

ECE 595: Machine Learning I

Lecture 8.3: Deep Features

Spring 2020

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Outline

Feature Analysis

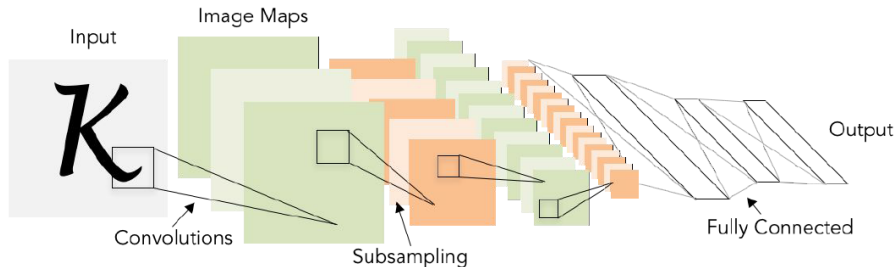
- Lecture 7 Principal Component Analysis (PCA)
- Lecture 8 Hand-Crafted and Deep Features

This Lecture

- Little History of Feature Extractions
- Convolution
 - What is convolution (if you don't know what it is yet)?
 - Some interesting facts about convolution
- SIFT and HOG
 - Gaussian derivatives
 - Pyramid
 - Histogram of oriented gradients
- Deep Features
 - What are they?
 - How to use them?

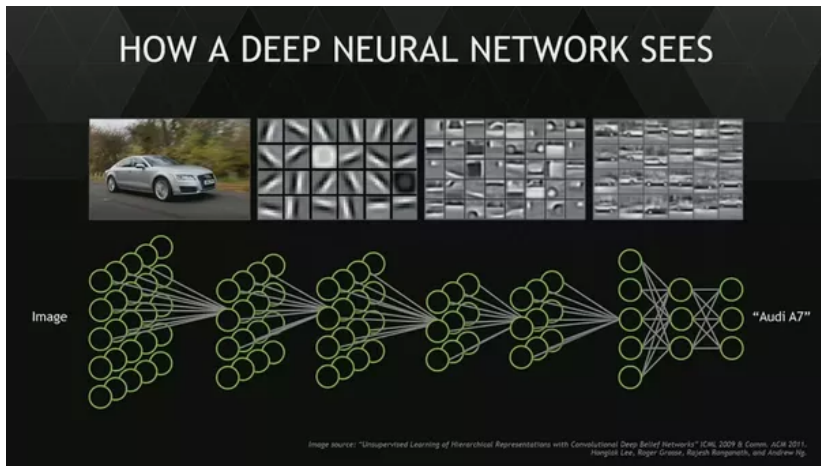
Deep Features

- Create a convolutional neural network (See Deep Learning courses).
- Investigate the features extracted at different stages of the network.



Source: Stanford CS 231n Lecture Note

Deep Features



https://www.analyticsvidhya.com/blog/2018/03/essentials-of-deep-learning-visualizing-convolutional-neural-networks/cnn_filters/

Hierarchical Representations

Preview

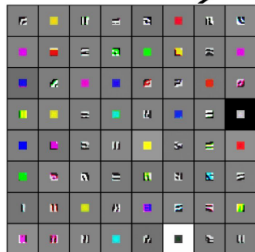


Low-level
features

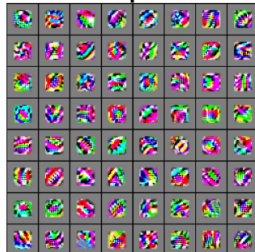
Mid-level
features

High-level
features

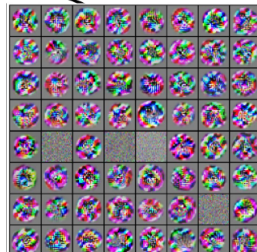
Linearly
separable
classifier



VGG-16 Conv1_1



VGG-16 Conv3_2



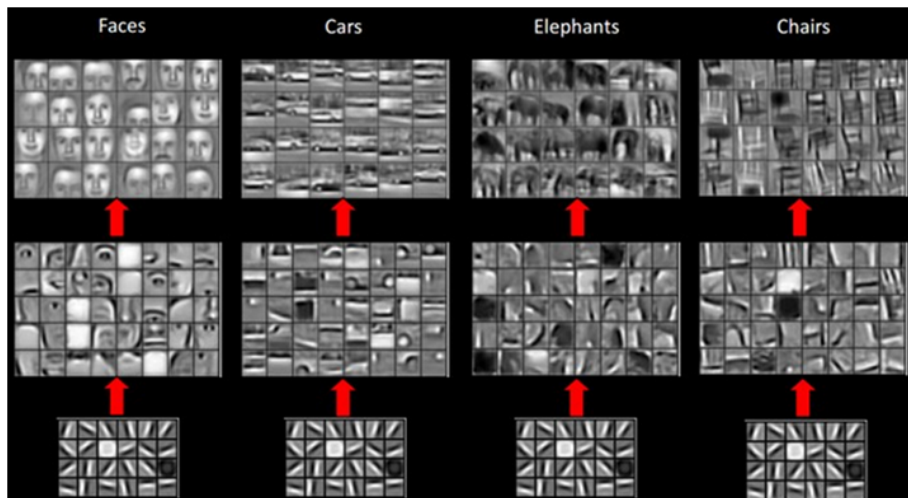
VGG-16 Conv5_3

[Zeiler and Fergus 2013]

Visualization of VGG-16 by Lane McIntosh. VGG-16 architecture from [Simonyan and Zisserman 2014].

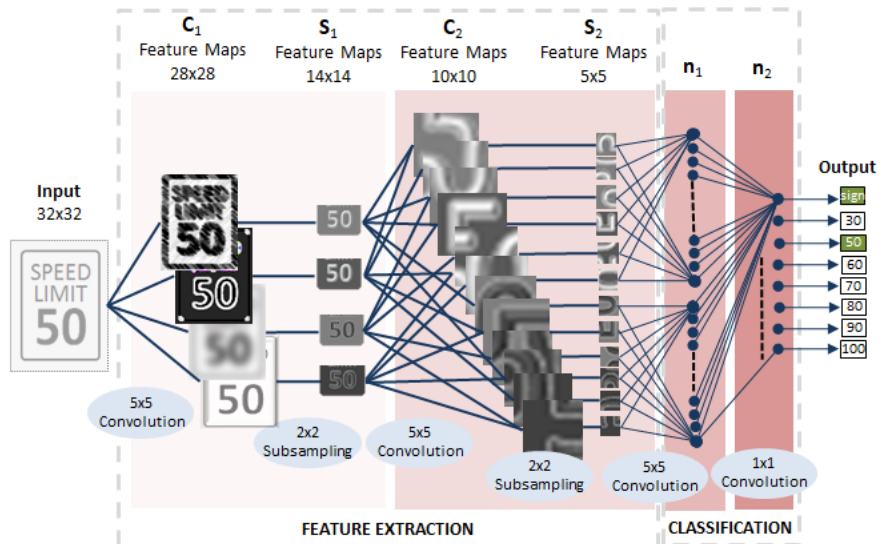
Deep Features

- Going through the layers, the network learns different representations



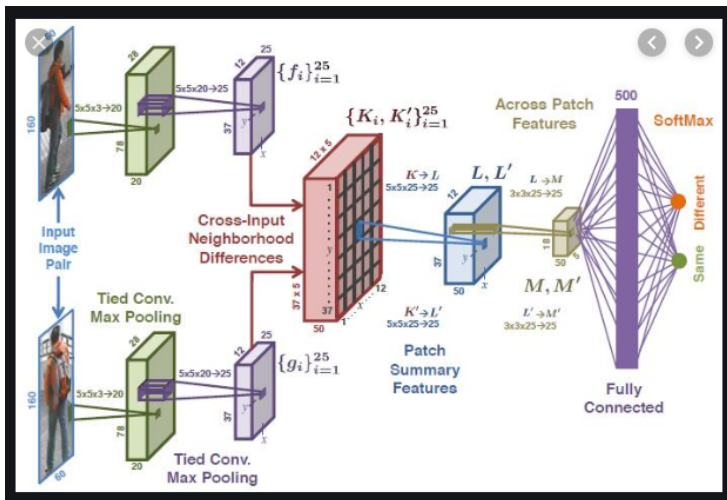
Hierarchical Representations

https://e2e.ti.com/blogs_/b/behind_the_wheel/archive/2018/02/08/ai-in-automotive-practical-deep-learning















Combining Features

http://www.fubin.org/research/Person_ReID/Person_ReID.html



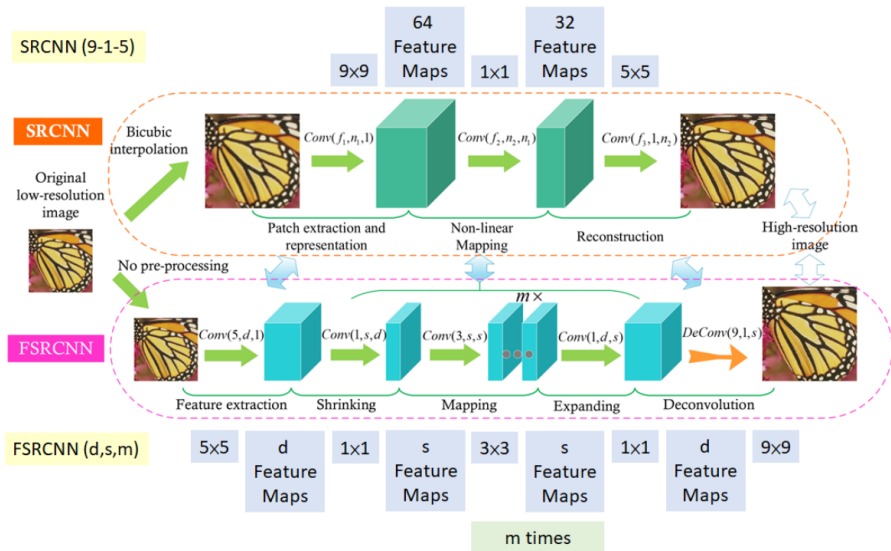
Using Deep Features for kNN

<https://github.com/cvjena/semantic-embeddings>

Query	#1	#21	#41	#61	#81	#101	#121	#141	#161	#181	
 orange	 bowl	 orange	 orange	 apple	 bowl	 can	 orange	 clock	 apple	 tulip	Classification Features
	 orange	 orange	 orange	 orange	 orange	 bowl	 apple	 pear	 apple	 apple	Semantic Embeddings
 palm tree	 palm tree	 palm tree	 palm tree	 palm tree	 spider	 bus	 spider	 spider	 kangaroo	 spider	Classification Features
	 palm tree	 palm tree	 palm tree	 palm tree	 palm tree	 forest	 willow tree	 oak tree	 sunflower	 oak tree	Semantic Embeddings
 chimpanzee	 girl	 chimpanzee	 girl	 woman	 boy	 girl	 chimpanzee	 chimpanzee	 chimpanzee	 chimpanzee	Classification Features
	 chimpanzee	 chimpanzee	 chimpanzee	 chimpanzee	 chimpanzee	 bear	 bear	 shrew	 crocodile	 shrew	Semantic Embeddings

Using Deep Features for Super-Resolution

<https://towardsdatascience.com/review-fsrcnn-super-resolution-80ca2ee14da4>



Reading List

Convolution

- Oppenheim and Willsky, Signals and Systems, Chapter 2.
- ECE 637 Image Processing 1
<https://engineering.purdue.edu/~bouman/ece637/notes/>

SIFT and HOG

- ECE 661 Computer Vision <https://engineering.purdue.edu/kak/computervision/ECE661Folder/Lecture9.pdf>
- Lowe's original SIFT paper <https://people.eecs.berkeley.edu/~malik/cs294/lowe-ijcv04.pdf>
- Blog on HOG <https://www.learnopencv.com/histogram-of-oriented-gradients/>

Deep Features

- Stanford CS 231n <http://cs231n.stanford.edu/>