

# Day 10: Final Project Presentations & Going Further with ML/DL

Summer STEM: Machine Learning

Department of Electrical and Computer Engineering  
NYU Tandon School of Engineering  
Brooklyn, New York

August 12, 2021

# Outline

1 Supervised Learning

2 Unsupervised Learning

3 Social Impact of Machine Learning

4 Course Takeaway

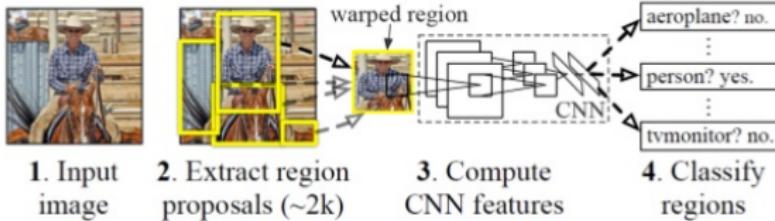
# Object Detection

- Faster-RCNN
- YoLo

# Object Detection

## R-CNN Architecture

**R-CNN: Regions with CNN features**



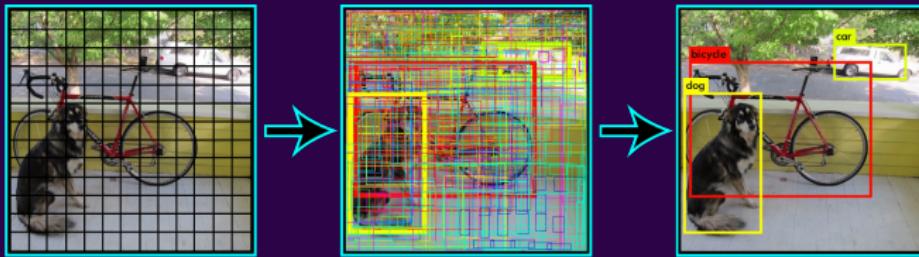
Region Proposal Based Object Detection

# Object Detection

## YOLO

- Divides the image into  $n \times n$  grid-cells
- For each grid cell,
  - predicts  $B$  bounding boxes and its box confidence score
  - Each box will have its class probability
  - All class probabilities are combined to detect one object

# Object Detection



YOLO (<https://pjreddie.com/darknet/yolo/>)

# Semantic Segmentation

- Every Pixel is associated with a class
- Encoder-decoder structure
- Decode using transposed convolution or deconvolution

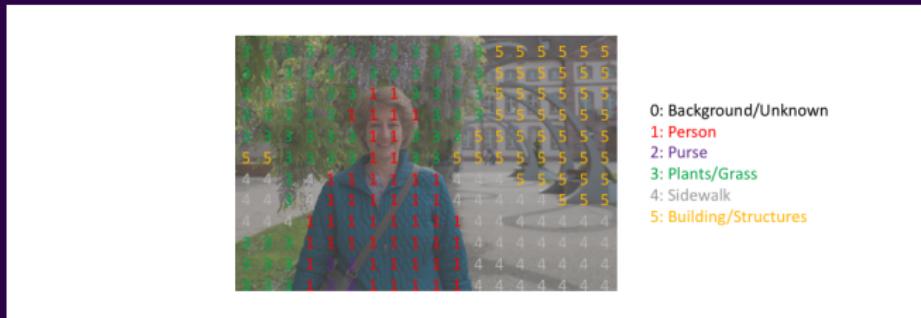


Image Segmentation (Source:  
<https://www.jeremyjordan.me/semantic-segmentation/>)

# Instance Segmentation

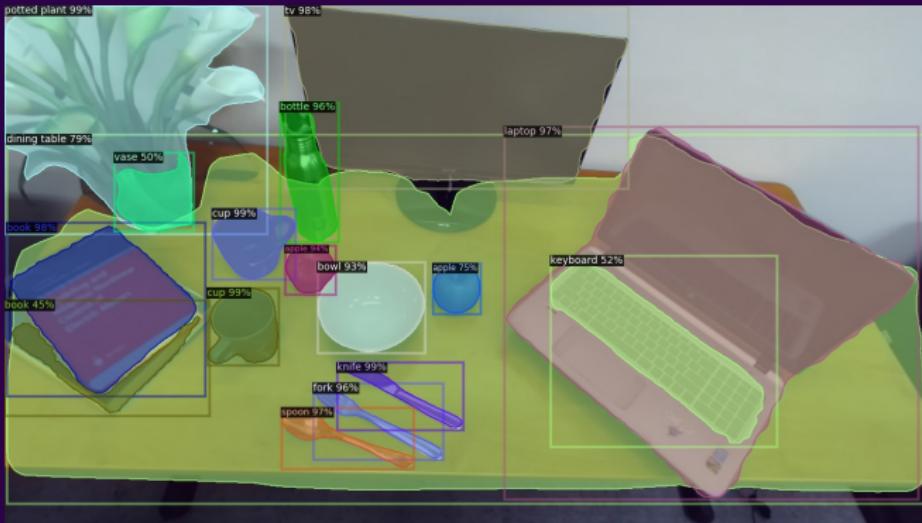


Image generated using Mask-RCNN  
(<https://github.com/facebookresearch/detectron2>)

# Outline

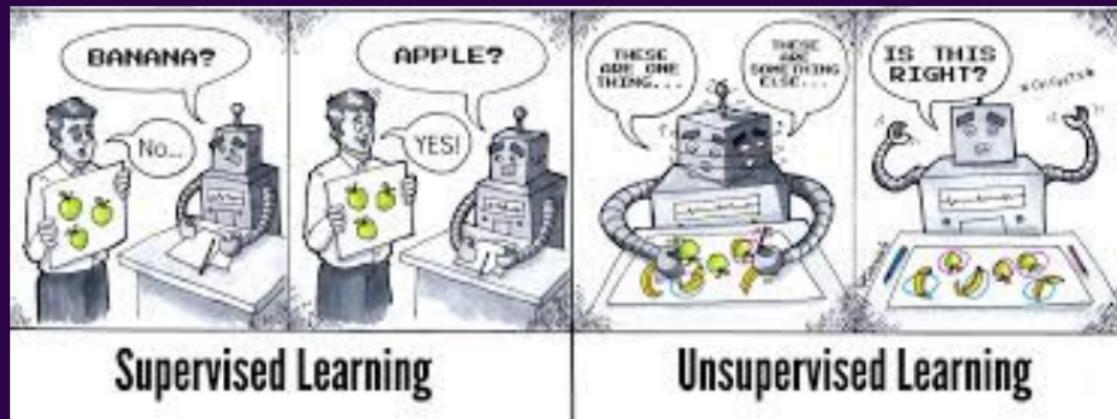
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# Unsupervised Learning



# Clustering



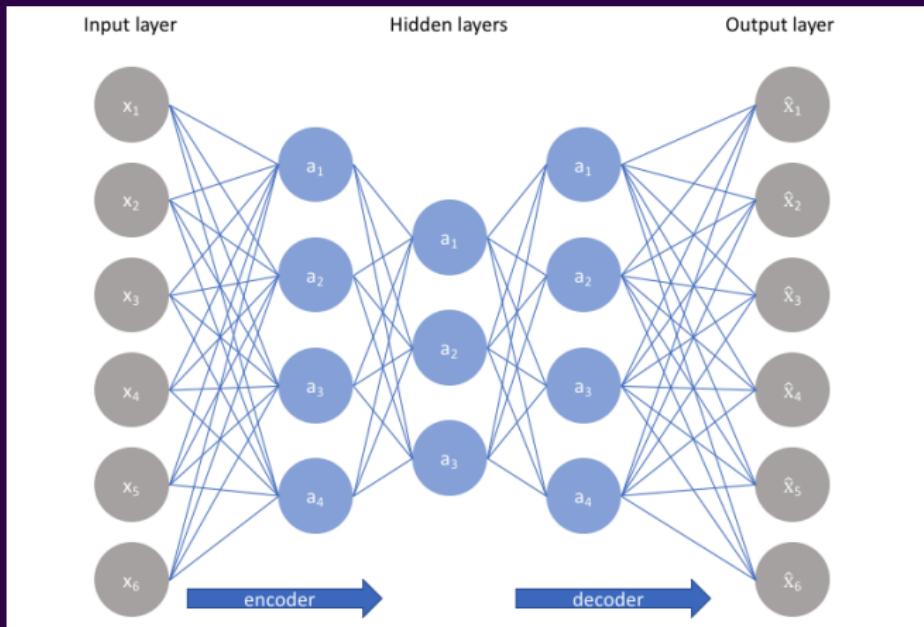
# Generative models

- Generate images, art...



Human face generation one of the most difficult tasks

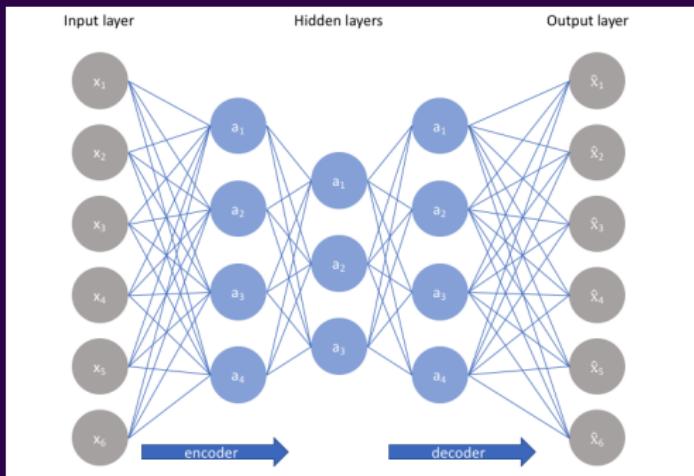
# Autoencoders



From Jeremy Jordan's Post on Autoencoders

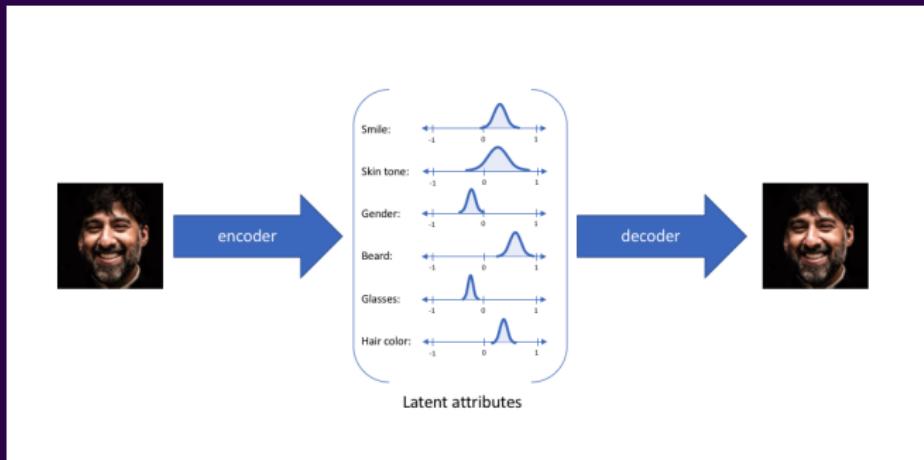
# Autoencoders

$$\text{Loss}(x) = \sum_{i=1}^N ||x - \hat{x}||^2$$



From Jeremy Jordan's Post on Autoencoders

# Variational Autoencoders



From Jeremy Jordan's Post on Variational Autoencoders

# Variational Autoencoders

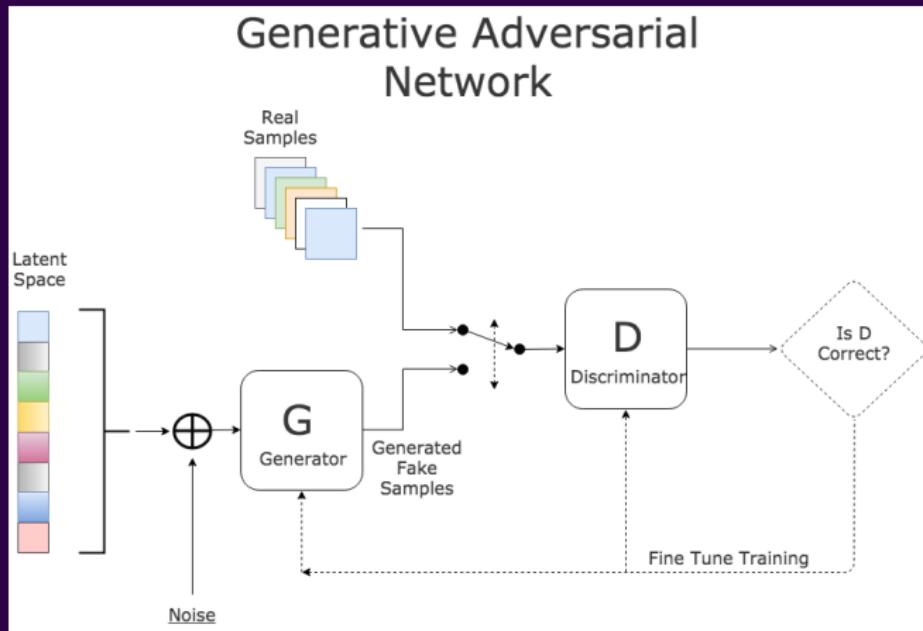


VAE face generation implemented by Wojciech Mormul

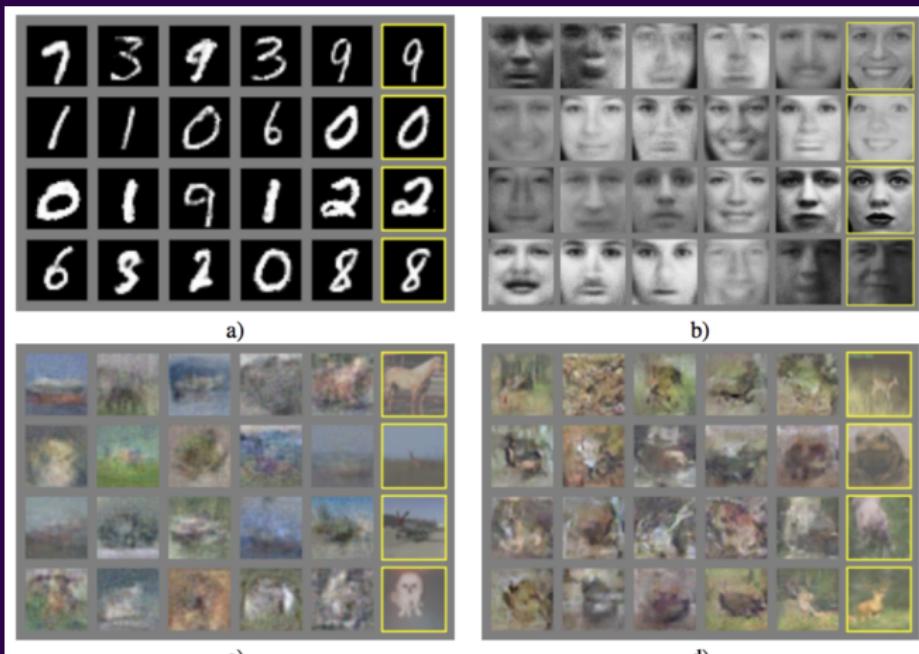
# GANs: Generative Adversarial Networks

- Invented in 2014 by Ian Goodfellow
- Goal: generate samples never seen before
- How: game between two networks
  - Generator Network
  - Discriminator Network
- **Goal of Generator:** generate fake samples indistinguishable from real samples
- **Goal of Discriminator:** be able to tell apart real and fake samples

# GANs: Generative Adversarial Networks



# Beginning



Generated images (yellow) on a) MNIST b) TFD c) CIFAR-10 (MLP model) d) CIFAR-10 (Conv model)  
"Generative Adversarial Networks", Goodfellow et. al. 2014

# Progress



Improvement of GANs in producing photo-realistic faces over the years

# Celebrity Faces



Human face generation one of the most difficult tasks

# Applications of GANs



Image Colorization (Source: <https://github.com/jantic/DeOldify>)

# Applications of GANs

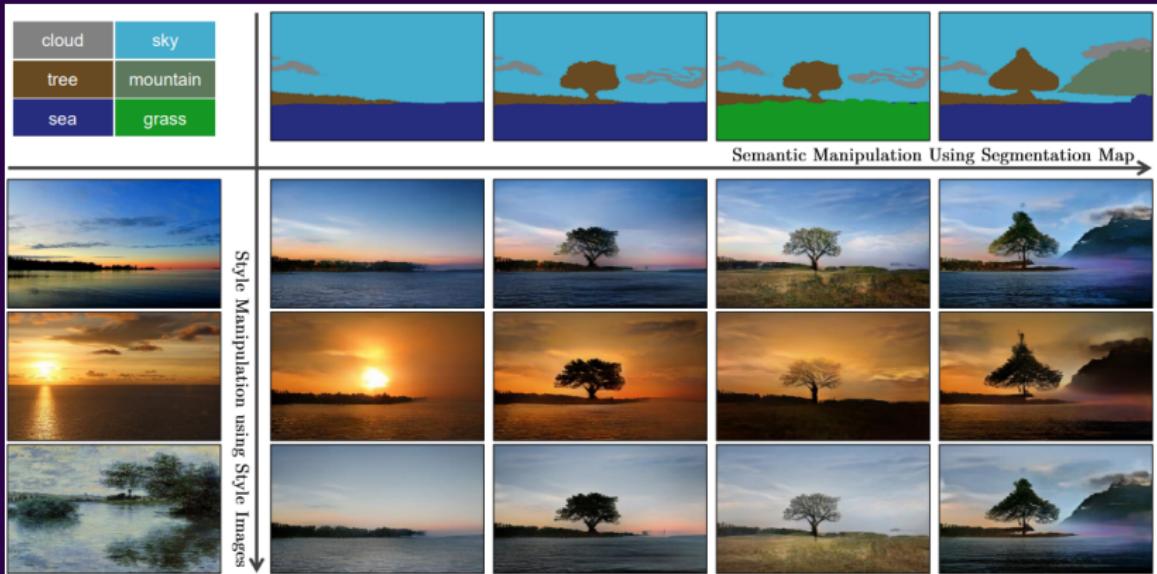


Image Synthesis (Source: <https://github.com/NVlabs/SPADEn>)

# Applications of GANs

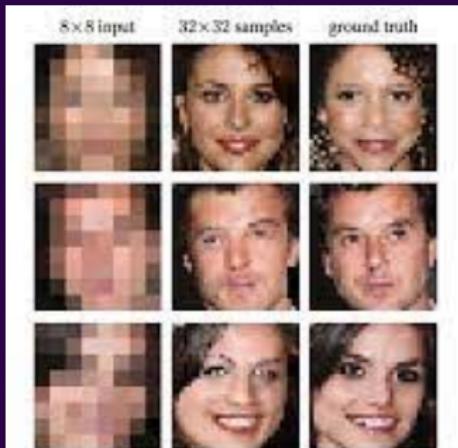


Figure 1: Illustration of our probabilistic pixel recursive super resolution model trained end-to-end on a dataset of celebrity faces. The left column shows  $8 \times 8$  low resolution inputs from the test set. The middle and last columns show  $32 \times 32$  images as predicted by our model vs. the ground truth. Our model incorporates strong face priors to synthesize realistic hair and skin details.

Image Super-Resolution (Source: Dahl et al., "Pixel recursive super resolution")

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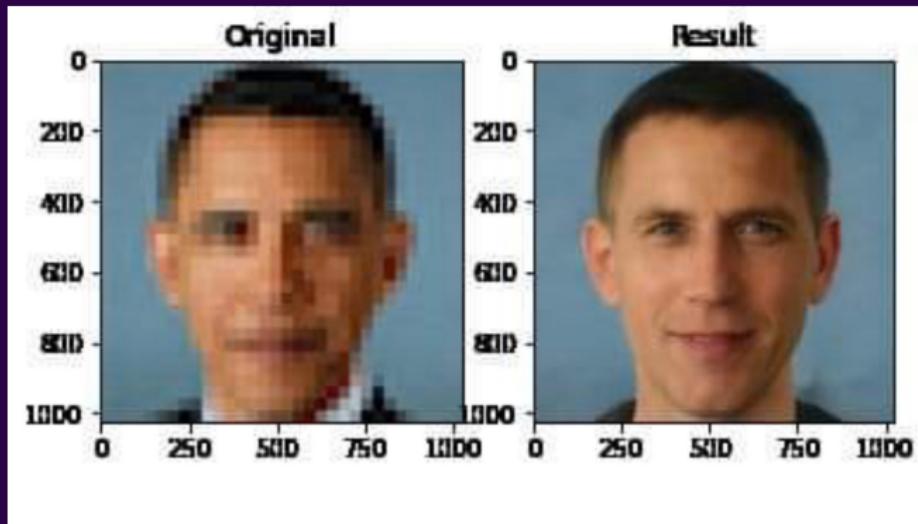
4 Course Takeaway

# How Would You Use ML/DL?

- Think about potential applications with deep learning.
- Discuss its social implications.

# Can AI/ML be Biased?

PULSE is a face depixelizing algorithm, but...



# Can AI/ML be Biased?

(From the article Design AI so that it's fair)

- When Google Translate converts news articles written in Spanish into English, phrases referring to women often become 'he said' or 'he wrote'.
- Software designed to warn people using Nikon cameras when the person they are photographing seems to be blinking tends to interpret Asians as always blinking.

# Other Sources of Bias

Now that we know biased data lead to biased model, are there any other sources of bias in our machine learning pipeline?

# De-Bias ML Can be Hard

How would you solve this problem?

The image shows a 2x3 grid of six photographs. The top row contains 'Skyscrapers' (two tall buildings), 'Airplanes' (a view from an airplane window), and 'Cars' (a car parked at night). The bottom row contains 'Bikes' (a person riding a bicycle), 'Gorillas' (two gorillas), and 'Graduation' (a person in a graduation cap and gown). Each image has a caption below it.

diri noir avec banan @jackyalcine · Jun 29  
Google Photos, y'all [REDACTED] My friend's not a gorilla.

813 394 TWITTER

# Safety of AI

Boston Dynamics Parkour Atlas: What machine learning algorithms might have been used here?

# Safety of AI

- The same model can have drastically different performance for different hyper-parameters.
- 100% accuracy is rarely achieved on unseen data.
- Should we let a medical robot with CNN-based vision system perform surgery autonomously?
- If a self-driving car crashes and hurts people, who should be responsible for it?

# Carbon Footprint of Deep Learning

## Common carbon footprint benchmarks

in lbs of CO<sub>2</sub> equivalent

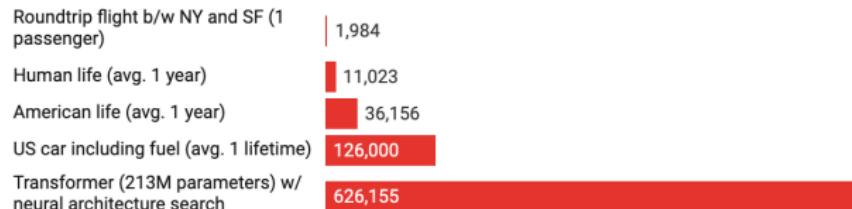


Chart: MIT Technology Review • Source: Strubell et al. • [Created with Datawrapper](#)

Source: MIT Tech Review

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# Course Takeaway

- ML is the combination of math and computer science.
- We've only shown you a subsection
  - Supervised Learning: Linear/Logistic Regression and Neural Networks
- Deep learning has wide applications, but we are also responsible for its consequences. —The greater the power, the greater the responsibility!

# Thank You!

- Thank You!