Deep Learning for Business

Deep Learning with CNN & RNN

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Deep Learning with CNN

(Convolutional Neural Network)

CNN (Convolutional Neural Network)

CNN Structure

- FF (Feed-Forward) NN (Neural Network)
- Designed based on an animal's visual cortex
  - Individual vision neurons progressively focus on overlapping tile shape regions
  - Vision tile regions sequentially shift (convolution process) to cover the overall visual field
- CNNs use MLPs (Multi-Layer Perceptrons) for this process

CNN (Convolutional Neural Network)

CNN Characteristics

- Deep Learning CNN techniques became well known based on an outstanding (winning) performance of image recognition at the ImageNet Challenge 2012 by Krizhevsky & Hinton from the University of Toronto
- CNNs need a minimal amount of preprocessing

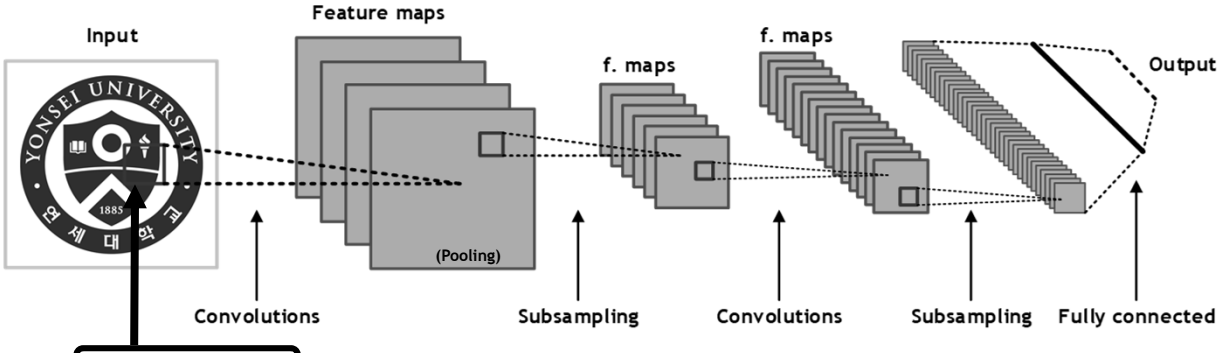
CNN (Convolutional Neural Network)

CNN Characteristics

- ReLU (Rectified Linear Units) activation functions are often used $g(y) = \max(0, y)$
- CNNs are used in image/video recognition, recommender systems, natural language processing, Chess, Go, etc.

CNN (Convolutional Neural Network)

CNN Structure



Filtering field sequentially shifts around (convolution process) to process the whole image

CNN (Convolutional Neural Network)

Convolutional Layer

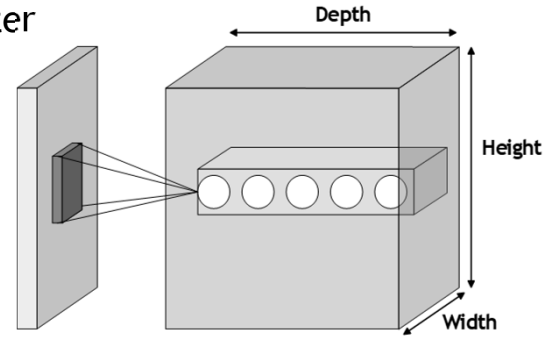
- Convolution is used to find the same feature in different places of an image

- Convolution is conducted using learnable filters/kernels (that have small receptive fields) that are passed (convoluted) through the input data/image

CNN (Convolutional Neural Network)

Convolutional Layer

- Each filter moves sequentially across (convolved) the input data/image to make a 2-dimensional activation map based on each filter



CNN (Convolutional Neural Network)

Feature Maps

- Feature Maps are made from the activation maps of the filters

- Number of Learnable filters/kernels (and how the data, weight training, bias values, etc. are used) in the Convolution process determines how many Feature Maps are generated after Convolution

CNN (Convolutional Neural Network)

Subsampling

- Subsampling uses a selecting operation (pooling) on the Feature Maps

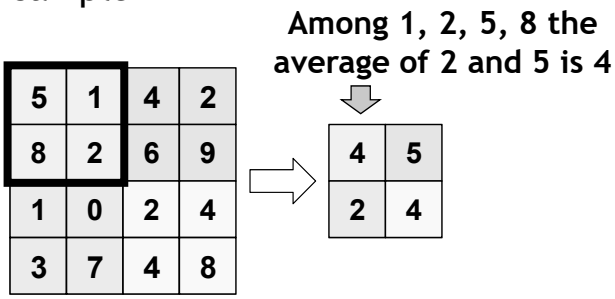
- Subsampling is a non-linear down-sampling process that results in smaller Feature Maps

- Most popular subsampling schemes (many exist)
  - Median Value
  - Average Value
  - Max Pooling

CNN (Convolutional Neural Network)

Subsampling: Median Value

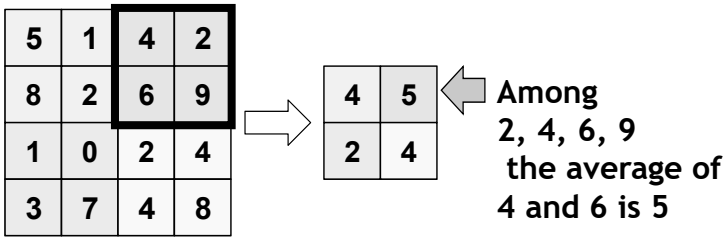
- For each sub-region select the median value (middle value) as the representative sample



CNN (Convolutional Neural Network)

Subsampling: Median Value

- For each sub-region select the median value (middle value) as the representative sample

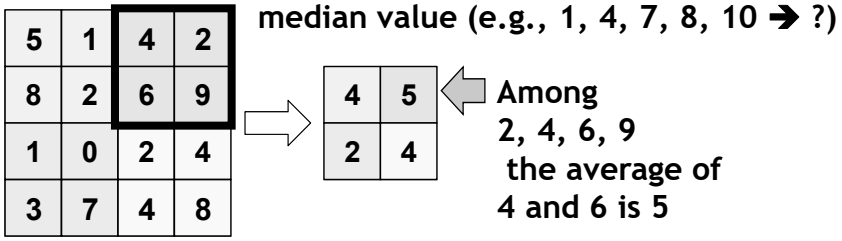


CNN (Convolutional Neural Network)

Subsampling: Median Value

- For each sub-region select the median value (middle value) as the representative sample

If there were an odd number of values, then the middle one would be the median value (e.g., 1, 4, 7, 8, 10 ➔ ?)

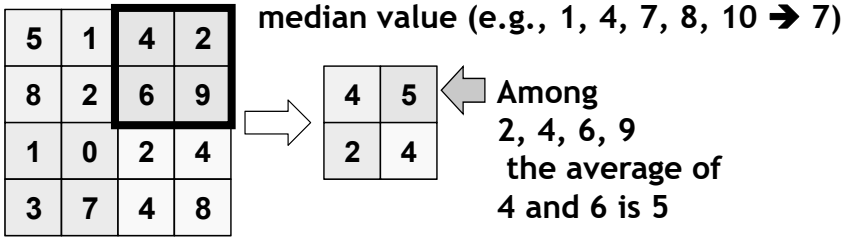


CNN (Convolutional Neural Network)

Subsampling: Median Value

- For each sub-region select the median value (middle value) as the representative sample

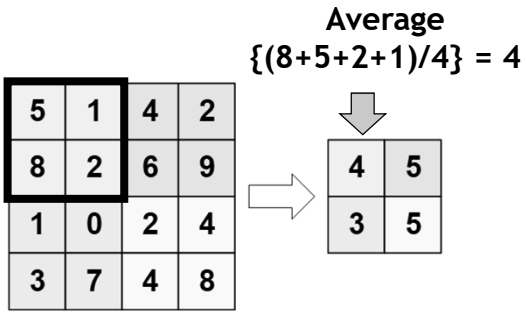
If there were an odd number of values, then the middle one would be the median value (e.g., 1, 4, 7, 8, 10 ➔ 7)



CNN (Convolutional Neural Network)

Subsampling: Average Value

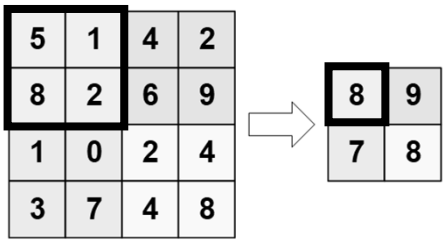
- For each sub-region use the average value as the representative



CNN (Convolutional Neural Network)

Subsampling: Max Value

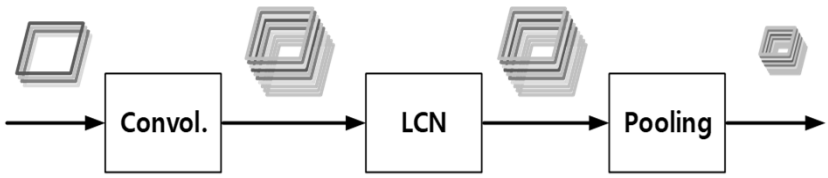
- Each sub-region selects its max value as its representative value



CNN Techniques

CNN Processing Characteristics

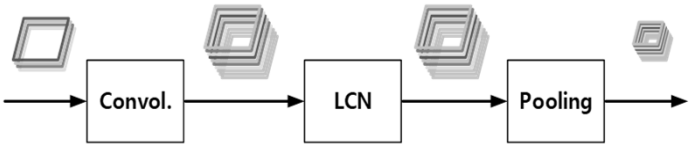
- Convolution layer increases number of feature maps
- Pooling (subsampling) layer deceases spatial resolution



CNN Techniques

LCN (Local Contrast Normalization)

- LCN improves the optimization results and the image's invariance
  (i.e., characteristic of not changing after transformation or processing)
- LCN can be used on the image after convolution and before pooling (subsampling)



CNN Techniques

Dropout

- On each iteration, selected neurons are randomly turned off
  - Based on a probability model

- Helps in training neurons to properly work even when other neurons may not exist (neuron failure)
  - Provides robustness to the CNN

CNN Techniques

Full Connected MLP Output Layer

- Output layer uses a fully connected MLP (Multi-Layer Perceptron) to the previous hidden layer

- Outputs are computed with a matrix multiplication and biased offset

CNN Techniques

Ensemble

- Ensembles are created by repeated random sampling of the training (labeled) data

- Ensembles improve the accuracy and reliability by providing an improved global image of the data's actual statistics

- Ensemble models are often used in Deep NNs

CNN Techniques

Bagging

- Bagging uses multiple iterations of training the CNN with training/labeled data that has random sample replacements

- After training, the results of all trained models of all iterations are combined

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References

References

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References

Image sources

- Neuron
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References

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