Faculty of Computers and Artificial Intelligence

Computer Science Department

2021/2022

CS 396 Selected Topics in CS-2

Research Project

Report Submitted for Fulfillment of the Requirements and ILO's for Selected Topics in CS-2 course for Fall 2021

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• Paper Details

- Paper Name: Image Classification using Convolutional Neural Networks.
- Authors : Muthukrishnan Ramprasath , M.Vijay Anand , Shanmugasundaram Hariharan

- Paper date : 2018

Project Description

In recent year, with the speedy development in the digital contents identification, automatic

classification of the images became most challenging task in the fields of computer vision.

Automatic understanding and analysing of images by system is difficult as compared to human

visions. Several research have been done to overcome problem in existing

classification

system, but the output was narrowed only to low level image primitives. However, those

approach lack with accurate classification of images. In this paper, our system uses deep

learning algorithm to achieve the expected results in the area like computer visions. Our system

present Convolutional Neural Network (CNN), a machine learning algorithm being used for

automatic classification the images. Our system uses the Digit of MNIST dataset as a bench

mark for classification of grayscale images. The grayscale images in the data set used for

training which require more computational power for classification of images. By training the

images using CNN network we obtain the 98% accuracy result in the experimental part it shows

that our model achieves the high accuracy in classification of images

Datasets for it : MNIST dataset

dataset link : https://www.tensorflow.org/datasets/catalog/mnist

It includes 70000 image for (Training & Testing)

number of classes : 10

dimension of images = 28*28

number of traning : 60000

number of testing : 10000

Implementation details

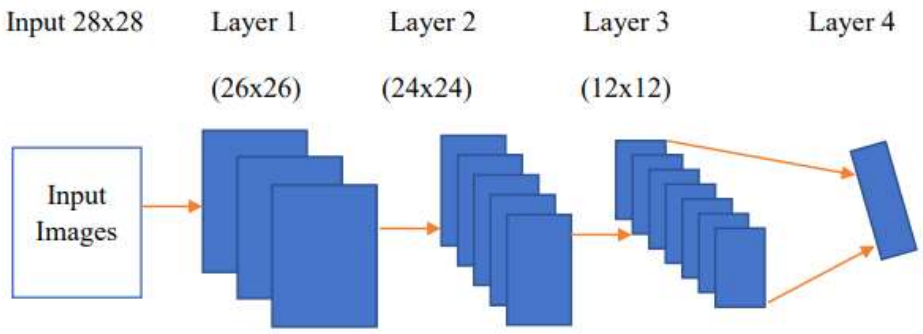


Figure 1: Architecture of Convolutional Neural Network (CNN)

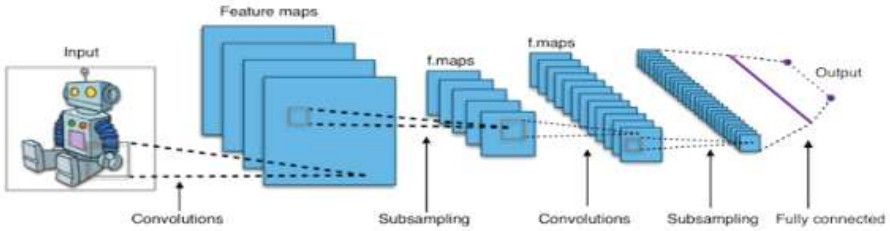


Figure. 2 Typical CNN Architecture

Our Model

[69]:
```
model = Sequential()


model.add(Conv2D (32 ,(3,3) ,kernel_regularizer=regularizers.l2(0.0001), input_shape = x_train.shape [1: ]))
model.add(Activation ( "relu" ))
model.add(MaxPooling2D (pool_size = (2,2)))

model.add(Conv2D (64 ,(3,3),kernel_regularizer=regularizers.l2(0.0001)))
model.add(Activation ( "relu" ))
model.add(MaxPooling2D (pool_size = (2,2)))

model.add(Conv2D (64 ,(3,3),kernel_regularizer=regularizers.l2(0.0001)))
model.add(Activation ( "relu" ))
model.add(MaxPooling2D (pool_size = (2,2)))

model.add (Flatten())
model.add (Dense (64))
model.add (Activation ("relu"))

model.add (Dense (32))
model.add (Activation ("relu"))

model.add (Dense (10))
model.add (Activation ("softmax"))
```

model.summary

In [70]:
```
model.summary()
```

```
Model: "sequential_7"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
conv2d_14 (Conv2D)           (None, 26, 26, 32)        320
_________________________________________________________________
activation_21 (Activation)   (None, 26, 26, 32)        0
_________________________________________________________________
max_pooling2d_11 (MaxPooling (None, 13, 13, 32)        0
_________________________________________________________________
conv2d_15 (Conv2D)           (None, 11, 11, 64)        18496
_________________________________________________________________
activation_22 (Activation)   (None, 11, 11, 64)        0
_________________________________________________________________
max_pooling2d_12 (MaxPooling (None, 5, 5, 64)          0
_________________________________________________________________
conv2d_16 (Conv2D)           (None, 3, 3, 64)          36928
_________________________________________________________________
activation_23 (Activation)   (None, 3, 3, 64)          0
_________________________________________________________________
max_pooling2d_13 (MaxPooling (None, 1, 1, 64)          0
_________________________________________________________________
flatten_3 (Flatten)          (None, 64)                0
_________________________________________________________________
dense_9 (Dense)              (None, 64)                4160
_________________________________________________________________
activation_24 (Activation)   (None, 64)                0
_________________________________________________________________
dense_10 (Dense)             (None, 32)                2080
_________________________________________________________________
activation_25 (Activation)   (None, 32)                0
_________________________________________________________________
dense_11 (Dense)             (None, 10)                330
_________________________________________________________________
activation_26 (Activation)   (None, 10)                0
```

Hyperparameters:

optimizer = 'adam'

loss = ''sparse_categorical_crossentropy''

epochs = 5

batch_size = 128

learning rate = 0.001

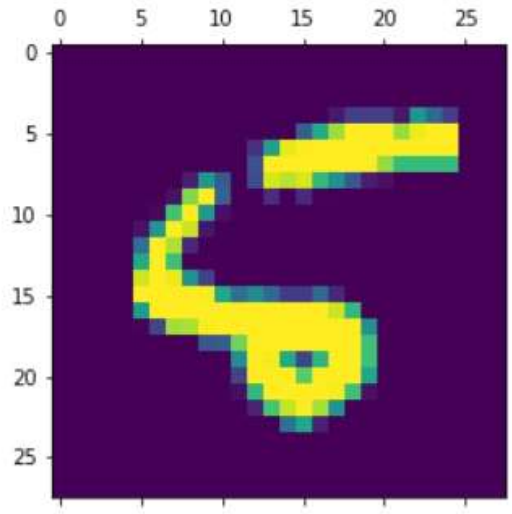
regularization = 0.0001

- **Testing results**

Outputs :

this image is number 5 and he is predicted as num 5

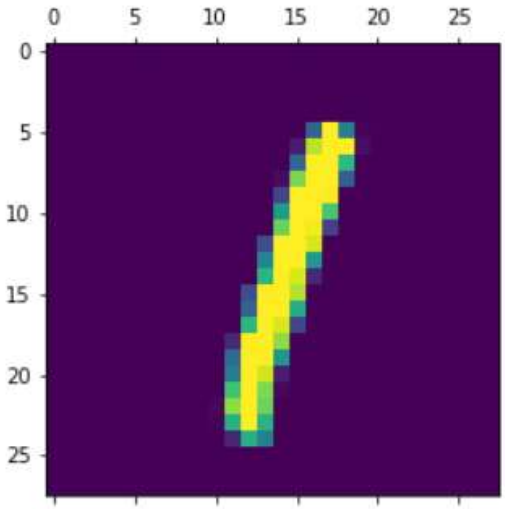
```
In [74]: plt.matshow(x_test[8])
Out[74]: <matplotlib.image.AxesImage at 0x1bdb9c35190>
```




```
In [75]: y_predicted = model.predict(x_test)

In [76]: np.argmax(y_predicted[8])
Out[76]: 5

In [77]: y_test[8]
Out[77]: 5
```

this image is number 1 and he is predicted as num 1

```
In [115]: plt.matshow(x_test[5])
Out[115]: <matplotlib.image.AxesImage at 0x1bdb751c940>
```



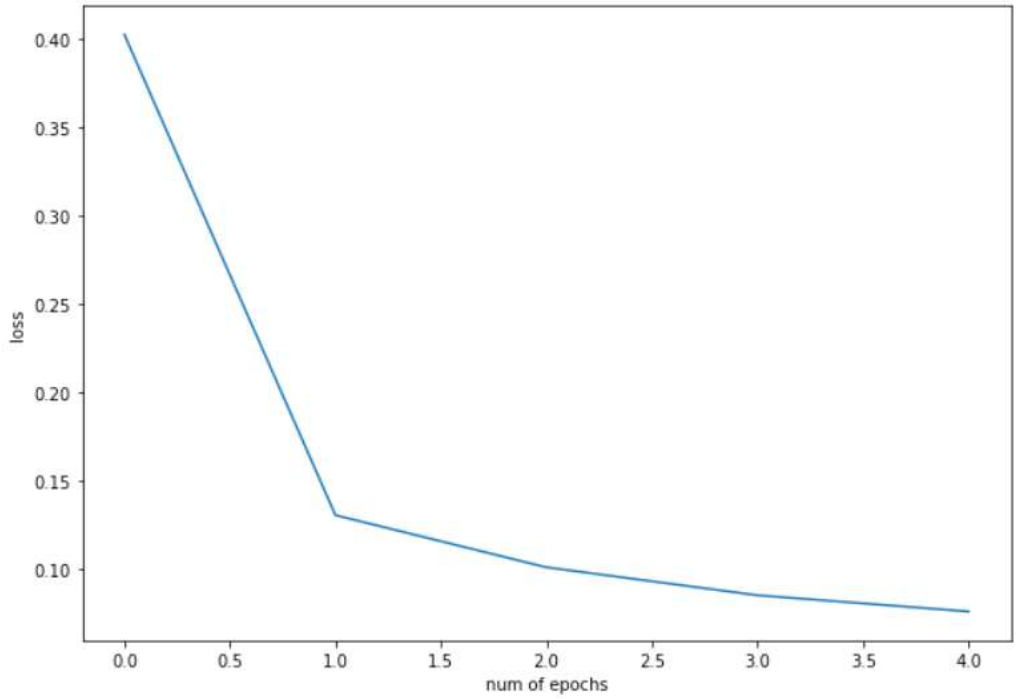

```
In [116]: y_predicted = model.predict(x_test)

In [117]: np.argmax(y_predicted[5])
Out[117]: 1

In [118]: y_test[5]
Out[118]: 1
```

Accuracy : 98 %

```
In [72]: hist = model.fit (x_train , y_train , batch_size = 128 , epochs = 5)

Epoch 1/5
469/469 [==============================] - 13s 28ms/step - loss: 0.4025 - accuracy: 0.8778
Epoch 2/5
469/469 [==============================] - 13s 29ms/step - loss: 0.1301 - accuracy: 0.9648
Epoch 3/5
469/469 [==============================] - 13s 28ms/step - loss: 0.1005 - accuracy: 0.9745
Epoch 4/5
469/469 [==============================] - 13s 28ms/step - loss: 0.0847 - accuracy: 0.9791
Epoch 5/5
469/469 [==============================] - 13s 29ms/step - loss: 0.0755 - accuracy: 0.9825

In [73]: model.evaluate(x_test , y_test )

313/313 [==============================] - 1s 3ms/step - loss: 0.0810 - accuracy: 0.9806
Out[73]: [0.08100221306085587, 0.9805999994277954]
```

loss Curve:

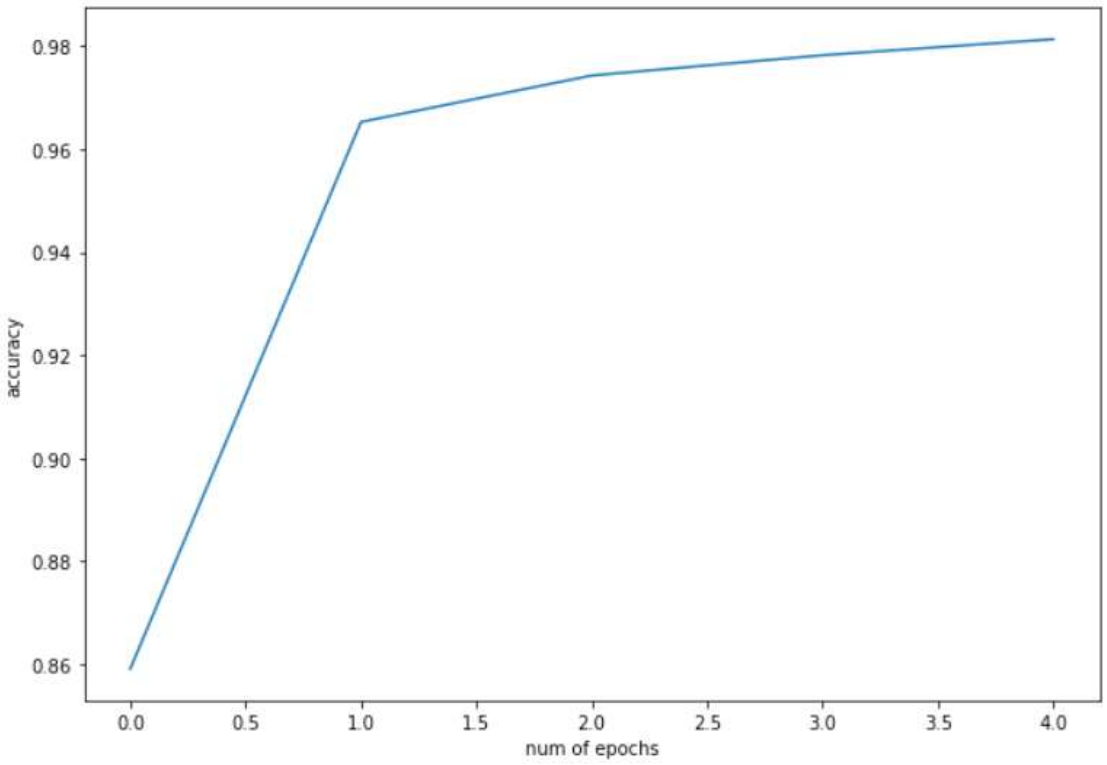
```
In [82]: plt.figure(figsize = (10,7))
         plt.plot(xc , train_loss)
         plt.xlabel('num of epochs')
         plt.ylabel('loss')

Out[82]: Text(0, 0.5, 'loss')
```



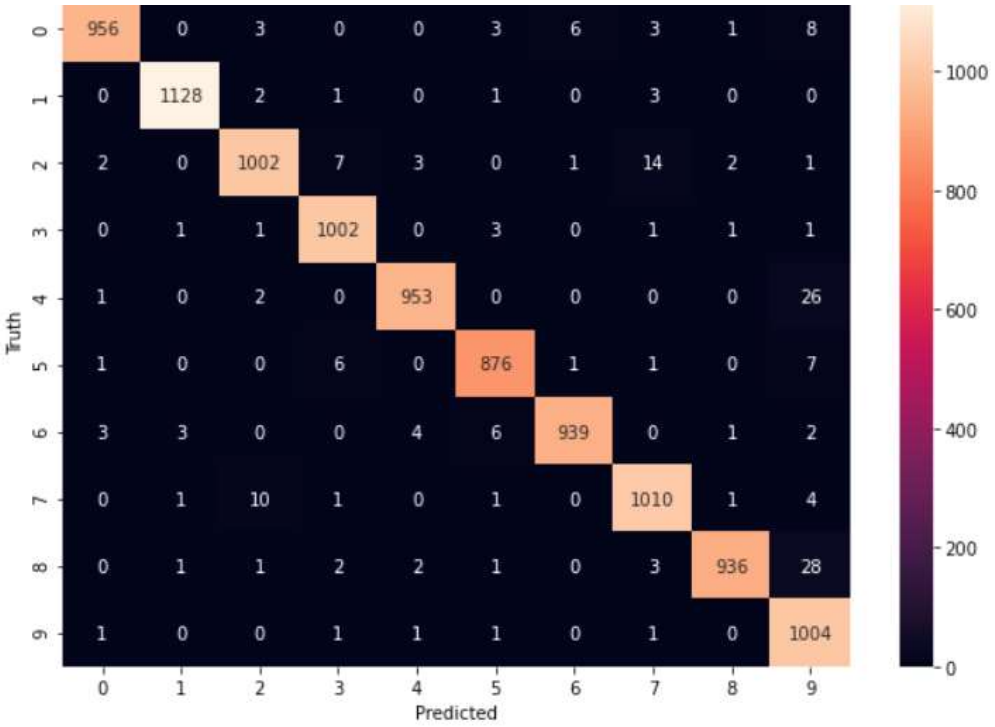
accuracy curve:

```
: plt.figure(figsize = (10,7))
  plt.plot(xc , train_accuracy)
  plt.xlabel('num of epochs')
  plt.ylabel('accuracy')
```

```
: Text(0, 0.5, 'accuracy')
```



Confusion matrix:


Truth
Predicted
0 956 0 3 0 0 3 6 3 1 8
1 0 1128 2 1 0 1 0 3 0 0
2 2 0 1002 7 3 0 1 14 2 1
3 0 1 1 1002 0 3 0 1 1 1
4 1 0 2 0 953 0 0 0 0 26
5 1 0 0 6 0 876 1 1 0 7
6 3 3 0 0 4 6 939 0 1 2
7 0 1 10 1 0 1 0 1010 1 4
8 0 1 1 2 2 1 0 3 936 28
9 1 0 0 1 1 1 0 1 0 1004
0 1 2 3 4 5 6 7 8 9
1000
800
600
400
200
0