Day 9: 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

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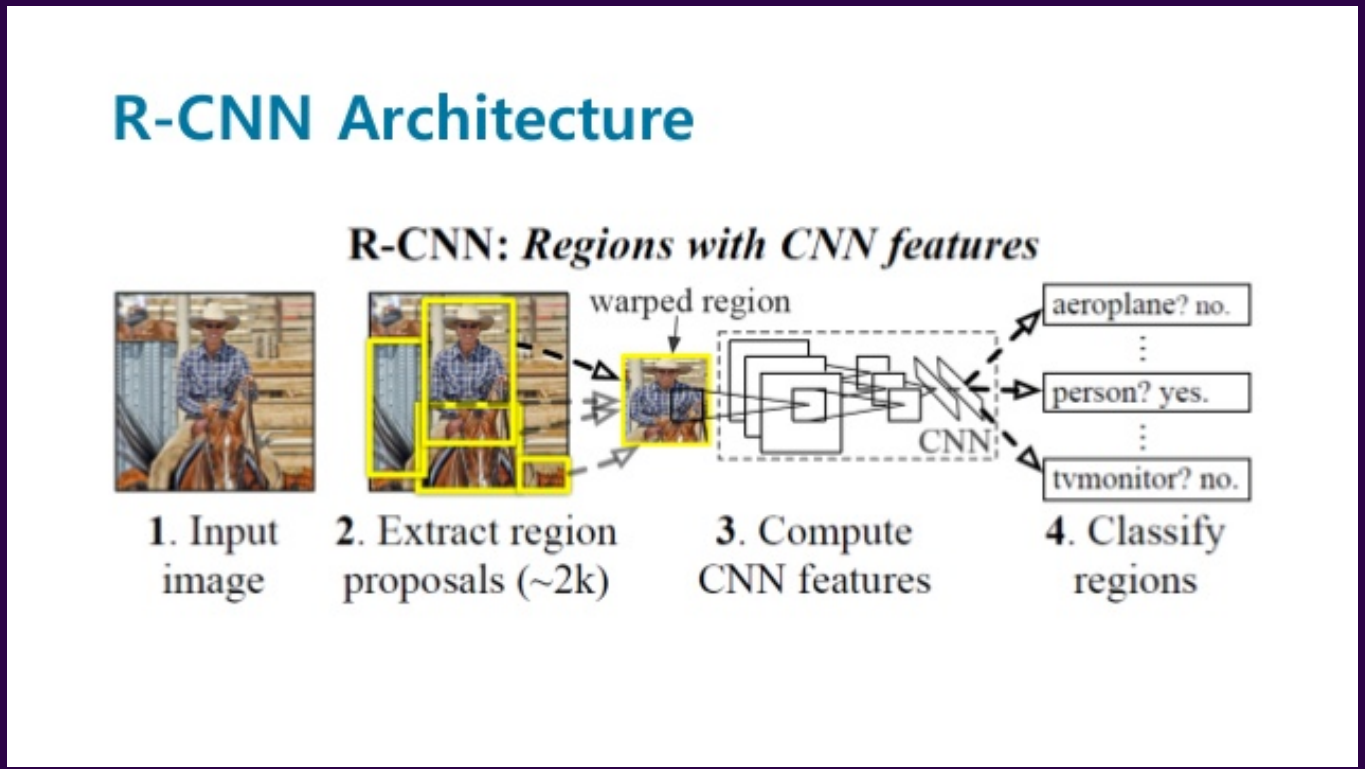
NYU TANDON SCHOOL OF ENGINEERING

Outline

Object Detection

- Faster-RCNN
- YoLo

Object Detection



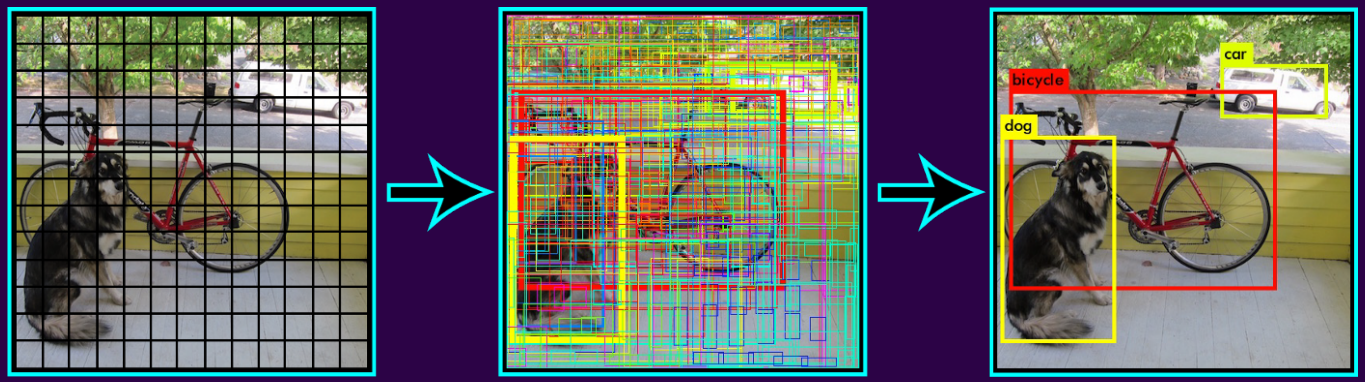
Region Proposal Based Object Detection

Object Detection

YOLO

- Divides the image into nxn grid-cells
- For each grid cell,
  - predicts B bouding boxes and it box confidence score
  - Each box will have its class probability
  - All class probability 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

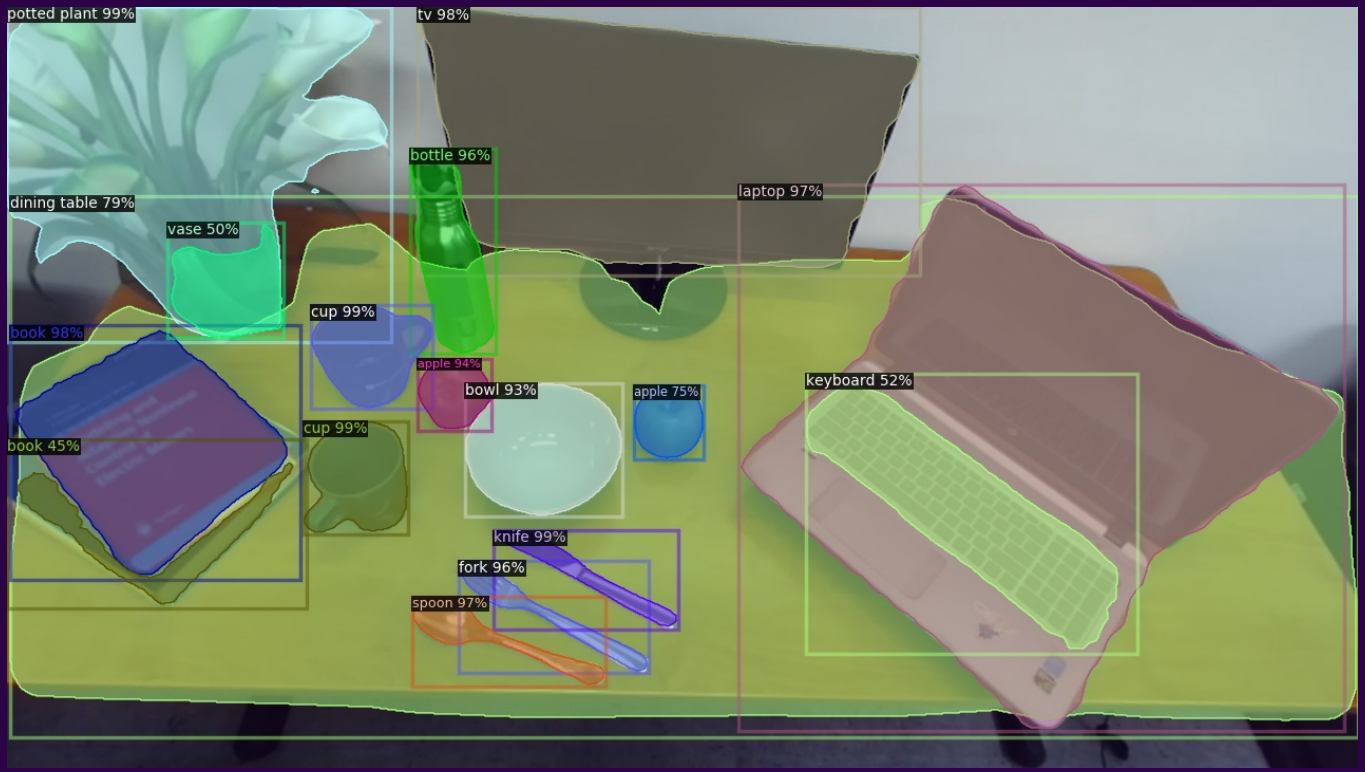
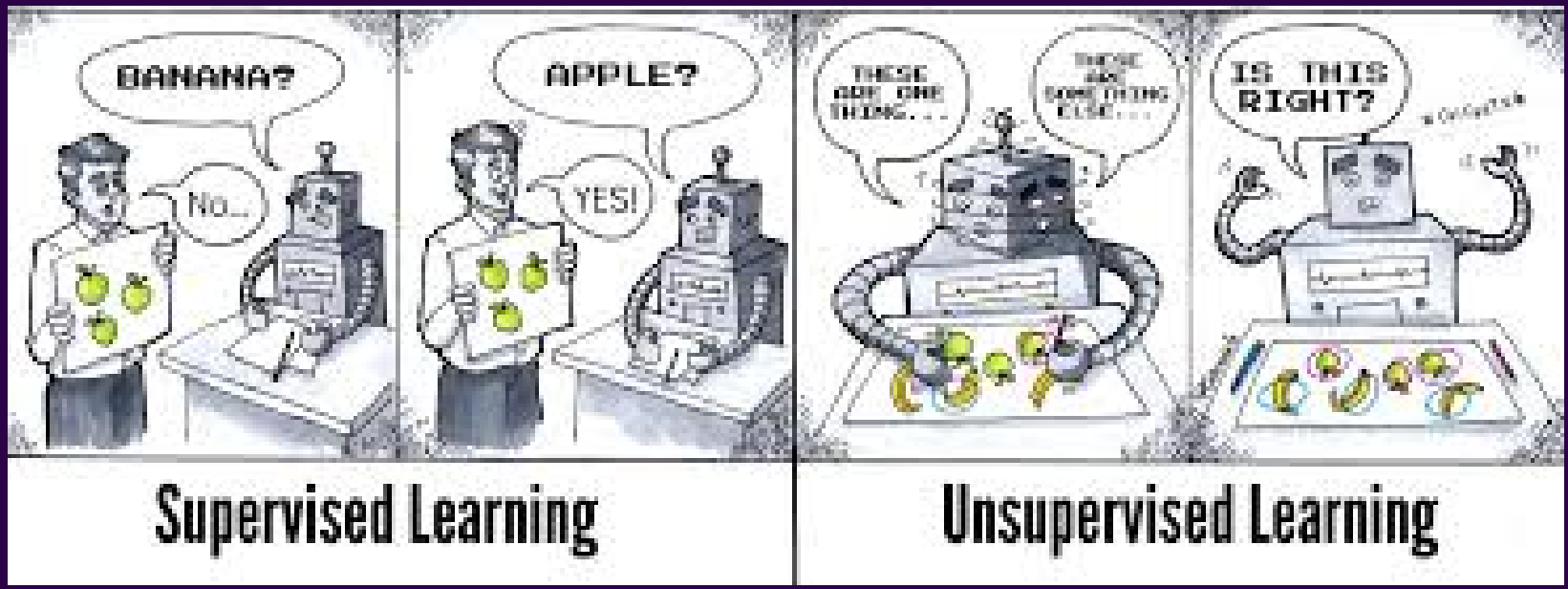


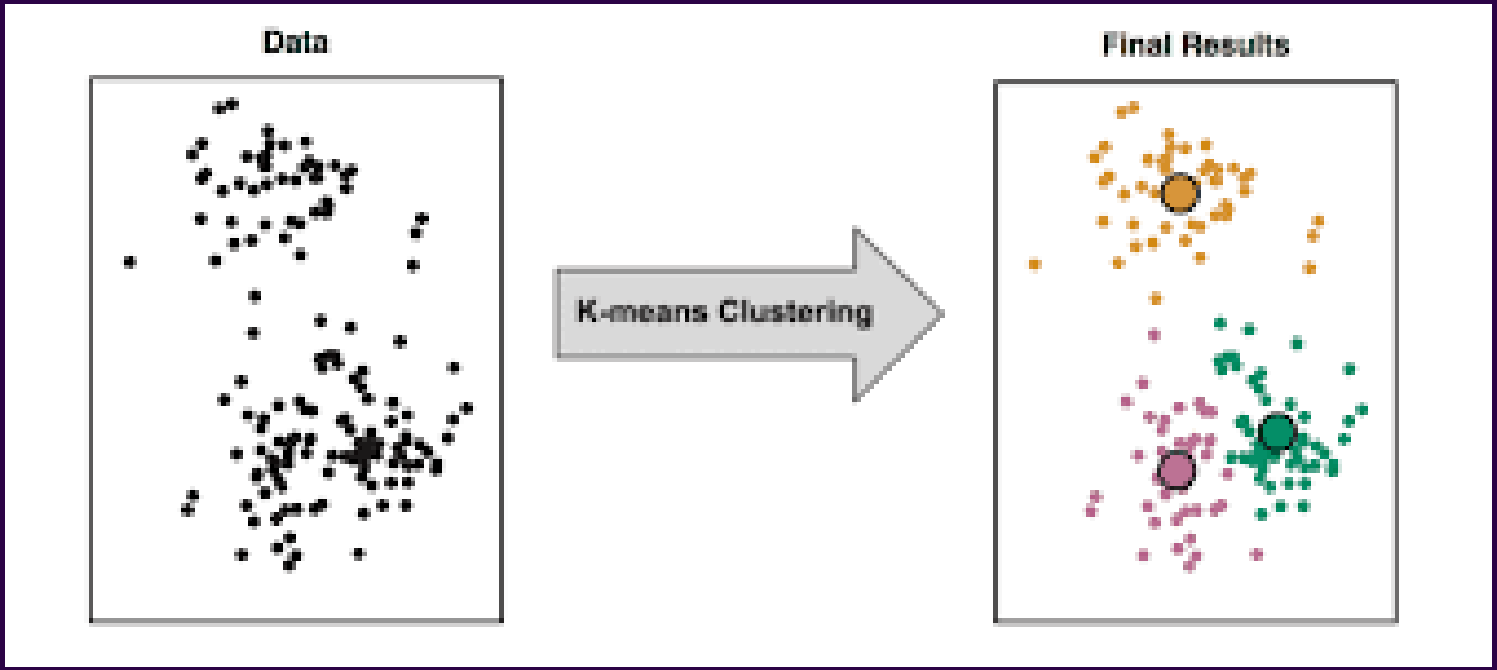
Image generated using Mask-RCNN (https://github.com/facebookresearch/detectron2)

Outline

Unsupervised Learning



Clustering

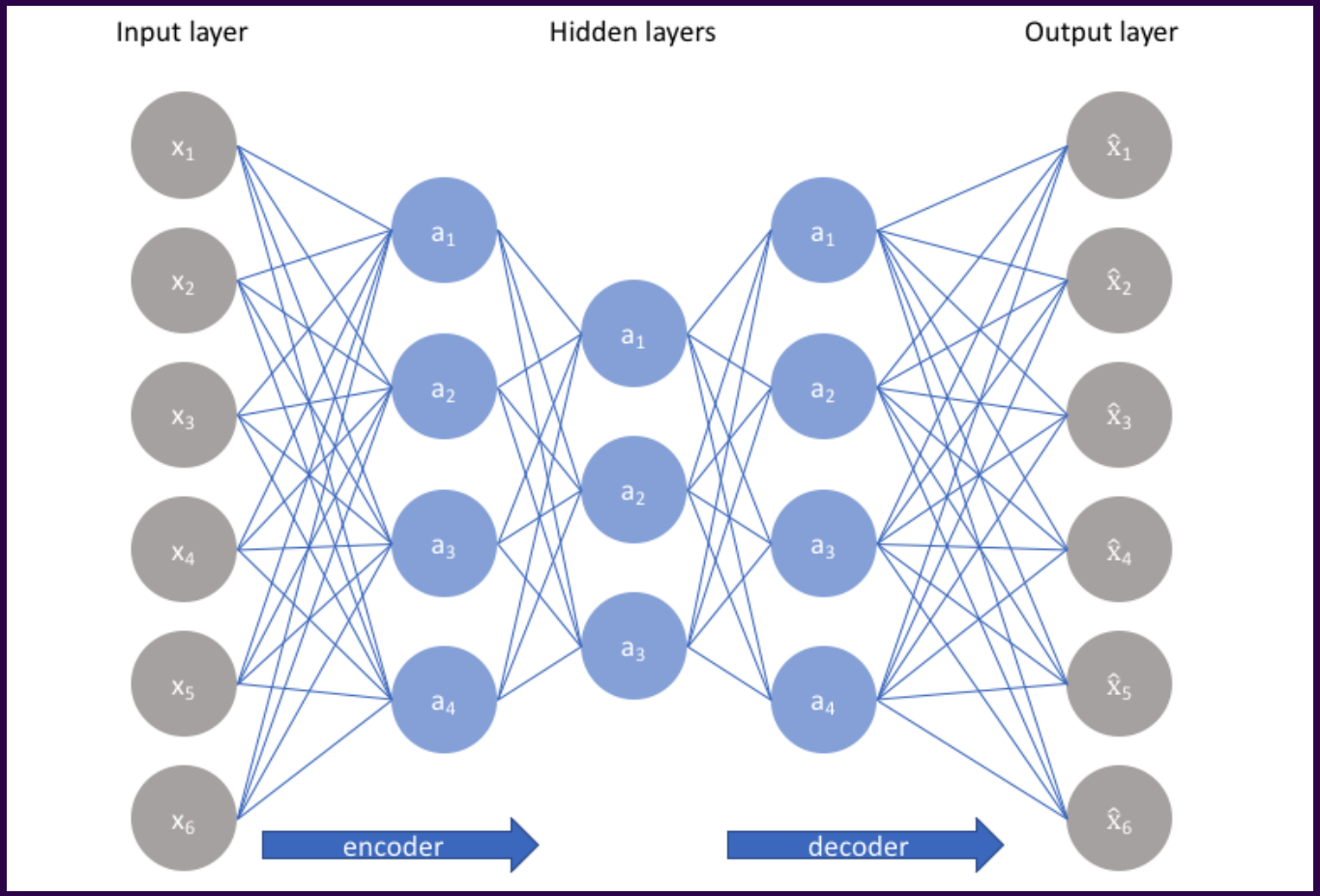


Generative models

- Generate images, art...

Human face generation one of the most difficult tasks

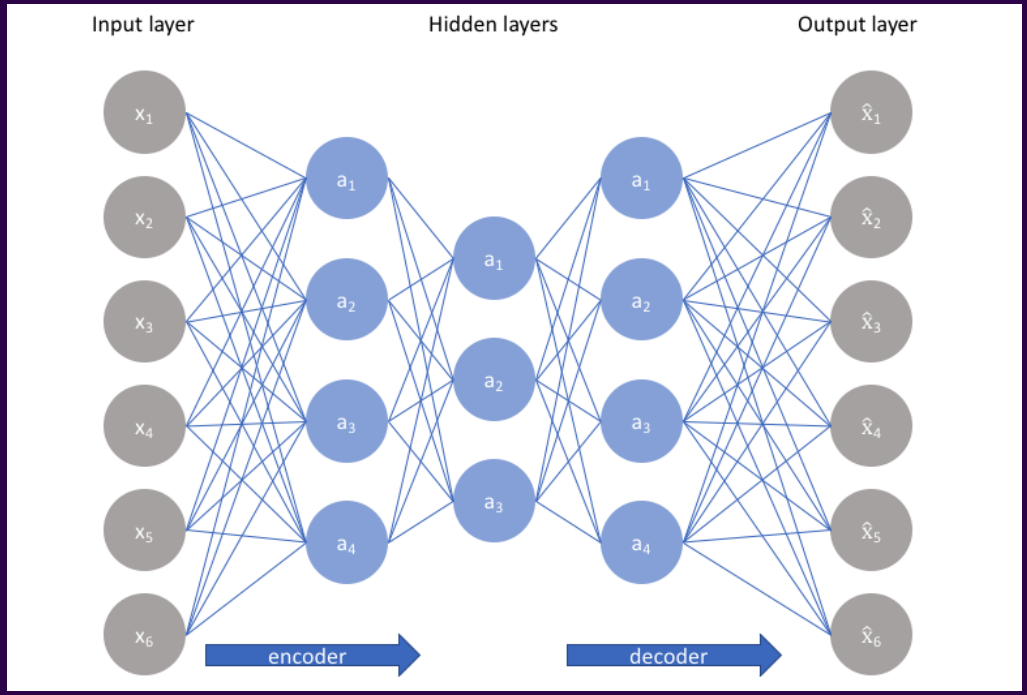
Autoencoders



From Jeremy Jordan's Post on Autoencoders

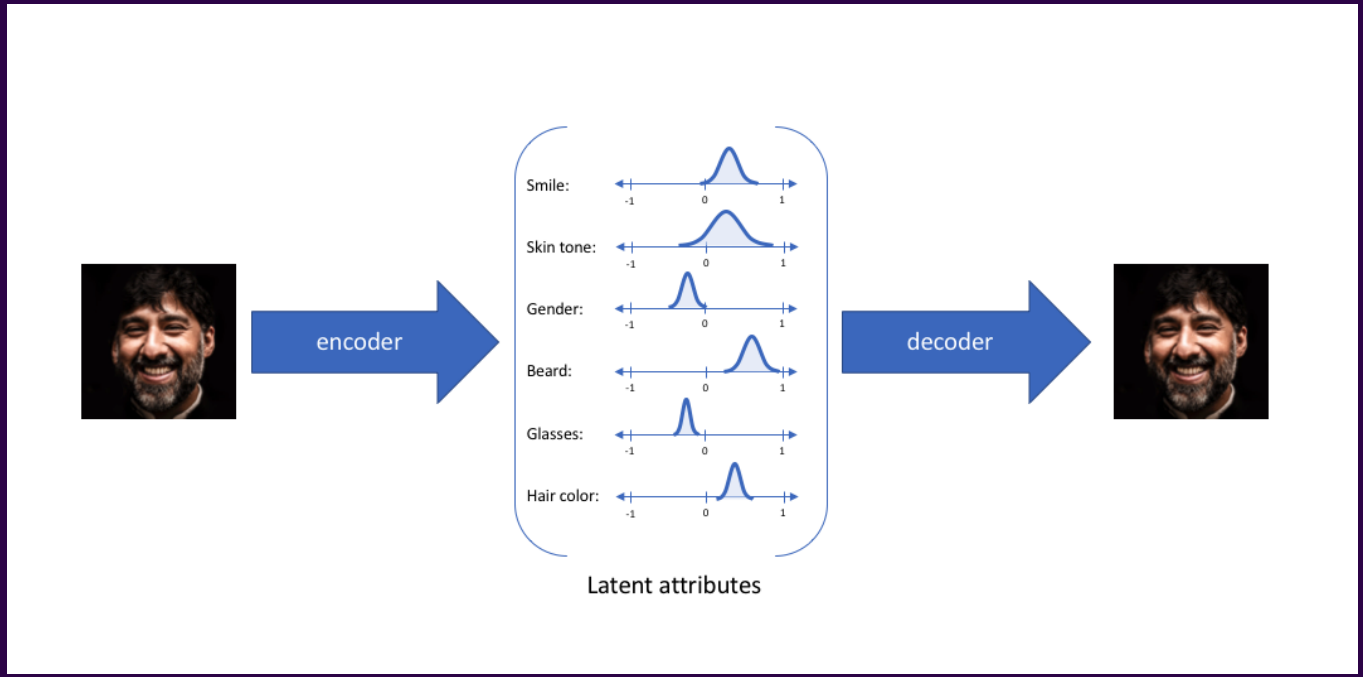
Autoencoders

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



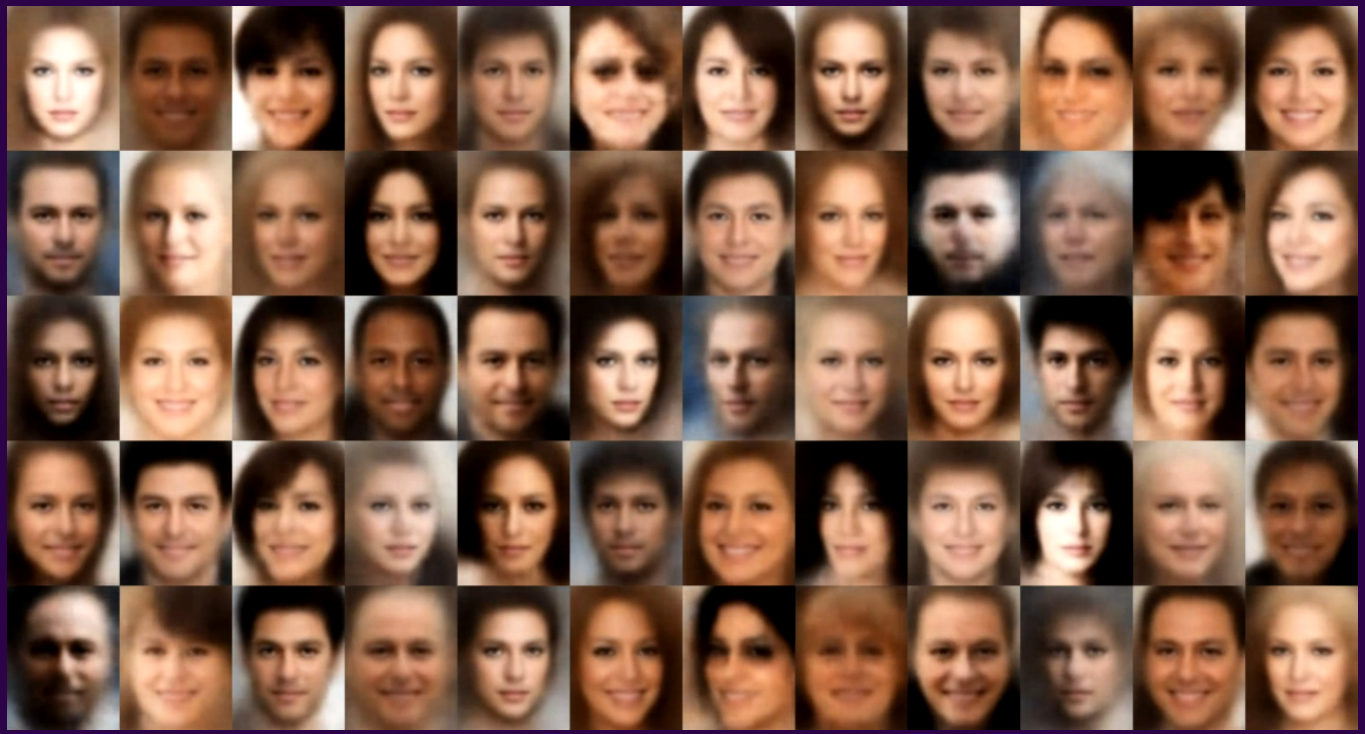
From Jeremy Jordan's Post on Autoencoders

Variational Autoencoders



From Jeremy Jordan's Post on Variational Autoencoders

Variational Autoencoders

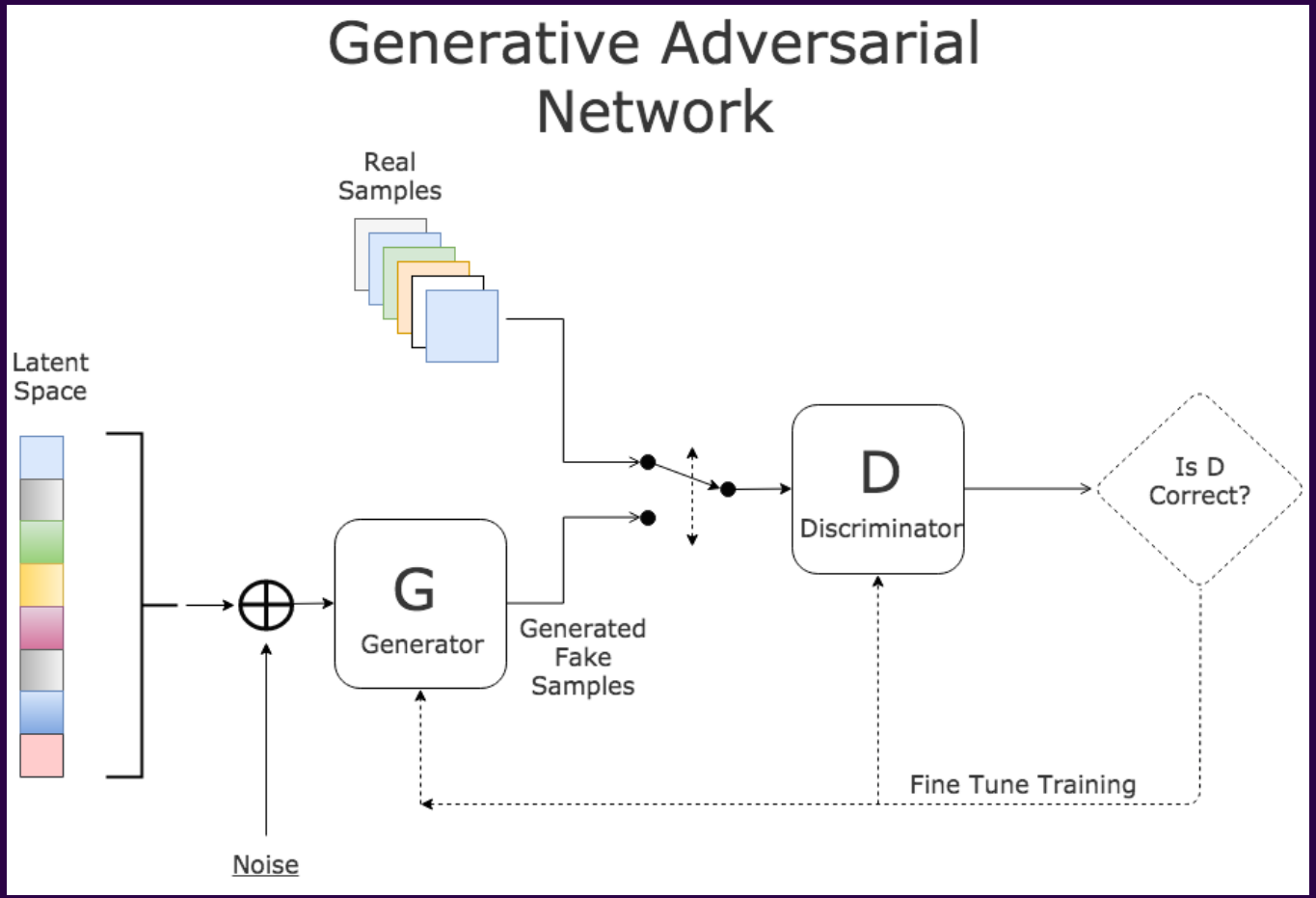


VAE face generation implemented by Wojciech Mormul

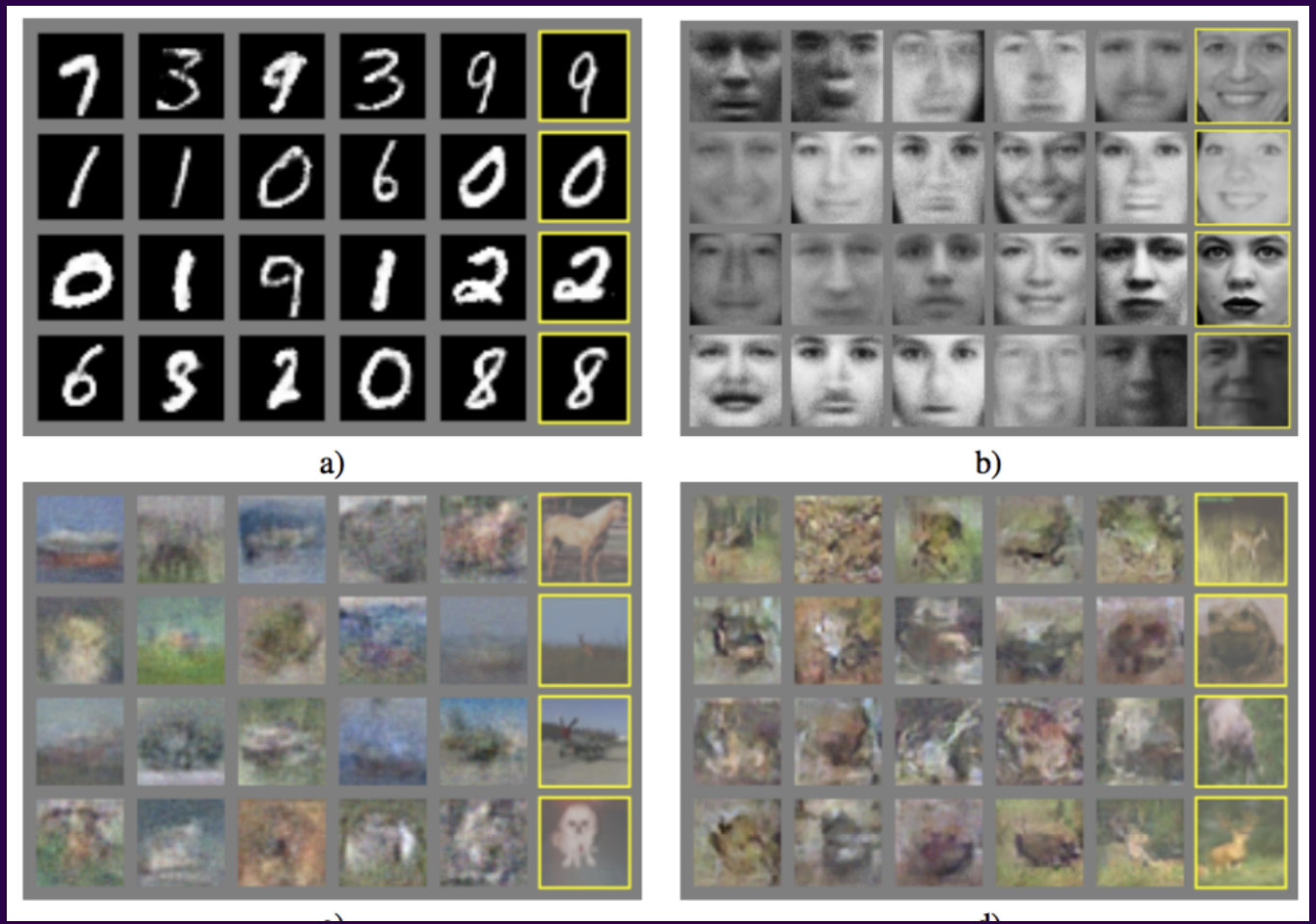
GANs: Generative Adversarial Networks

- 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

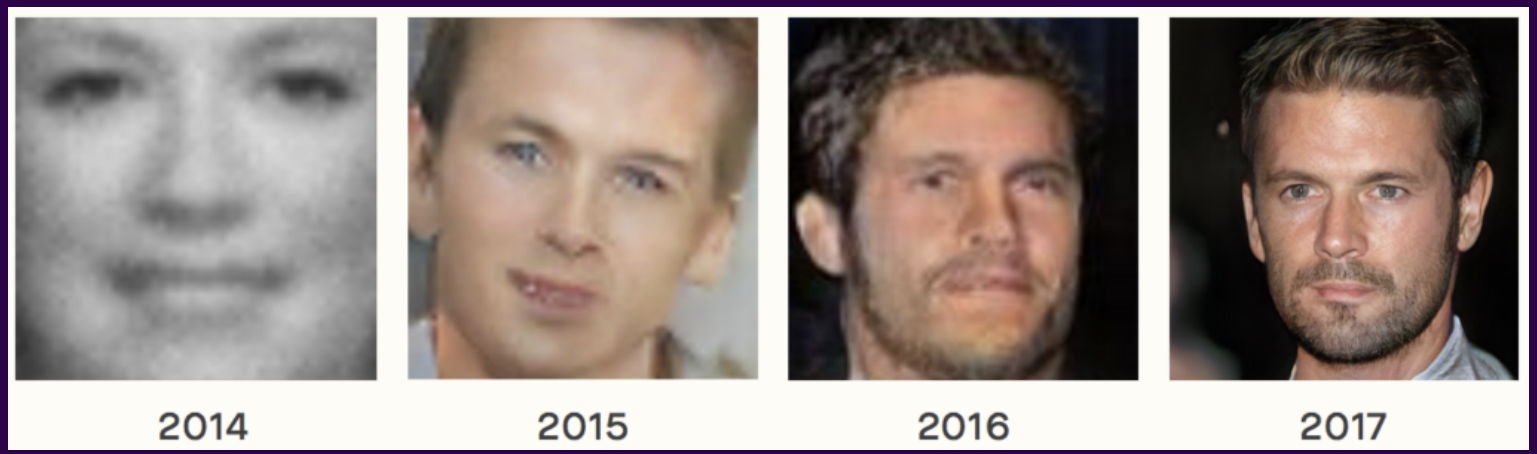


Beginning



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

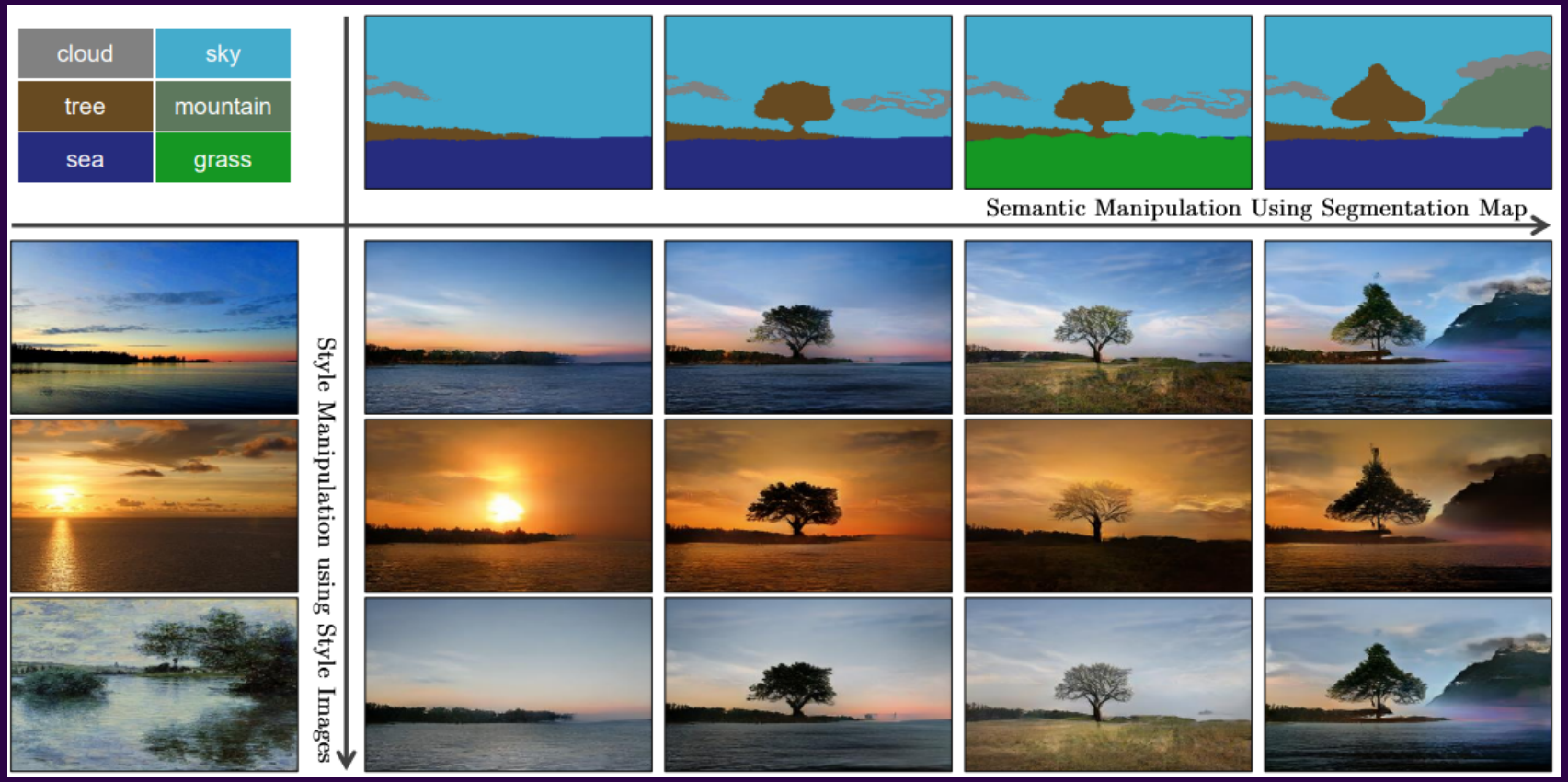


Image Synthesis (Source: https://github.com/NVlabs/SPADEn)

Applications of GANs

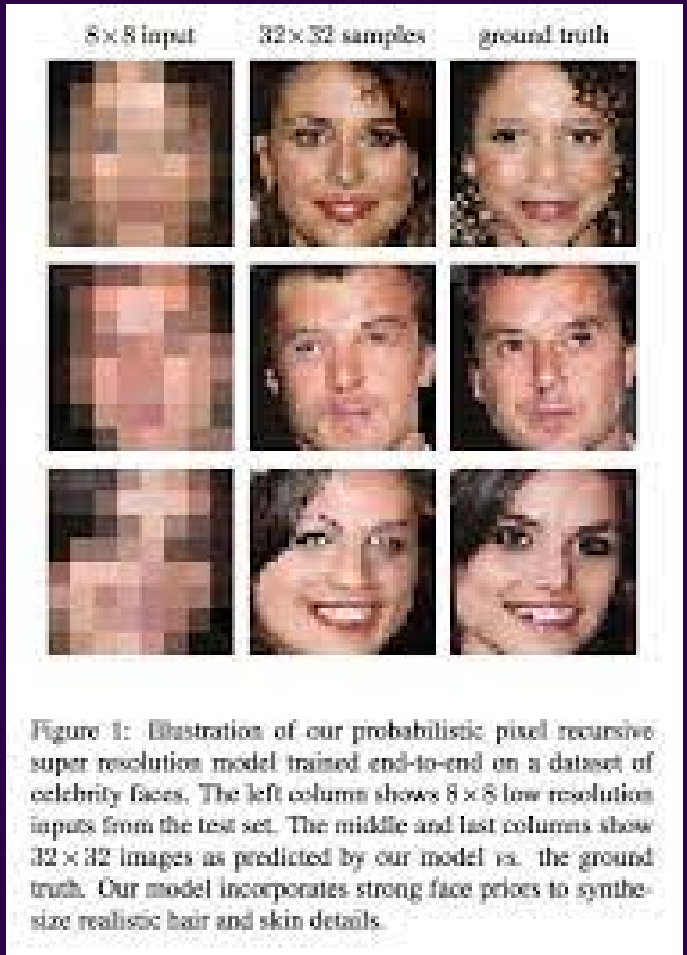


Figure 1: Illustration of our probabilistic pixel recursive super resolution model trained end-to-end on a dataset of celebrity faces. The left column shows 8 × 8 low resolution inputs from the test set. The middle and last columns show 32 × 32 images as predicted by our model vs. the ground truth. Our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

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

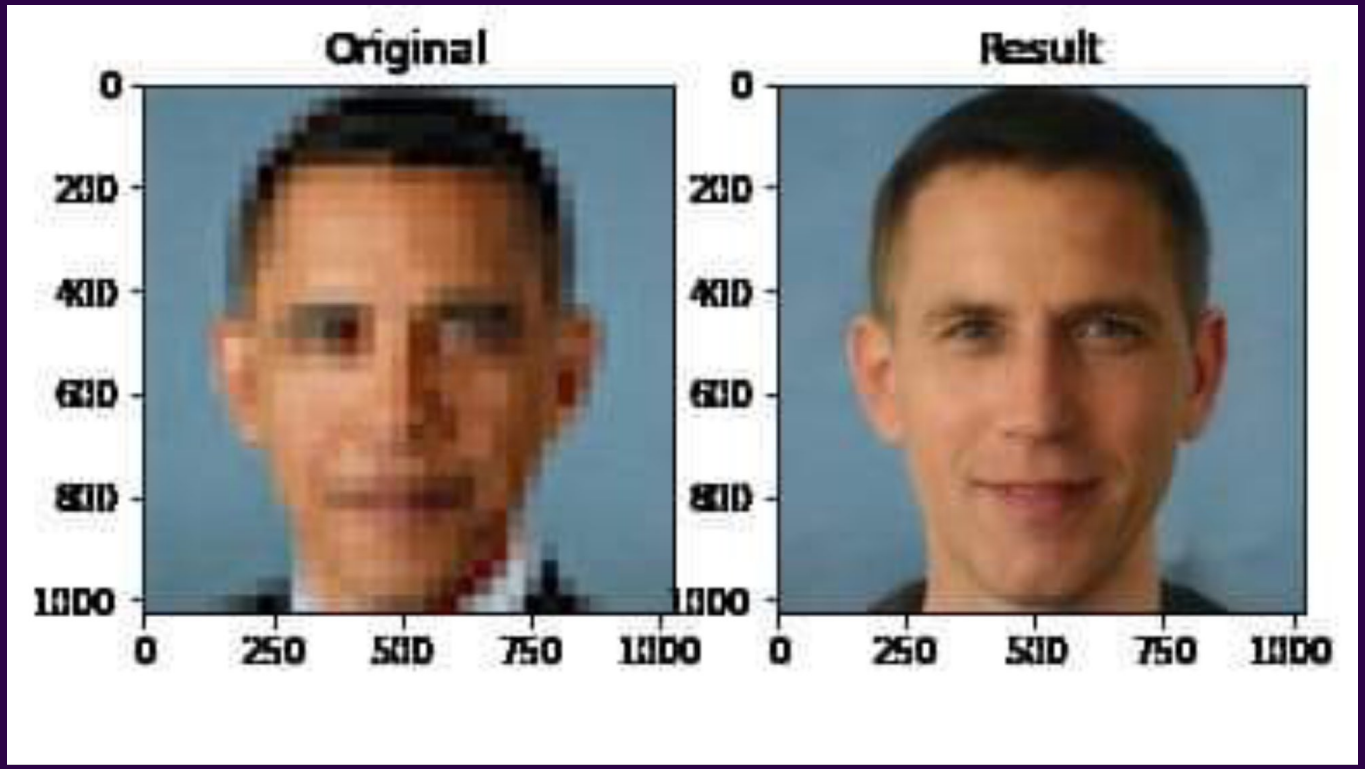
Outline

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?

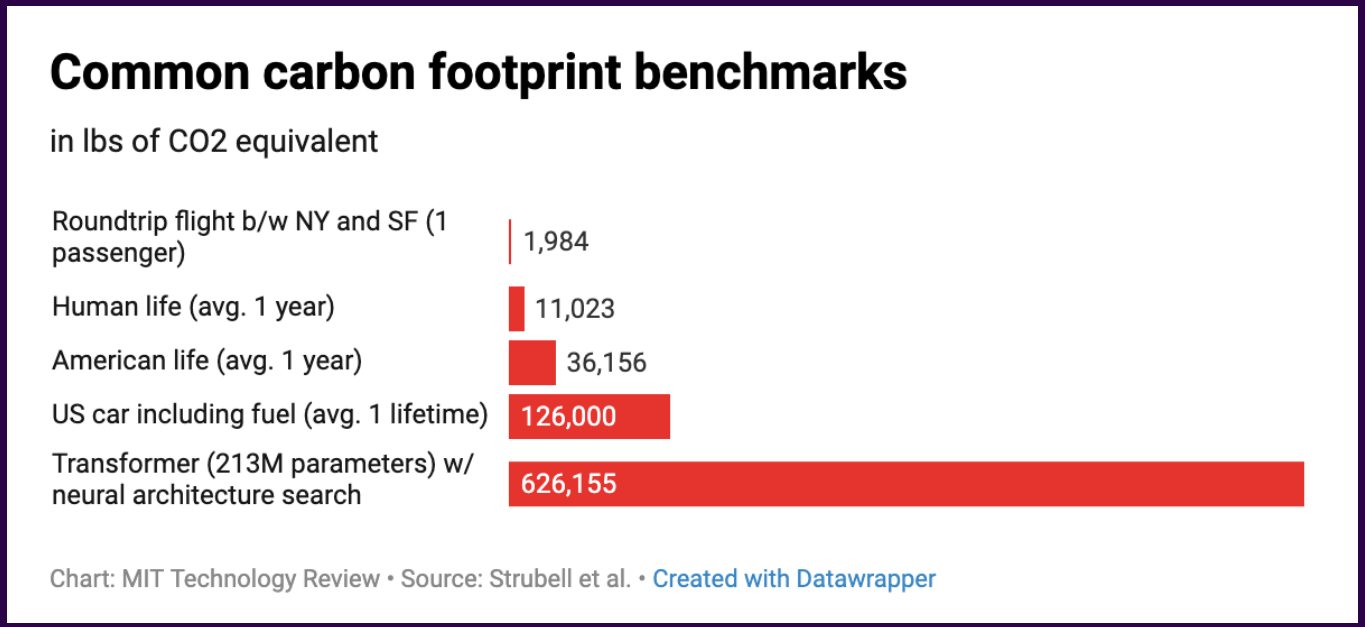
Safety of AI

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



Source: MIT Tech Review

Outline

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!