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Introduction to Data Science with Python
Lecture 4: Deep Learning

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Signify Research (formerly known as Philips Lighting)

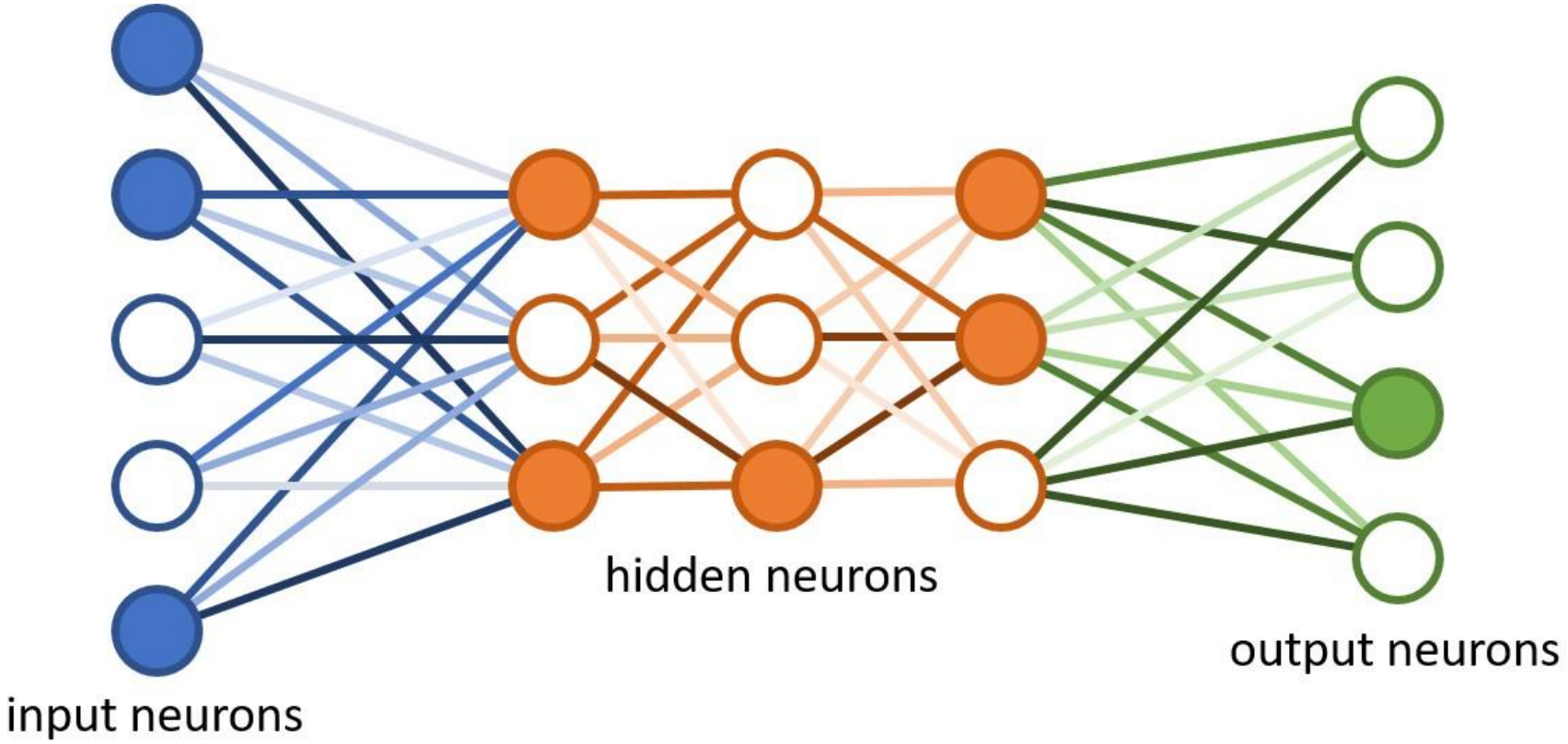
Outline

- Neural Networks
- Building blocks
  - Convolution operation
  - Activation function
  - Pooling
  - Loss function
  - Back propagation
- Deep Learning Frameworks
- Examples (MLP, CNN, GANS)

Deep Learning

- **Deep learning** (also known as deep structured learning or hierarchical learning) is part of a broader family of machine learning methods based on learning data representations, as opposed to task-specific algorithms. Learning can be supervised, semi-supervised or unsupervised.

- Applications: automatic speech recognition, image recognition, visual art processing, natural language processing, drug discovery and toxicology, customer relationship management, recommendation systems, bioinformatics, mobile advertising, image restoration, financial fraud detection, military and many more.

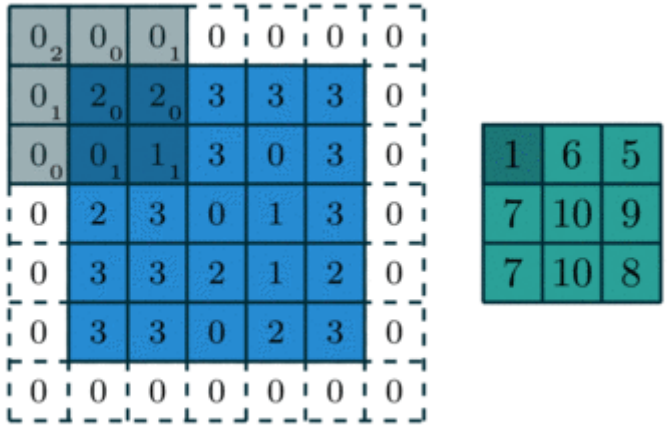


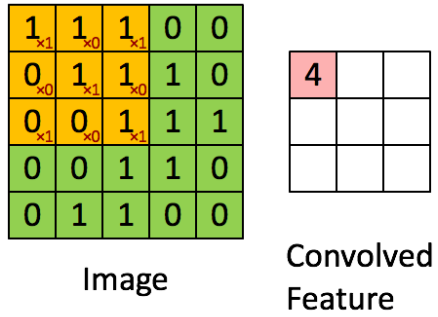
Neural Networks

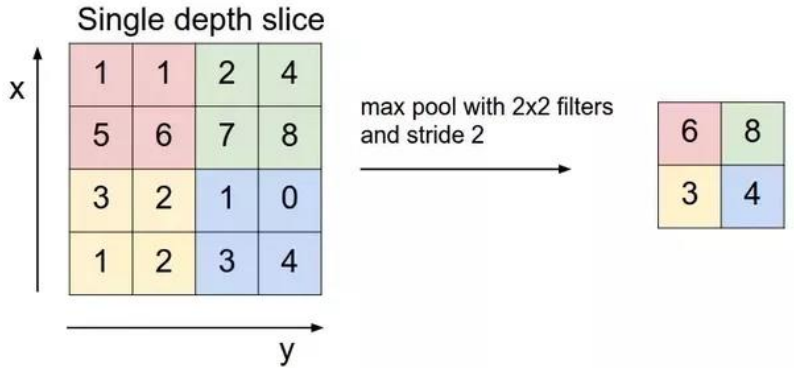
Neural Networks are a class of models, architectures of which are built with different layers.

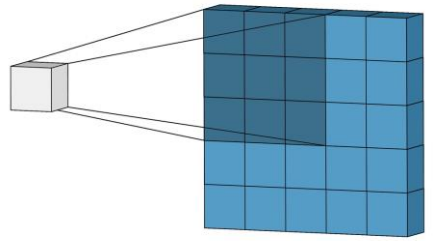
Neutral Network Blocks

- The convolution operation calculates the sum of the element-wise multiplication between the input matrix and kernel matrix.
- The pooling layer serves to progressively reduce the spatial size of the representation, to reduce the number of parameters and amount of computation in the network, and hence to also control overfitting.





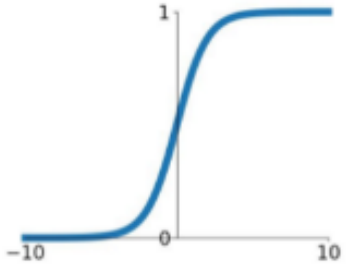




Activation function

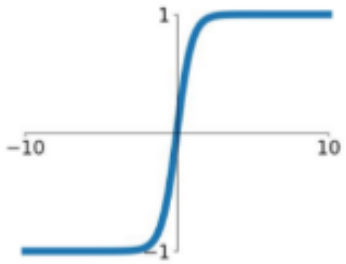
Sigmoid

$$\sigma(x) = \frac{1}{1+e^{-x}}$$



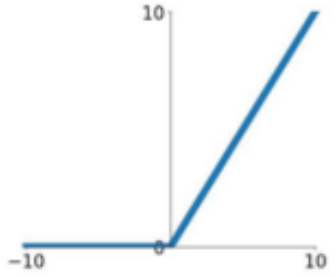
tanh

$$\tanh(x)$$



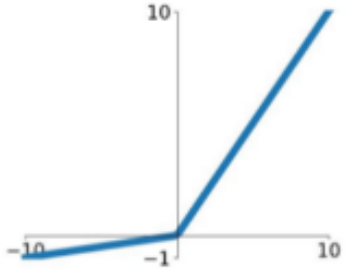
ReLU

$$\max(0, x)$$



Leaky ReLU

$$\max(0.1x, x)$$

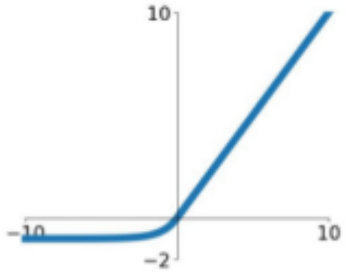


Maxout

$$\max(w_1^T x + b_1, w_2^T x + b_2)$$

ELU

$$\begin{cases} x & x \geq 0 \\ \alpha(e^x - 1) & x < 0 \end{cases}$$



General Idea

- Learning in a neural network progresses by making incremental adjustments to the biases and weights.
- Error is a function of internal parameters of model, weights and bias.
- **Backpropagation** is a method used in artificial neural networks to calculate a gradient that is needed in the calculation of the weights to be used in the network.
- The current error is typically propagated backwards to a previous layer, where it is used to modify the weights and bias in such a way that the error is minimized.

Deep Learning Frameworks

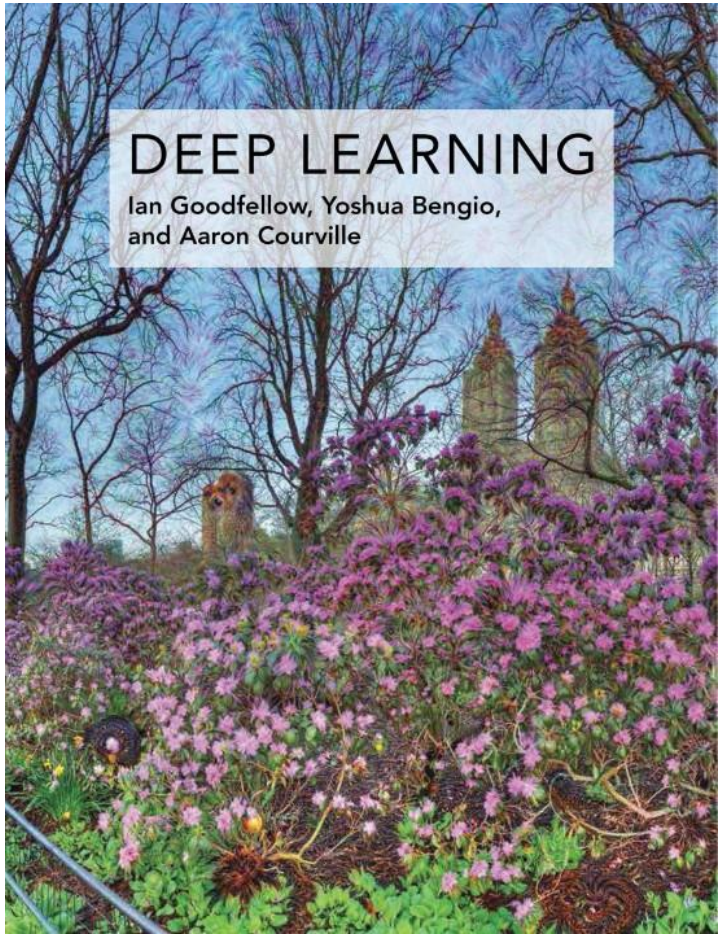
Examples

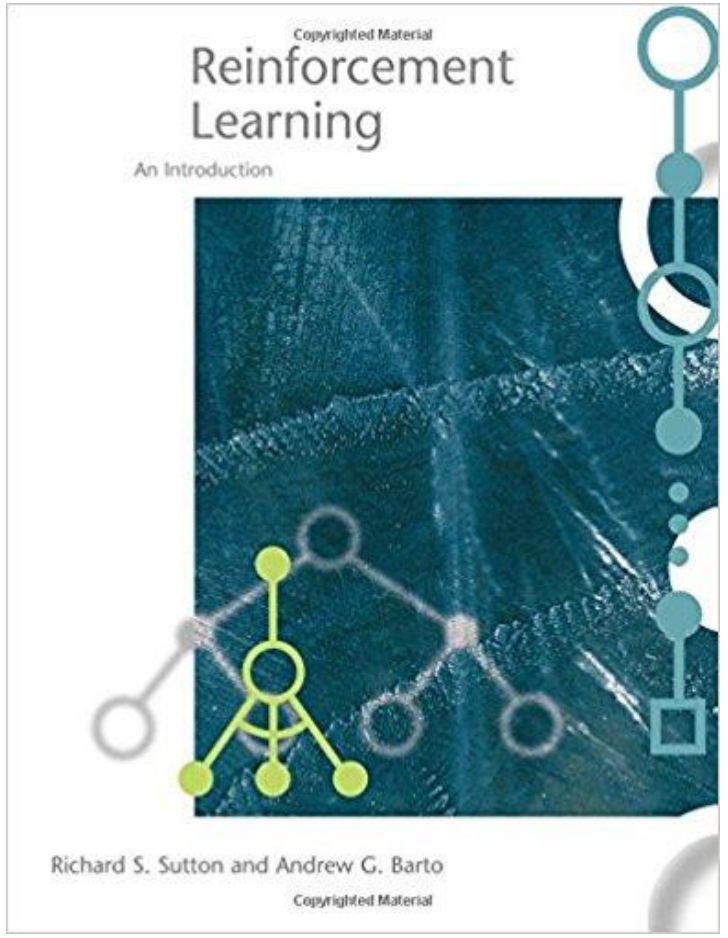
- Image-to-Image (Generative Adversarial Networks)
- ConvNetJS MNIST Demo
- Google AI Experiments
  - http://projector.tensorflow.org/
  - https://playground.tensorflow.org

Assignment 4

- Finish all tasks at Tensorflow NN Playground
- Try to run any neural network in Keras Tutorials

Resources


DEEP LEARNING
Ian Goodfellow, Yoshua Bengio,
and Aaron Courville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Reinforcement Learning
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Richard S. Sutton and Andrew G. Barto
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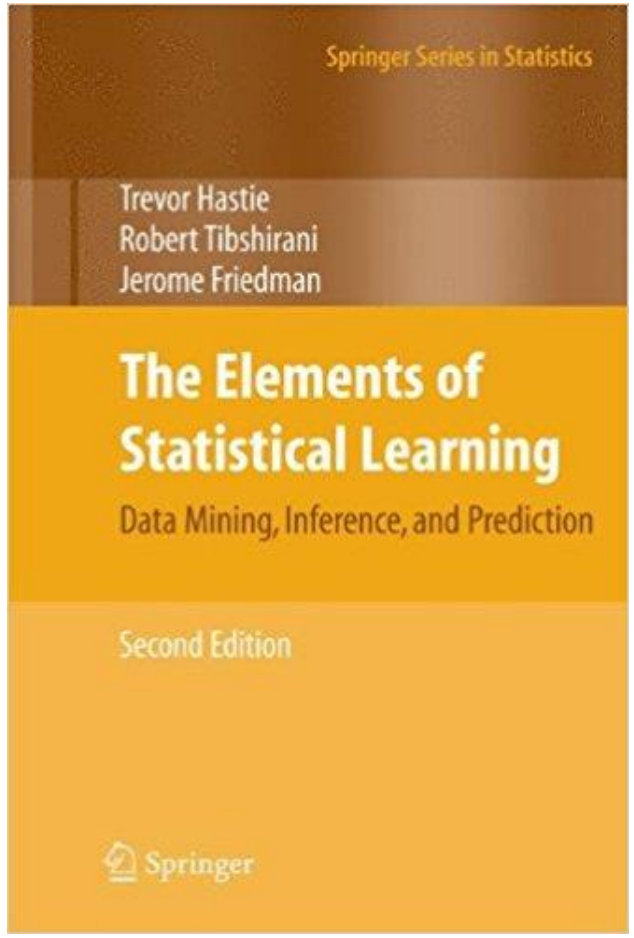
Springer Series in Statistics
Trevor Hastie
Robert Tibshirani
Jerome Friedman
The Elements of Statistical Learning
Data Mining, Inference, and Prediction
Second Edition
Springer

Resources

CS231n: Convolutional Neural Networks for Visual Recognition

Spring 2018

Previous Years: [Winter 2015] [Winter 2016] [Spring 2017]

Resources

PLURALSIGHT

Resources

DataCamp