

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 regarding 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.

Winter 2016 Assignments

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

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

Assignment #3: Recurrent Neural Networks, Image Captioning, Image Gradients, DeepDream

Module 0: Preparation

Python / Numpy Tutorial

IPython Notebook Tutorial

Terminal.com 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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