Detection of Text written in air

import all the required libraries

In [ ]:
```
import tensorflow as tf
import tensorflow.keras.callbacks as TensorBoard
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Dense, Dropout, Activation, Flatten, Conv2D, MaxPooling2D
import cv2
import numpy as np
import matplotlib.pyplot as plt
```

Loading the data for the training

In [ ]:
```
mnist = tf.keras.datasets.mnist
(x_train, y_train),(x_test,y_test) = mnist.load_data()
```

Printing the dimensions of the array containing the data for the training

In [ ]:
```
print("training data shape is {} ".format(x_train.shape))
print("train label data shape is {} ".format(y_train.shape))
print("test data shape is {} ".format(x_test.shape))
print("test label data shape is {} ".format(y_test.shape))
```

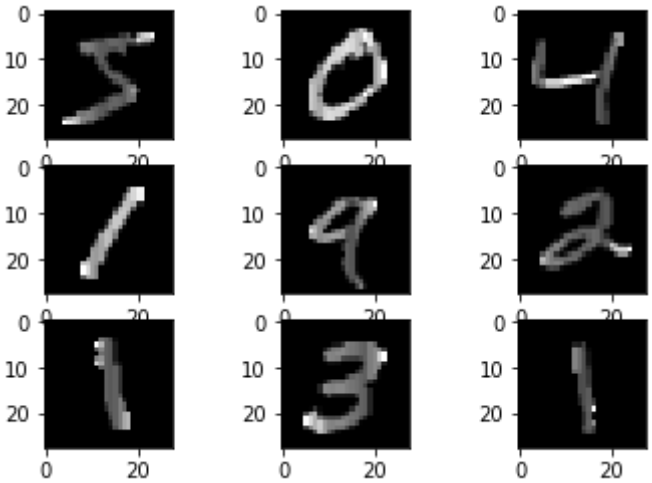
```
training data shape is (60000, 28, 28)
train label data shape is (60000,)
test data shape is (10000, 28, 28)
test label data shape is (10000,)
```

Preparing the data for the training

In [ ]:
```
x_train = tf.keras.utils.normalize(x_train,axis=1) #values are scaled between 0 and 1
x_test = tf.keras.utils.normalize(x_test,axis=1)
x_train = x_train.reshape(x_train.shape[0], 28, 28, 1) #reshaping the data to fit the CNN model
x_test = x_test.reshape(x_test.shape[0], 28, 28, 1)
x_train = x_train.astype('float32')
x_test = x_test.astype('float32')
print("training data shape is {} ".format(x_train.shape))
```

```
training data shape is (60000, 28, 28, 1)
```

In [ ]:
```
for i in range(0,9):
    plt.subplot(330+1+i)
    plt.imshow(x_train[i].reshape(28,28), cmap=plt.get_cmap('gray'))
plt.show()
```



Network Structure

In [ ]:
```
##the model
input_shape = (28, 28, 1)
model = Sequential()
model.add(Conv2D(64,(3,3),input_shape = input_shape))
model.add(Activation("relu"))
model.add(MaxPooling2D(pool_size=(2,2)))

model.add(Conv2D(64,(3,3)))
model.add(Activation("relu"))
model.add(MaxPooling2D(pool_size=(2,2)))

model.add(Flatten())
#model.add(Dense(1024))
#model.add(Dense(512))
#model.add(Dense(128))
model.add(Dense(64))
model.add(Dense(10))
```

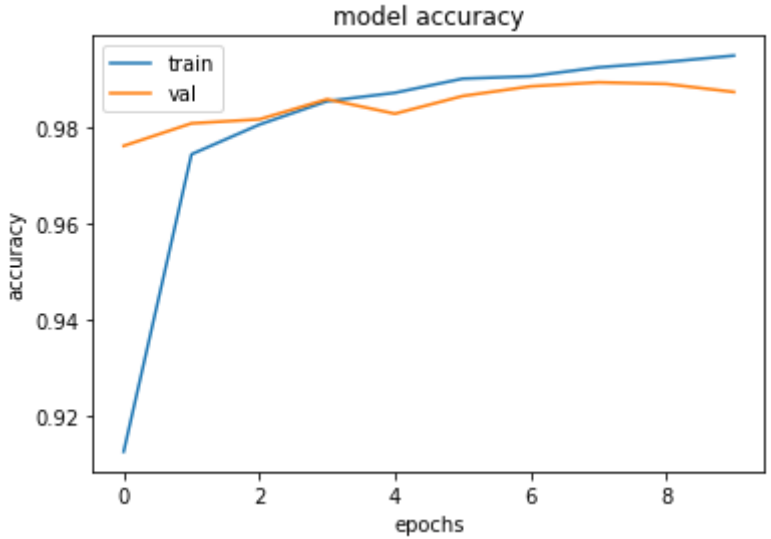
```
model.add(Activation('sigmoid'))

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

history=model.fit(x_train,y_train,validation_split=0.1,batch_size=120,epochs=10)
```

```
Train on 54000 samples, validate on 6000 samples
Epoch 1/10
54000/54000 [==============================] - 42s 778us/sample - loss: 0.2878 - accuracy: 0.9126 - val_loss: 0.0855 - val_accurac
y: 0.9760
Epoch 2/10
54000/54000 [==============================] - 46s 844us/sample - loss: 0.0841 - accuracy: 0.9743 - val_loss: 0.0658 - val_accurac
y: 0.9807
Epoch 3/10
54000/54000 [==============================] - 45s 829us/sample - loss: 0.0624 - accuracy: 0.9804 - val_loss: 0.0624 - val_accurac
y: 0.9815
Epoch 4/10
54000/54000 [==============================] - 47s 875us/sample - loss: 0.0484 - accuracy: 0.9853 - val_loss: 0.0471 - val_accurac
y: 0.9857
Epoch 5/10
54000/54000 [==============================] - 51s 942us/sample - loss: 0.0418 - accuracy: 0.9870 - val_loss: 0.0602 - val_accurac
y: 0.9827
Epoch 6/10
54000/54000 [==============================] - 51s 936us/sample - loss: 0.0332 - accuracy: 0.9899 - val_loss: 0.0490 - val_accurac
y: 0.9863
Epoch 7/10
54000/54000 [==============================] - 49s 912us/sample - loss: 0.0296 - accuracy: 0.9904 - val_loss: 0.0436 - val_accurac
y: 0.9883
Epoch 8/10
54000/54000 [==============================] - 46s 850us/sample - loss: 0.0240 - accuracy: 0.9923 - val_loss: 0.0444 - val_accurac
y: 0.9892
Epoch 9/10
54000/54000 [==============================] - 49s 904us/sample - loss: 0.0202 - accuracy: 0.9934 - val_loss: 0.0401 - val_accurac
y: 0.9888
Epoch 10/10
54000/54000 [==============================] - 50s 924us/sample - loss: 0.0167 - accuracy: 0.9947 - val_loss: 0.0440 - val_accurac
y: 0.9872
```

In [ ]:

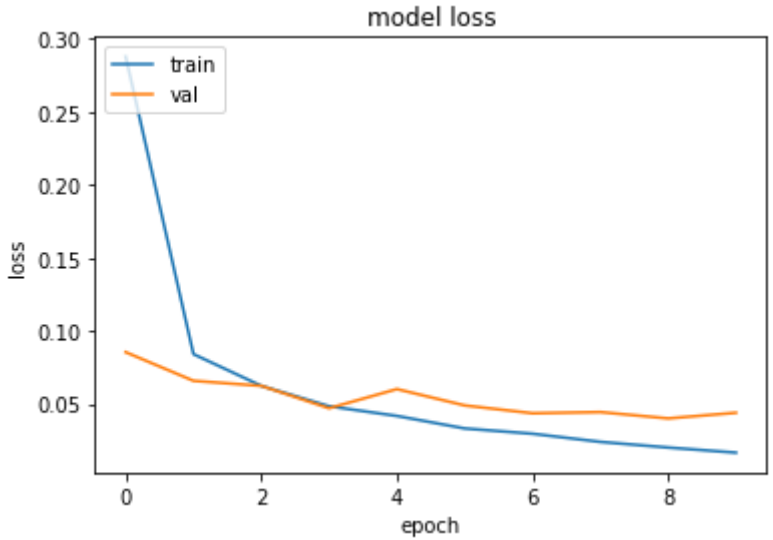
```
plt.plot(history.history['accuracy'])
plt.plot(history.history['val_accuracy'])
plt.title('model accuracy')
plt.ylabel('accuracy')
plt.xlabel('epochs')
plt.legend(['train','val'], loc='upper left')
```

Out[ ]: <matplotlib.legend.Legend at 0x2ae01ff0588>



In [ ]:

```
plt.plot(history.history['loss'])
plt.plot(history.history['val_loss'])
plt.title('model loss')
plt.ylabel('loss')
plt.xlabel('epoch')
plt.legend(['train', 'val'], loc='upper left')
plt.show()
```



Detection

In [ ]:
```
##the detection
lower_red = np.array([150,150,120])
upper_red = np.array([180,255,255])

lower_blue = np.array([90,150,120])
upper_blue = np.array([110,255,255])

cap = cv2.VideoCapture('test4.avi')
ret1, frame = cap.read()
```

In [ ]:
```
hsv = cv2.cvtColor(frame, cv2.COLOR_BGR2HSV)
mask1 = cv2.inRange(hsv, lower_red, upper_red)
ret2, mask1 = cv2.threshold(mask1, 120, 255, cv2.THRESH_BINARY_INV)
r,c = np.shape(mask1)
print(r,c)
prevblobs = 0
i = 0
masks = np.zeros((10,r,c))
```

```
480 640
```

The tracking of red color on the finger

In [ ]:

```
while True:
    ret1, frame1 = cap.read()

    if ret1:
        hsv = cv2.cvtColor(frame1, cv2.COLOR_BGR2HSV)
        mask2 = cv2.inRange(hsv, lower_red, upper_red)
        mask3 = cv2.inRange(hsv, lower_blue, upper_blue)

        ret2, mask2 = cv2.threshold(mask2, 120, 255, cv2.THRESH_BINARY_INV)
        ret2, mask3 = cv2.threshold(mask3, 120, 255, cv2.THRESH_BINARY_INV)

        mask2 = cv2.erode(mask2, None, iterations = 12)
        mask2 = cv2.dilate(mask2, None, iterations = 3)
        mask2 = cv2.medianBlur(mask2,15)

        mask3 = cv2.erode(mask3, None, iterations = 12)
        mask3 = cv2.dilate(mask3, None, iterations = 3)
        mask3 = cv2.medianBlur(mask3,15)

        params = cv2.SimpleBlobDetector_Params()
        params.minThreshold = 100
        params.maxThreshold = 150
        params.filterByArea = True
        params.minArea = 700

        detector = cv2.SimpleBlobDetector_create(params)

        keypoints = detector.detect(mask2)
        keypoints1 = detector.detect(mask3)
        blobs = len(keypoints1)
        #print(blobs)
        #contours, hierarchy = cv2.findContours(mask2,cv2.RETR_TREE,cv2.CHAIN_APPROX_SIMPLE)

        imgKeyPoints = cv2.drawKeypoints(frame1, keypoints, np.array([]), (0,0,255),cv2.DRAW_MATCHES_FLAGS_DRAW_RICH_KEYPOINTS)


        mask1 = cv2.bitwise_and(mask1,mask2);

        cv2.imshow('mask2', mask2)
        cv2.imshow('mask1',mask1)
        cv2.imshow('frame', imgKeyPoints)
```

```
        #print("blobs",blobs)
        #print("prevblobs",prevblobs)
        z = np.sum(mask1==0)
        if blobs-prevblobs >= 1 and z>5000:
            print("done")
            masks[i][:][:] = mask1
            mask1 = mask1*0 + 255
            i=i+1
        prevblobs = blobs
        k = cv2.waitKey(5) & 0xFF
        if k == 27:
            break

    else:
        break
#cv2.imwrite('letter.png',mask1)
cv2.destroyAllWindows()
cap.release()
```

```
done
done
done
done
```

In [ ]:

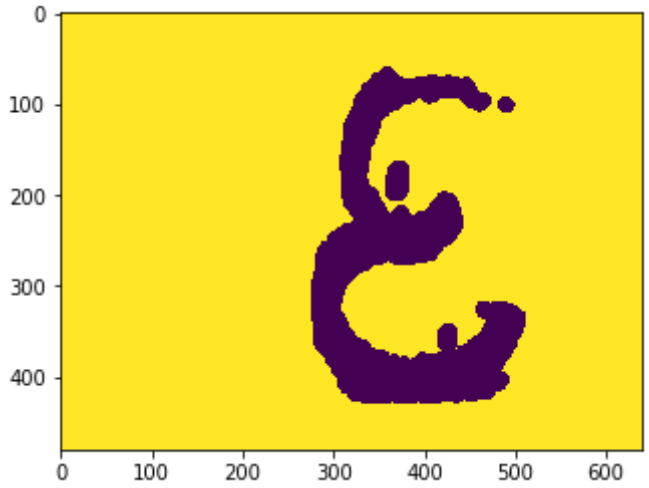
```
a = np.zeros(i)
i=i-1
j=i
k=i
print(i)
```

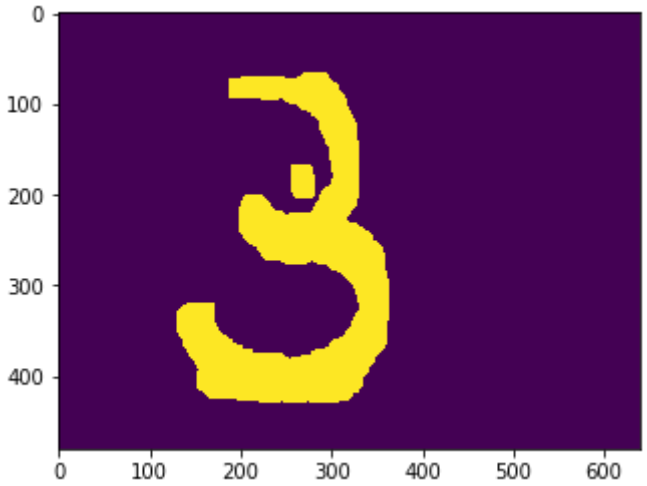
```
3
```

In [ ]:

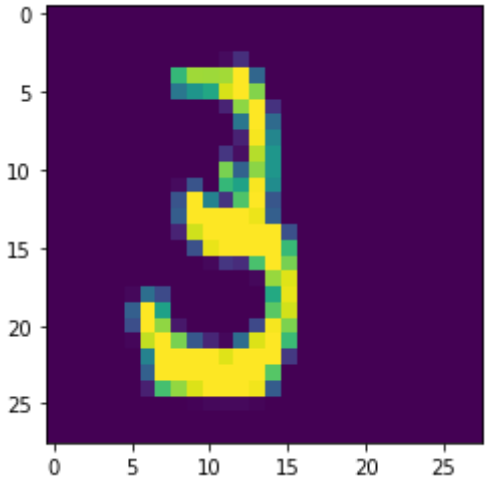
```
while i>=0:
    img = masks[i][:][:]
    plt.imshow(img)
    plt.show()
    ret2, img1 = cv2.threshold(img, 120, 255, cv2.THRESH_BINARY_INV)
    img1 = cv2.flip(img1,1)
    img1 = cv2.erode(img1, None, iterations = 10)
    #plt.imshow(img1)
    #plt.show()
    img1 = cv2.dilate(img1, None, iterations = 10)
    plt.imshow(img1)
```

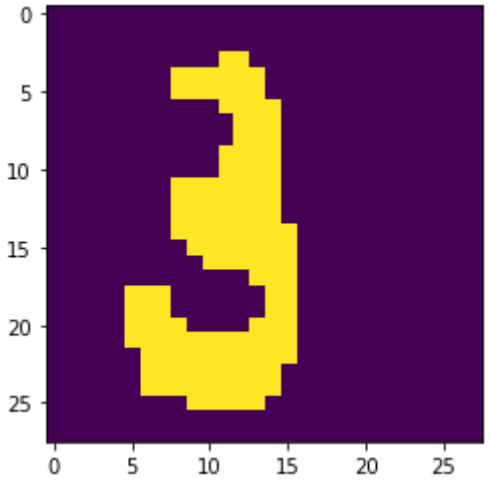
```
plt.show()

img2 = cv2.resize(img1,(28,28),interpolation = cv2.INTER_AREA)

print(np.shape(img2))

plt.imshow(img2)
plt.show()
img2 = img2>0
plt.imshow(img2)
plt.show()
test1 = tf.keras.utils.normalize(img2,axis=1) #making the image fit the CNN
test1 = test1.reshape(1,28,28,1)
predictions = model.predict(test1)
print("prediction: "),
print(np.argmax(predictions))
a[i] = np.argmax(predictions)
i = i-1
```



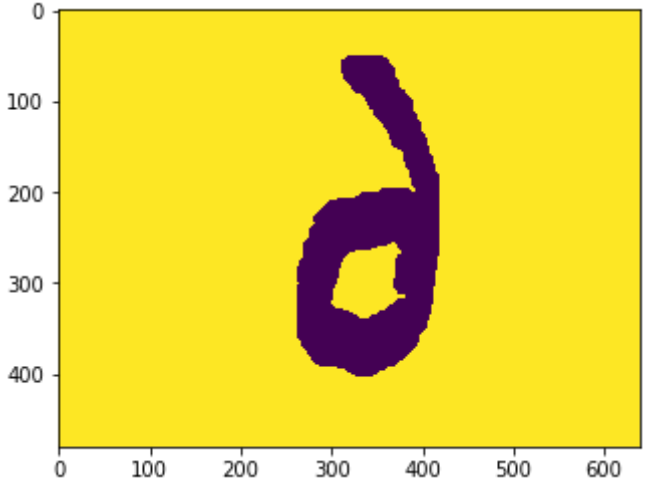

0
100
200
300
400
0
100
200
300
400
500
600

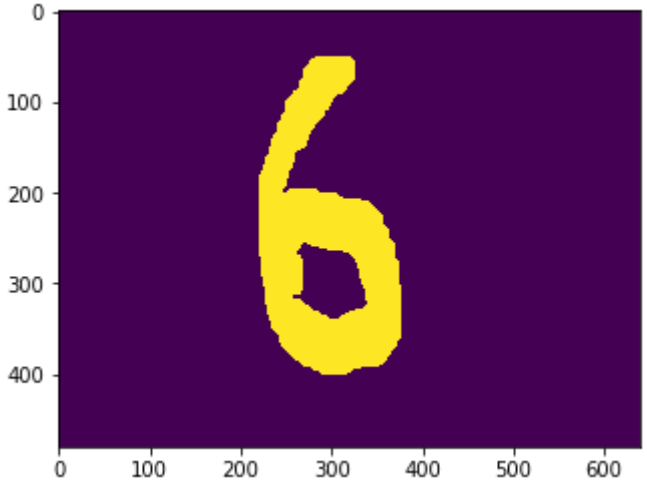
```
(28, 28)
```


0
5
10
15
20
25
0
5
10
15
20
25

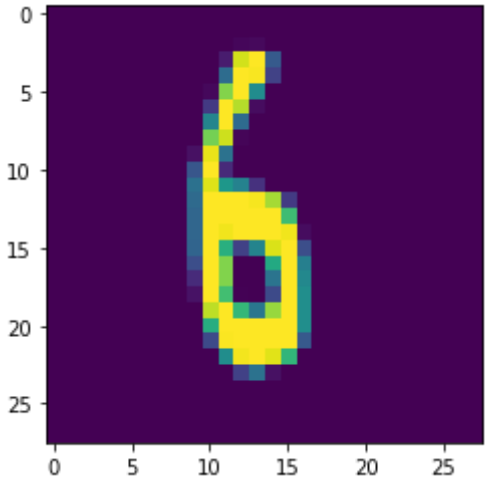


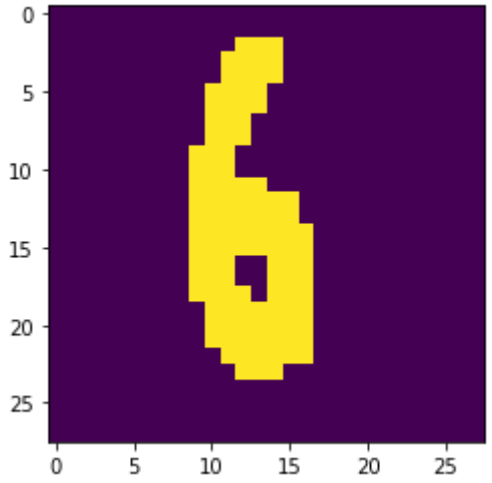

```
prediction:
3
```



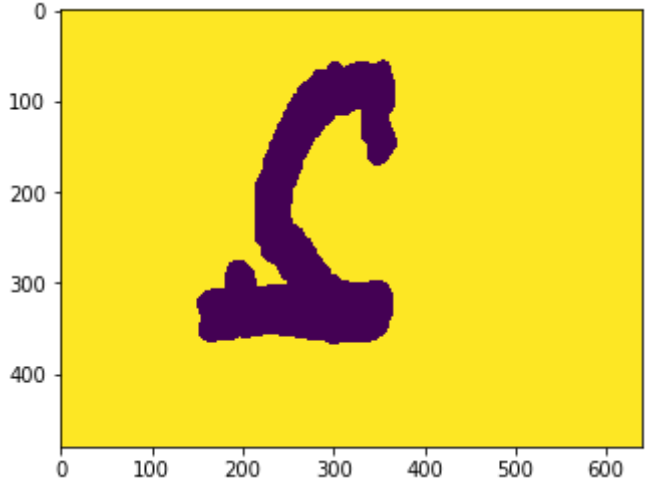

0
100
200
300
400
0
100
200
300
400
500
600

```
(28, 28)
```


0
5
10
15
20
25
0
5
10
15
20
25

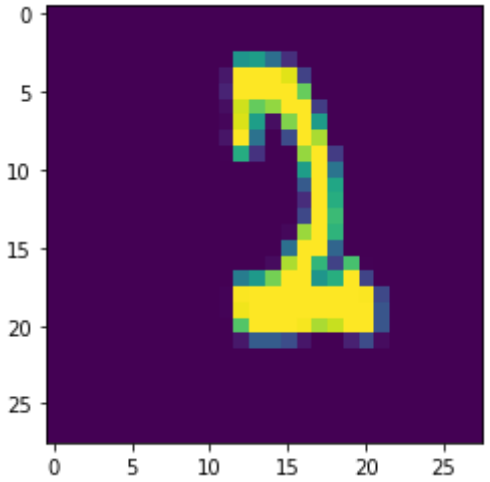


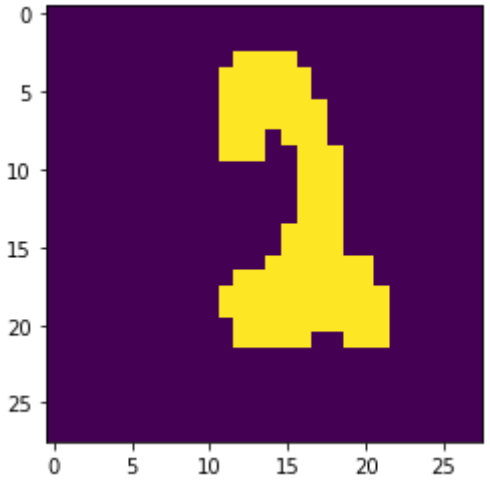

```
prediction:
6
```



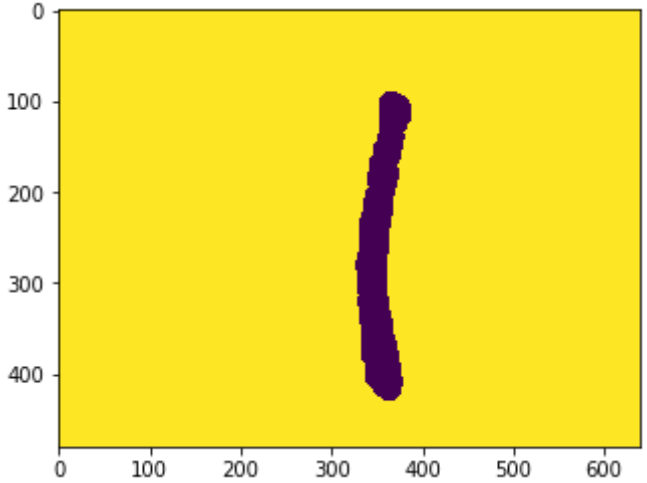

0
100
200
300
400
0
100
200
300
400
500
600

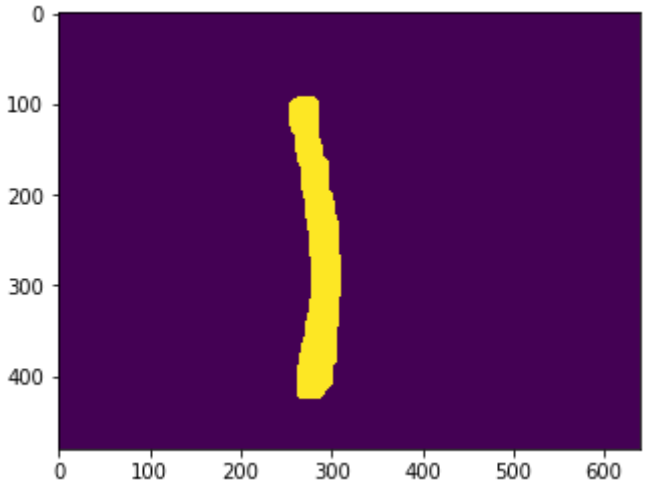
```
(28, 28)
```


0
5
10
15
20
25
0
5
10
15
20
25

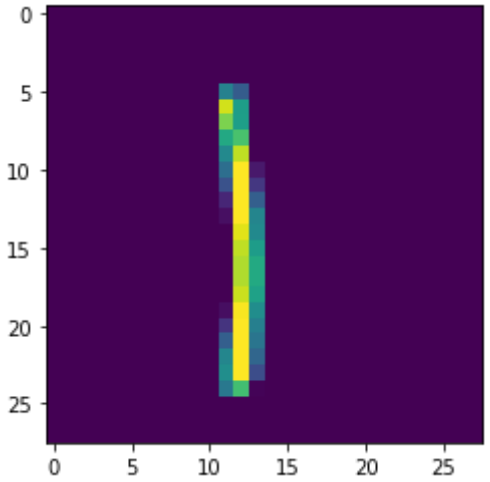


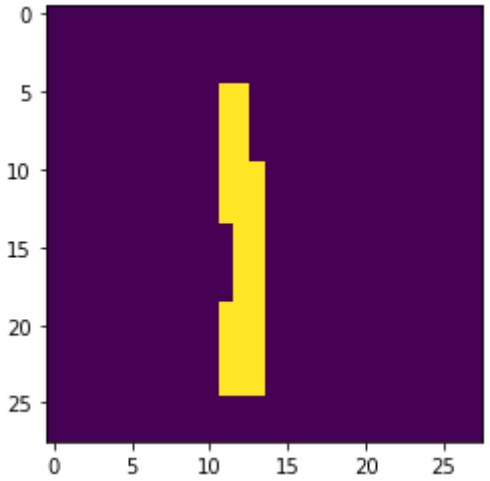

```
prediction:
2
```




0
100
200
300
400
0
100
200
300
400
500
600

```
(28, 28)
```


0
5
10
15
20
25
0
5
10
15
20
25

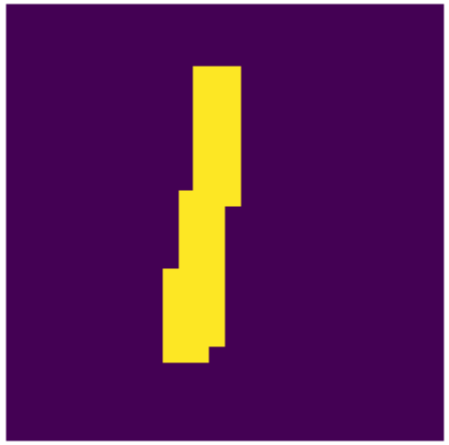



```
prediction:
1
```

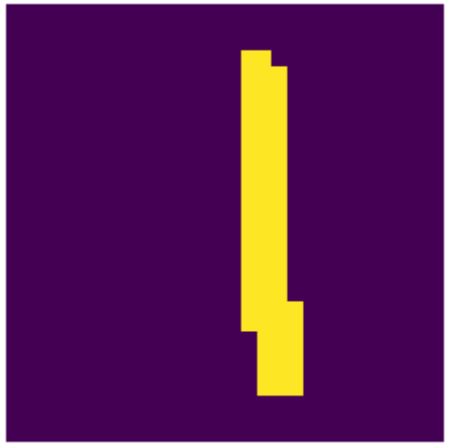
Validation on the test data

In [ ]:

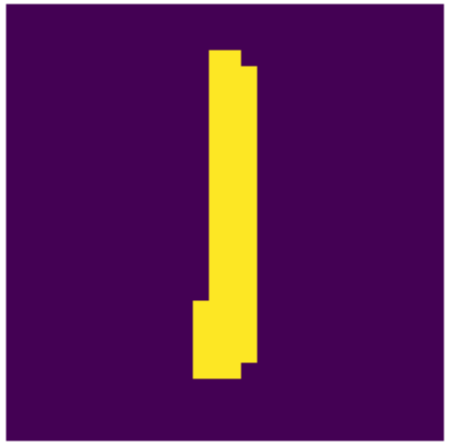
```
j=0
while j<=9:
    img = cv2.cvtColor(cv2.imread('test1_'+str(j)+'.jpg'), cv2.COLOR_BGR2GRAY)
    ret2, img1 = cv2.threshold(img, 120, 255, cv2.THRESH_BINARY_INV)
    img1 = cv2.flip(img1,1)
    img1 = cv2.erode(img1, None, iterations = 10)
    img1 = cv2.dilate(img1, None, iterations = 10)
    img2 = cv2.resize(img1,(28,28),interpolation = cv2.INTER_AREA)
    img2 = img2>0
    plt.axis('off')
    plt.imshow(img2)
    plt.show()
    test1 = tf.keras.utils.normalize(img2,axis=1) #making the image fit the CNN
    test1 = test1.reshape(1,28,28,1)
    predictions = model.predict(test1)
    print("prediction: "),
    print(np.argmax(predictions))
    j=j+1
```



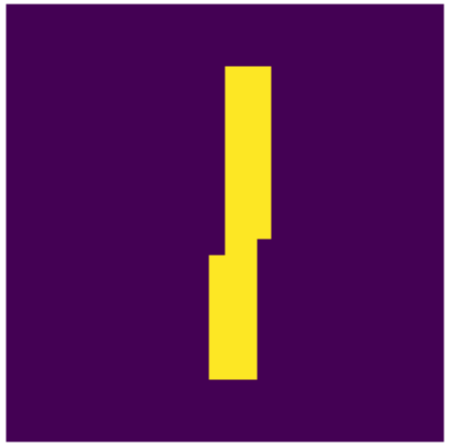
```
prediction:
1
```



```
prediction:
1
```

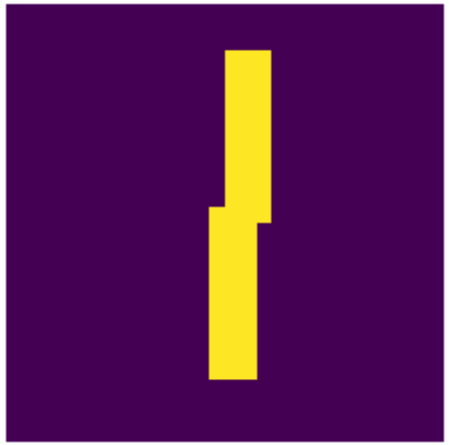


```
prediction:
1
```

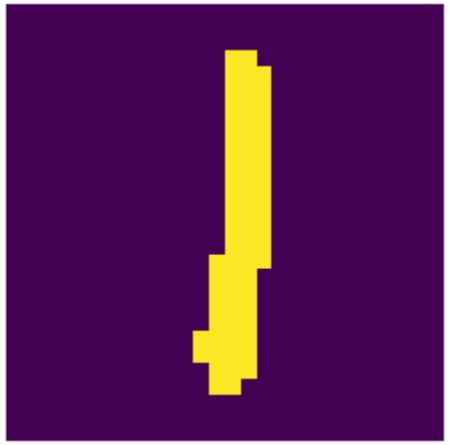


```
prediction:
1
```

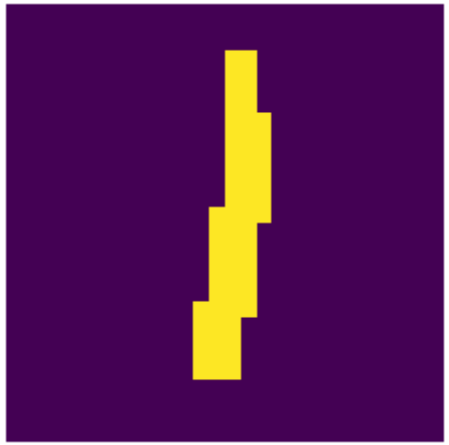
```
prediction:
1
```



```
prediction:
1
```

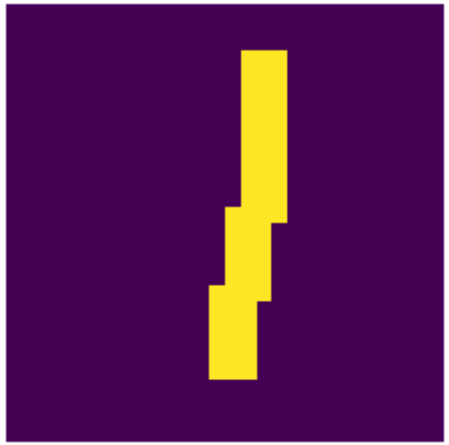


```
prediction:
1
```



```
prediction:
1
```

```
prediction:
1
```



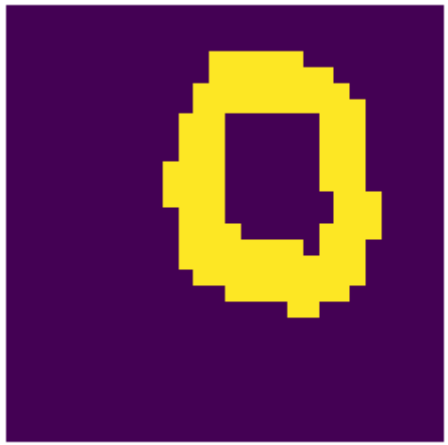
```
prediction:
1
```

In [ ]:

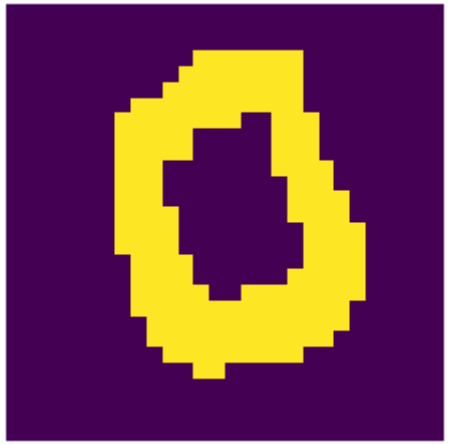
```
j=0
while j<=9:
    img = cv2.cvtColor(cv2.imread('test0_'+str(j)+'.jpg'), cv2.COLOR_BGR2GRAY)
    ret2, img1 = cv2.threshold(img, 120, 255, cv2.THRESH_BINARY_INV)
    img1 = cv2.flip(img1,1)
    img1 = cv2.erode(img1, None, iterations = 10)
    img1 = cv2.dilate(img1, None, iterations = 10)
    img2 = cv2.resize(img1,(28,28),interpolation = cv2.INTER_AREA)
    img2 = img2>0
    plt.axis('off')
```

```
    plt.imshow(img2)
    plt.show()
    test1 = tf.keras.utils.normalize(img2,axis=1) #making the image fit the CNN
    test1 = test1.reshape(1,28,28,1)
    predictions = model.predict(test1)
    print("prediction: "),
    print(np.argmax(predictions))
    j=j+1
```

```
prediction:
0
```

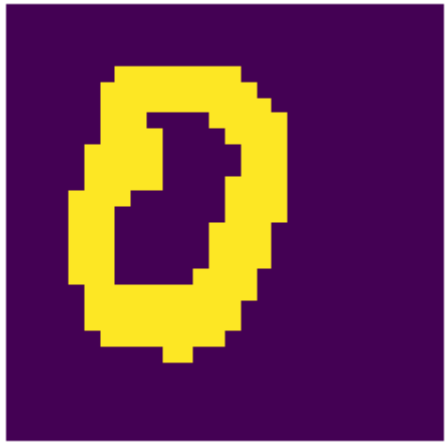


```
prediction:
0
```

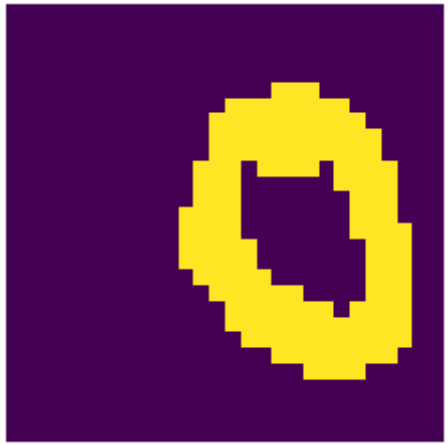


```
prediction:
0
```

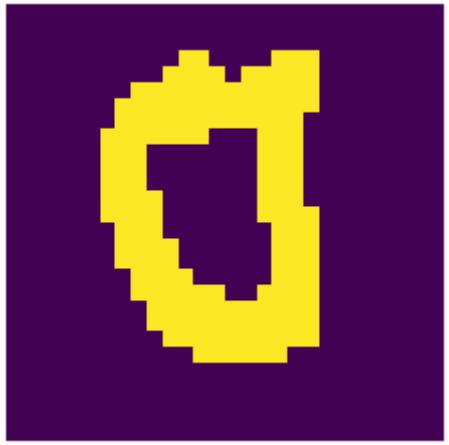
```
prediction:
0
```



```
prediction:
0
```



```
prediction:
1
```



```
prediction:
0
```

```
prediction:
0
```

```
prediction:
8
```

```
prediction:
0
```

In [ ]:

```
j=0
while j<=9:
    img = cv2.cvtColor(cv2.imread('test2_'+str(j)+'.jpg'), cv2.COLOR_BGR2GRAY)
    ret2, img1 = cv2.threshold(img, 120, 255, cv2.THRESH_BINARY_INV)
    img1 = cv2.flip(img1,1)
    img1 = cv2.erode(img1, None, iterations = 10)
    img1 = cv2.dilate(img1, None, iterations = 10)
    img2 = cv2.resize(img1,(28,28),interpolation = cv2.INTER_AREA)
    img2 = img2>0
    plt.axis('off')
```

```
    plt.imshow(img2)
    plt.show()
    test1 = tf.keras.utils.normalize(img2,axis=1) #making the image fit the CNN
    test1 = test1.reshape(1,28,28,1)
    predictions = model.predict(test1)
    print("prediction: "),
    print(np.argmax(predictions))
    j=j+1
```

```
prediction:
2
```

```
prediction:
2
```

```
prediction:
2
```

```
prediction:
2
```

```
prediction:
2
```

```
prediction:
2
```

```
prediction:
2
```

```
prediction:
2
```

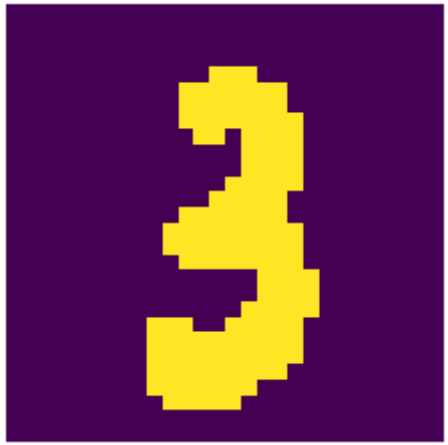
```
prediction:
2
```

```
prediction:
2
```

In [ ]:

```
j=0
while j<=9:
    img = cv2.cvtColor(cv2.imread('test3_'+str(j)+'.jpg'), cv2.COLOR_BGR2GRAY)
    ret2, img1 = cv2.threshold(img, 120, 255, cv2.THRESH_BINARY_INV)
    img1 = cv2.flip(img1,1)
    img1 = cv2.erode(img1, None, iterations = 10)
    img1 = cv2.dilate(img1, None, iterations = 10)
    img2 = cv2.resize(img1,(28,28),interpolation = cv2.INTER_AREA)
    img2 = img2>0
    plt.axis('off')
```

```
    plt.imshow(img2)
    plt.show()
    test1 = tf.keras.utils.normalize(img2,axis=1) #making the image fit the CNN
    test1 = test1.reshape(1,28,28,1)
    predictions = model.predict(test1)
    print("prediction: "),
    print(np.argmax(predictions))
    j=j+1
```

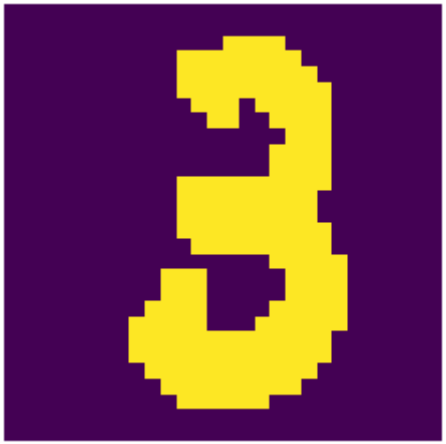


```
prediction:
3
```

```
prediction:
3
```

```
prediction:
3
```

```
prediction:
3
```



```
prediction:
3
```

```
prediction:
3
```

```
prediction:
3
```

```
prediction:
3
```

```
prediction:
3
```

```
prediction:
3
```

In [ ]:

```
j=0
while j<=9:
    img = cv2.cvtColor(cv2.imread('test4_'+str(j)+'.jpg'), cv2.COLOR_BGR2GRAY)
    ret2, img1 = cv2.threshold(img, 120, 255, cv2.THRESH_BINARY_INV)
    img1 = cv2.flip(img1,1)
    img1 = cv2.erode(img1, None, iterations = 10)
    img1 = cv2.dilate(img1, None, iterations = 10)
    img2 = cv2.resize(img1,(28,28),interpolation = cv2.INTER_AREA)
    img2 = img2>0
    plt.axis('off')
```

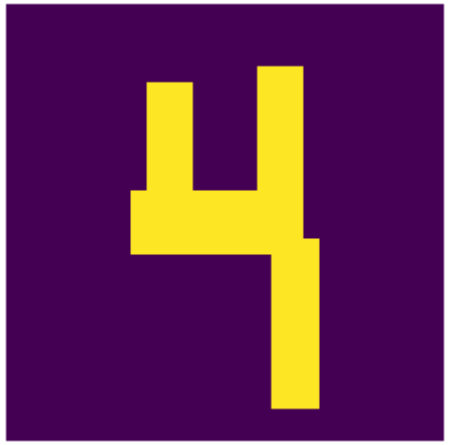
```
    plt.imshow(img2)
    plt.show()
    test1 = tf.keras.utils.normalize(img2,axis=1) #making the image fit the CNN
    test1 = test1.reshape(1,28,28,1)
    predictions = model.predict(test1)
    print("prediction: "),
    print(np.argmax(predictions))
    j=j+1
```

```
prediction:
4
```

```
prediction:
8
```

```
prediction:
8
```

```
prediction:
6
```



```
prediction:
4
```

```
prediction:
4
```

```
prediction:
4
```

```
prediction:
4
```

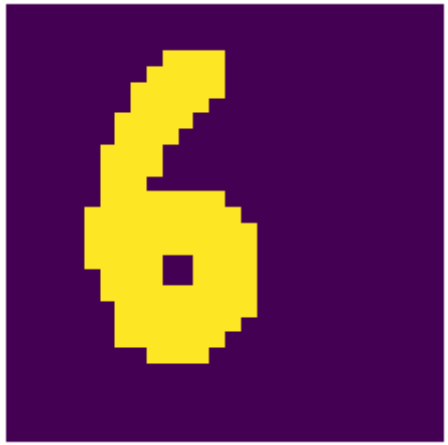
```
prediction:
4
```

```
prediction:
4
```

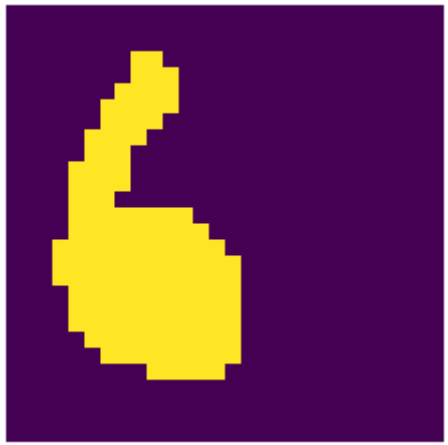
In [ ]:

```
j=0
while j<=9:
    img = cv2.cvtColor(cv2.imread('test6_'+str(j)+'.jpg'), cv2.COLOR_BGR2GRAY)
    ret2, img1 = cv2.threshold(img, 120, 255, cv2.THRESH_BINARY_INV)
    img1 = cv2.flip(img1,1)
    img1 = cv2.erode(img1, None, iterations = 10)
    img1 = cv2.dilate(img1, None, iterations = 10)
    img2 = cv2.resize(img1,(28,28),interpolation = cv2.INTER_AREA)
    img2 = img2>0
    plt.axis('off')
```

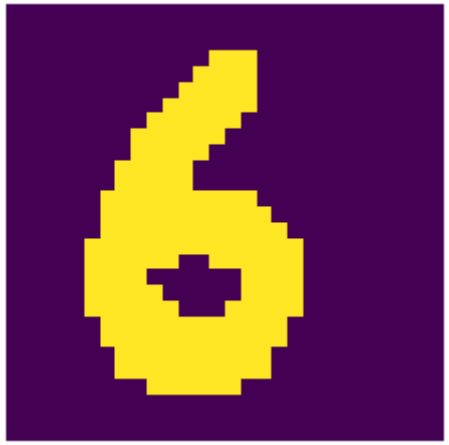
```
    plt.imshow(img2)
    plt.show()
    test1 = tf.keras.utils.normalize(img2,axis=1) #making the image fit the CNN
    test1 = test1.reshape(1,28,28,1)
    predictions = model.predict(test1)
    print("prediction: "),
    print(np.argmax(predictions))
    j=j+1
```



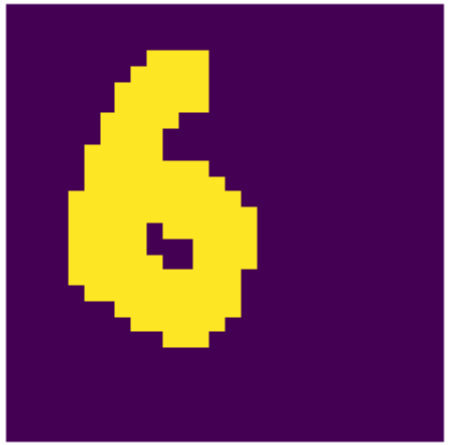
```
prediction:
6
```



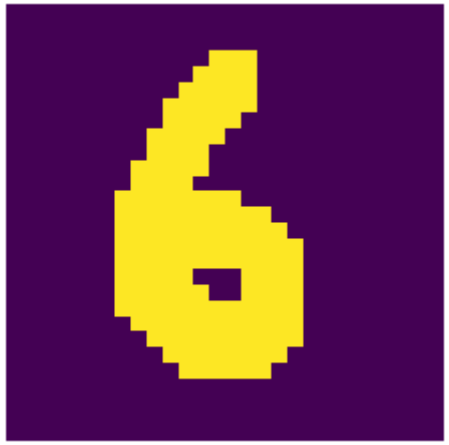
```
prediction:
6
```



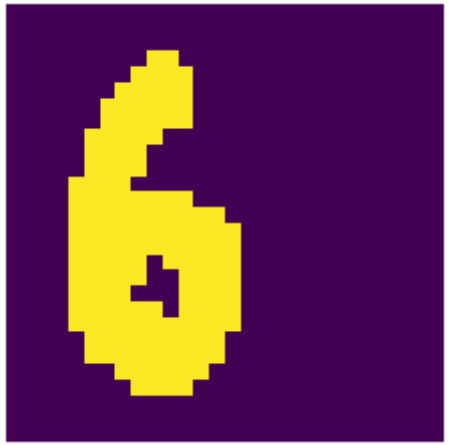
```
prediction:
6
```



```
prediction:
6
```

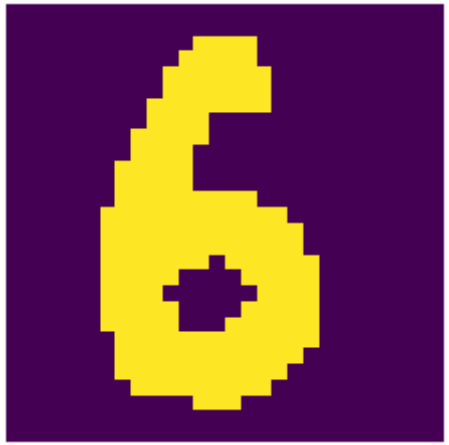


```
prediction:
6
```

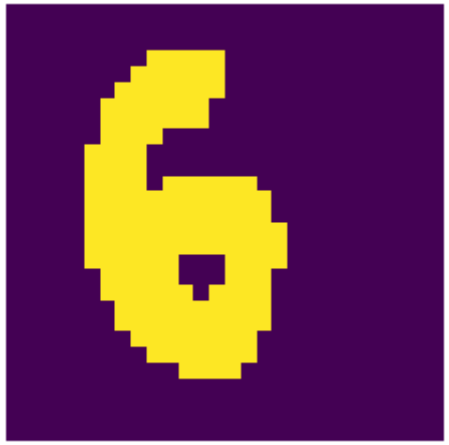


```
prediction:
6
```

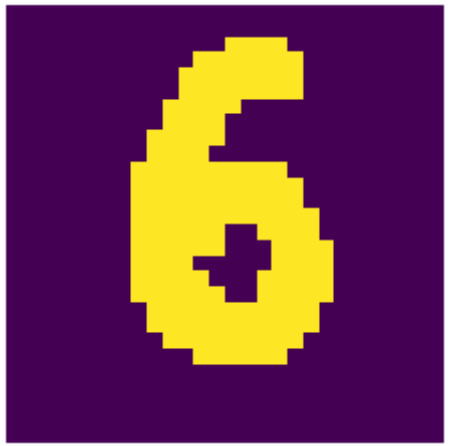
```
prediction:
6
```



```
prediction:
6
```



```
prediction:
6
```



```
prediction:
6
```

In [ ]:

```
j=0
while j<=9:
    img = cv2.cvtColor(cv2.imread('test5_'+str(j)+'.jpg'), cv2.COLOR_BGR2GRAY)
    ret2, img1 = cv2.threshold(img, 120, 255, cv2.THRESH_BINARY_INV)
    img1 = cv2.flip(img1,1)
    img1 = cv2.erode(img1, None, iterations = 10)
    img1 = cv2.dilate(img1, None, iterations = 10)
    img2 = cv2.resize(img1,(28,28),interpolation = cv2.INTER_AREA)
    img2 = img2>0
    plt.axis('off')
```

```
    plt.imshow(img2)
    plt.show()
    test1 = tf.keras.utils.normalize(img2,axis=1) #making the image fit the CNN
    test1 = test1.reshape(1,28,28,1)
    predictions = model.predict(test1)
    print("prediction: "),
    print(np.argmax(predictions))
    j=j+1
```

```
prediction:
5
```

```
prediction:
5
```

```
prediction:
5
```

```
prediction:
5
```

```
prediction:
5
```

```
prediction:
5
```

```
prediction:
5
```

```
prediction:
5
```

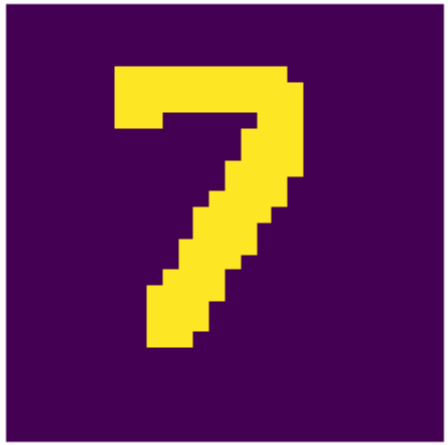
```
prediction:
5
```

```
prediction:
5
```

In [ ]:

```
j=0
while j<=9:
    img = cv2.cvtColor(cv2.imread('test7_'+str(j)+'.jpg'), cv2.COLOR_BGR2GRAY)
    ret2, img1 = cv2.threshold(img, 120, 255, cv2.THRESH_BINARY_INV)
    img1 = cv2.flip(img1,1)
    img1 = cv2.erode(img1, None, iterations = 10)
    img1 = cv2.dilate(img1, None, iterations = 10)
    img2 = cv2.resize(img1,(28,28),interpolation = cv2.INTER_AREA)
    img2 = img2>0
    plt.axis('off')
```

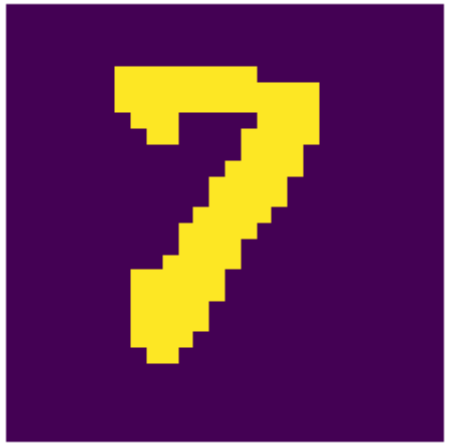
```
    plt.imshow(img2)
    plt.show()
    test1 = tf.keras.utils.normalize(img2,axis=1) #making the image fit the CNN
    test1 = test1.reshape(1,28,28,1)
    predictions = model.predict(test1)
    print("prediction: "),
    print(np.argmax(predictions))
    j=j+1
```



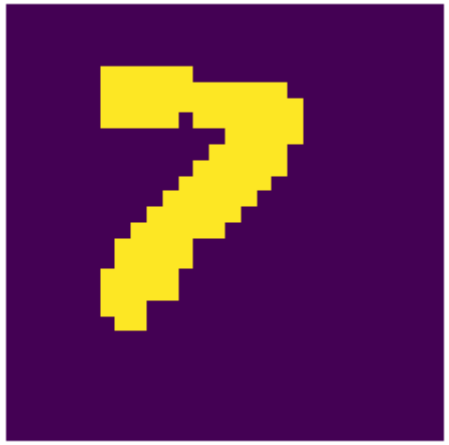
```
prediction:
7
```

```
prediction:
7
```

```
prediction:
7
```

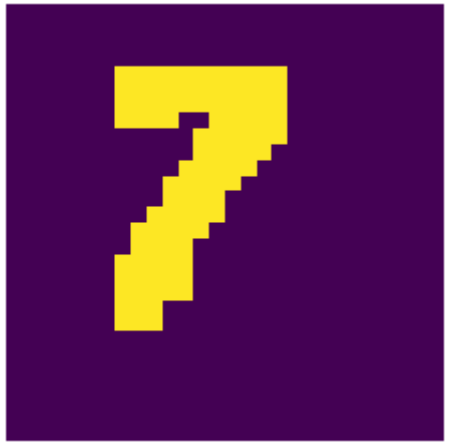


```
prediction:
7
```

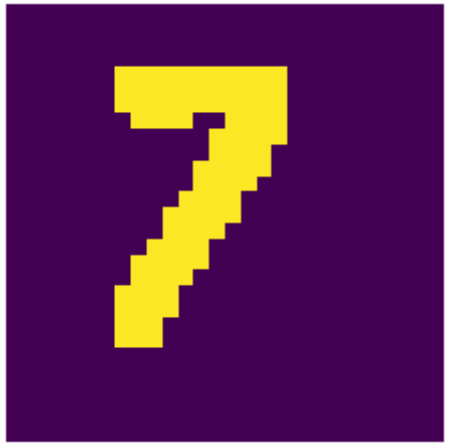


```
prediction:
7
```

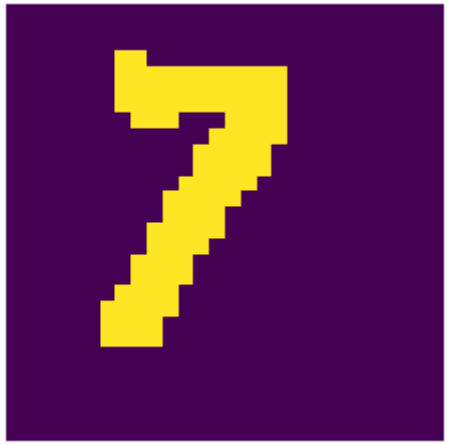
```
prediction:
7
```



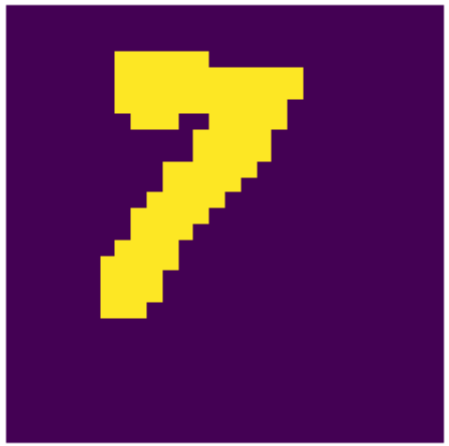
```
prediction:
7
```



```
prediction:
7
```



```
prediction:
7
```



```
prediction:
7
```

In [ ]:

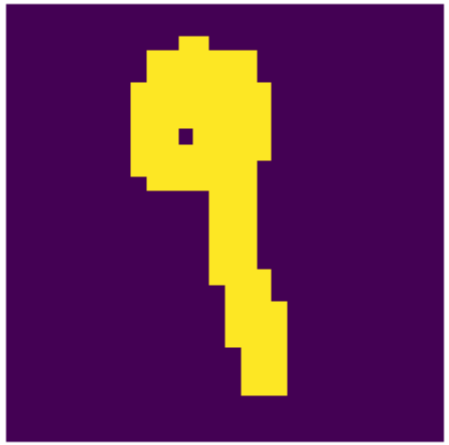
```
j=0
while j<=9:
    img = cv2.cvtColor(cv2.imread('test9_'+str(j)+'.jpg'), cv2.COLOR_BGR2GRAY)
    ret2, img1 = cv2.threshold(img, 120, 255, cv2.THRESH_BINARY_INV)
    img1 = cv2.flip(img1,1)
    img1 = cv2.erode(img1, None, iterations = 10)
    img1 = cv2.dilate(img1, None, iterations = 10)
    img2 = cv2.resize(img1,(28,28),interpolation = cv2.INTER_AREA)
    img2 = img2>0
    plt.axis('off')
```

```
    plt.imshow(img2)
    plt.show()
    test1 = tf.keras.utils.normalize(img2,axis=1) #making the image fit the CNN
    test1 = test1.reshape(1,28,28,1)
    predictions = model.predict(test1)
    print("prediction: "),
    print(np.argmax(predictions))
    j=j+1
```

```
prediction:
4
```

```
prediction:
9
```

```
prediction:
8
```



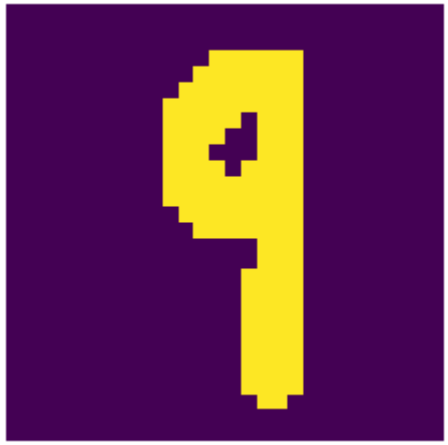
```
prediction:
1
```

```
prediction:
9
```

```
prediction:
9
```

```
prediction:
9
```

```
prediction:
8
```



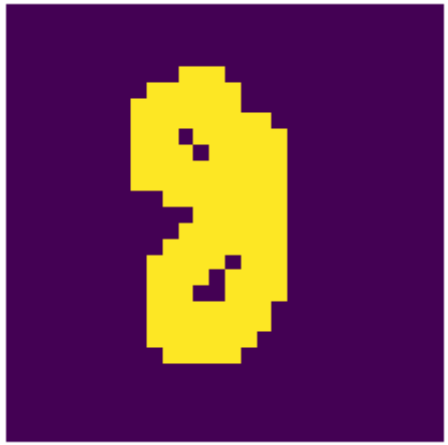
```
prediction:
9
```

```
prediction:
9
```

In [ ]:

```
j=0
while j<=9:
    img = cv2.cvtColor(cv2.imread('test8_'+str(j)+'.jpg'), cv2.COLOR_BGR2GRAY)
    ret2, img1 = cv2.threshold(img, 120, 255, cv2.THRESH_BINARY_INV)
    img1 = cv2.flip(img1,1)
    img1 = cv2.erode(img1, None, iterations = 10)
    img1 = cv2.dilate(img1, None, iterations = 10)
    img2 = cv2.resize(img1,(28,28),interpolation = cv2.INTER_AREA)
    img2 = img2>0
    plt.axis('off')
```

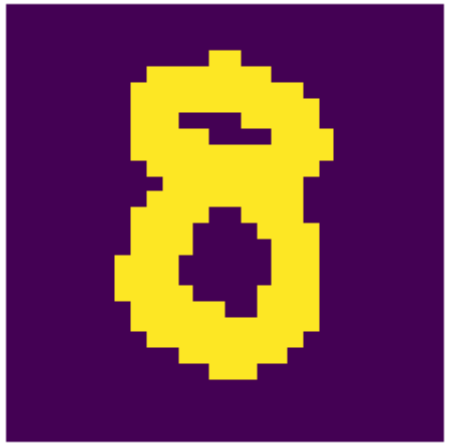
```
    plt.imshow(img2)
    plt.show()
    test1 = tf.keras.utils.normalize(img2,axis=1) #making the image fit the CNN
    test1 = test1.reshape(1,28,28,1)
    predictions = model.predict(test1)
    print("prediction: "),
    print(np.argmax(predictions))
    j=j+1
```



```
prediction:
8
```

```
prediction:
8
```

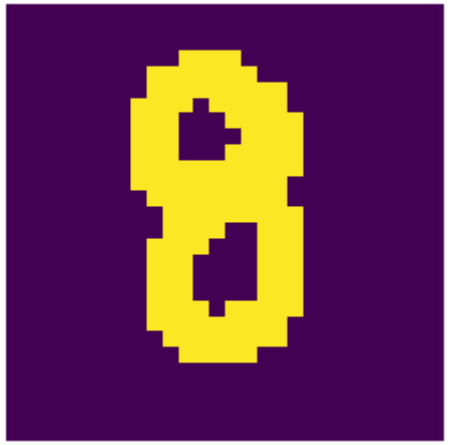
```
prediction:
8
```



```
prediction:
0
```

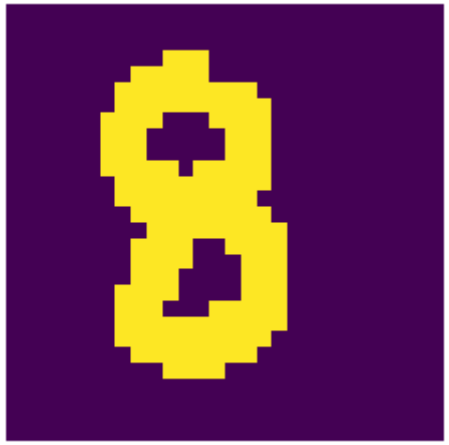
```
prediction:
8
```

```
prediction:
8
```

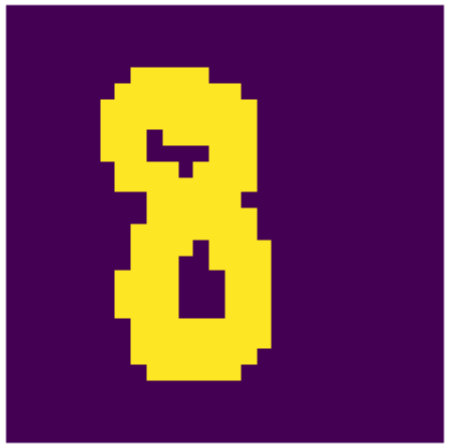


```
prediction:
8
```

```
prediction:
8
```



```
prediction:
8
```



```
prediction:
8
```

In [ ]:

```
i=0
accuracy_test = np.zeros(10,dtype=int)
while i<=9:
    j=0
    while j<=9:
        img = cv2.cvtColor(cv2.imread('test'+str(i)+'_'+str(j)+'.jpg'), cv2.COLOR_BGR2GRAY)
        ret2, img1 = cv2.threshold(img, 120, 255, cv2.THRESH_BINARY_INV)
        img1 = cv2.flip(img1,1)
        img1 = cv2.erode(img1, None, iterations = 10)
        img1 = cv2.dilate(img1, None, iterations = 10)
```

```
        img2 = cv2.resize(img1,(28,28),interpolation = cv2.INTER_AREA)
        img2 = img2>0
        test1 = tf.keras.utils.normalize(img2,axis=1) #making the image fit the CNN
        test1 = test1.reshape(1,28,28,1)
        predictions = model.predict(test1)
        pred = np.argmax(predictions)
        if pred == i:
            accuracy_test[i] = accuracy_test[i]+1
        j=j+1
    i=i+1
```

In [ ]:

```
index = np.array([0,1,2,3,4,5,6,7,8,9])
accuracy_test = accuracy_test/10
plt.bar(index,accuracy_test,color='blue',width=0.4)
plt.xlabel('Digits')
plt.ylabel('Accuracy')
plt.title('ACCURACY OF INPUTS OF SPECIFIC DIGITS')
plt.show()
```