PANTECH SOLUTIONS®
Technology Beyond the Dreams

AI Master Class series – Day 10

Overview on CNN | Designing Neural Network

Day-10 Agenda.

01.

Neural Network

Neural Network & Perceptron

02.

Deep Learning Algorithm

Overview & Types

03.

CNN & CNN Architecture

Architecture with Softmax Activation Function

04.

Implementation of NN

Implementation & Basic Syntax on Keras

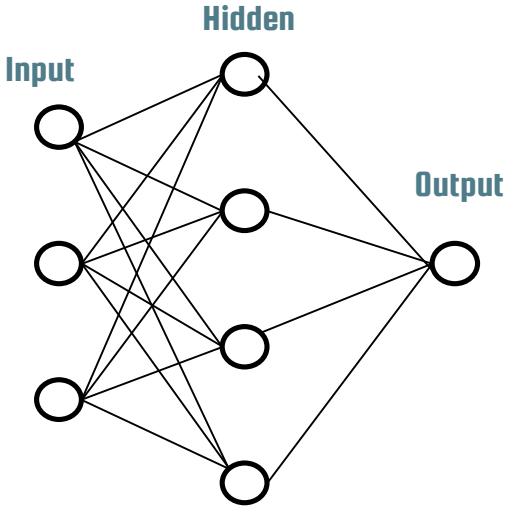
05.

Designing Neural Network

Pima Indians diabetes classification

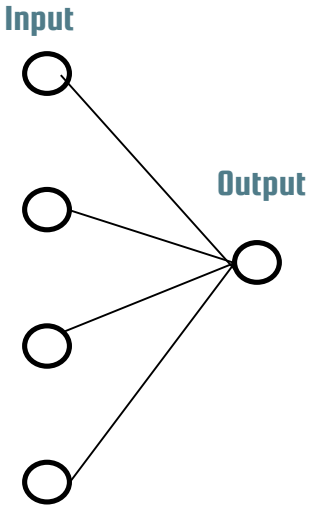
Neural Network.

- It has Interconnected input and output In which each connection has an associated weights
- It will adjust the weight during the learning process



Perceptron.

- Only Input and output Layer no hidden layer
- Simple decision making



Deep Learning Algorithm.

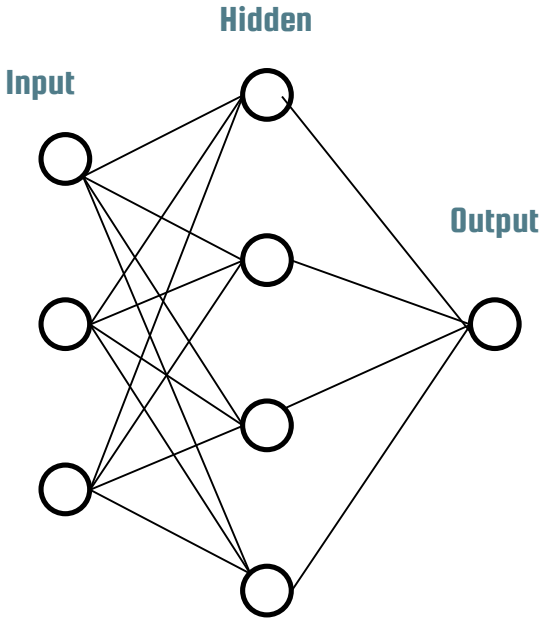
01 ARTIFICIAL NEURAL NETWORK (ANN)

02 RECURRENT NEURAL NETWORK (RNN)

01 CONVOLUTIONAL NEURAL NETWORK (CNN)

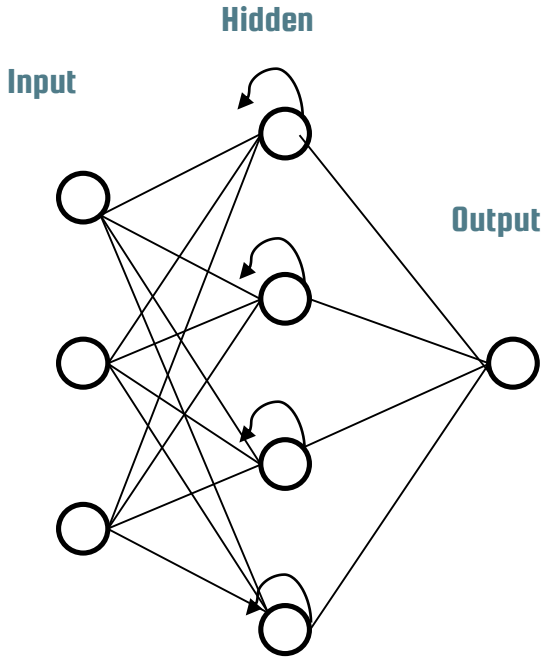
ANN.

- Learns any Non-Linear Function, It is known as Universal Function Approximators
- Activation Function introduce non linear property to network, so it will identify complex relationship between input & output
- Output of each neuron is the activation of weighted sum of Input, If there is no Activation function, network can't learn non-linear function
- Feed Forward Neural Network – Input processed in one direction
- When hidden layer is more than one, that is Deep Neural Network



RNN.

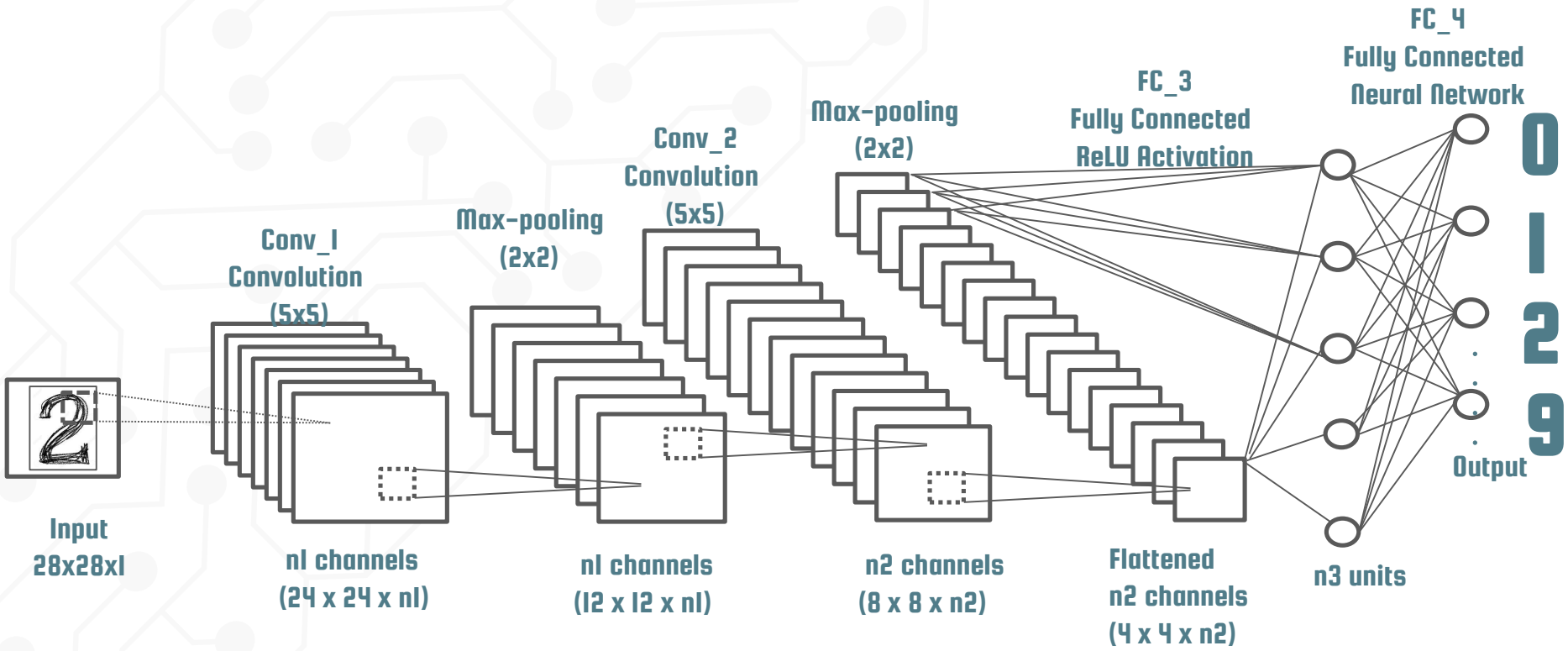
- Looping system in hidden layer of ANN is known as RNN
- It captures sequential info of input data, that is dependency between words to make prediction. Whereas, ANN cannot capture sequential information
- RNN shares parameters across different time steps, so that there will be few parameter to train
- It is the time series version of ANN. Common Recurrent layers are LSTM(Long Short Term Memory) & GRU (Grated Recurrent Units)
- GRU is used to how much pass data needed to flow through model
- It is mostly used in NLP (Natural Language Processing)



CNN.

- CNN learns the filter automatically to extract the right features from the data
- It captures spatial features (Arrangement of pixels) whereas ANN can't.
- It also follows parameter sharing like RNN, applies single filter in different part of single image. Whereas ANN can't.
- It don't have recurrent connections like RNN, instead it has convolution type of hidden layers
- Convolution and pooling functions are used as activation functions
- CONVOLUTION: Input image and other as Filter on input image(Kernel) produces output image.
- POOLING: picking maximum value from selected region is Max pooling and vice versa.

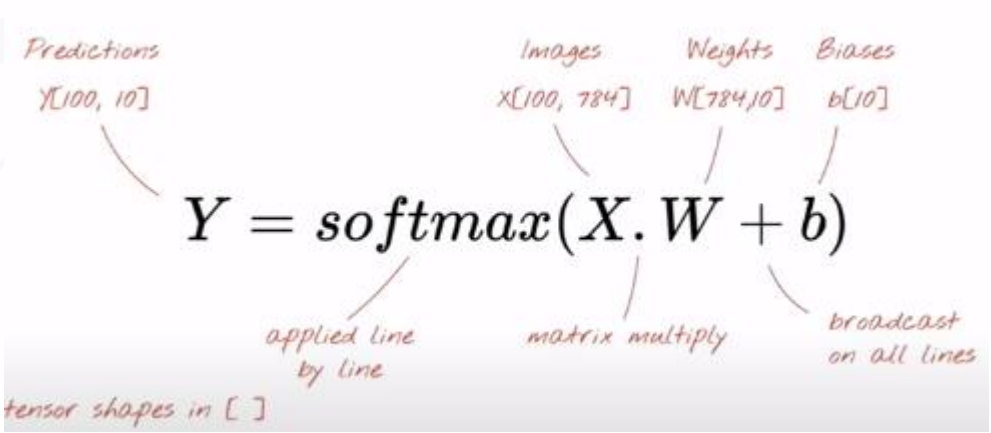
CNN Architecture.



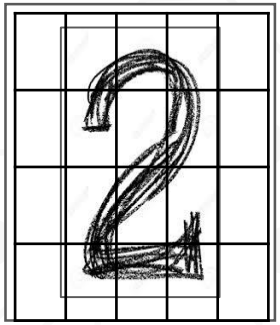
Simple Softmax Classification.

$$softmax(L_n) = \frac{e^{L_n}}{||e^{L}||}$$

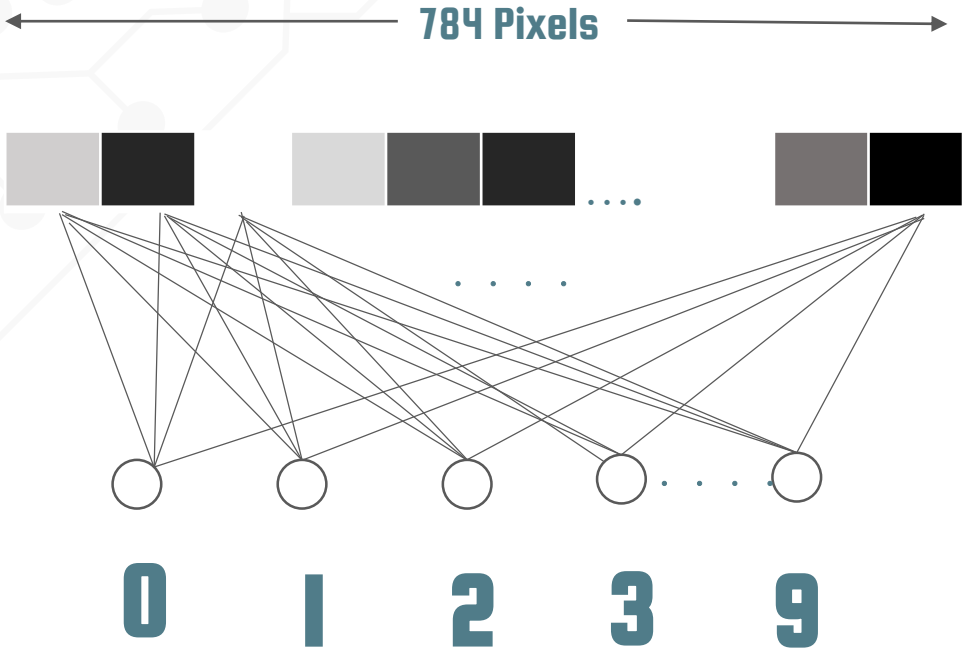
$$L = X.W + b$$



Simple Softmax Classification.



Input
28x28xl



100 image at a time.

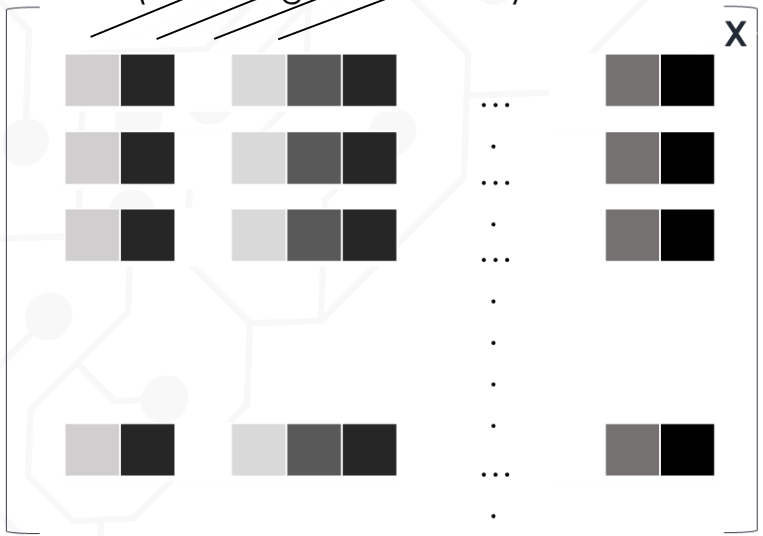
Weights
784x10 Matrix

$$\begin{bmatrix} W_{0,0} & W_{0,1} & W_{0,2} & \dots & W_{0,9} \\ W_{1,0} & W_{1,1} & W_{1,2} & \dots & W_{1,9} \\ W_{2,0} & W_{2,1} & W_{2,2} & \dots & W_{2,9} \\ W_{3,0} & W_{3,1} & W_{3,2} & \dots & W_{3,9} \\ W_{4,0} & W_{4,1} & W_{4,2} & \dots & W_{4,9} \\ \vdots & & \vdots & & \\ W_{783,0} & W_{783,1} & W_{783,2} & \dots & W_{783,9} \end{bmatrix}$$

Dot Product

X

Input Image
100x784 (100 images Flattened)



100x10 Matrix

$$\begin{bmatrix} L_{0,0} & W_{0,1} & W_{0,2} & \dots & W_{0,9} \\ L_{1,0} & W_{1,1} & W_{1,2} & \dots & W_{1,9} \\ L_{2,0} & W_{2,1} & W_{2,2} & \dots & W_{2,9} \\ L_{3,0} & W_{3,1} & W_{3,2} & \dots & W_{3,9} \\ L_{4,0} & W_{4,1} & W_{4,2} & \dots & W_{4,9} \\ \vdots & & \vdots & & \\ L_{99,0} & L_{99,1} & L_{99,2} & \dots & W_{99,9} \end{bmatrix}$$

+

Bias
1x10 Matrix

$$\begin{bmatrix} b_0 & b_1 & b_2 & b_3 & \dots & b_9 \end{bmatrix}$$

In TensorFlow.

Y[100x10]

X[100x784]

W[784x10]

b[10]

```
Y = tf.nn.softmax(tf.matmul(X,W)+b)
```

Cross Entropy

Actual Probability

0	1	2	3	4	5	6	7	8	9
0	0	1	0	0	0	0	0	0	0

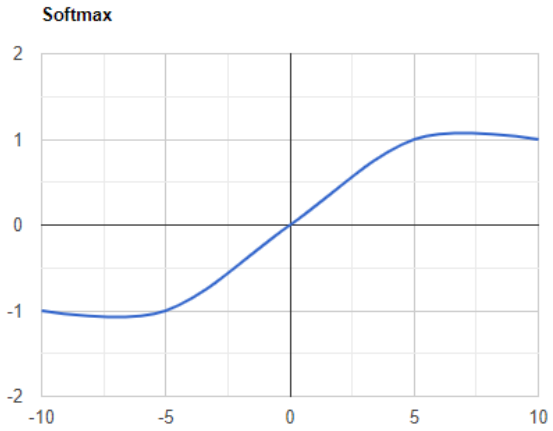
$$-\sum Y'_i . log(Y_i)$$

Computed Probability

0	1	2	3	4	5	6	7	8	9
0.1	0.2	0.9	0.5	0.3	0.1	0.2	0.1	0.3	0.1

SOFTMAX Function.

- Softmax activation function will be applied in the last layer of Neural network, instead of ReLU, tanh, Sigmoid.
- It is used to map the non-normalized output of a network to a probability distribution over predicted output class. That is it converts output of last layer into a essential probability distribution.



$$softmax(L_n) = \frac{e^{L_n}}{||e^{L}||}$$

Implementation of NN.

Feed Forward

- Set of Input features and random weights
- Weights will be optimized by back propagation

Back Propagation.

- Calculating error between predicted output and target output and use Gradient descent method to update weights

Gradient Descent.

- Machine Learning algorithm
- It operates iteratively to find the optimal values for its parameters. user-defined learning rate, and initial parameter values

Vanishing & Exploding Gradient.

- It is very common problem in every Neural Network, which is associated with Backpropagation.
- Weights of network are updated through backpropagation by finding gradients.
- When the number of hidden layer is high, then the gradient vanishes or explodes as it propagates backward. It leads instability in network, unable to learn from training
- The explosion occurs through exponential growth by repeatedly multiplying gradients through the network layers that have values larger than 1.0
- It can be fixed by redesigning the network, using Long Short Term Memory networks, Gradient clipping, etc.

Keras Basic Syntax.

Adding Layers

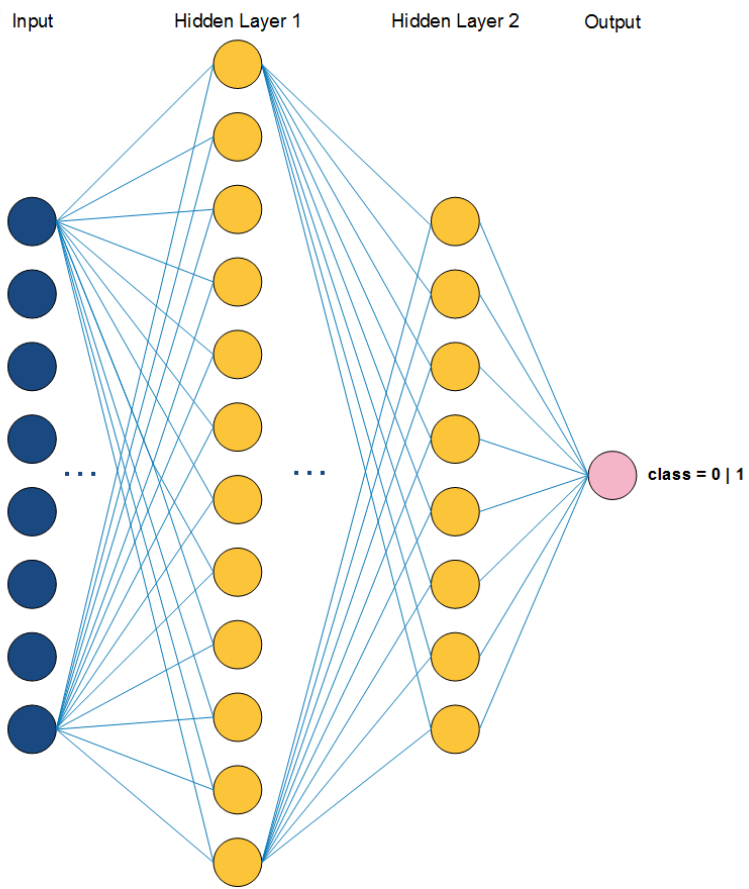
```
model.add(Dense(12, input_dim=8, init='uniform', activation='relu'))

model.add(Dense(8, activation='relu'))
```

Compile Model

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

Optimizer – String identifier of an existing optimizer
loss function – This is the objective that the model will try to minimize
list of metrics – For any classification problem you will want to set this to metrics=['accuracy']



Batch vs Epoch.

Training occurs over epochs and each epoch is split into batches.

Epoch – One pass through all of the rows in the training dataset
Batch – One or more samples considered by the model within an epoch before weights are updated.

Keras Basic Syntax.

Save & Load Model.

Save

```
model_json = model.to_json()
with open("model.json", "w") as json_file:
    json_file.write(model_json)

model.save_weights("model.h5")
print("Saved model to disk")
```

Load

```
json_file = open('model.json', 'r')
loaded_model_json = json_file.read()
json_file.close()
loaded_model = model_from_json(loaded_model_json)
loaded_model.load_weights("model.h5")
```

Practical session

Designing your First Neural Network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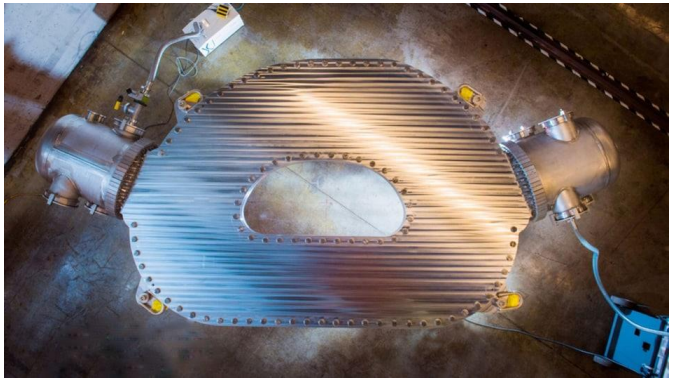
Today's Short Bytes – Tech News

MIT Researchers Build Powerful Superconducting Magnet That Can Lead to Clean Fusion Energy

The new technology could fundamentally provide an "inexhaustible" source of energy.



Thanks!

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Tomorrow session

Object recognition