

Computer Vision

Andrew Zhou, 16 November 2020



Overview

01

What is Computer Vision?

Definition & Characteristics

- Extract useful information from images
- AI & Data Science & Engineering &...
- Visual tasks often “easy” for humans
- Automation & scaling

Areas of Application



Automotive



Digital/Social Media



Manufacturing



Medicine



Entertainment



Security

Tasks & Techniques

02

What Computer
Vision does

Basic Tasks

Recognition	Tracking	Imaging
Detect, recognize, identify	Follow, associate	Create, generate, modify

Algorithms

03

The nitty-gritty

Algorithms

Dimension Reduction

PCA, Eigenvalues

Ensembling

Adaboost, Cascading
Classifiers

Sparsity

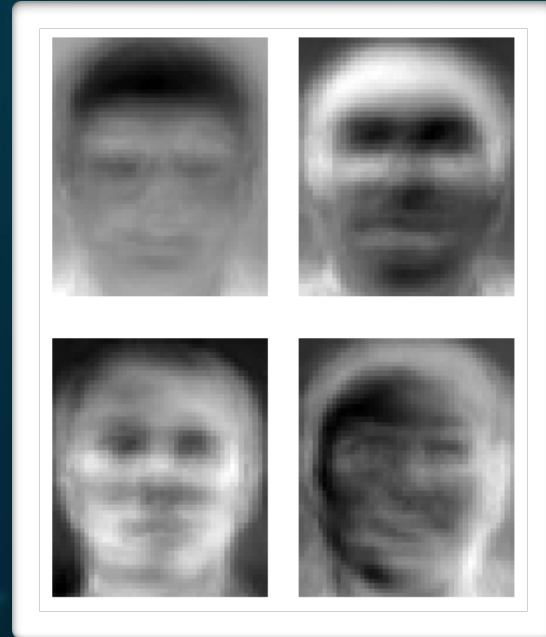
Compressed Sensing

Neural Networks

CNNs, GANs

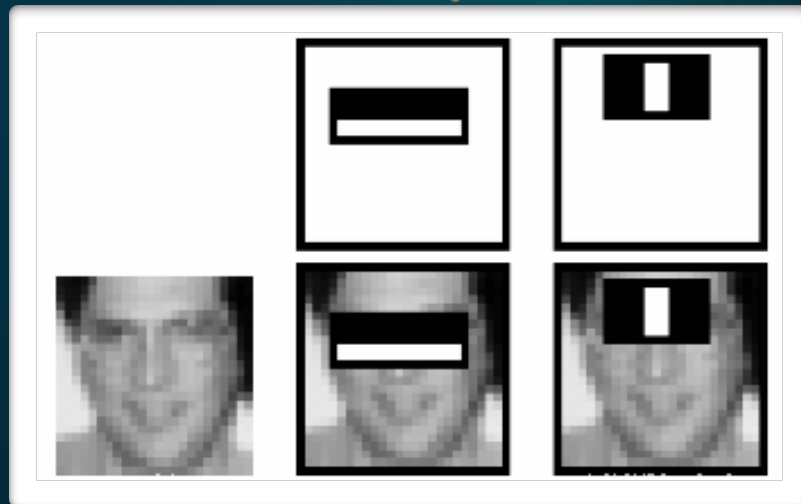
Dimension Reduction for Facial Recognition

- Top principal components yield “eigenfaces”
- Standard lighting, image size
- From $m \times n$ features to ~ 100



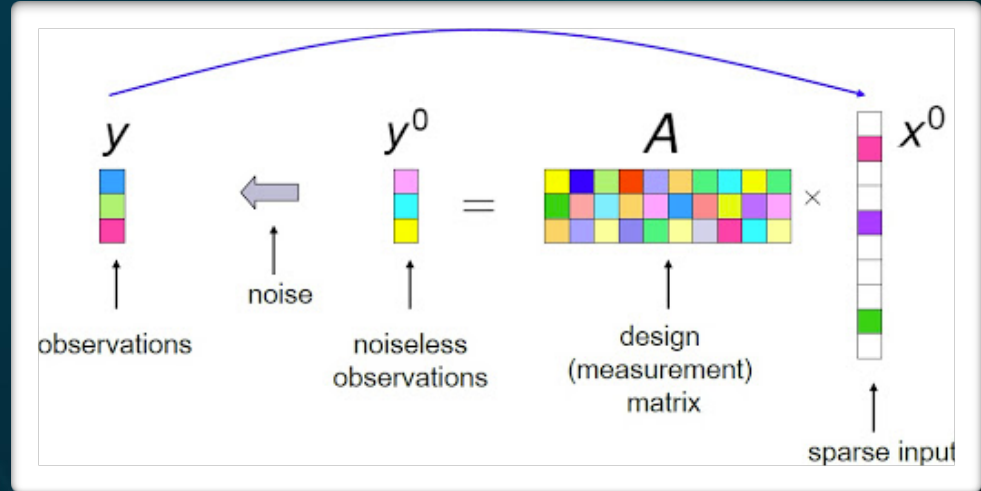
Ensembling for Facial Recognition

- Viola-Jones Object Detection
 - Haar Features
 - Convolution Kernel
 - Sliding window
- Many, many weak classifiers
- Cascading with AdaBoost

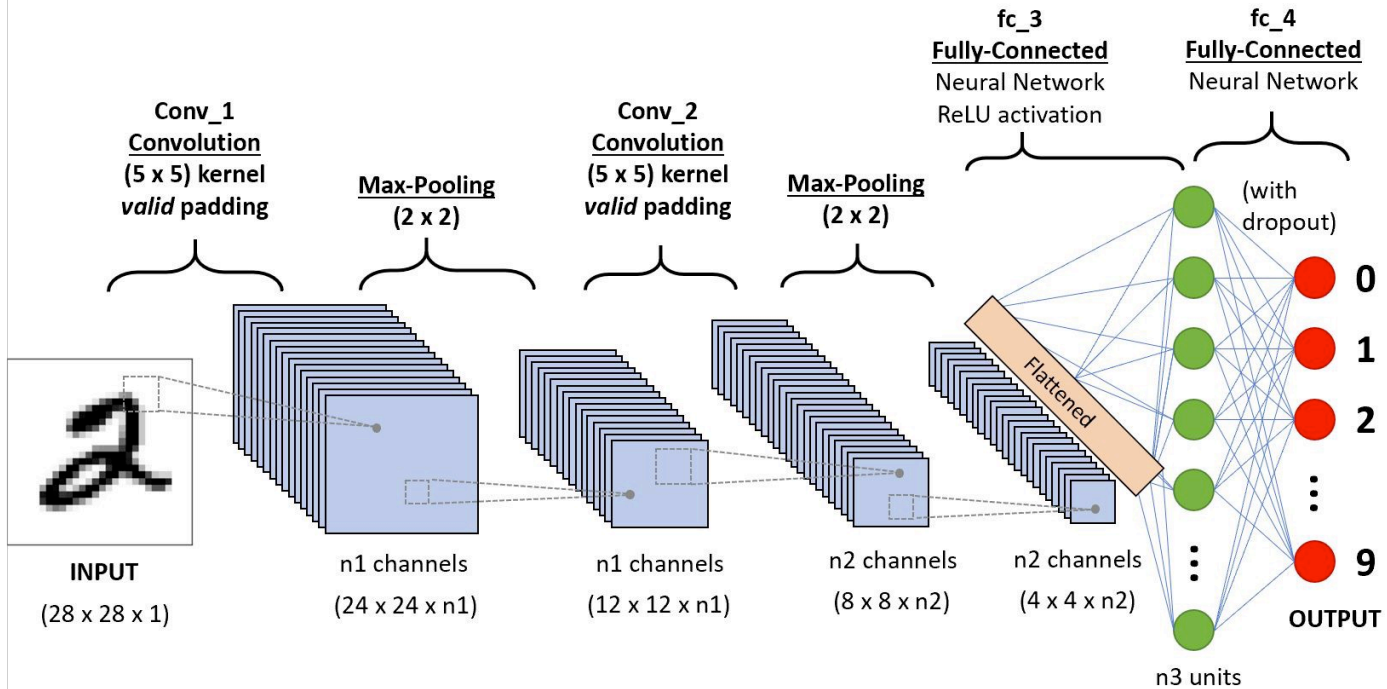


Sparsity in Medical Imaging

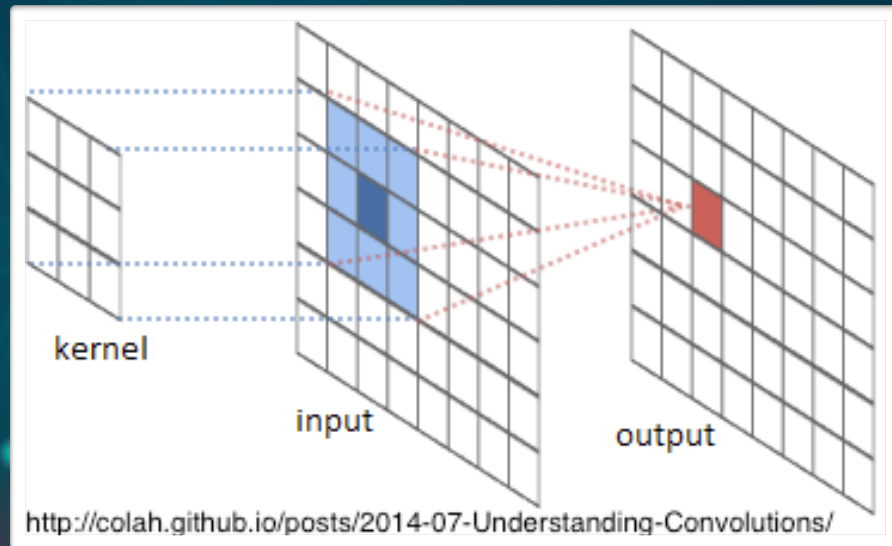
- Real-world signals often sparse
- Reconstruct signal from very few measurements
- Less exposure to radiation during X-rays, MRIs



Convolutional Neural Nets



Convolution Kernels



Kernel		Image		Output																			
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Convolution Kernels



Original Image



Box-filtered image



Gaussian-filtered image

Kernels used for blurring:
(note that the values shown
have been scaled up to
integers for clarity)

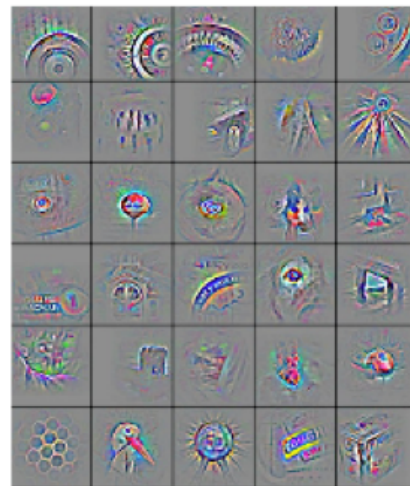
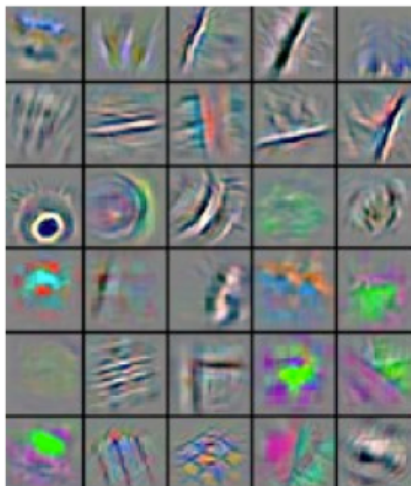
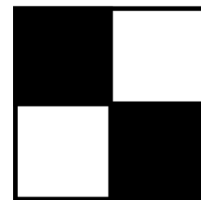
↑

1	1	1	1	1
1	1	1	1	1
1	1	1	1	1
1	1	1	1	1
1	1	1	1	1

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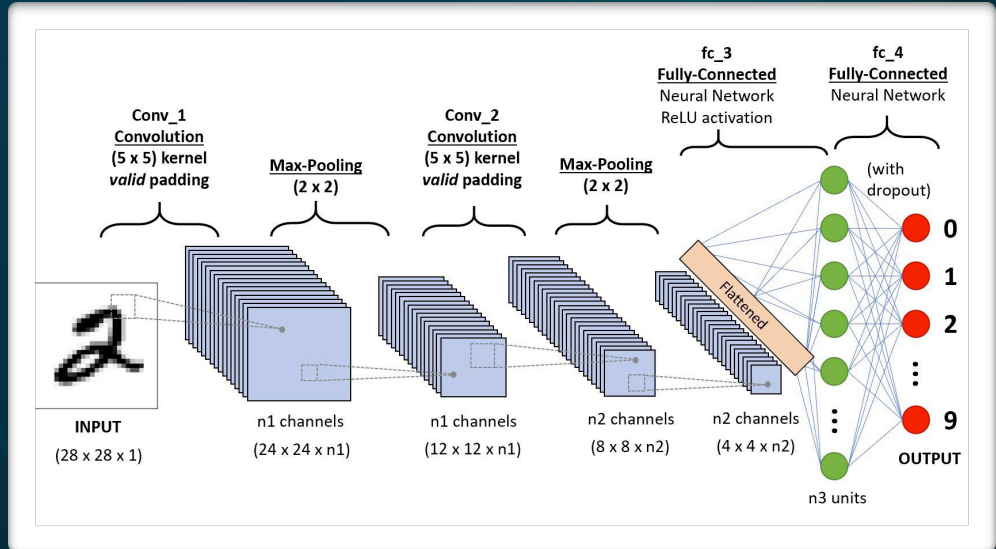
0	0	0	5	0	0	0
0	5	18	32	18	5	0
0	18	64	100	64	18	0
5	32	100	100	100	32	5
0	18	64	100	64	18	0
0	5	18	32	18	5	0
0	0	0	5	0	0	0

Haar vs CNN Kernels



Convolutional Neural Nets

- Pooling: downsample image
- Padding: border behavior
- Stride: shifting the kernel
- Activation, dropout, etc.



Ethics & Society

04

1984?

Concerns



Safety



Liberty



Fairness



Truth



Thank you!

Resources

- Slidesgo
- Wikipedia
- OpenCV.org

- <https://docs.opencv.org/3.4/haar.png>
- https://docs.opencv.org/3.4/d2/d99/tutorial_js_face_detection.html
- <https://stackoverflow.com/questions/51008505/kernels-and-weights-in-convolutional-neural-networks>
- <https://www.pico.net/kb/what-is-the-difference-between-same-and-valid-padding-in-tf-nn-max-pool-of-tensorflow>
- https://miro.medium.com/max/3288/1*uAeANQIOQPqWZnnuH-VEyw.jpeg
- <https://www.gamasutra.com/features/20010209/figure1.jpg>
- <https://sites.google.com/site/yorkyuhuang/home/tutorial/machine-learning>
- <https://towardsdatascience.com/whats-the-difference-between-haar-feature-classifiers-and-convolutional-neural-networks-ce6828343aeb>
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