應用機器學習

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課程目標

1. 了解基本的數據分析
2. 了解基本的機器學習(Machine Learning)方法
3. 掌握Python的基本操作和一些有用的package
4. 處理及從網上下載數據
5. 在Python上應用機器學習

今天課堂概要

Introduction to deep learning

1. Neural network design
2. Training approach
3. Regularization
4. Example of deep learning (case with code)
5. Self-learning resources

TYPES OF NEURAL NETWORK

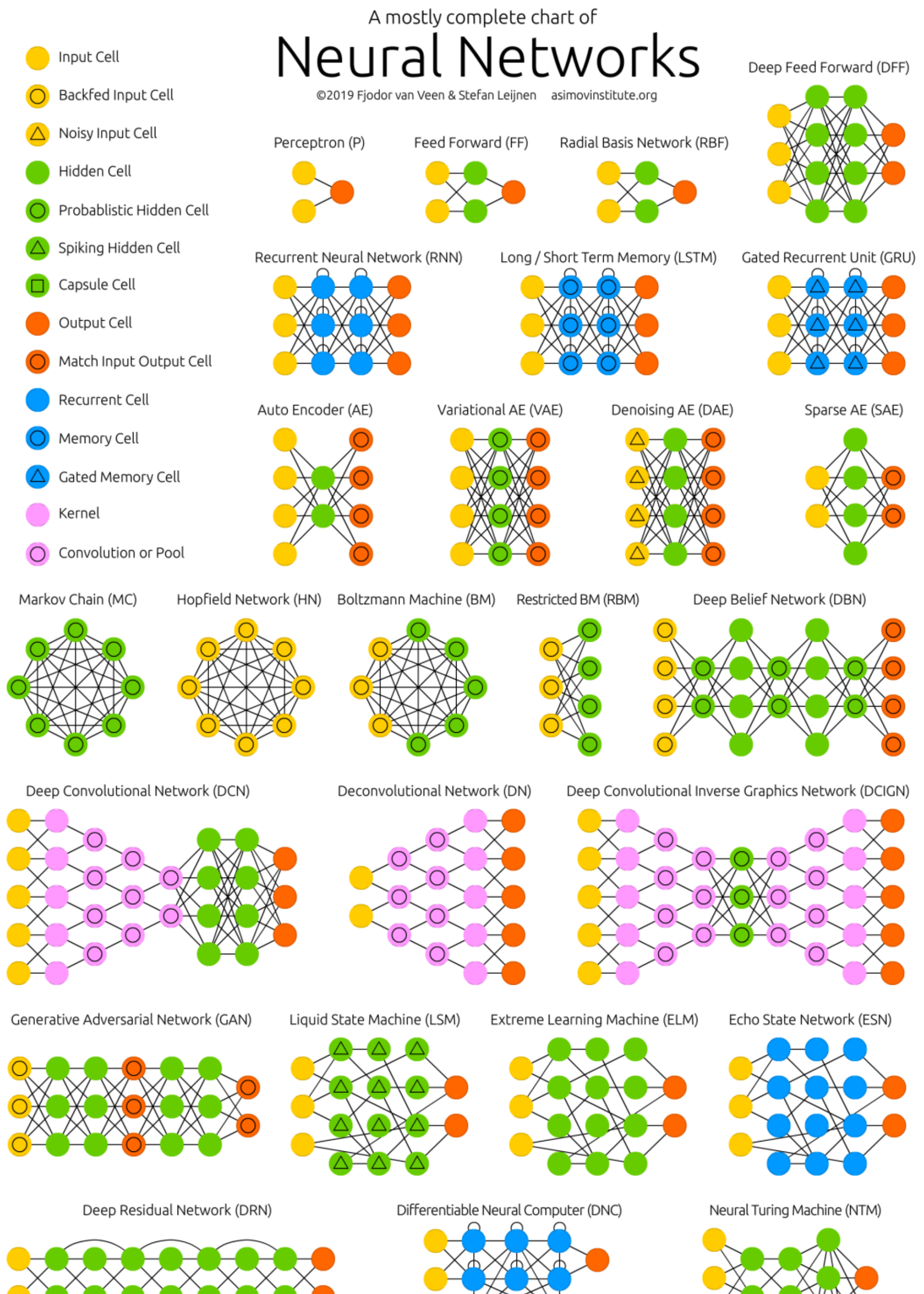
Feedforward

Recurrent network

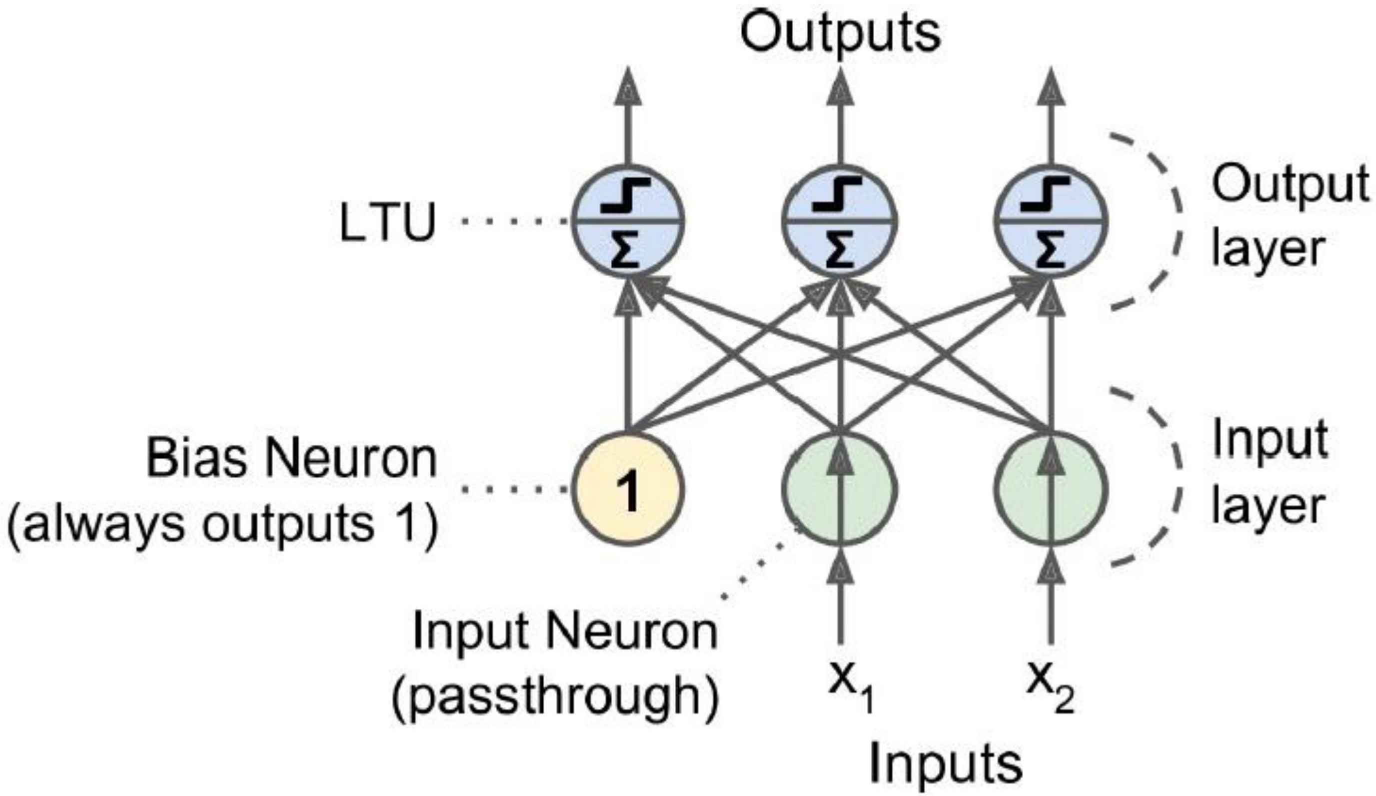
Convolutional network

Auto-encoder network

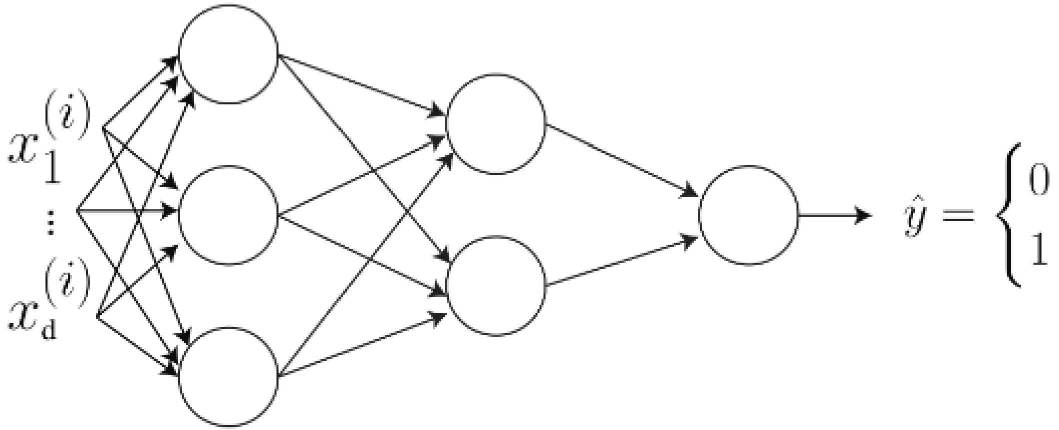
etc.



NEURAL NETWORK DESIGN



Consider a two layer neural network. On the left, the input is a flattened image vector $x^{(1)}, ..., x_d^{(i)}$. In the first hidden layer, notice how all inputs are connected to all neurons in the next layer. This is called a *fully connected* layer.



The next step is to compute how many parameters are in this network. One way of doing this is to compute the forward propagation by hand.

$$z^{[1]} = W^{[1]}x^{(i)} + b^{[1]} \tag{3.1}$$
$$a^{[1]} = g(z^{[1]}) \tag{3.2}$$
$$z^{[2]} = W^{[2]}a^{[1]} + b^{[2]} \tag{3.3}$$
$$a^{[2]} = g(z^{[2]}) \tag{3.4}$$
$$z^{[3]} = W^{[3]}a^{[2]} + b^{[3]} \tag{3.5}$$
$$\hat{y}^{(i)} = a^{[3]} = g(z^{[3]}) \tag{3.6}$$

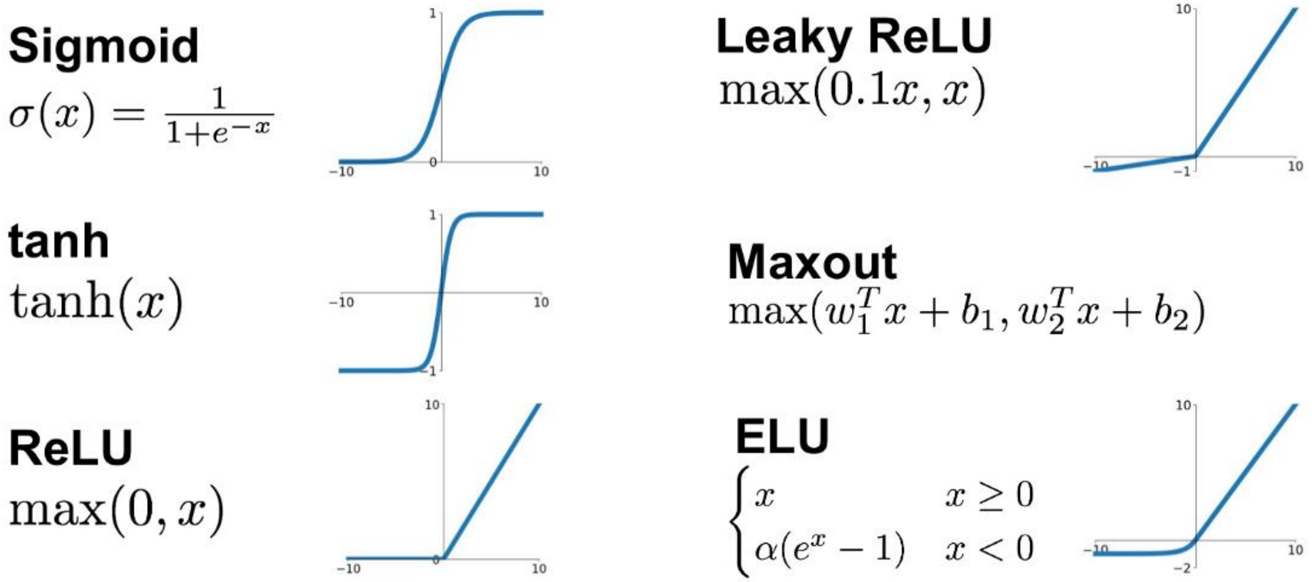
ACTIVATION FUNCTION

$$g(x) = \frac{1}{1+\exp(-w^T x)}$$

$$g(z) = \frac{1}{1+e^{-z}} \qquad \text{(sigmoid)}$$

$$g(z) = \max(z, 0) \qquad \text{(ReLU)}$$

$$g(z) = \frac{e^z - e^{-z}}{e^z + e^{-z}} \qquad \text{(tanh)}$$



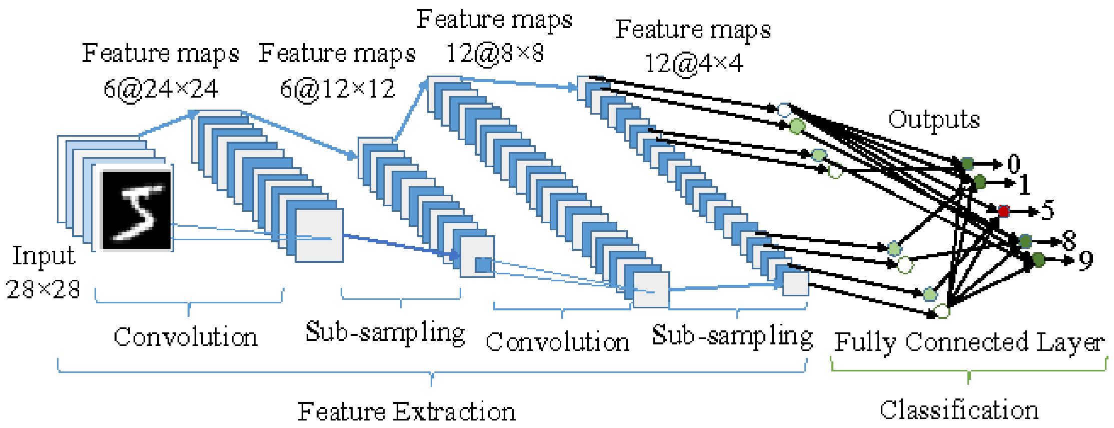
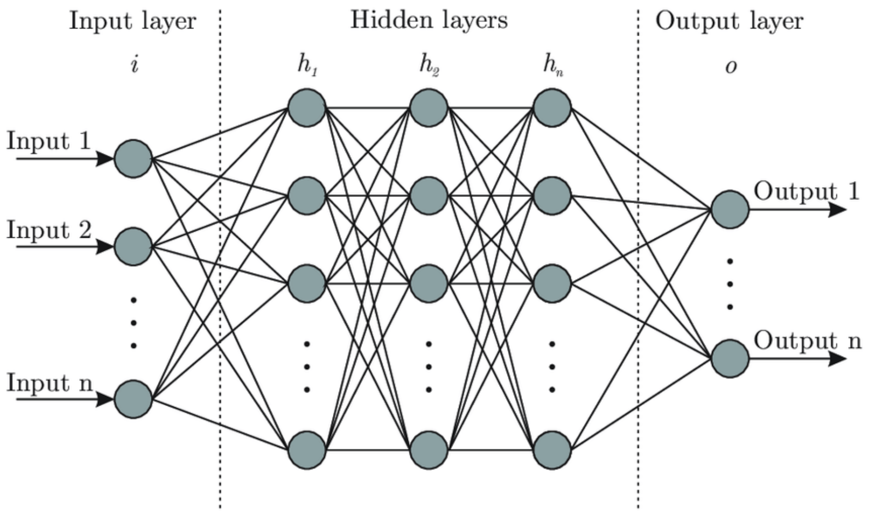
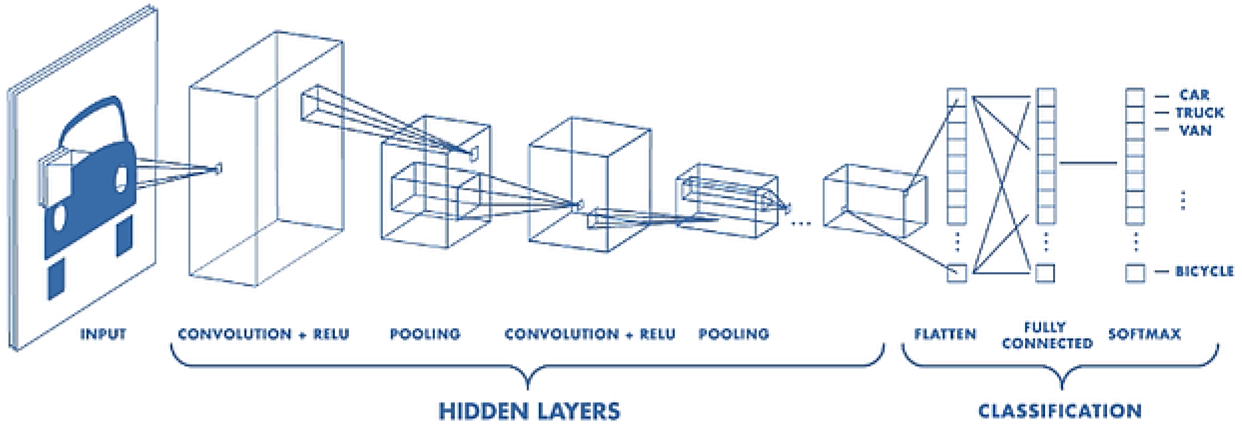
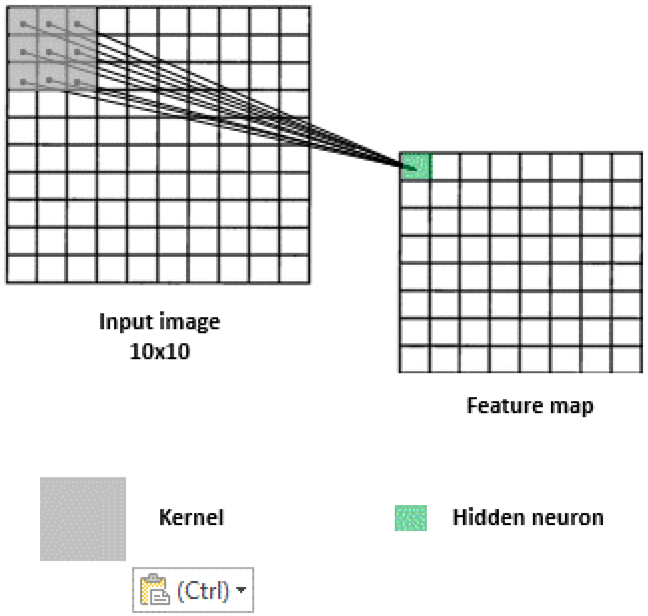


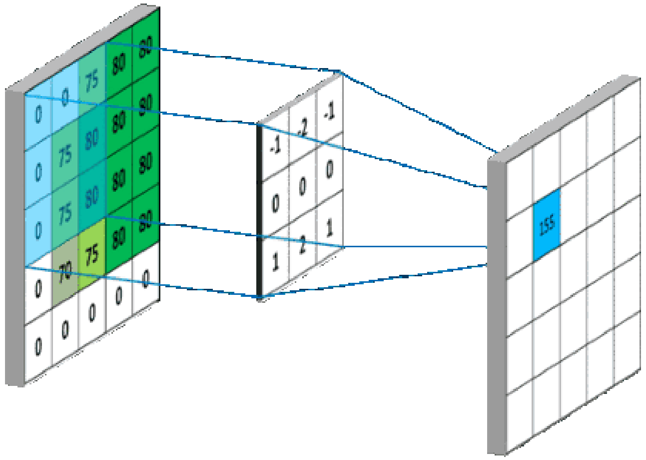
Fig. 1. CNN block diagram.



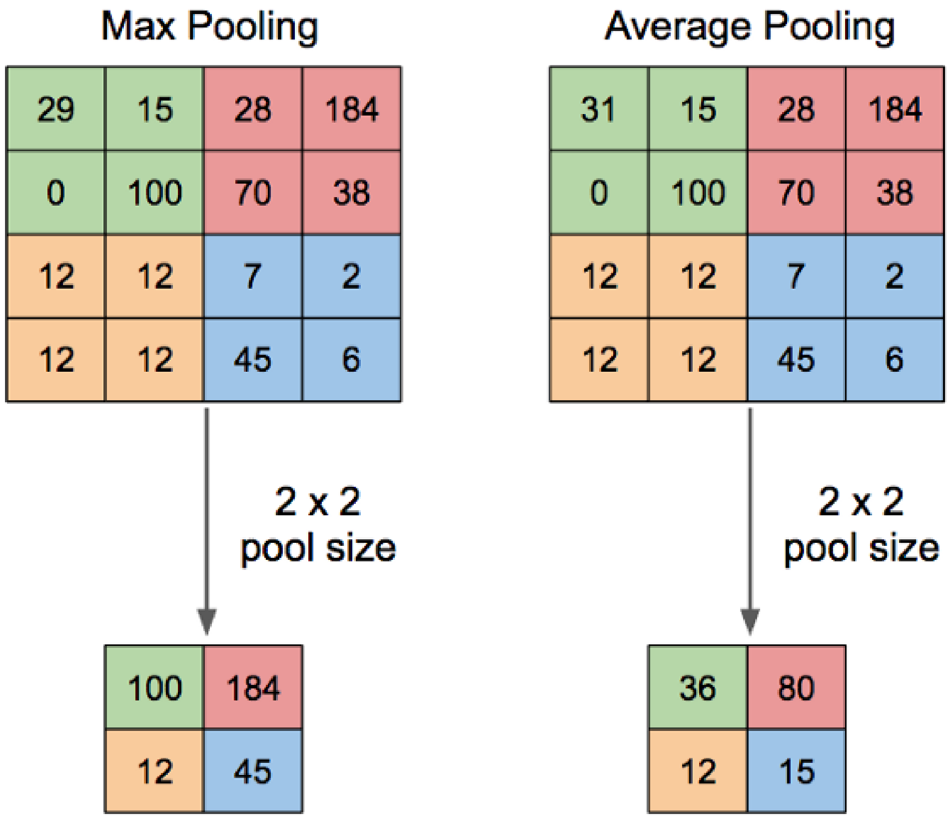


CONVOLUTION

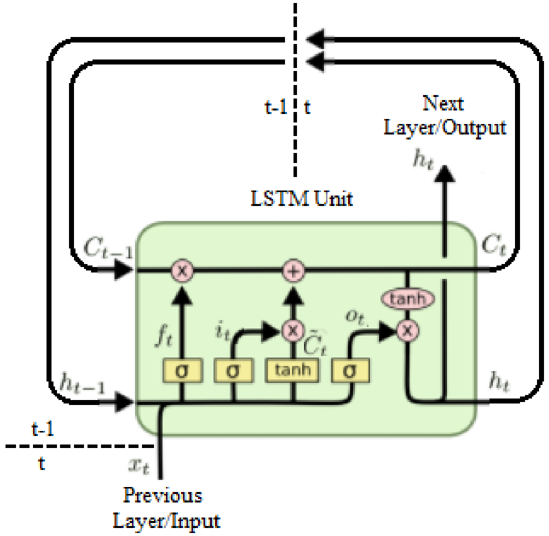




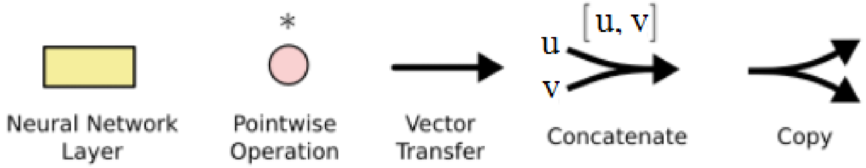
POOLING


Max Pooling
29 15 28 184
0 100 70 38
12 12 7 2
12 12 45 6
2 x 2
pool size
100 184
12 45
Average Pooling
31 15 28 184
0 100 70 38
12 12 7 2
12 12 45 6
2 x 2
pool size
36 80
12 15

LSTM CELL



$$f_t = \sigma\left(W_f \cdot [h_{t-1}, x_t] \;+\; b_f\right)$$
$$i_t = \sigma\left(W_i \cdot [h_{t-1}, x_t] \;+\; b_i\right)$$
$$\tilde{C}_t = \tanh(W_C \cdot [h_{t-1}, x_t] \;+\; b_C)$$
$$C_t = f_t * C_{t-1} + i_t * \tilde{C}_t$$
$$o_t = \sigma\left(W_o \; [h_{t-1}, x_t] \;+\; b_o\right)$$
$$h_t = o_t * \tanh\left(C_t\right)$$



INITIALIZING NEURAL NETWORKS

https://www.deeplearning.ai/ai-notes/initialization/

TRAINING ALGO: MINI-BATCH GRADIENT DESCENT

Mini-batch gradient descent is a variation of the gradient descent algorithm that splits the training dataset into small batches that are used to calculate model error and update model coefficients.

Upsides

The model update frequency is higher than batch gradient descent which allows for a more robust convergence, avoiding local minima.

The batched updates provide a computationally more efficient process than stochastic gradient descent.

The batching allows both the efficiency of not having all training data in memory and algorithm implementations.

Downsides

Mini-batch requires the configuration of an additional "mini-batch size" hyperparameter for the learning algorithm. (e.g. 64, 128, 256, …)

Error information must be accumulated across mini-batches of training examples like batch gradient descent.

EPOCH - BATCH SIZE - ITERATIONS

Epoch: One Epoch is when an ENTIRE dataset is passed forward and backward through the neural network only ONCE.

Batch Size: Total number of training examples present in a single batch.

Iterations: The number of batches needed to complete one epoch.

We can divide the dataset of 2000 examples into batches of 500 then it will take 4 iterations to complete 1 epoch.

Where Batch Size is 500 and Iterations is 4, for 1 complete epoch.

REGULARIZATION

Regularization with penalization of L1 & L2

Dropout (Srivastava 2014)

DROPOUT

The term “dropout” refers to dropping out units (both hidden and visible) in a neural network.

Simply put, dropout refers to ignoring units (i.e. neurons) during the training phase of certain set of neurons which is chosen at random. By “ignoring”, I mean these units are not considered during a particular forward or backward pass.

Some Observations:

- Dropout forces a neural network to learn more robust features that are useful in conjunction with many different random subsets of the other neurons.
- Dropout roughly doubles the number of iterations required to converge. However, training time for each epoch is less.

MNIST DATASET

http://yann.lecun.com/exdb/mnist/

INSTALL KERAS

Run code on anaconda prompt: pip install keras

https://www.tensorflow.org/install/gpu

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3. Regularization
4. Example of deep learning

下一課...

1. Medium
2. Reference books

SUGGESTED BOOKS

Deep Learning with Python

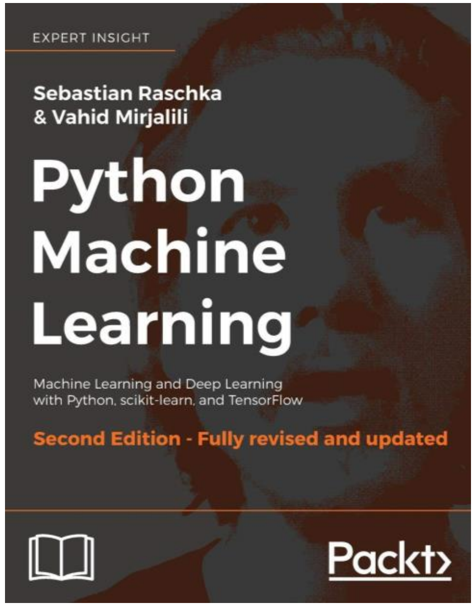
by *Francois Chollet*

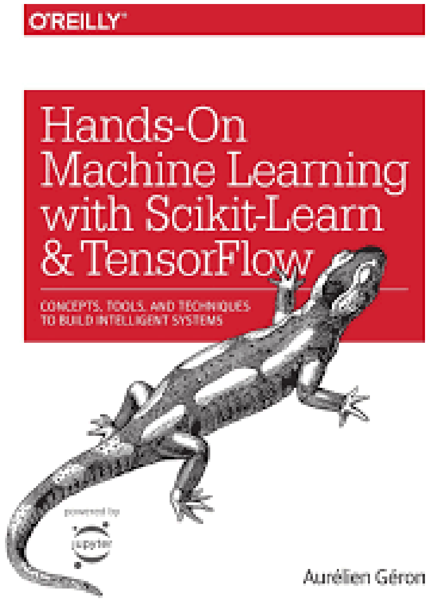
Hands-On Machine Learning with Scikit-Learn and TensorFlow

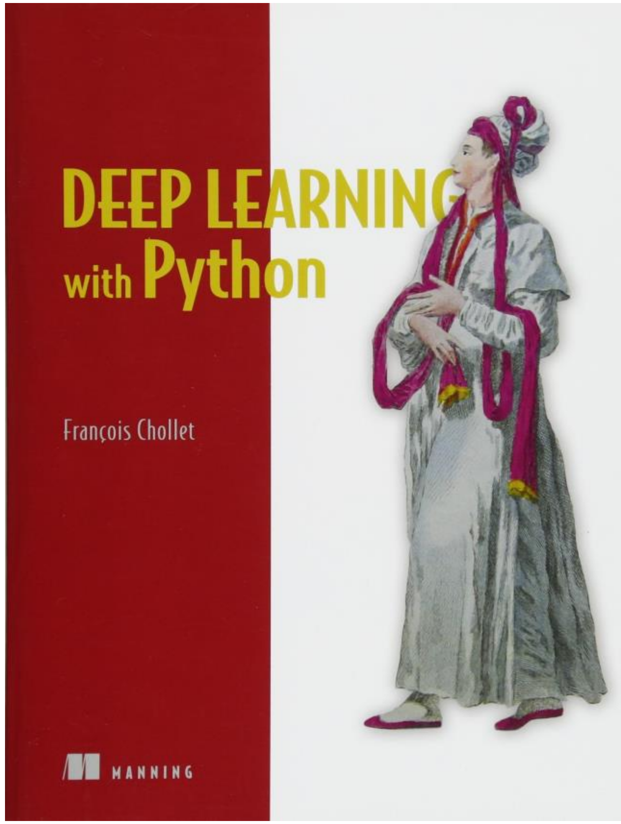
by *Aurelien Geron*

Python Machine Learning

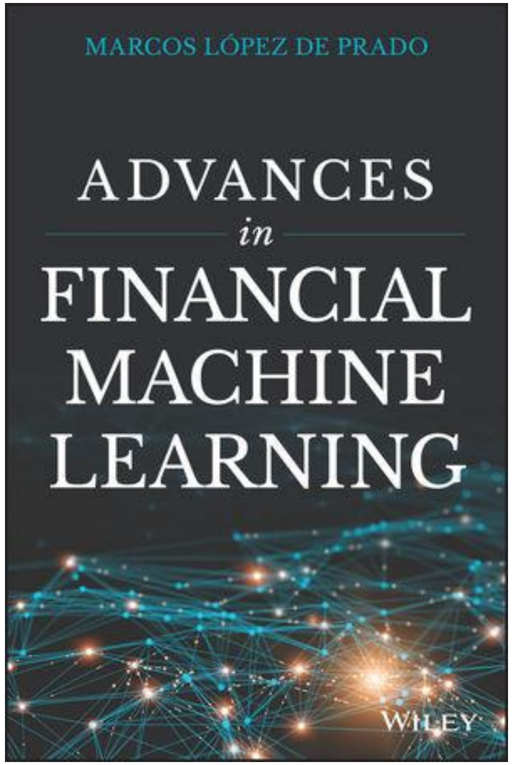
by *Sebastian Raschka*

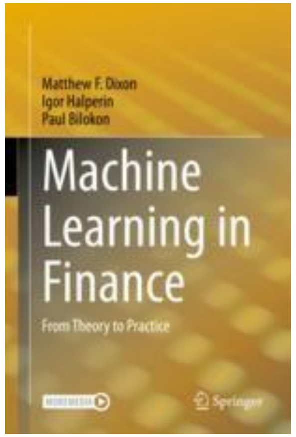


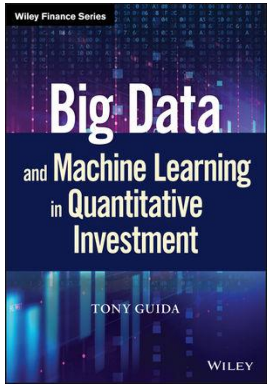




MACHINE LEARNING FOR QUANTITATIVE FINANCE







Machine Learning in Finance From Theory to Practice

by *Dixon, Matthew F., Halperin, Igor, Bilokon, Paul*

Big Data and Machine Learning in Quantitative Investment

by Tony Guida

Advances in Financial Machine Learning

by Marcos Lopez de Prado, Steven Jay Cohen

https://github.com/mfrdixon/ML_Finance_Codes