Talks-with-Images

An Overview of Image Processing, Computer Vision, and Deep Learning

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Part I:

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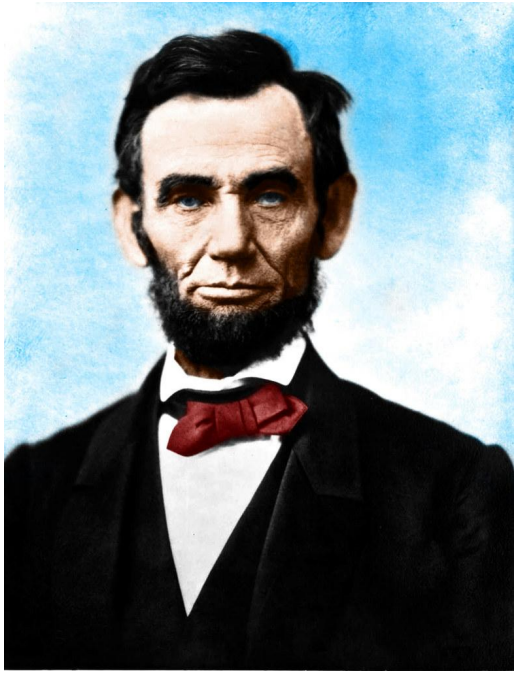
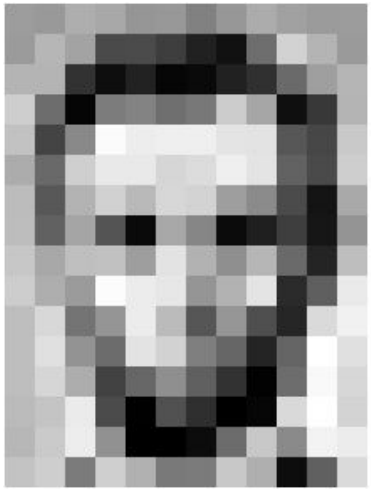
Images

What humans see



What a computer sees



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155	182	163	74	75	62	33	17	110	210	180	154
180	180	50	14	84	6	10	33	48	106	159	181
206	109	5	124	131	111	120	204	166	15	56	180
194	68	137	251	237	239	239	228	227	87	71	201
172	105	207	233	233	214	220	239	228	98	74	206
188	88	179	209	185	215	211	158	139	75	20	169
189	97	165	84	10	168	134	11	31	62	22	148
199	168	191	193	158	227	178	143	182	106	36	190
205	174	155	252	236	231	149	178	228	43	95	234
190	216	116	149	236	187	86	150	79	38	218	241
190	224	147	108	227	210	127	102	36	101	255	224
190	214	173	66	103	143	96	50	2	109	249	215
187	196	235	75	1	81	47	0	6	217	255	211
183	202	237	145	0	0	12	108	200	138	243	236
195	206	123	207	177	121	123	200	175	13	96	218

157	153	174	168	150	152	129	151	172	161	155	156
155	182	163	74	75	62	33	17	110	210	180	154
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190	214	173	66	103	143	96	50	2	109	249	215
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183	202	237	145	0	0	12	108	200	138	243	236
195	206	123	207	177	121	123	200	175	13	96	218

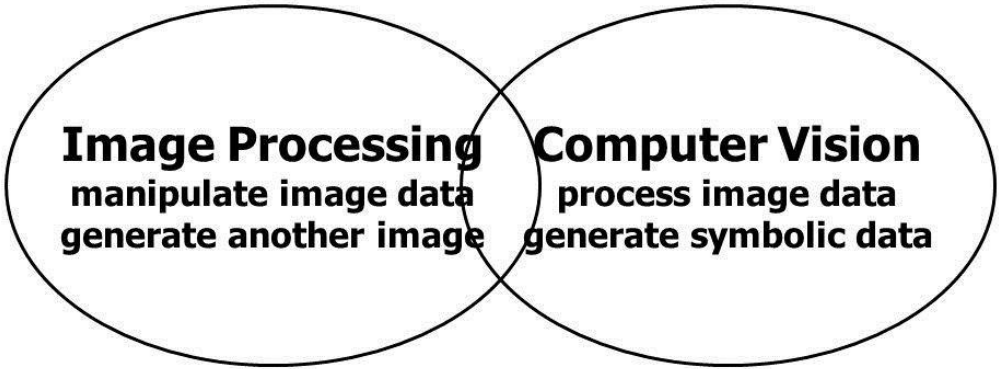
Image processing

Application: Removing noise from an image

Image processing vs computer vision

Image processing: image in ->(some function) -> image out

Computer Vision: understanding the contents of an image

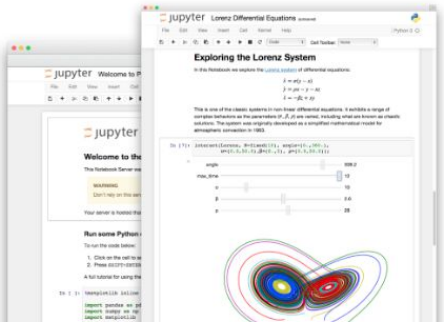


TOOLS , LIBRARY, FRAMEWORK

Let's code...

Jupyter Notebook

The Jupyter Notebook is a web-based interactive computing platform that allows users to author data- and code-driven narratives that combine live code, equations, narrative text, visualizations, interactive dashboards and other media.

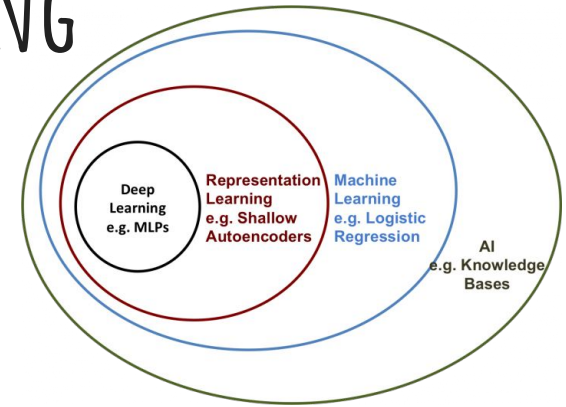


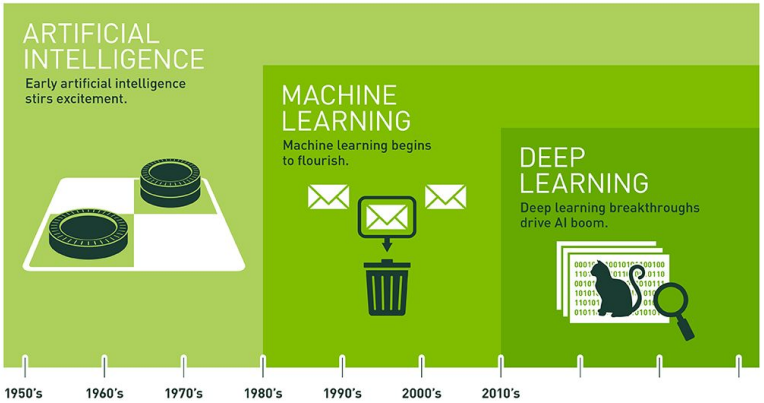
AI vs MACHINE LEARNING vs DEEP LEARNING

AI (*technique to enable machine to mimic humans*) is super-set of ML

ML (*program machines to learn and improve with experience*) and **ML** is the super-set of **DL**.

DL (*achieve great power and flexibility by learning to* ***represent the data as nested hierarchy of concepts***, *i.e, more depth features with multiple processing layers, hence "deep"*).





Since an early flush of optimism in the 1950s, smaller subsets of artificial intelligence – first machine learning, then deep learning, a subset of machine learning – have created ever larger disruptions.

Machine learning in 7 steps

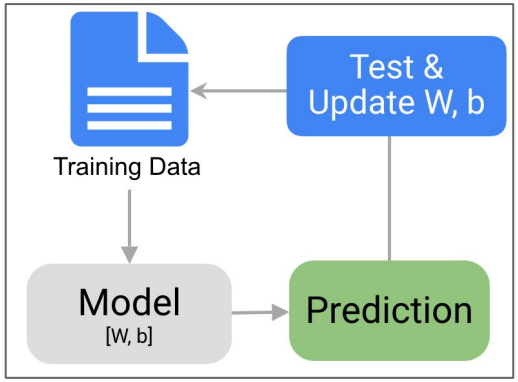
1

2

Color (nm)	Alcohol %	Beer or Wine?
610	5	Beer
599	13	Wine
693	14	Wine

1. Problem Statement
2. Data Preparation
3. Choosing a **model**
4. **Training**
5. Evaluation / **Validation**
6. Hyperparameter tuning
7. Prediction/**Testing**

4



3

6

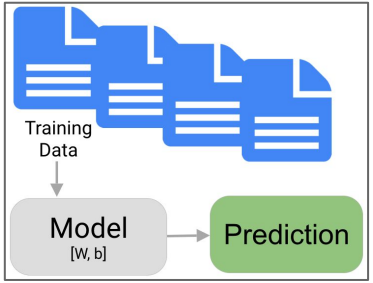
$$y = m * x + b$$

OUTPUT SLOPE INPUT Y-INTERCEPT

WEIGHTS = $\begin{bmatrix} m_{1,1} & m_{1,2} \\ m_{2,1} & m_{2,2} \\ m_{3,1} & m_{3,2} \end{bmatrix}$

BIASES = $\begin{bmatrix} b_{1,1} & b_{1,2} \\ b_{2,1} & b_{2,2} \\ b_{3,1} & b_{3,2} \end{bmatrix}$

5



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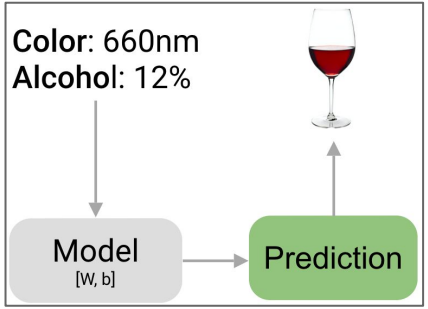
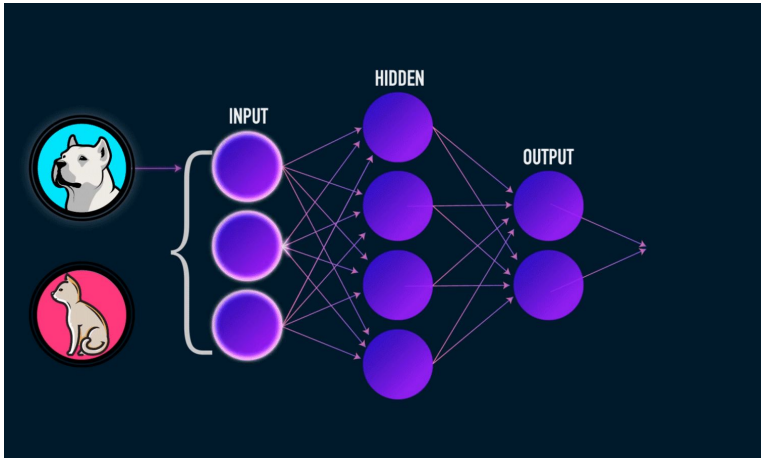
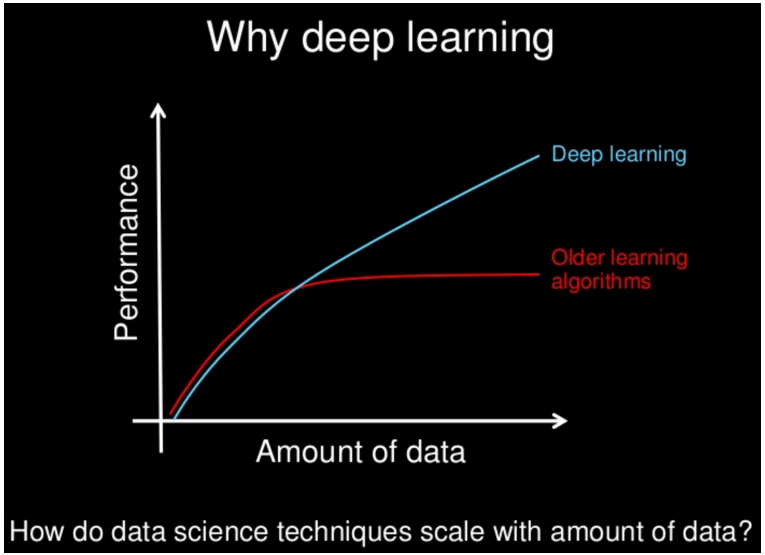


Deep Learning

- Based on Concept on Artificial Neural Networks
- *"The hierarchy of concepts allows the computer to learn complicated concepts by building them out of simpler ones. If we draw* ***a graph showing how these concepts are built on top of each other****, the graph is deep, with many layers. For this reason, we call this approach to AI deep learning."* - Ian GoodFellow

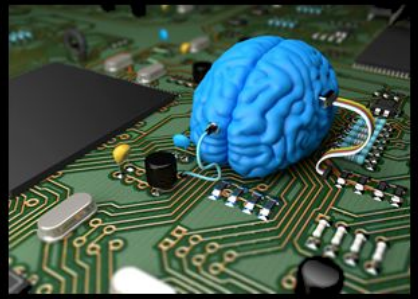




Let's code

Deep Learning

What society thinks I do



What my friends think I do

What other computer scientists think I do

What mathematicians think I do

What I think I do

```
In [1]:
import keras
Using TensorFlow backend.
```

What I actually do

Deep learning with images

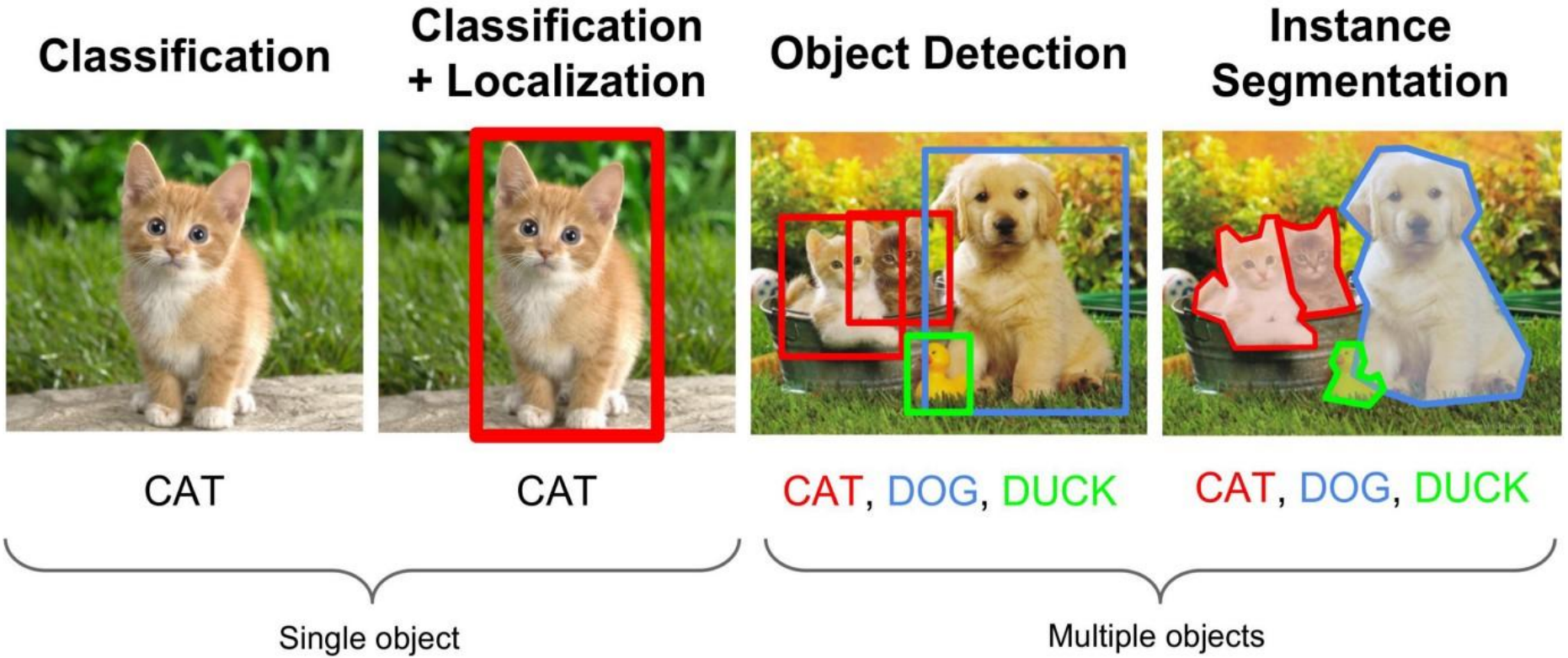
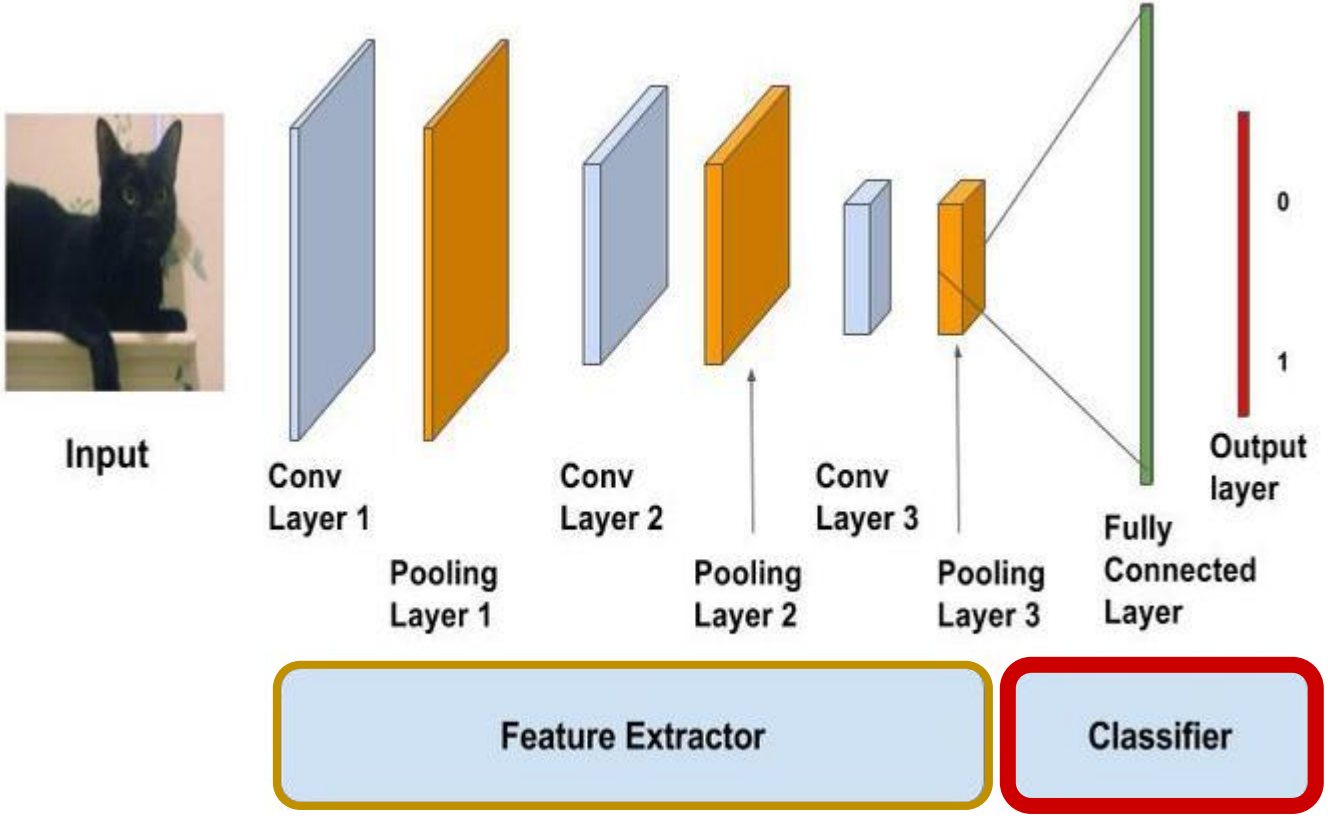
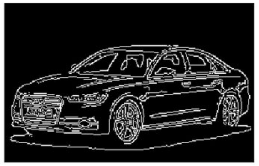


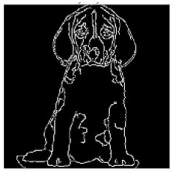
Image classification

Dataset
- Images
- Classes



Feature extraction

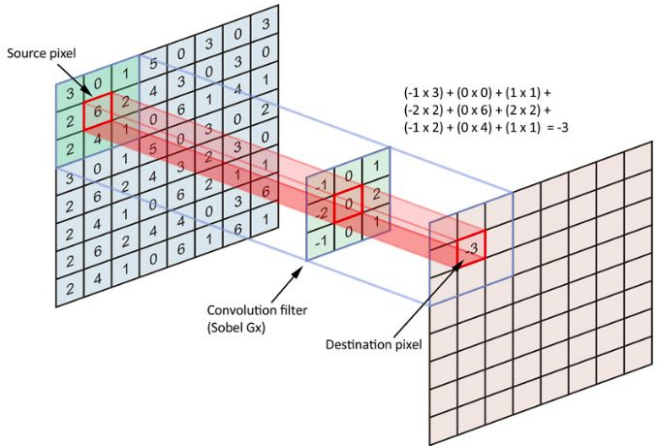




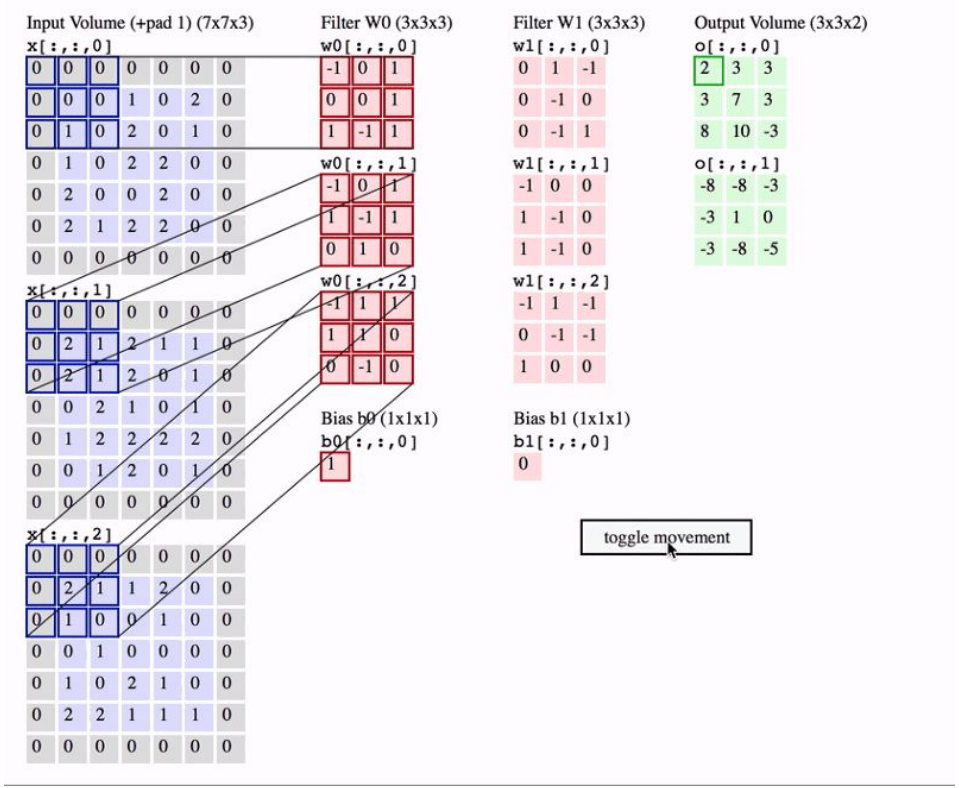
- HOG: Histogram of Oriented Gradients
- SIFT: Scale Invariant Feature Transform
- SURF: Speeded-Up Robust Feature
- **CNN: Convolution Neural Network**

1x1	1x0	1x1	0	0
0x0	1x1	1x0	1	0
0x1	0x0	1x1	1	1
0	0	1	1	0
0	1	1	0	0

4		



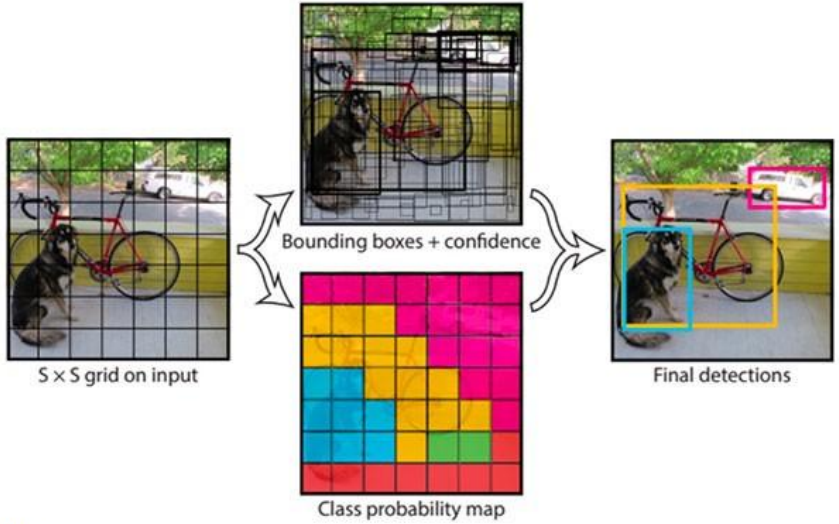
Convolution neural Network



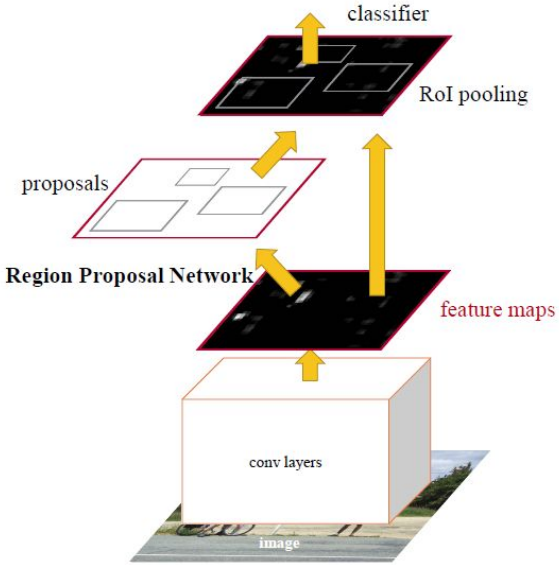
Object detection

Dataset

- Images
- Bounding Boxes(x,y,w,h)
- Classes



Region Proposal Network, providing a number of regions which are then passed to common DL based classification architectures.

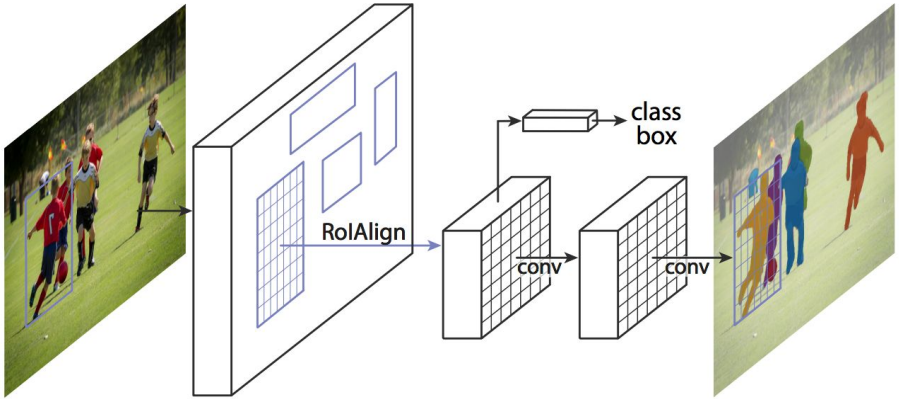


With the need of real time object detection, many one-step object detection architectures have been proposed, like YOLO, YOLOv2, YOLOv3, SSD, RetinaNet etc. which try to combine the detection and classification step.

SEGMENTATION

Dataset

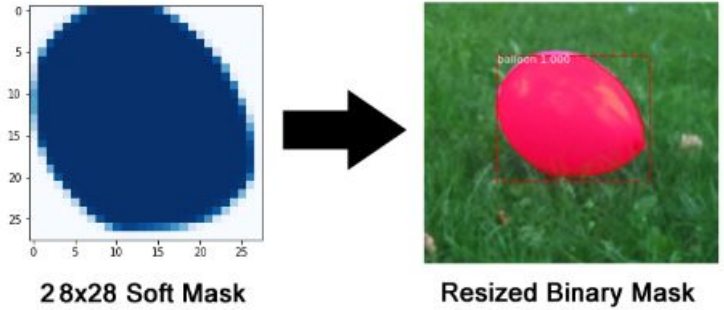
- Images
- Coordinates[list of (x,y)]
- Classes



Segmentation Masks

The mask branch is CNN that takes the positive regions selected by the ROI classifier and generates masks for them.

The generated masks are low resolution: 28x28 pixels. But they are soft masks, represented by float numbers, so they hold more details than binary masks.



Face recognition

Dataset

- Images
- Classes

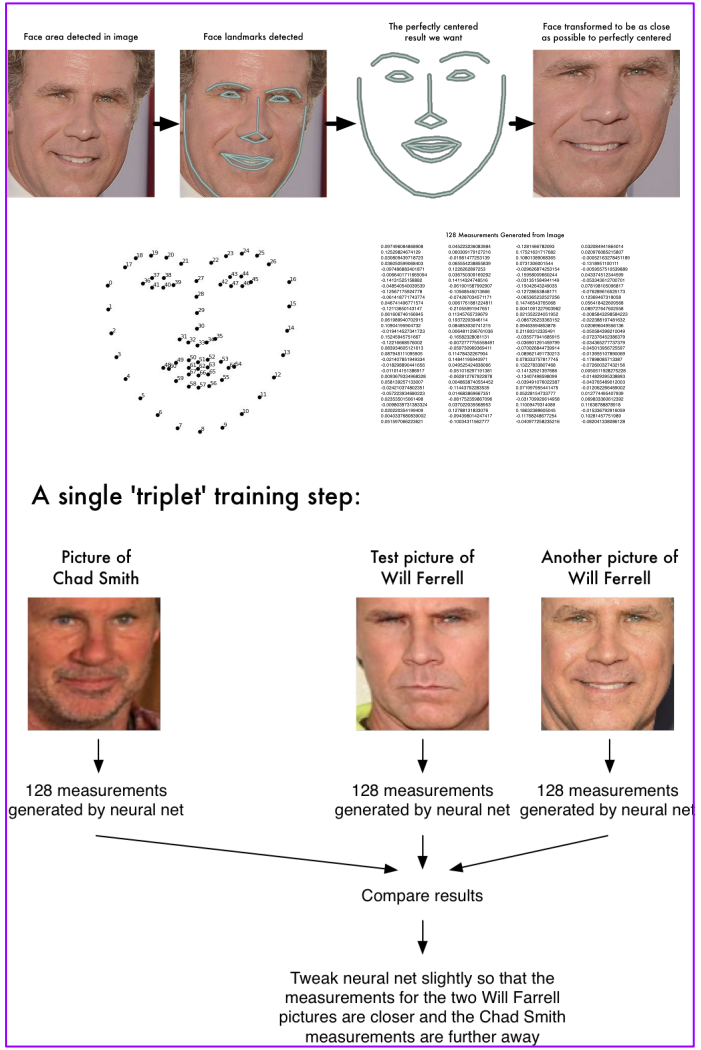
Facebook automatically tags people in your photos that you have tagged before. I'm not sure if this is helpful or creepy! :P

Algorithm:

- Face Detection
- Face Alignment

- DeepNet Model to extract features
  Pass the centered face image through a neural network that knows how to measure features of the face. Save those 128 measurements.

- *Testing new face : Extract 128 measurements and find the most similar match*



Style transfer

- Problem Statement
  - Given:
    - Content Image
    - Style Image
  - Result:
    - Stylized Image
- Algorithm
  - Feature Extraction of Content (A)
  - Feature Extraction of Style (B)
  - Merge Features(A+B)

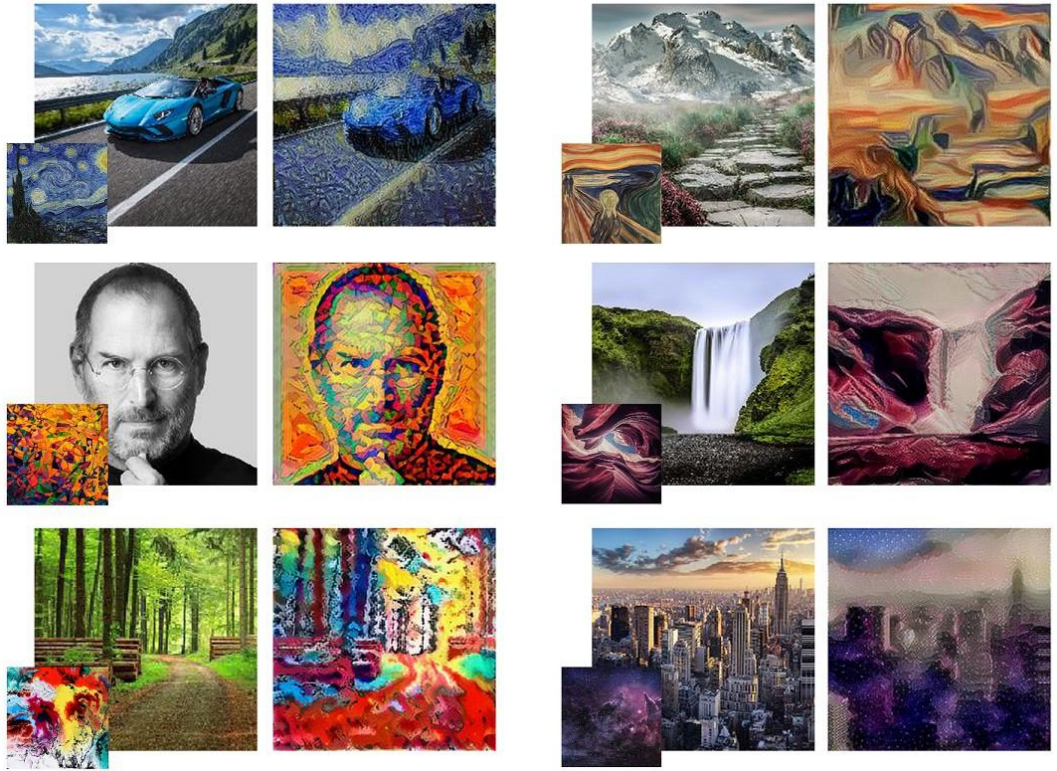
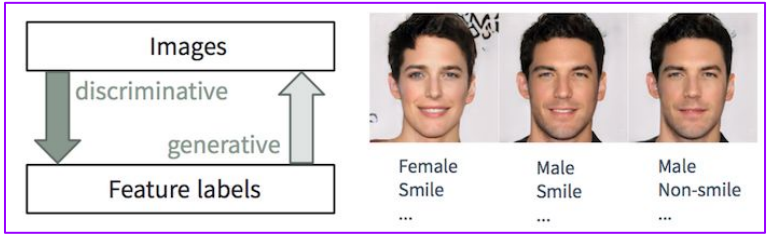
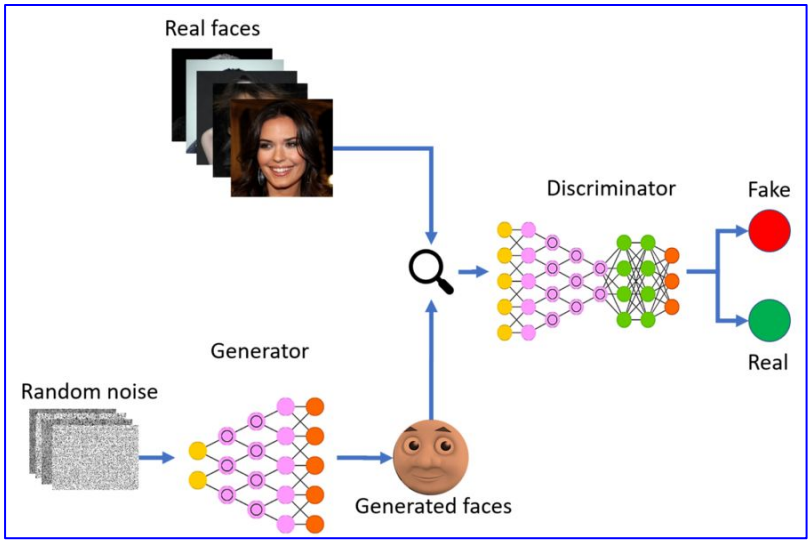


Image generation





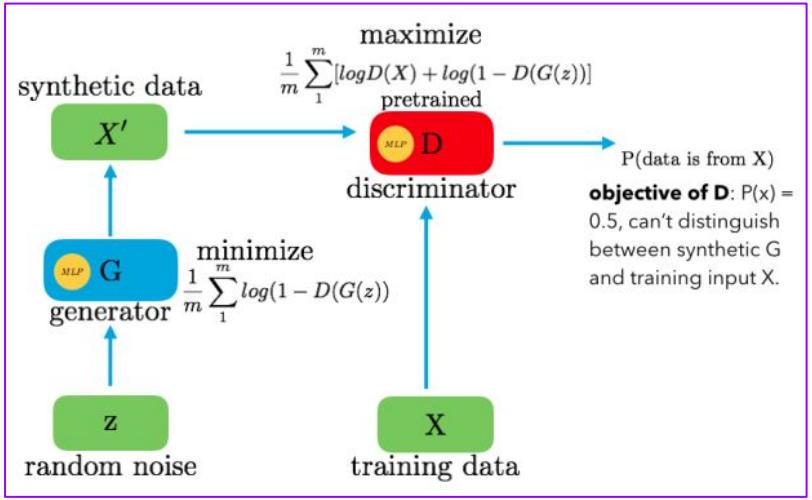
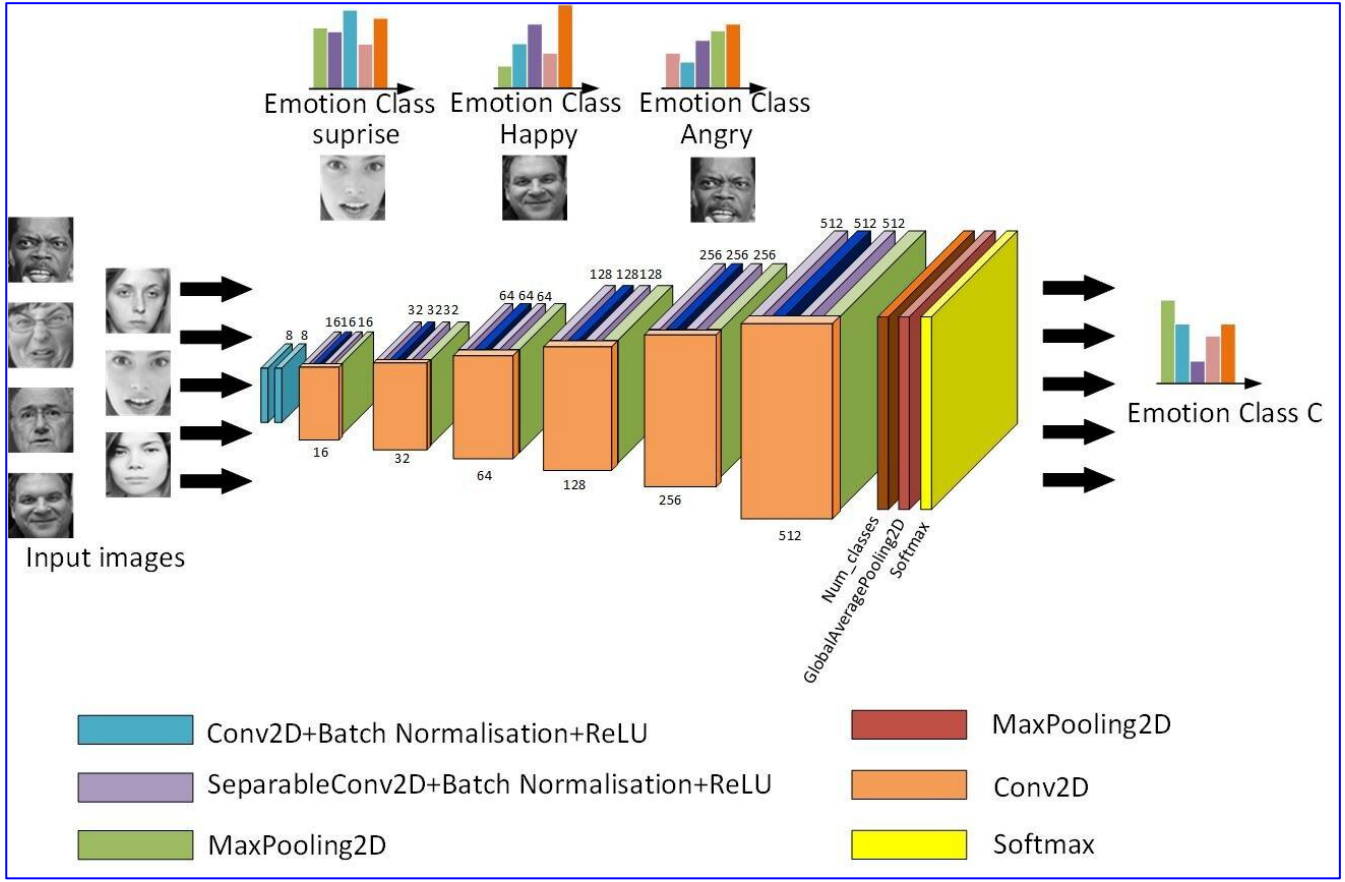


Image analytics

1. Problem Statement
2. Data Preparation
3. Choosing **model(s)**
   a. **Training**
   b. Evaluation / **Validation**
   c. Hyperparameter tuning
   d. Prediction/**Testing**
4. Combine Results
5. Presentation



Interesting Links

- https://setosa.io/ev/image-kernels/
- https://www.youtube.com/watch?v=nKW8Ndu7Mjw
- https://towardsdatascience.com/gentle-dive-into-math-behind-convolutional-neural-networks-79a07dd44cf9
- https://www.thispersondoesnotexist.com/
- https://playground.tensorflow.org/
- https://reiinakano.com/arbitrary-image-stylization-tfjs/
- https://blog.insightdatascience.com/generating-custom-photo-realistic-faces-using-ai-d170b1b59255
- https://engineering.matterport.com/splash-of-color-instance-segmentation-with-mask-r-cnn-and-tensorflow-7c761e238b46
- https://github.com/ageitgey/face_recognition
- https://medium.com/@manivannan_data/how-to-train-yolov2-to-detect-custom-objects-9010df784f36


DONE WITH OUR PRESENTATION
NOW WE HAVE TO ANSWER QUESTIONS