

CS231n Convolutional Neural Networks for Visual Recognition

These notes accompany the Stanford CS class [CS231n: Convolutional Neural Networks for Visual Recognition](#).

For questions/concerns/bug reports contact [Justin Johnson](#) regarding the assignments, or contact [Andrej Karpathy](#) regarding the course notes. You can also submit a pull request directly to our [git repo](#).

We encourage the use of the [hypothes.is](#) extension to annotate comments and discuss these notes inline.

Spring 2018 Assignments

Assignment #1: Image Classification, kNN, SVM, Softmax, Neural Network

Assignment #2: Fully-Connected Nets, Batch Normalization, Dropout, Convolutional Nets

Module 0: Preparation

Setup Instructions

Python / Numpy Tutorial

IPython Notebook Tutorial

Google Cloud Tutorial

AWS Tutorial

Module 1: Neural Networks

Image Classification: Data-driven Approach, k-Nearest Neighbor, train/val/test splits

[L1/L2 distances, hyperparameter search, cross-validation](#)

Linear classification: Support Vector Machine, Softmax

[parameteric approach, bias trick, hinge loss, cross-entropy loss, L2 regularization, web demo](#)

Optimization: Stochastic Gradient Descent

[optimization landscapes, local search, learning rate, analytic/numerical gradient](#)

Backpropagation, Intuitions

[chain rule interpretation, real-valued circuits, patterns in gradient flow](#)

Neural Networks Part 1: Setting up the Architecture

[model of a biological neuron, activation functions, neural net architecture, representational power](#)

Neural Networks Part 2: Setting up the Data and the Loss

[preprocessing](#), [weight initialization](#), [batch normalization](#), [regularization \(L2/dropout\)](#), [loss functions](#)

Neural Networks Part 3: Learning and Evaluation

[gradient checks](#), [sanity checks](#), [babysitting the learning process](#), [momentum \(+nesterov\)](#), [second-order methods](#), [Adagrad/RMSprop](#), [hyperparameter optimization](#), [model ensembles](#)

Putting it together: Minimal Neural Network Case Study

[minimal 2D toy data example](#)

Module 2: Convolutional Neural Networks

Convolutional Neural Networks: Architectures, Convolution / Pooling Layers

[layers](#), [spatial arrangement](#), [layer patterns](#), [layer sizing patterns](#), [AlexNet/ZFNet/VGGNet case studies](#), [computational considerations](#)

Understanding and Visualizing Convolutional Neural Networks

[tSNE embeddings](#), [deconvnets](#), [data gradients](#), [fooling ConvNets](#), [human comparisons](#)

Transfer Learning and Fine-tuning Convolutional Neural Networks

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