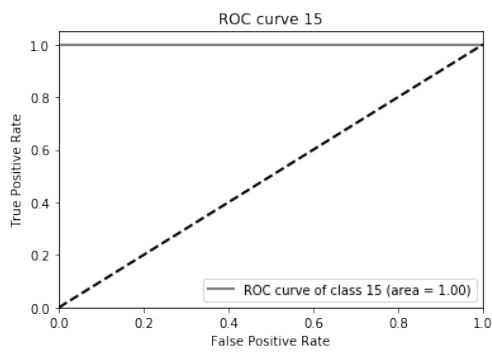
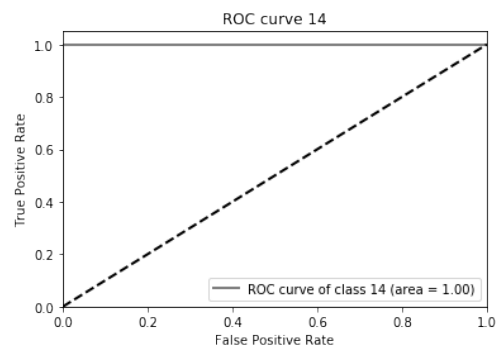
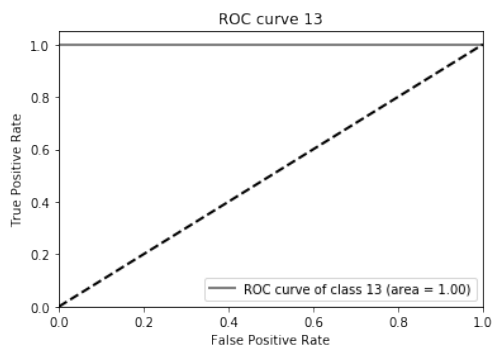
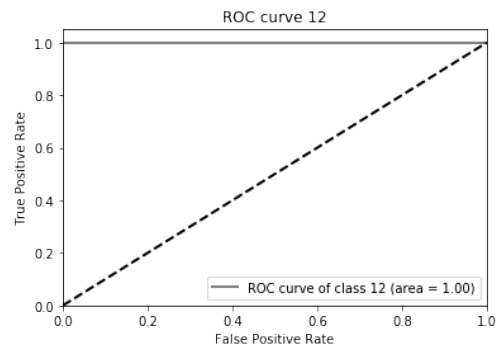
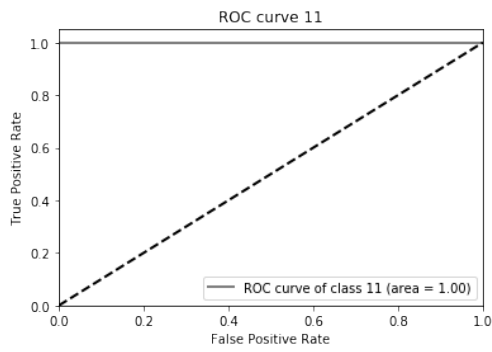
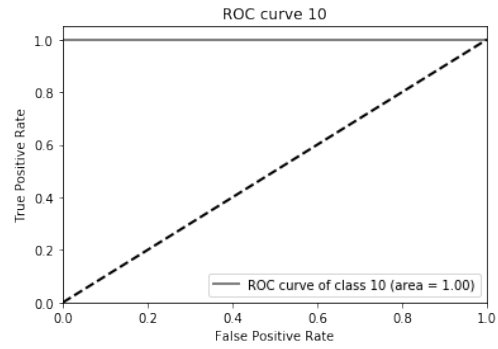
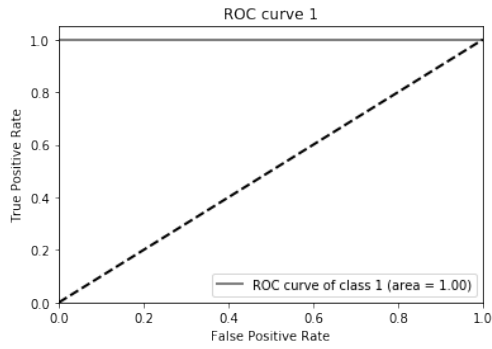


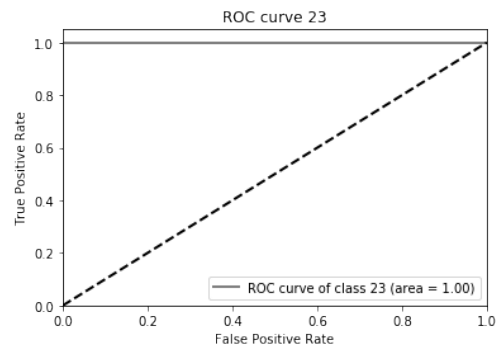
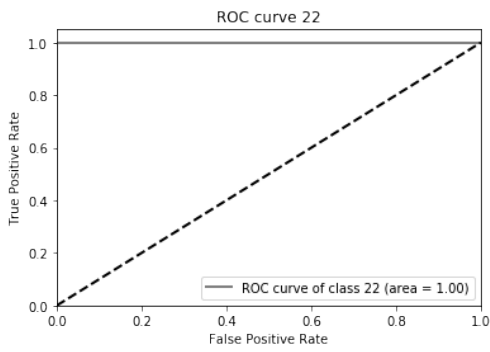
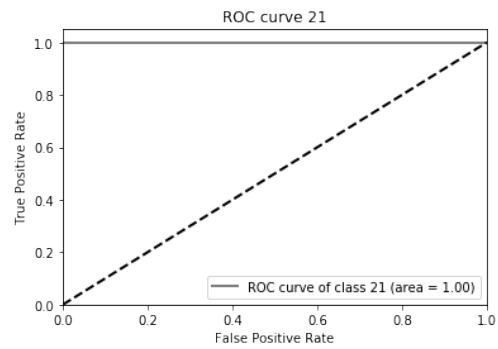
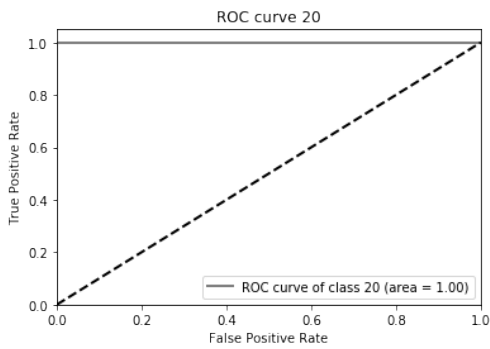
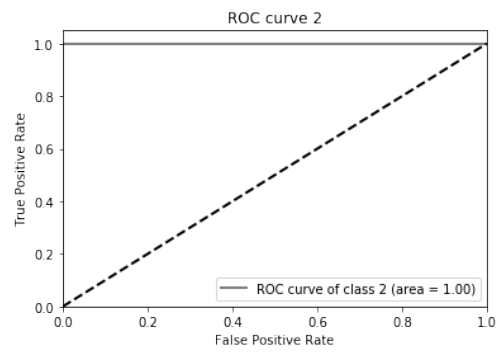
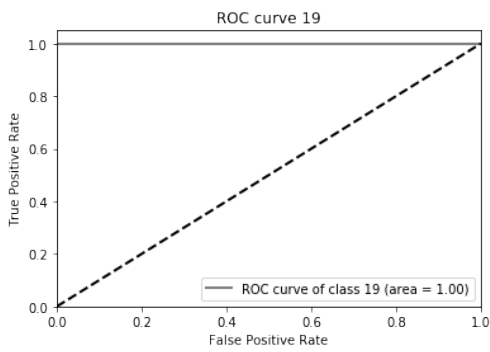
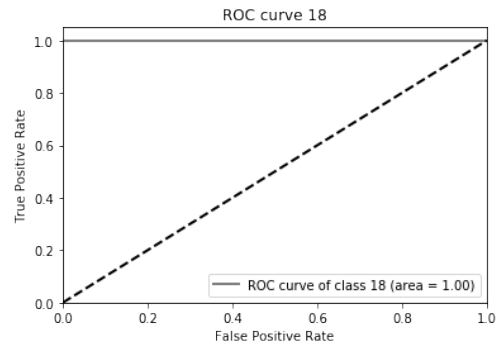
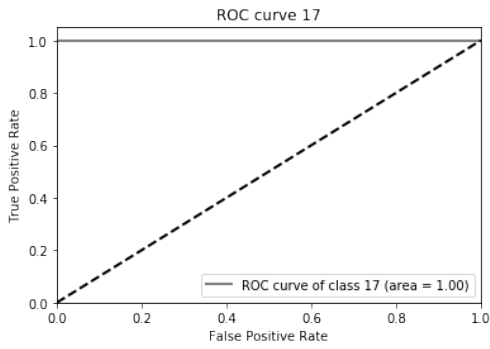


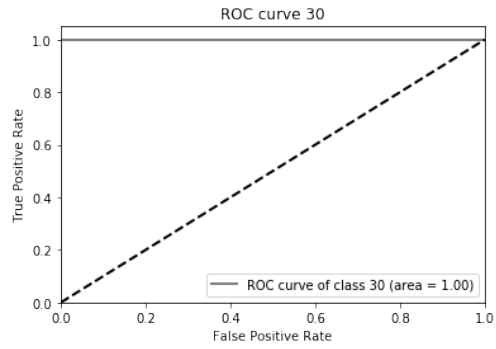
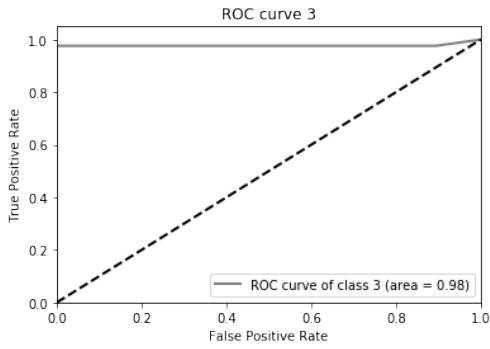
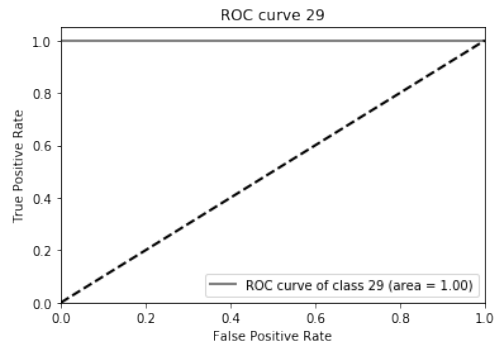
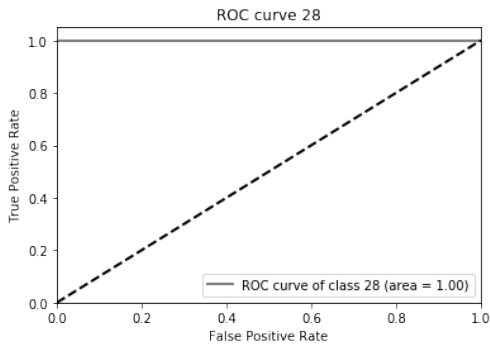
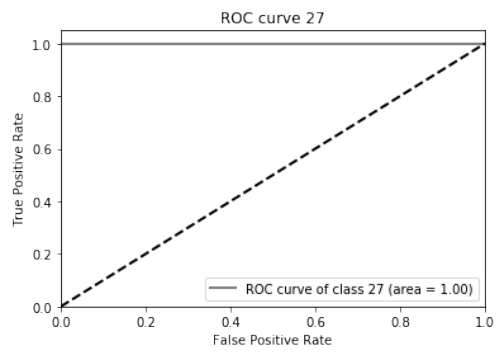
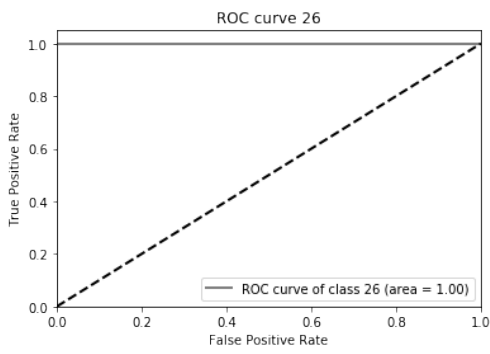
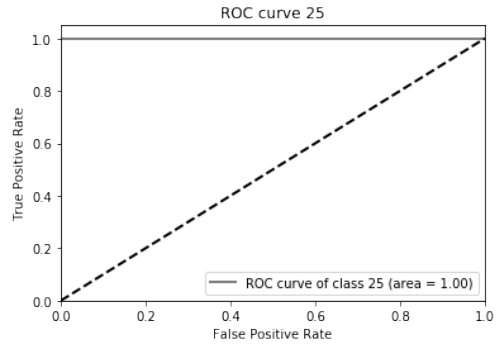
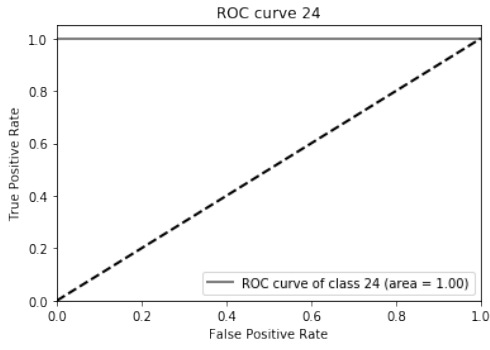


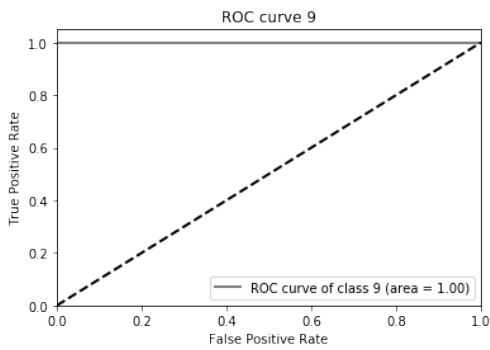
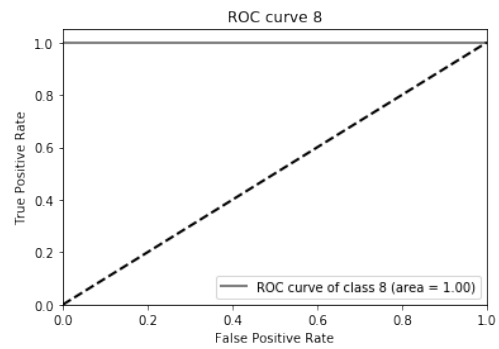
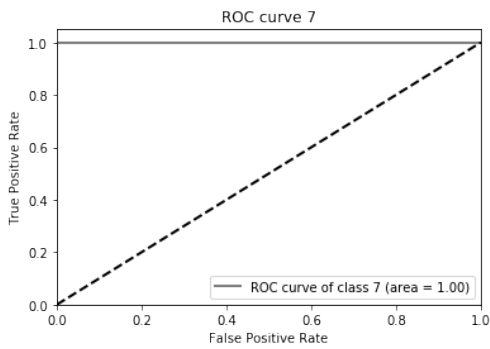
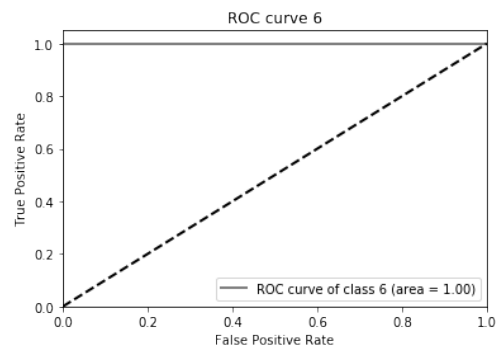
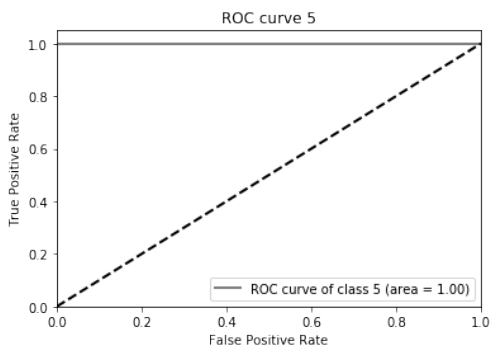
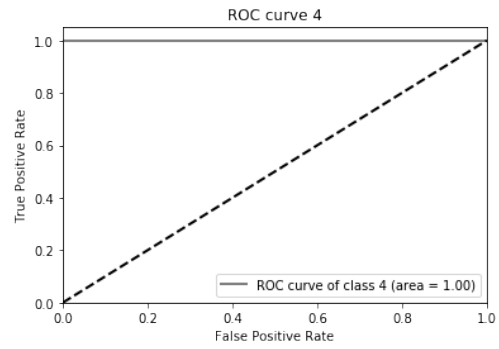
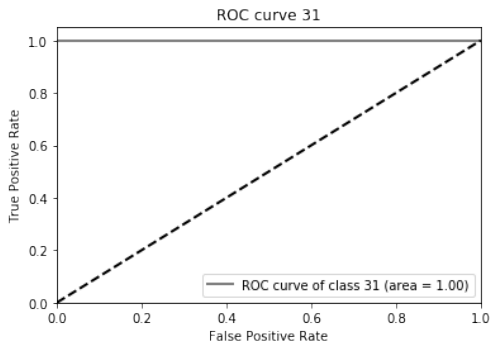


Lampiran 13 : ROC Subjek 3

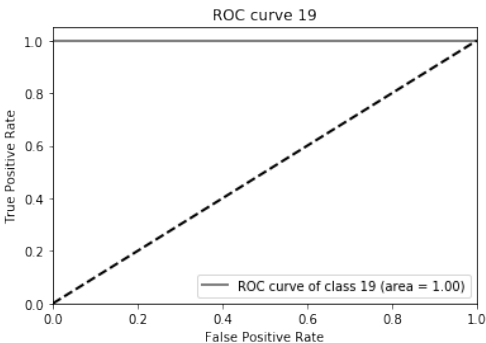
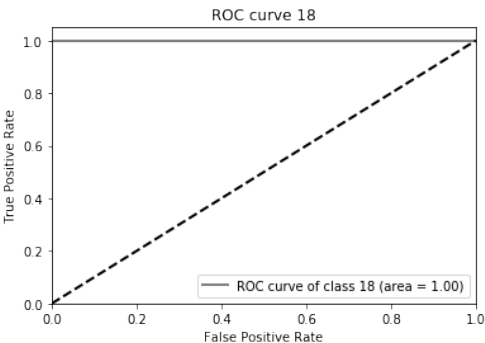
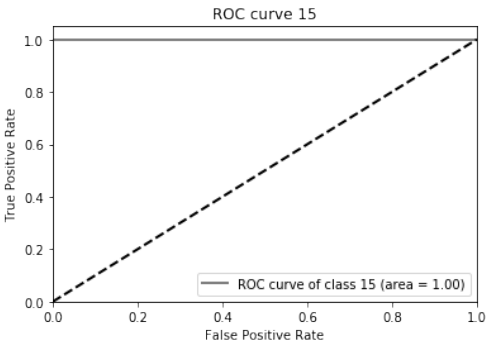
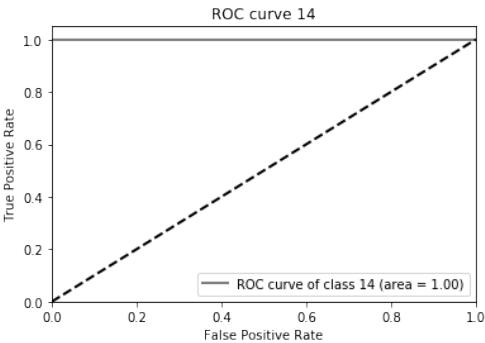
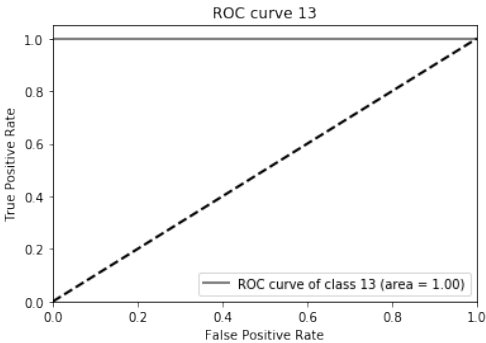
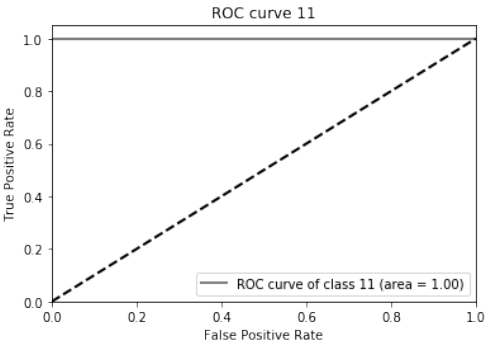
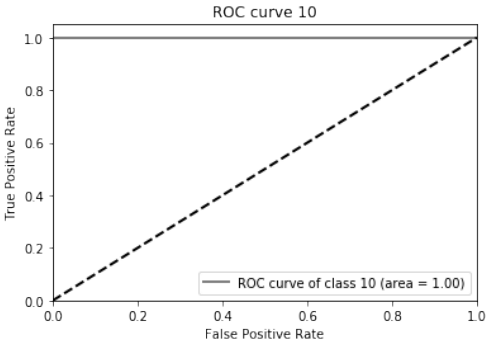
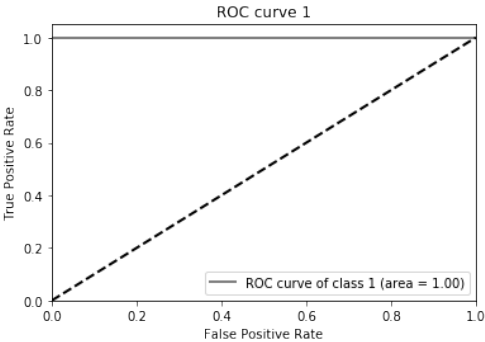


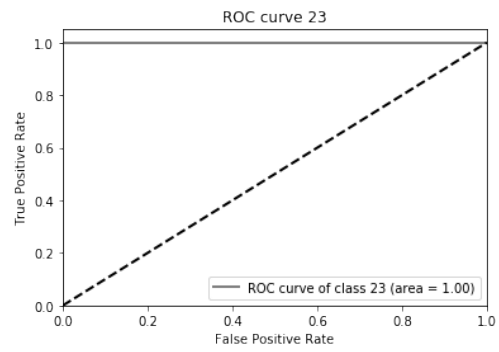
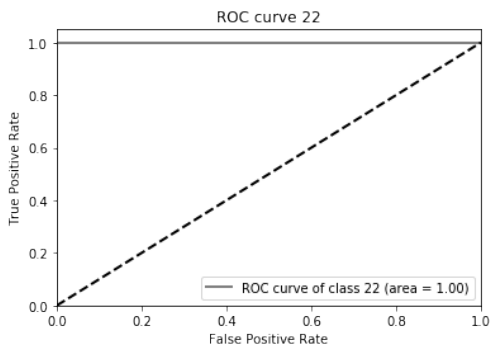
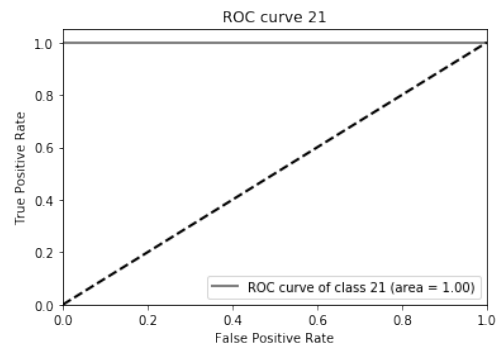
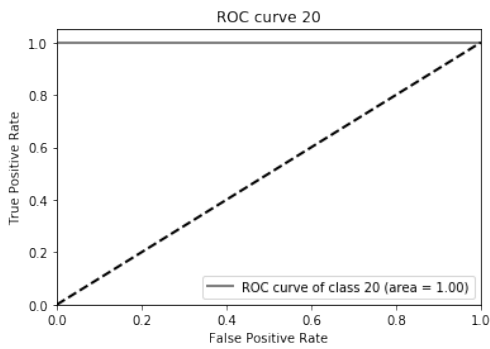
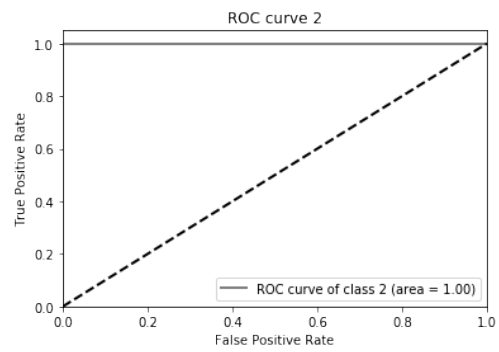
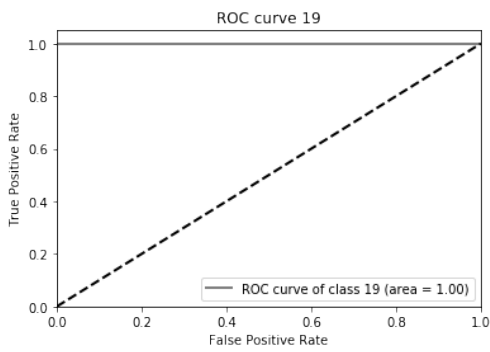
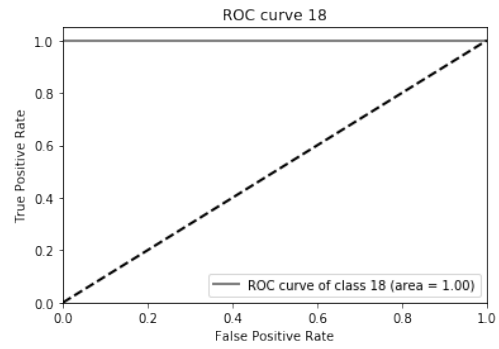
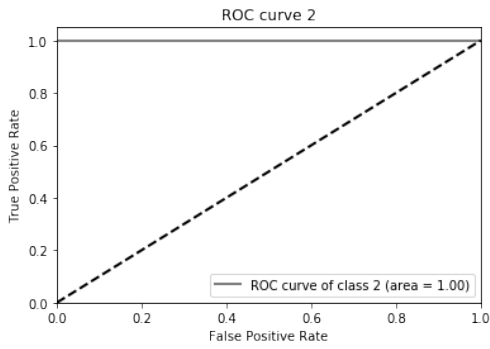


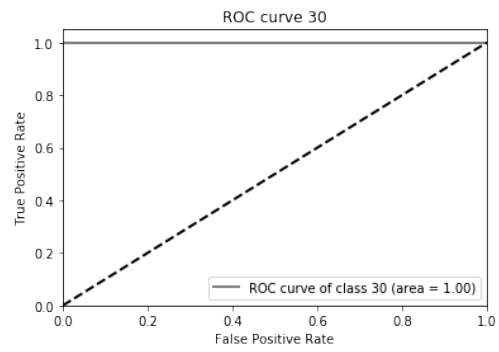
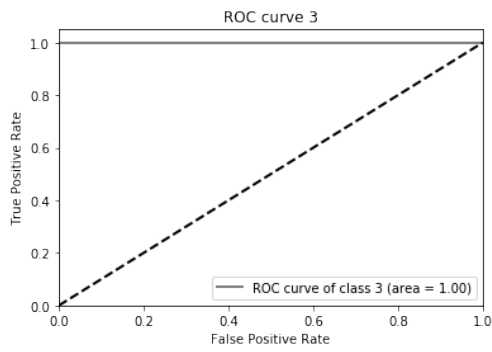
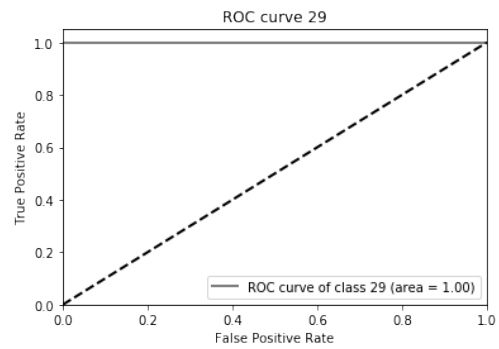
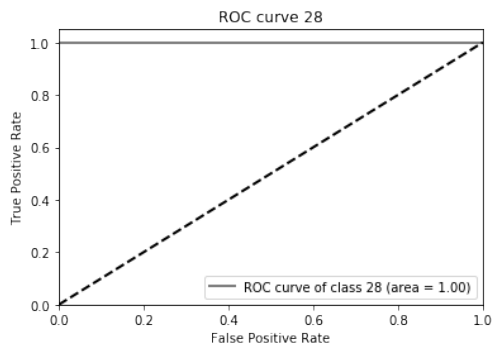
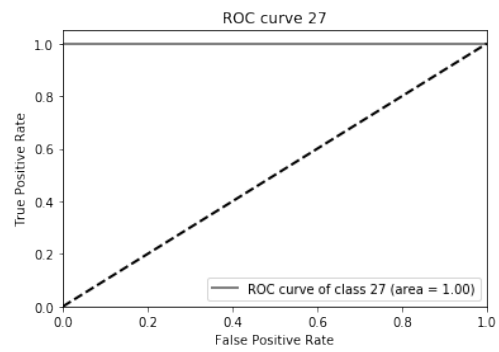
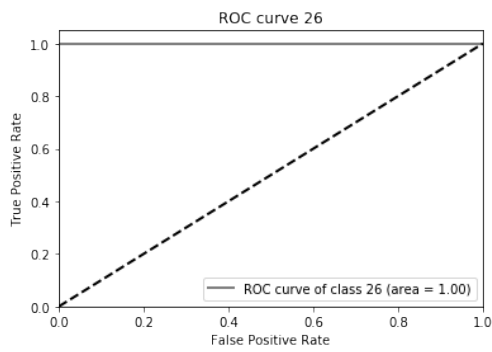
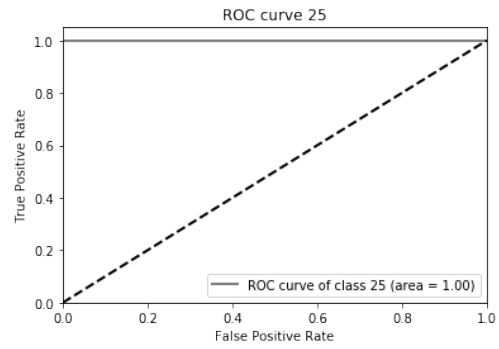
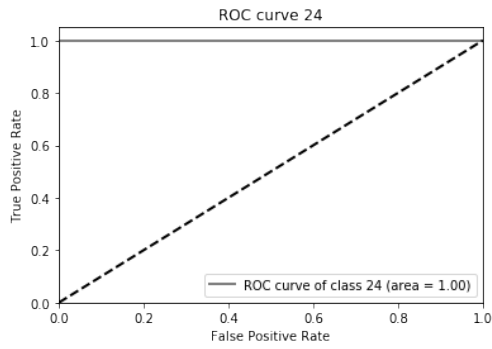


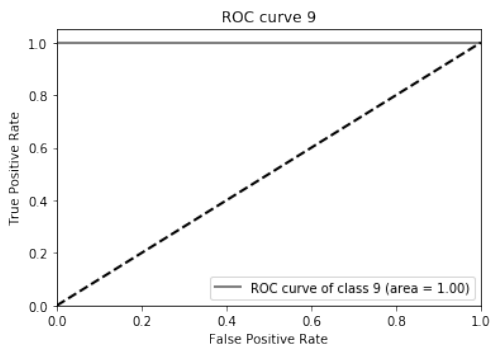
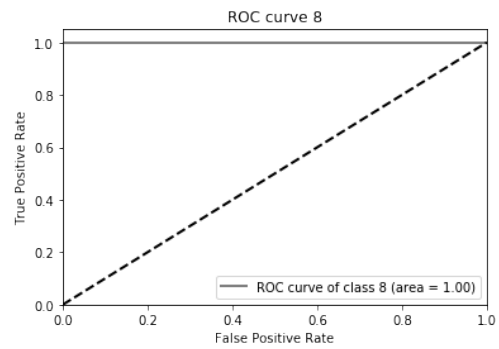
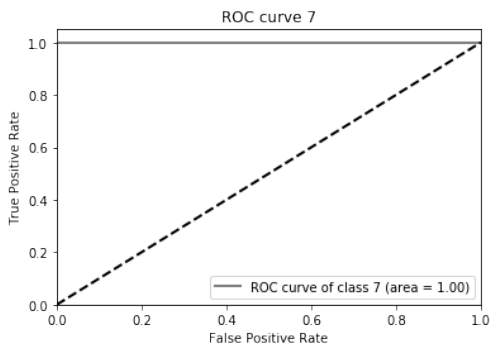
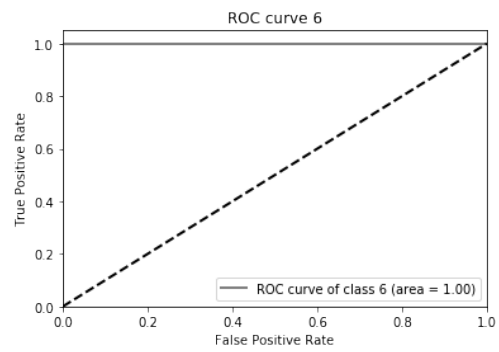
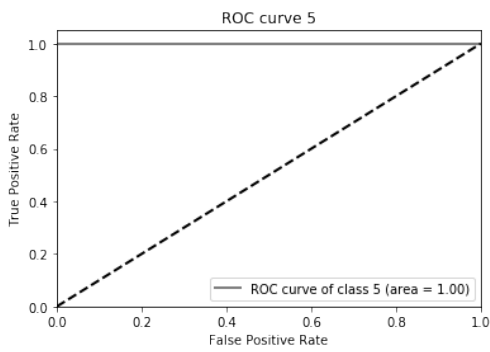
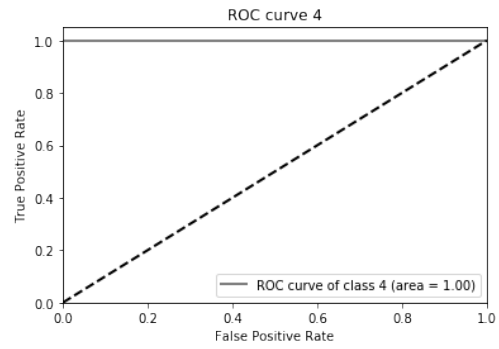
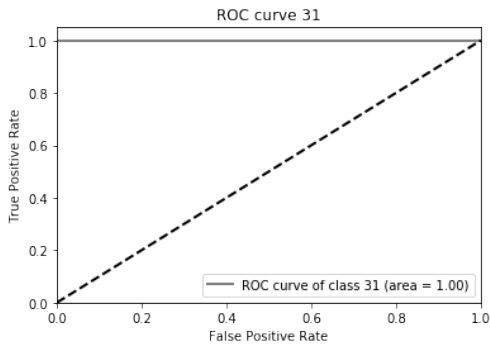


Lampiran 14 : ROC Subjek 4

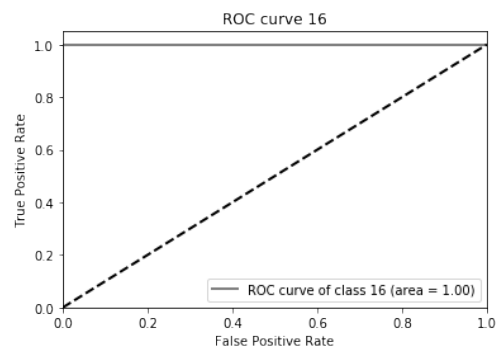
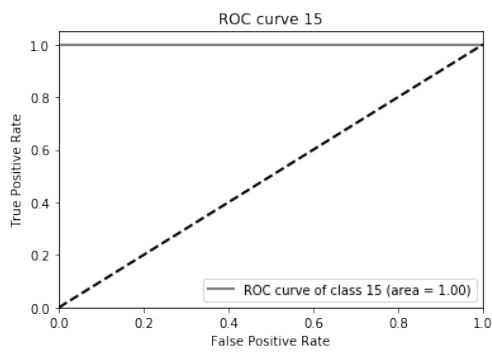
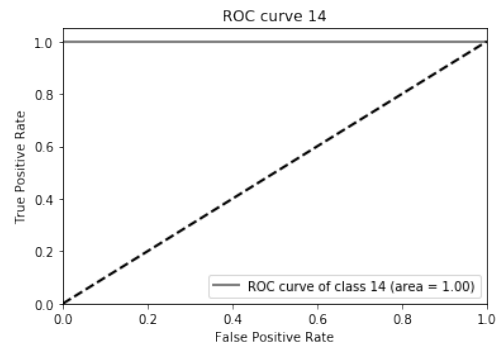
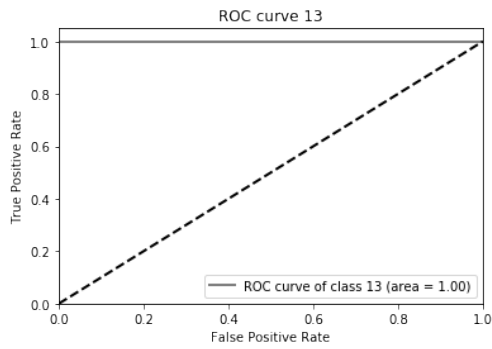
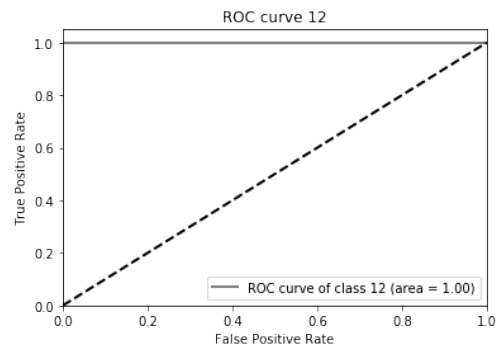
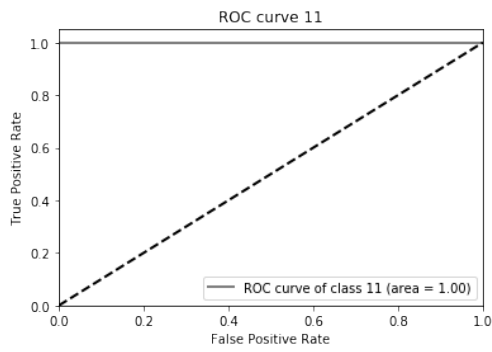
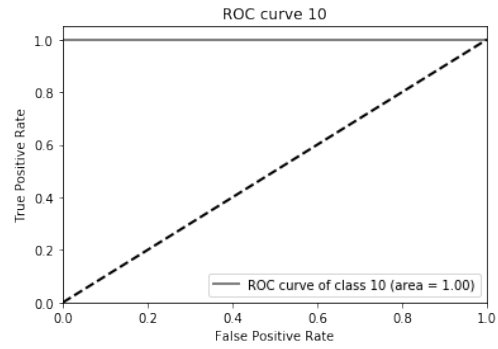
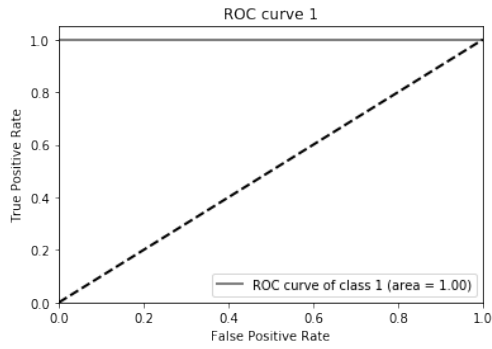


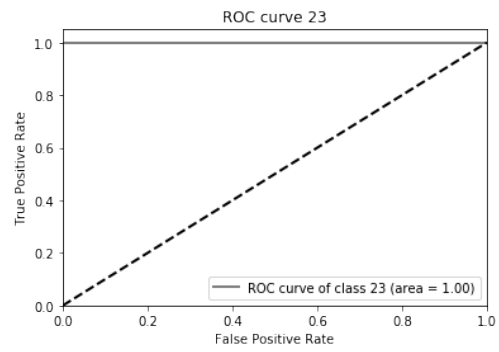
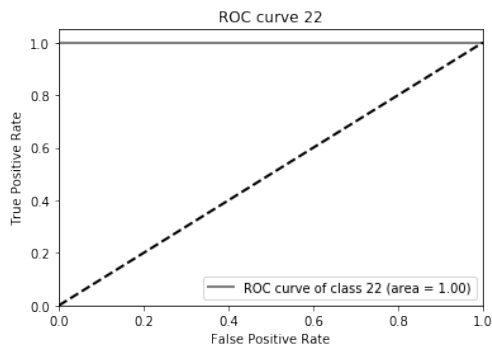
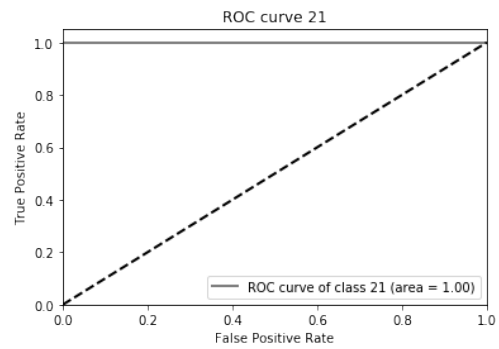
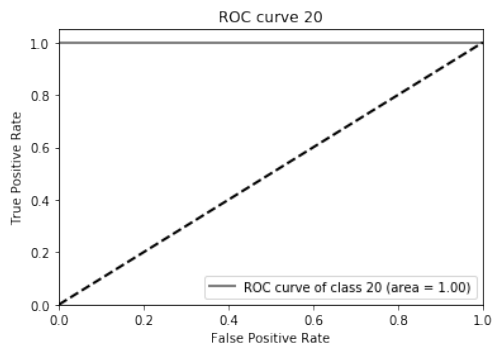
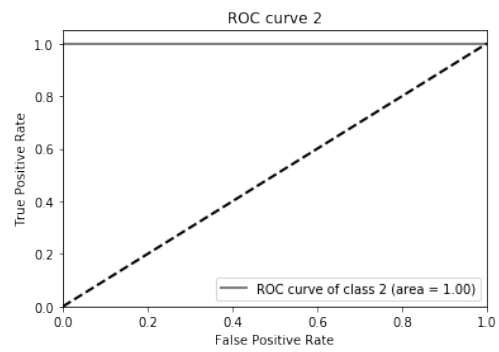
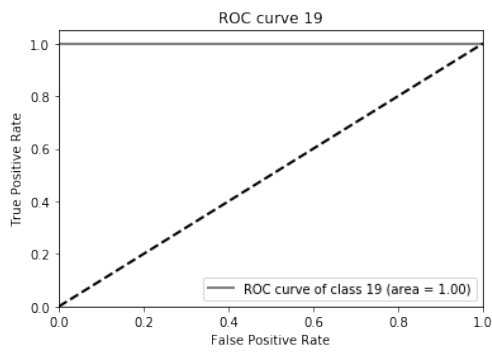
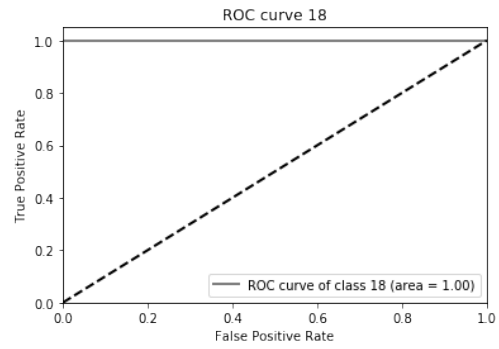
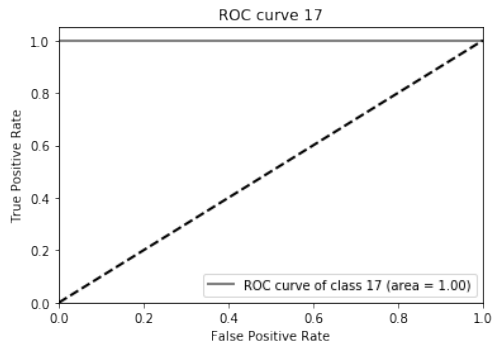


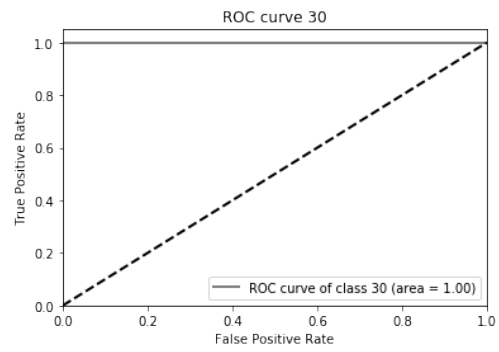
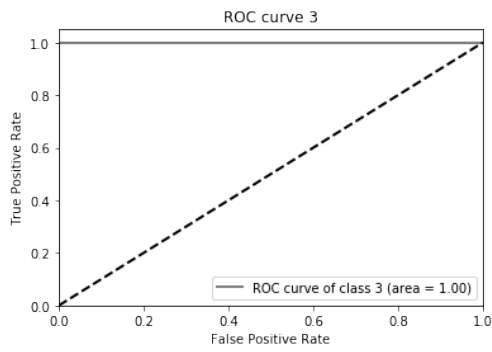
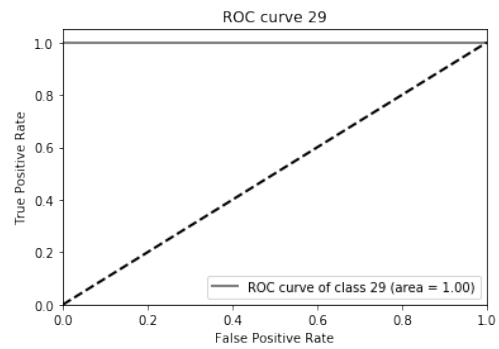
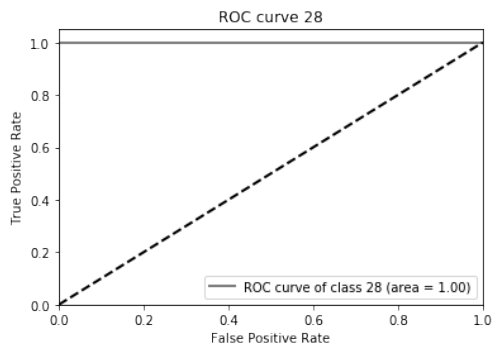
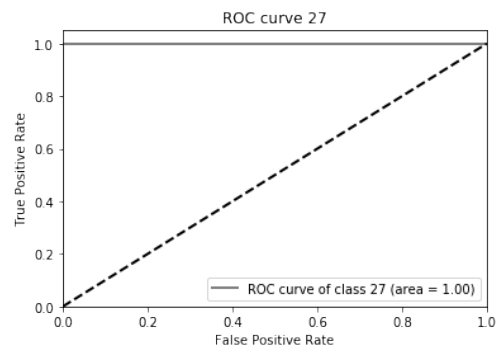
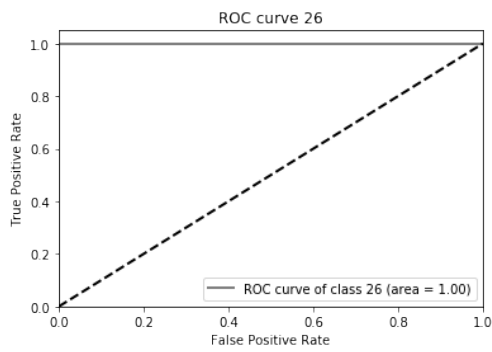
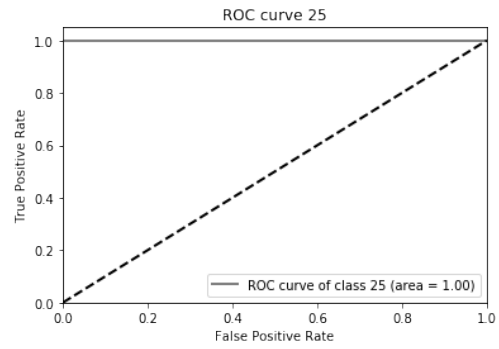
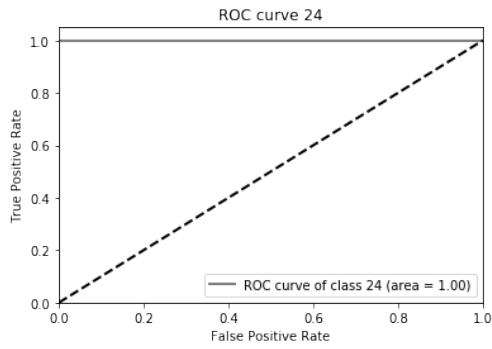


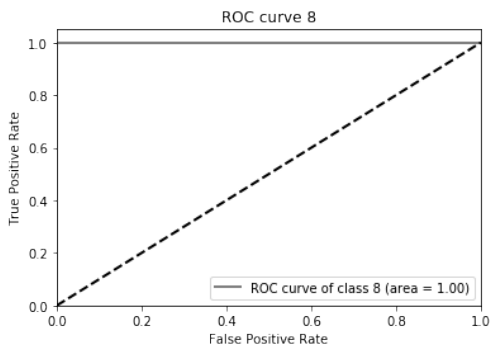
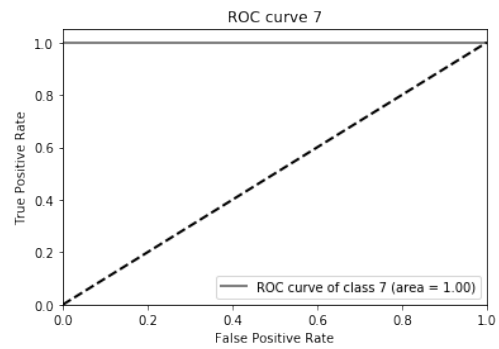
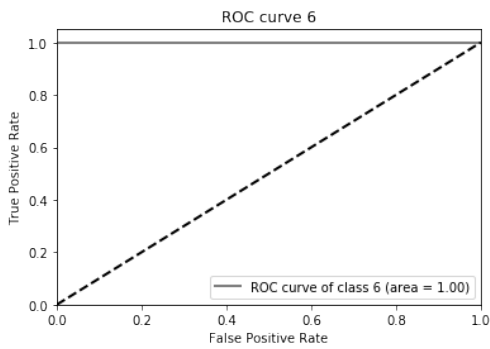
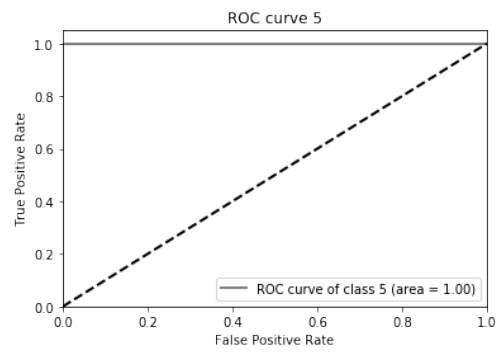
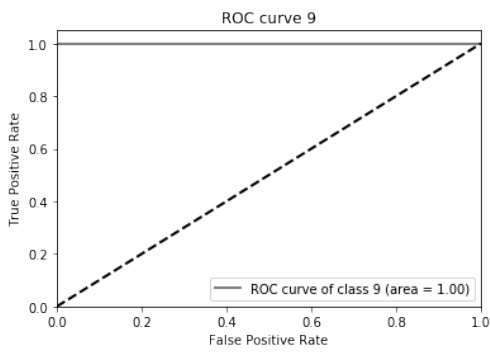
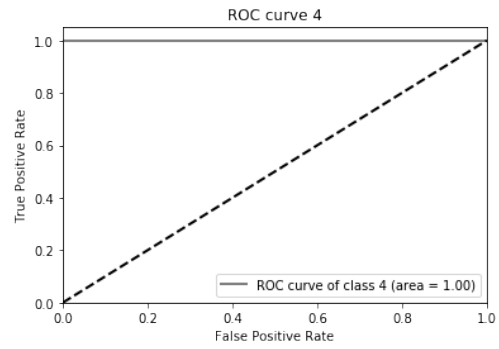
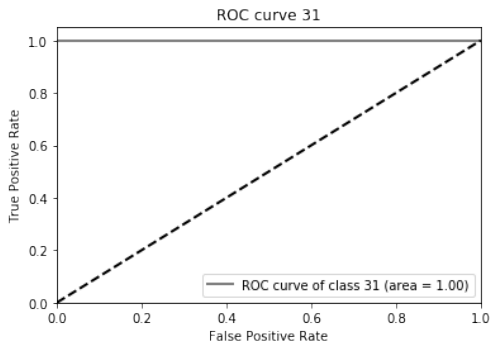


Lampiran 15 : ROC Subjek 5









Lampiran 16 : Source Code

```
import numpy as np
import pickle
import cv2
import keras
from os import listdir
from sklearn.preprocessing import LabelBinarizer
from keras.models import Sequential
from keras.layers.normalization import BatchNormalization
from keras.layers.convolutional import Conv2D
from keras.layers.convolutional import MaxPooling2D
from keras.layers.convolutional import Convolution2D, MaxPooling2D, ZeroPadding2D
from keras.layers.core import Activation, Flatten, Dropout, Dense
from keras import backend as K
from keras.preprocessing.image import ImageDataGenerator
from keras.optimizers import adam
from keras.preprocessing import image
from keras.preprocessing.image import img_to_array
from sklearn.preprocessing import MultiLabelBinarizer
from sklearn.model_selection import train_test_split
import matplotlib.pyplot as plt
import matplotlib
import pandas as pd
from skimage.color import rgb2gray
from skimage.transform import rescale, resize, downscale_local_mean
from skimage.feature import local_binary_pattern
from sklearn.model_selection import train_test_split
from skimage import data, color, feature
from skimage.feature import hog
import tensorflow as tf
import numpy as np
import matplotlib.pyplot as plt
from keras.models import Sequential
from keras.layers import Input, Activation, Dense, Conv2D, MaxPooling2D, ZeroPadding2D, Flatten
from keras.optimizers import Adam
from keras.layers.normalization import BatchNormalization
from keras.utils.np_utils import to_categorical
from keras.callbacks import TensorBoard
from sklearn.model_selection import train_test_split
```

```
from google.colab import drive
drive.mount('/content/drive')
```

```
INIT_LR = 1e-3
BS = 32
default_image_size = tuple((224, 224))
image_size = 0
directory_root = '/content/drive/My Drive/subjek3/subjek3'
width=224
height=224
depth=3
```

```
def convert_image_to_array(image_directory):

    try:
        image = cv2.imread(image_directory)

        if image is not None :

            image = cv2.resize(image, default_image_size)

            return img_to_array(image)
        else :
            return np.array([])

    except Exception as e:
        print(f"Error : {e}")

    return None
```

```

image_list, label_list = [], []

try:
    print("[INFO] Loading images ...")
    root_dir = listdir(directory_root)
    for directory in root_dir :
        # remove .DS_Store from list
        if directory == ".DS_Store" :
            root_dir.remove(directory)

    for hand_folder in root_dir :
        hand_posture_folder_list = listdir(f"{directory_root}/{hand_folder}")
        print(directory_root)
        for posture_folder in hand_posture_folder_list :
            # remove .DS_Store from list
            if posture_folder == ".DS_Store" :
                hand_posture_folder_list.remove(posture_folder)

        for hand_posture_folder in hand_posture_folder_list:
            print(f"[INFO] Processing {hand_posture_folder} ...")
            hand_posture_image_list = listdir(f"{directory_root}/{hand_folder}/{hand_p
osture_folder}")

            for single_hand_posture_image in hand_posture_image_list :
                if single_hand_posture_image == ".DS_Store" :
                    hand_posture_image_list.remove(single_hand_posture_image)

            for image in hand_posture_image_list[:30]:

                image_directory = f"{directory_root}/{hand_folder}/{hand_posture_folde
r}/{image}"

                if image_directory.endswith(".jpeg") == True or image_directory.endswi
th(".JPEG") == True:

                    image_list.append(convert_image_to_array(image_directory))

                    label_list.append(hand_posture_folder)

    print("[INFO] Image loading completed")
except Exception as e:
    print(f"Error : {e}")

```

```
image_size = len(image_list)
image_size
```

```
label_binarizer = LabelBinarizer()
image_labels = label_binarizer.fit_transform(label_list)
n_classes = len(label_binarizer.classes_)
```

```
print(label_binarizer.classes_)
print(n_classes)
```

```
np_image_list = np.array(image_list, dtype=np.float16) / 225.0
```

```
x_train, x_test, y_train, y_test = train_test_split(np_image_list, image_labels, test_size=0.2, random_state = 42)
```

```
print(x_train.shape)
print(y_train.shape)
print(x_test.shape)
print(y_test.shape)
```

```
aug = ImageDataGenerator(
    rotation_range=25, width_shift_range=0.1,
    height_shift_range=0.1, shear_range=0.2,
    zoom_range=0.2, horizontal_flip=True,
    fill_mode="nearest")
```

```
inputShape = (height, width, depth)
chanDim = -1
if K.image_data_format() == "channels_first":
    inputShape = (depth, height, width)
    chanDim = 1
model = Sequential()
model.add(Conv2D(input_shape=(224,224,3), filters=64, kernel_size=(3,3), padding="same",
activation="relu"))
model.add(BatchNormalization(axis=chanDim))
model.add(Conv2D(filters=64, kernel_size=(3,3), padding="same", activation="relu"))
model.add(BatchNormalization(axis=chanDim))
model.add(MaxPool2D(pool_size=(2,2), strides=(2,2)))
```

```

model.add(Conv2D(filters=128, kernel_size=(3,3), padding="same", activation="relu"))
model.add(BatchNormalization(axis=chanDim))
model.add(Conv2D(filters=128, kernel_size=(3,3), padding="same", activation="relu"))
model.add(BatchNormalization(axis=chanDim))
model.add(MaxPool2D(pool_size=(2,2), strides=(2,2)))
model.add(Conv2D(filters=256, kernel_size=(3,3), padding="same", activation="relu"))
model.add(BatchNormalization(axis=chanDim))
model.add(Conv2D(filters=256, kernel_size=(3,3), padding="same", activation="relu"))
model.add(BatchNormalization(axis=chanDim))
model.add(Conv2D(filters=256, kernel_size=(3,3), padding="same", activation="relu"))
model.add(BatchNormalization(axis=chanDim))
model.add(Conv2D(filters=256, kernel_size=(3,3), padding="same", activation="relu"))
model.add(BatchNormalization(axis=chanDim))
model.add(MaxPool2D(pool_size=(2,2), strides=(2,2)))
model.add(Conv2D(filters=512, kernel_size=(3,3), padding="same", activation="relu"))
model.add(BatchNormalization(axis=chanDim))
model.add(Conv2D(filters=512, kernel_size=(3,3), padding="same", activation="relu"))
model.add(BatchNormalization(axis=chanDim))
model.add(Conv2D(filters=512, kernel_size=(3,3), padding="same", activation="relu"))
model.add(BatchNormalization(axis=chanDim))
model.add(Conv2D(filters=512, kernel_size=(3,3), padding="same", activation="relu"))
model.add(BatchNormalization(axis=chanDim))
model.add(Conv2D(filters=512, kernel_size=(3,3), padding="same", activation="relu"))
model.add(BatchNormalization(axis=chanDim))
model.add(Conv2D(filters=512, kernel_size=(3,3), padding="same", activation="relu"))
model.add(BatchNormalization(axis=chanDim))
model.add(Conv2D(filters=512, kernel_size=(3,3), padding="same", activation="relu"))
model.add(BatchNormalization(axis=chanDim))
model.add(MaxPool2D(pool_size=(2,2), strides=(2,2)))
model.add(Flatten())
model.add(Dense(units=4096, activation="relu"))
model.add(BatchNormalization(axis=chanDim))
model.add(Dense(units=4096, activation="relu"))
model.add(BatchNormalization(axis=chanDim))
model.add(Dense(units=n_classes, activation="softmax"))
model.summary()

```

```
opt = adam(lr=INIT_LR, decay=INIT_LR / EPOCHS)
# distribution
model.compile(loss="categorical_crossentropy", optimizer=opt, metrics=["accuracy"])
# train the network
print("[INFO] training network...")
```

```
history = model.fit_generator(
    aug.flow(x_train, y_train, batch_size=BS),
    validation_data=(x_test, y_test),
    steps_per_epoch=len(x_train)/BS,
    epochs=EPOCHS, verbose=1
)
```

```
val_acc = history.history['val_acc']
acc = history.history['acc']
loss = history.history['loss']
val_loss = history.history['val_loss']
epochs = range(1, len(acc) + 1)
#Train and validation accuracy
plt.plot(epochs, acc, 'b', label='Training accuracy')
plt.plot(epochs, val_acc, 'r', label='Validation accuracy')
plt.title('Training and Validation accuracy')
plt.legend()
```

```
plt.figure()
#Train and validation loss
plt.plot(epochs, val_acc, 'b', label='Validation Accuracy')
plt.plot(epochs, val_loss, 'r', label='Validation loss')
plt.title('Validation Accuracy and Validation loss')
plt.legend()
plt.show()
```

```
print("[INFO] Calculating model accuracy")
scores = model.evaluate(x_test, y_test)
print(f"Test Accuracy: {scores[1]*100}")
```

```
from sklearn.metrics import confusion_matrix
import sklearn.metrics as metrics
predictions = model.predict(x_test)
predictions
y_pred = (predictions > 0.5)
```

```
matrix = metrics.confusion_matrix(y_test.argmax(axis=1), y_pred.argmax(axis=1))
matrix
```

```
from sklearn.metrics import classification_report
pred = model.predict(x_test, batch_size=32, verbose=1)
predicted = np.argmax(pred, axis=1)
report = classification_report(np.argmax(y_test, axis=1), predicted)
print(report)
```

```
import seaborn as sn
import pandas as pd
import matplotlib.pyplot as plt
vizualization = pd.DataFrame(matrix, index = label_binarizer.classes_,
                             columns = label_binarizer.classes_)
plt.figure(figsize = (17,10))
sn.heatmap(vizualization, annot=True)
```

```
for lay in model.layers:
    print(lay.name)
    print(lay.get_weights())
```

```
y_pred = model.predict_proba(x_test)
from sklearn.metrics import roc_auc_score
roc_auc_score(y_test, y_pred)
```

```
import numpy as np
from scipy import interp
import matplotlib.pyplot as plt
from itertools import cycle
from sklearn.metrics import roc_curve, auc

n_classes = len(label_binarizer.classes_)
y_score = model.predict(x_test)
# y_score = pred_ada
disease_class = label_binarizer.classes_
```

```

# Plot linewidth.
lw = 2

# Compute ROC curve and ROC area for each class
fpr = dict()
tpr = dict()
roc_auc = dict()
for i in range(n_classes):
    fpr[i], tpr[i], _ = roc_curve(y_test[:, i], y_score[:, i])
    roc_auc[i] = auc(fpr[i], tpr[i])

colors = cycle(['grey'])
for i, color in zip(range(n_classes), colors):
    plt.figure(i)
    plt.plot(fpr[i], tpr[i], color=color, lw=lw,
             label='ROC curve of class {0} (area = {1:0.2f})'
             ''.format(disease_class[i], roc_auc[i]))

    plt.plot([0, 1], [0, 1], 'k--', lw=lw)
    plt.xlim([0.0, 1.0])
    plt.ylim([0.0, 1.05])
    plt.xlabel('False Positive Rate')
    plt.ylabel('True Positive Rate')
    plt.title('ROC curve {0}'.format(disease_class[i]))
    plt.legend(loc="lower right")
    plt.show()

```