Convolutional Neural Networks:

Topics covered in the week:

- What is a Convolution
- Image Processing using convolution
- Filters for edge detection
- ANN vs CNN
- Convolution process and creation of feature maps
- Pooling layer
- Role of different layers in CNN
- CNN in Keras
- Case Study

What is a Convolution:

- Convolution is a mathematical transformation of a given function (analog or digital) into a from that is more useful than the original function given a requirement for e.g. image classification.

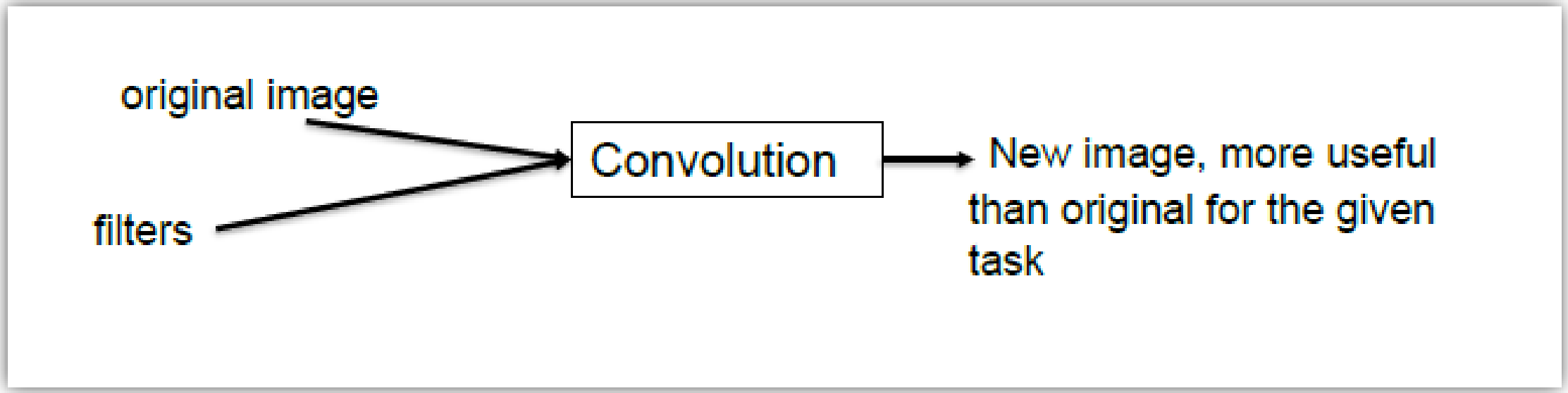
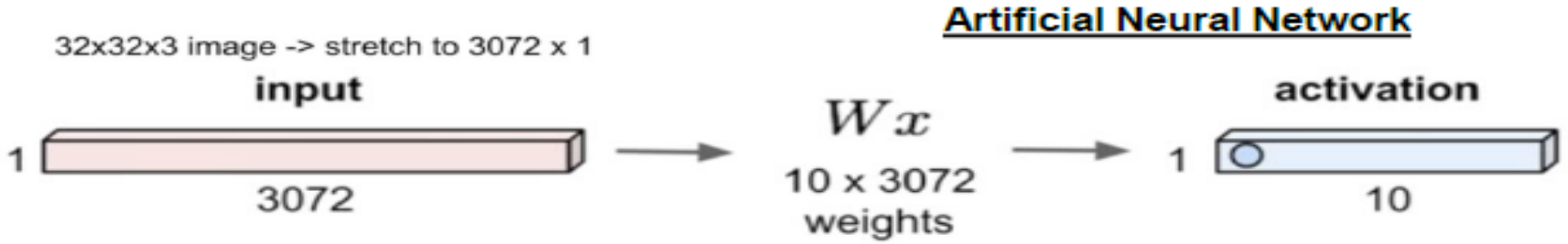


Image Processing using convolution:

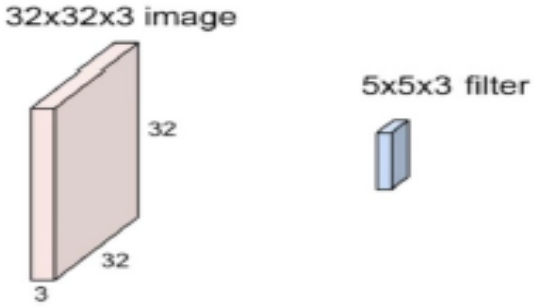
- Through the use of a filter function on the image function (convolution) , we try to detect edges.
- Convolution for Edge Detection / Horizontal edge detection.
- Convolution for Vertical Edge detection.
- Image gradient using Sobel operator / filter.

ANN Vs CNN:

Artificial neural network takes a vector as input. Spatial structure is ignored



Unlike ANN which work on vectors, CNN works on volumes maintaining spatial structures



Convolutional Neural Network

Filter will slide over the image (convolve) computing dot product
A single filter will apply on all 3 color channels

Convolution: Kernels and Filters

- Convolution uses a small array of numbers called a filter/kernel on the input image.
- The resulting output value in the corresponding pixel position of the output image is called a feature map.

Filters and Activation Map Size:

- Size of the new image in row and column is given by:
  - Rnew= ((image_rows–filter_rows) / stride) + 1. Similarly,
  - Cnew= ((image_cols–filter_cols)/stride) + 1

Padding:

- Filter convolution reduces output image size.
- In the convolution process, it is not possible to center the filter over the outermost pixels of the input image.
- A technique called **padding** is used to prevent image size reduction.

Pooling Layers:

- For object recognition we need high level features. Many of the low level features are redundant.
- Pooling layers provide an approach to down sampling feature maps by summarizing the presence of features in patches of the feature map.
- Two common pooling methods are **average pooling** and **max pooling** that summarize the average presence of a feature and the most activated presence of a feature respectively.
- A pooling layer is added after the convolutional layer.

Maxpooling Layer:

- Maxpooling operation breaks convolutional layer output into smaller patches, often 2x2 pixel areas (pooling layer filter size) with a stride of 2.
- For each 2x2 patch, a maxpooling layer looks at each value in a patch and selects only the maximum gradient value.
- Maxpooling helps feature selection by avoiding weak features and thus helps in dimensionality reduction.

Fully Connected Layer:

- At this layer, the high level features extracted by the previous conv layer are used for classification.
- This layer looks at the output of the previous layer i.e. the activation maps with high level features and determines which features most correlate to a particular class.

Convolutional Network:

The different layers in the CNN model may be:

- Input layer (the image)
- Convolutional Layer
- Nonlinearity (activation function)
- Pooling Layer
- Dense layer

Case Study: Image Classification using Deep CNN in Keras.

Context:

- The CIFAR-10 dataset contains 60,000 32x32 color images in 10 different classes.
- The 10 different classes represent airplanes, cars, birds, cats, deer, dogs, frogs, horses, ships, and trucks.
- There are 6,000 images of each class.
- The labels are represented by numbers and represent the following things: airplane : 0, automobile : 1, bird : 2, cat : 3, deer : 4, dog : 5, frog : 6, horse : 7, ship : 8, truck : 9.

Steps:

- Import necessary libraries.
- Get the data.
- Explore the data.
- Convert labels to one hot vectors.
- Understanding the layers used in model.
- Fit the model.
- Model score and Summary.

Questions?

Thank You!
Happy Learning!