KAIST Summer Session 2018

Module 3. Deep Learning with PyTorch

Convolutional Neural Network

KAIST College of Business

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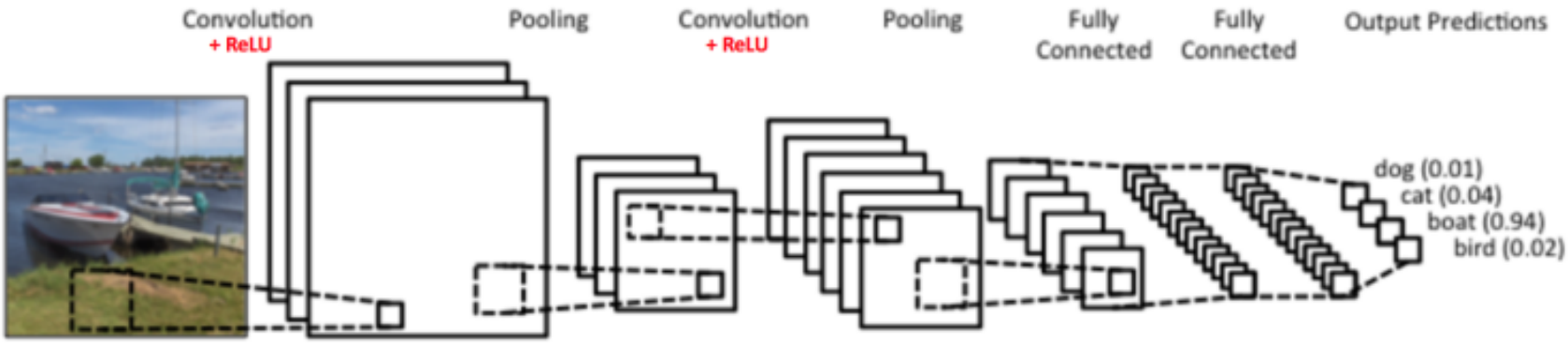
Review: What is CNN?

- A typical example of CNN



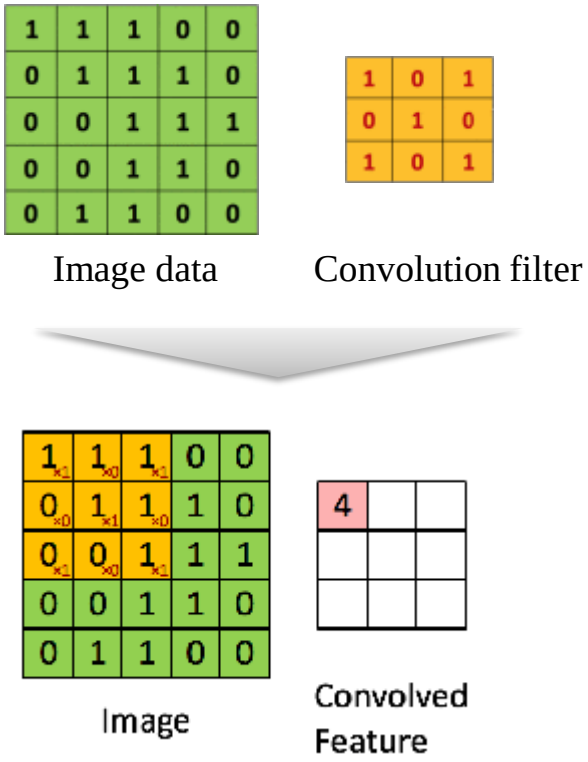
➢ Inputs (2-dimension × channels) → [Convolution -> ReLu -> Pooling] → …

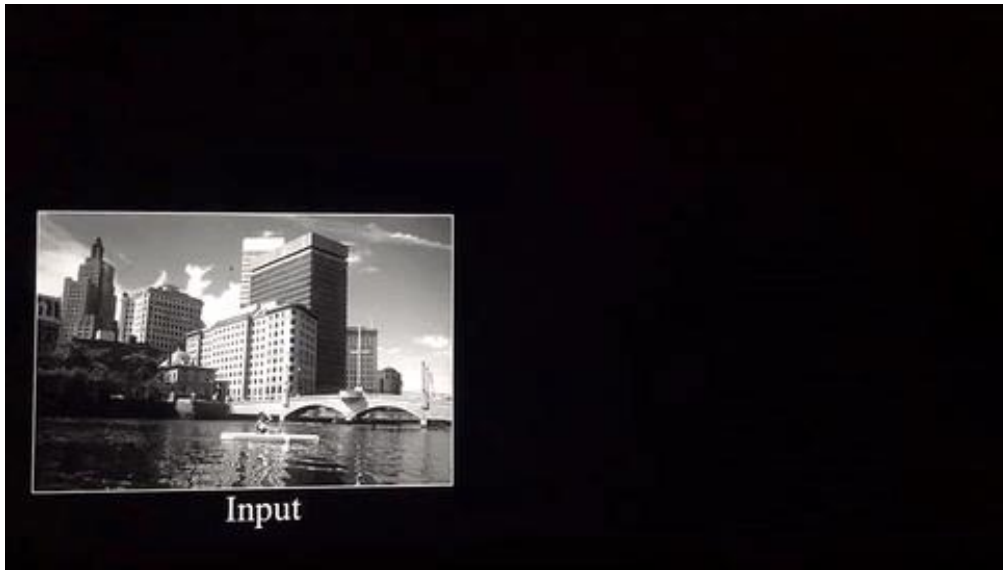
→ [Convolution -> ReLu -> Pooling] → Fully connected layer

→ Output prediction (Multi-class classification)

Review: What is CNN?

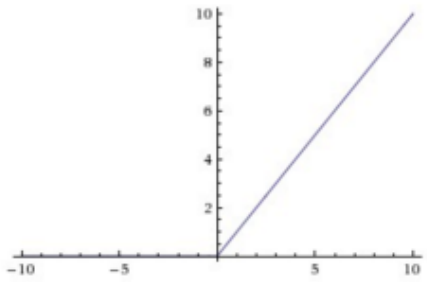
- Convolution



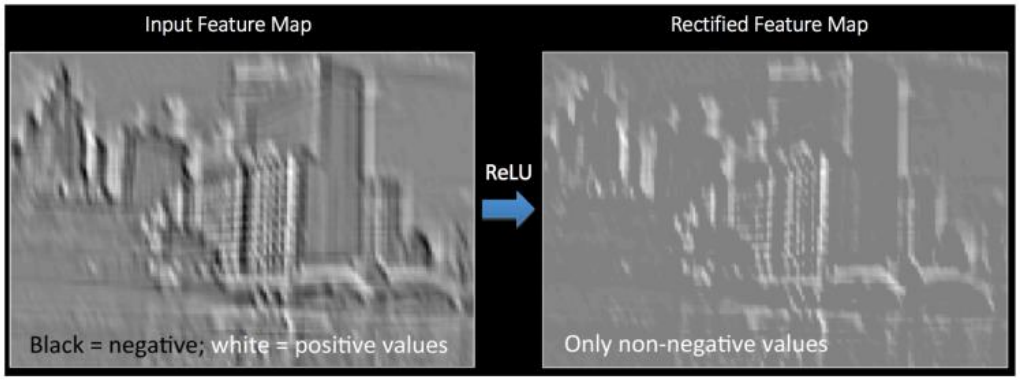


Review: What is CNN?

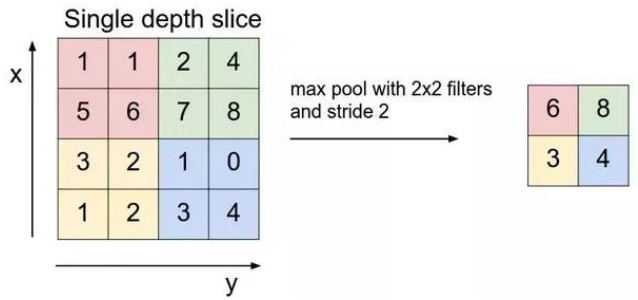
- ReLU

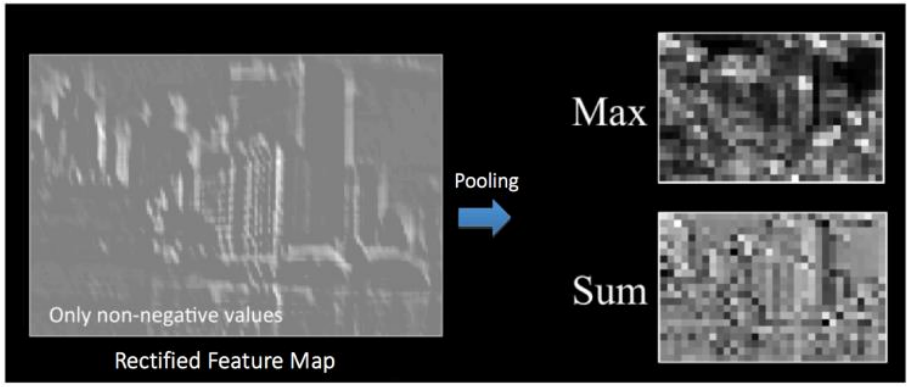


Output = Max(zero, Input)



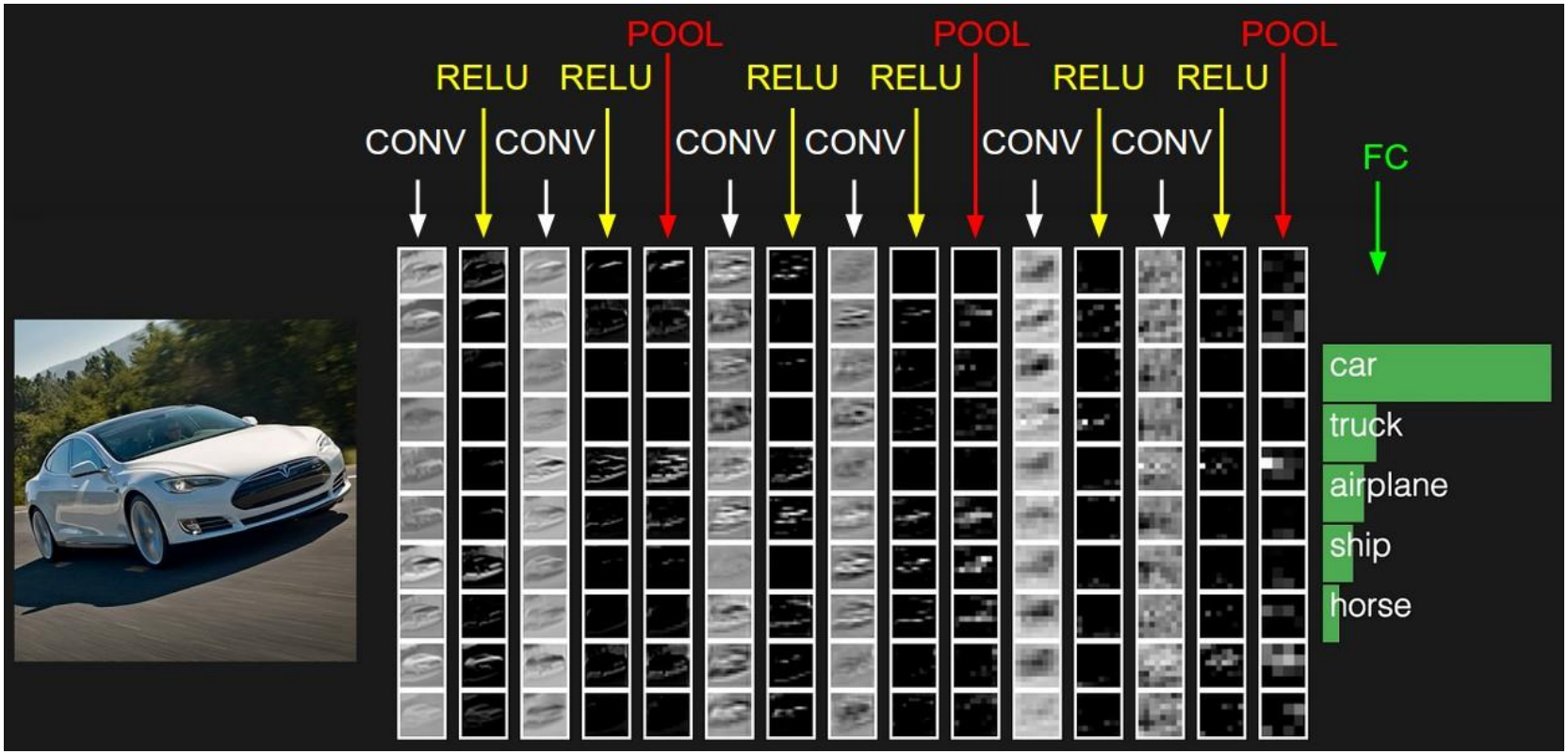
- Max pooling





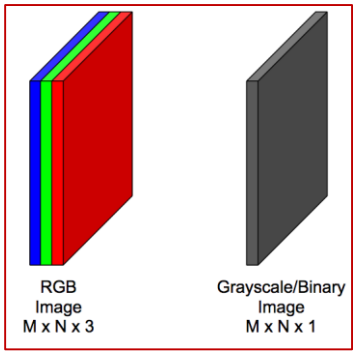
Review: What is CNN?

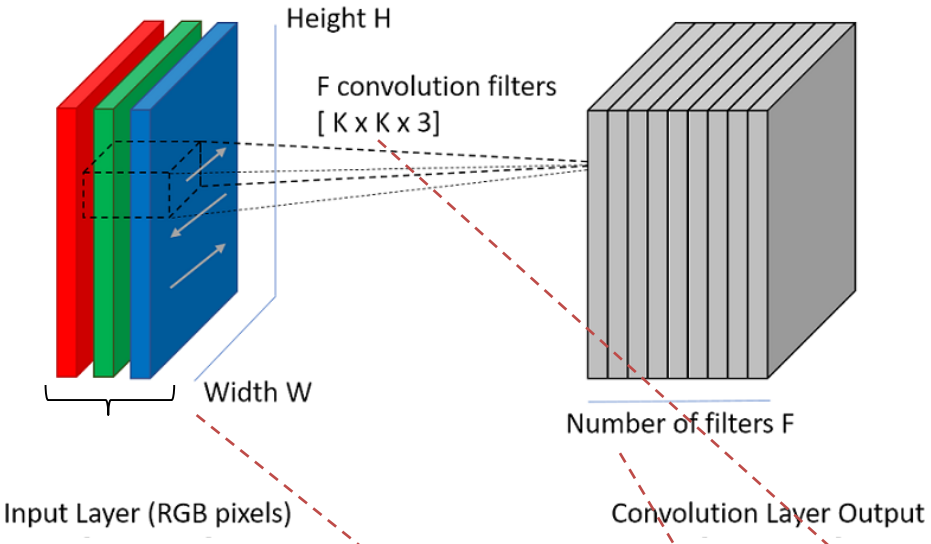
- Hierarchical feature representation (multiple convolution layers)



CNN in PyTorch

- Convolution





self.conv1 = torch.nn.Conv2d(num_of_channels, num_of_kernels, kernel_size)

self.conv2 = torch.nn.Conv2d(num_of_channels, num_of_kernels, kernel_size)

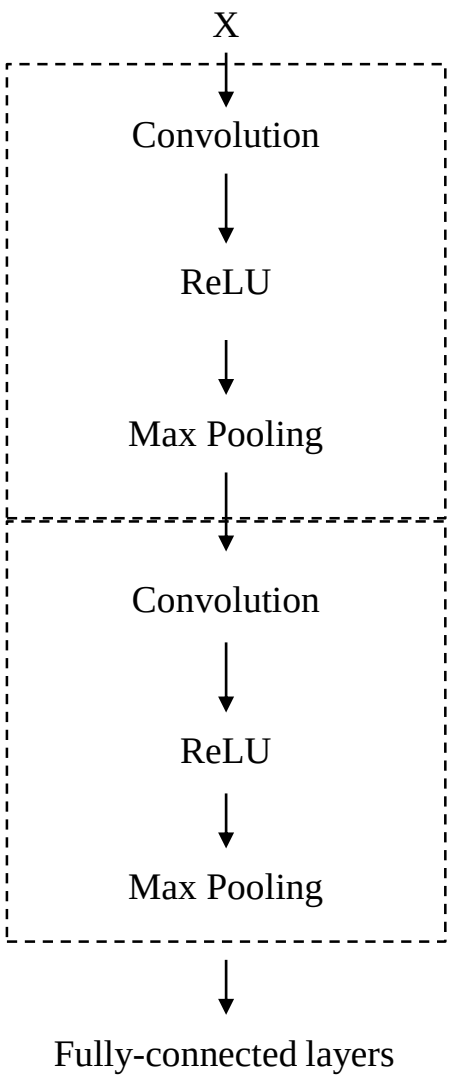
CNN in PyTorch

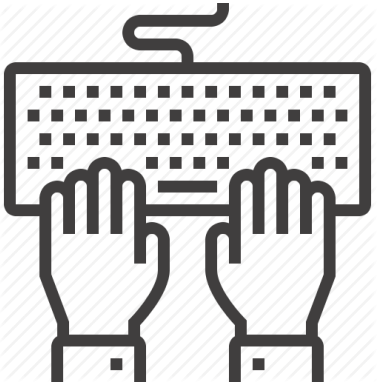
```python
import torch.nn as nn
import torch.nn.functional as F


class Net(nn.Module):
    def __init__(self):
        super(Net, self).__init__()
        self.conv1 = nn.Conv2d(3, 6, 5)
        self.pool = nn.MaxPool2d(2, 2)
        self.conv2 = nn.Conv2d(6, 16, 5)
        self.fc1 = nn.Linear(16 * 5 * 5, 120)
        self.fc2 = nn.Linear(120, 84)
        self.fc3 = nn.Linear(84, 10)

    def forward(self, x):
        x = self.pool(F.relu(self.conv1(x)))
        x = self.pool(F.relu(self.conv2(x)))
        x = x.view(-1, 16 * 5 * 5)
        x = F.relu(self.fc1(x))
        x = F.relu(self.fc2(x))
        x = self.fc3(x)
        return x


net = Net()
```



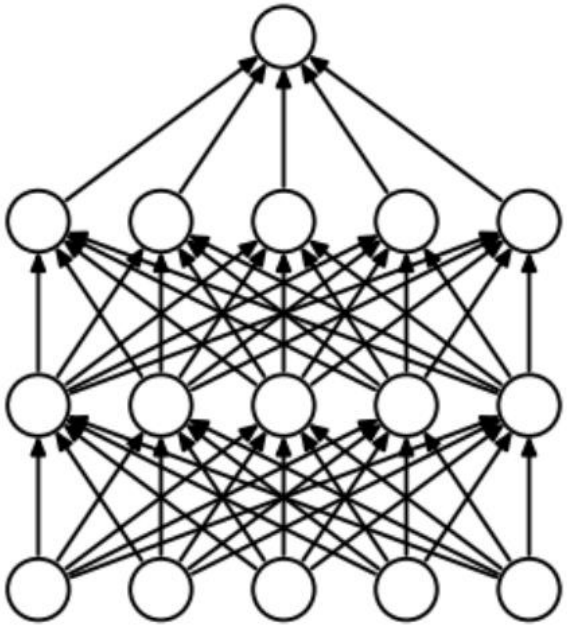


MNIST Classifier using CNN

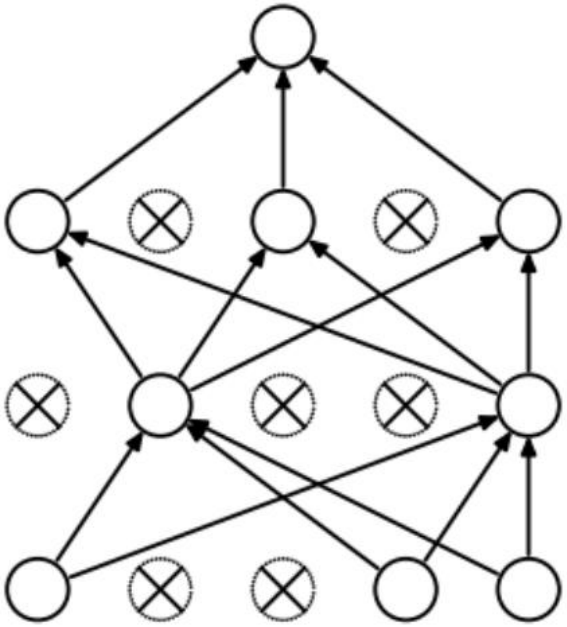
M3.5 Convolutional Neural Network_MNIST.ipynb

Improving Performance (1) Dropout

- Dropout avoids overfitting of neural networks



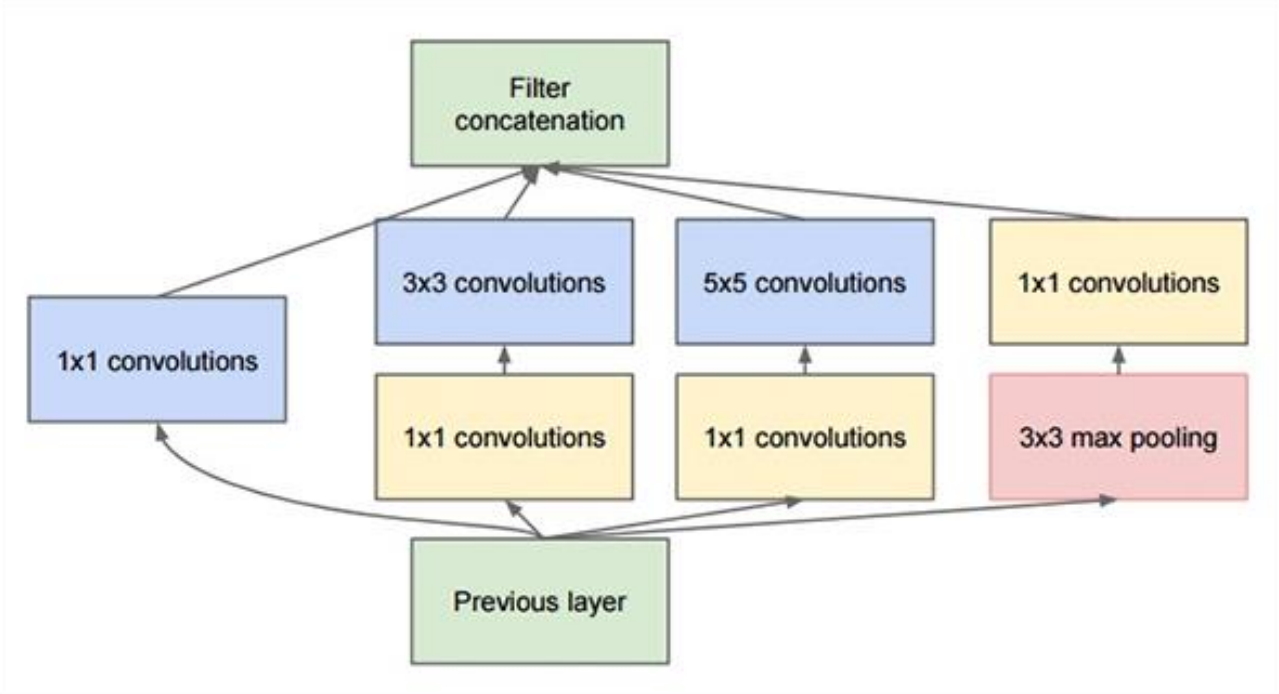
(a) Standard Neural Net



(b) After applying dropout.

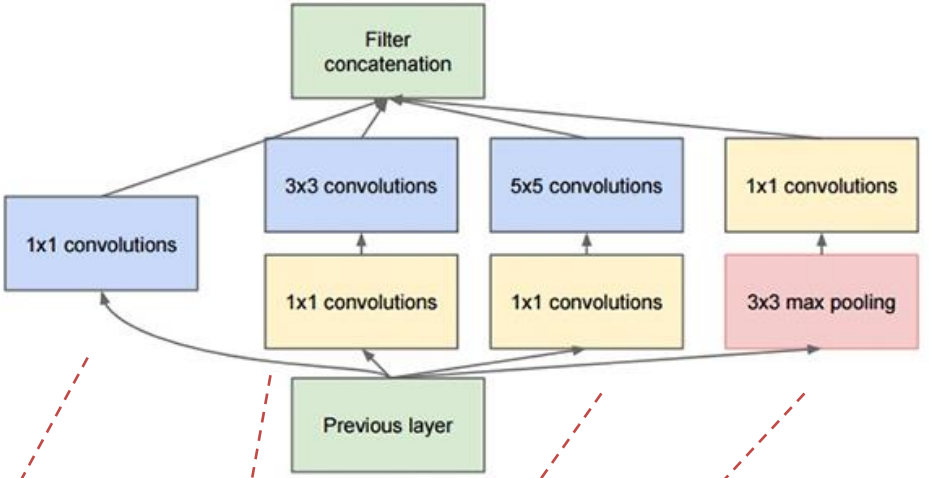
Improving Performance (2) Inception

- CNN can have filters with multiple sizes operating on the same level.
  - CNN with inception tends to be more efficient and has better performance (Szegedy et al. 2015)



Szegedy, C., Liu, W., Jia, Y., Sermanet, P., Reed, S., Anguelov, D., Erhan, D., Vanhoucke, V. and Rabinovich, A., 2015. Going Deeper with Convolutions. *In Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition.*

Improving Performance (2) Inception



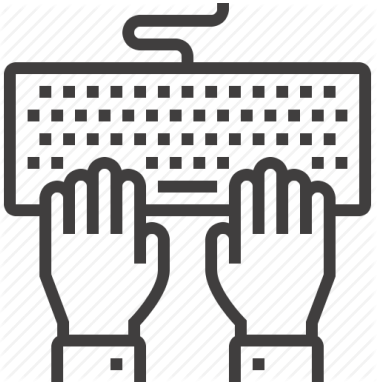

```python
class Inception(nn.Module):

    def __init__(self, in_channels):
        super(Inception, self).__init__()
        self.branch1x1 = nn.Conv2d(in_channels, 16, kernel_size=1)

        self.branch5x5_1 = nn.Conv2d(in_channels, 16, kernel_size=1)
        self.branch5x5_2 = nn.Conv2d(16, 24, kernel_size=5, padding=2)

        self.branch3x3dbl_1 = nn.Conv2d(in_channels, 16, kernel_size=1)
        self.branch3x3dbl_2 = nn.Conv2d(16, 24, kernel_size=3, padding=1)

        self.pool = nn.MaxPool2d(kernel_size=3, stride=1, padding=1)
        self.branch_pool = nn.Conv2d(in_channels, 24, kernel_size=1)
```



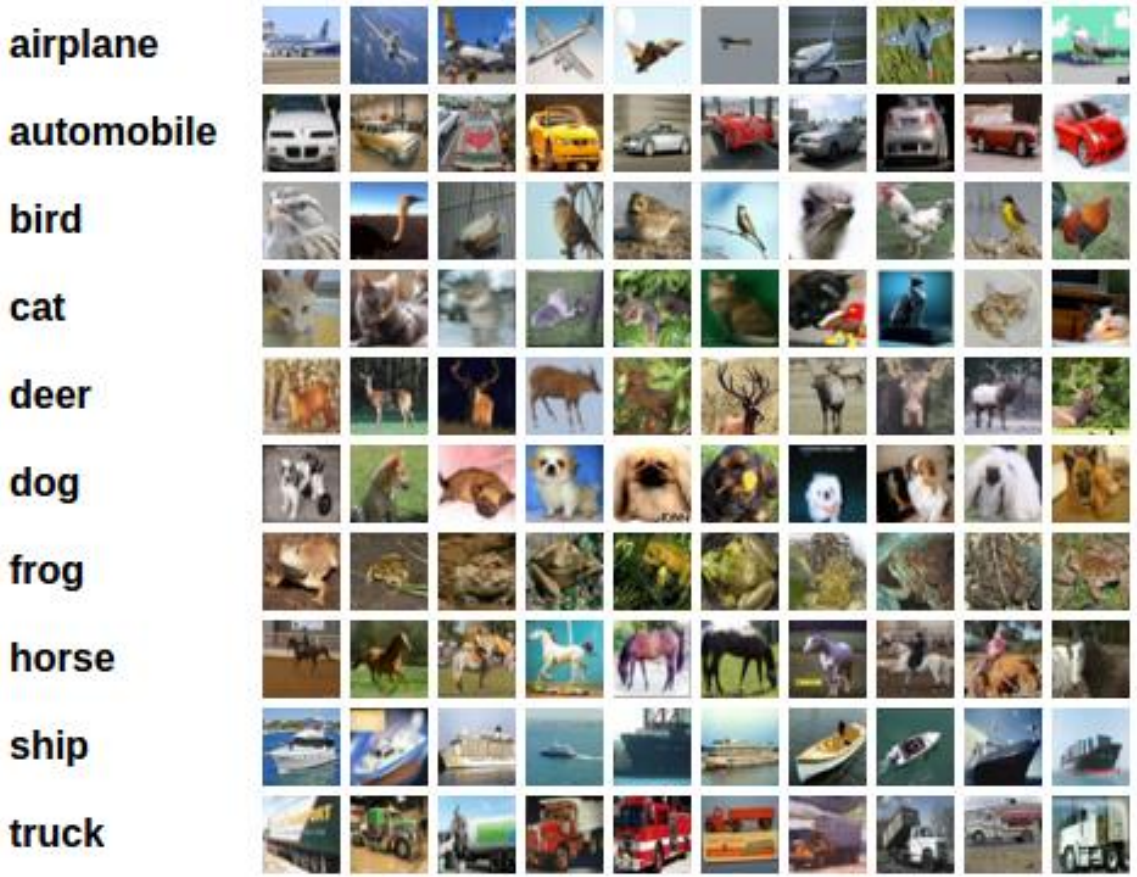
MNIST Classifier using CNN

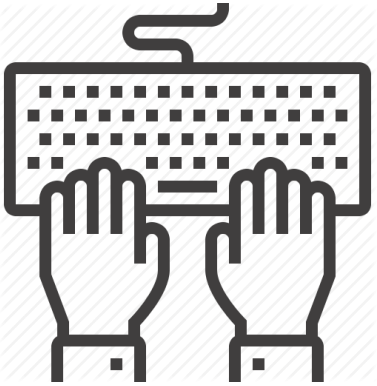
M3.5 Convolutional Neural Network (with inception)_MNIST.ipynb

Projects for CNN

Image Classification using CNN

- The CIFAR-10 dataset consists of 60000 32x32 color images in 10 classes.





CIFAR10 Classifier using CNN

M3.5 Convolutional Neural Network_CIFAR10.ipynb

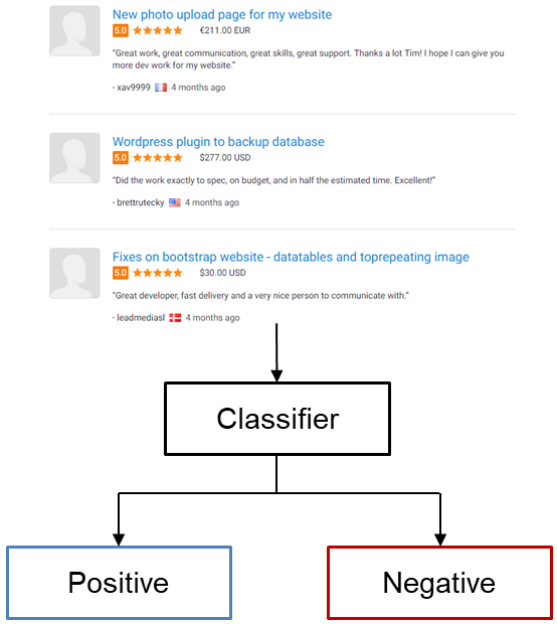
Sentence Classification using CNN

- For econominig research, classification for texts is one of the most popular applications of machine learning.
  - ➢ Example (See Module 1.8 for more examples)

(Lee et al. 2018)

Sample Messages	Content Tags
Welcome to the unveiling of the Pro Staff RF97 that I co-designed with Wilson Tennis. Learn more at http://bit.ly/29JXLdA. #FromFederer	BRANDMENTION, PRODMENTION, PRODLOCATION, HTTP
Coach Seve and me. Excited to be back in Brisbane! Happy we got the 1st practice of year out of the way!	SMALLTALK, EMOTION
Hello fans from Colombia! I am very happy to see you at the exo I am playing vs Tsonga on Saturday, December 15th! Buy your tickets starting September 12th on www.tuboleta.com. I hope to see you all there!	EMOTION, SMALLTALK, TARGET, PRODAVAIL, PRODLOCATION, PRODMENTION, HTTP
The Walking Dead Season 1 DVD/Blu-ray is now available, purchase it now!!! http://blogs.amctv.com/the-walking-dead/2011/03/season-1-dvd-blu-ray.php	BRANDMENTION, PRODMENTION, PRODAVAIL, PRODLOCATION, HTTP
Daryl makes a funny. What are some of your favorite #TheWalkingDead quotes? The highest rated quote will be turned into a graphic! #tbt	SMALLTALK, EMOTION, QUESTION, BRANDMENTION, ASKCOMMENT

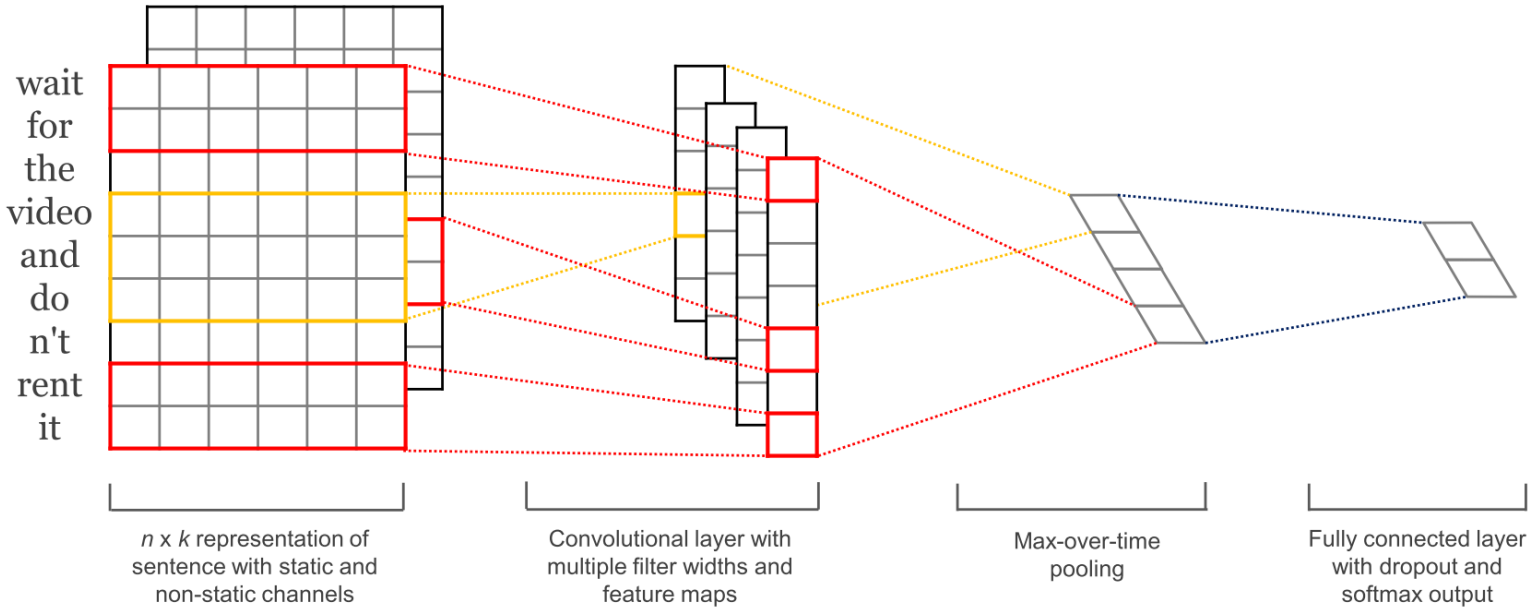
(Moreno and Terwiesch 2014)



Lee, D., Hosanagar, K. and Nair, H.S., 2018. Advertising Content and Consumer Engagement on Social Media: Evidence from Facebook. *Management Science*. forthcoming
Moreno, A. and Terwiesch, C., 2014. Doing Business with Strangers: Reputation in Online Service Marketplaces. *Information Systems Research*, 25(4), pp.865-886.

Sentence Classification using CNN

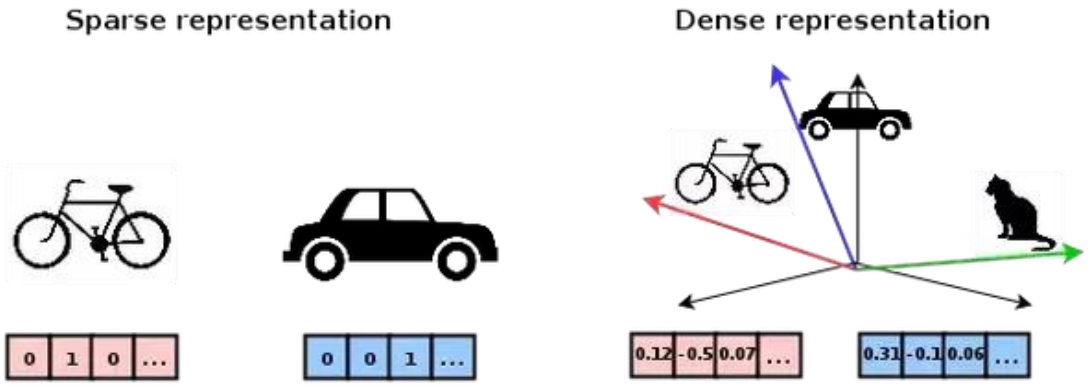
- CNN performs well in sentence classification (Kim 2014)
  - ➢ Pre-trained data is also helpful (e.g., word2vec trained on Wikipedia)

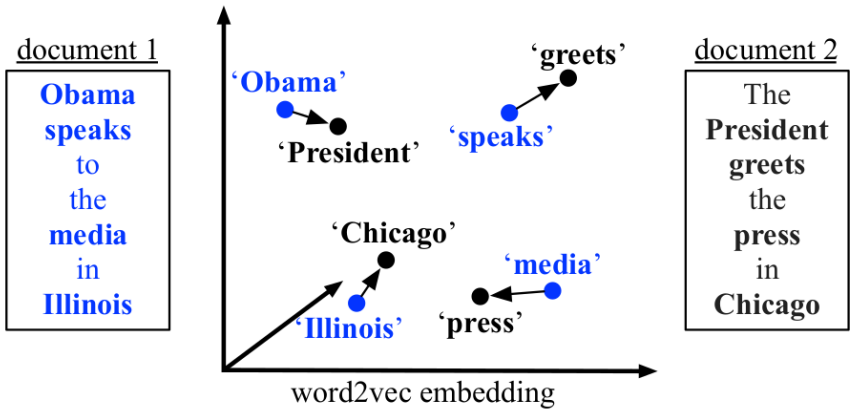


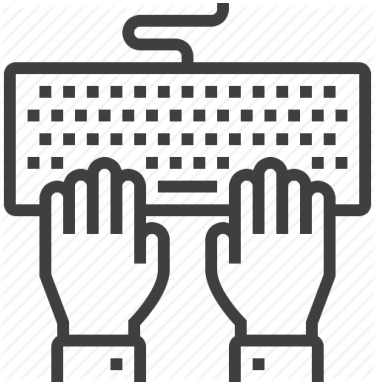
Kim, Y., 2014. Convolutional Neural Networks for Sentence Classification. *In Proceedings of the 2014 Conference on Empirical Methods in Natural Language Processing (EMNLP).*

Sentence Classification using CNN

- Word embedding (dense representation)
  - ➢ Word vectors can represent semantic relationship between words.







Sentence Classification using CNN

M3.5 Convolutional Neural Network_Sentence Classification.ipynb

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