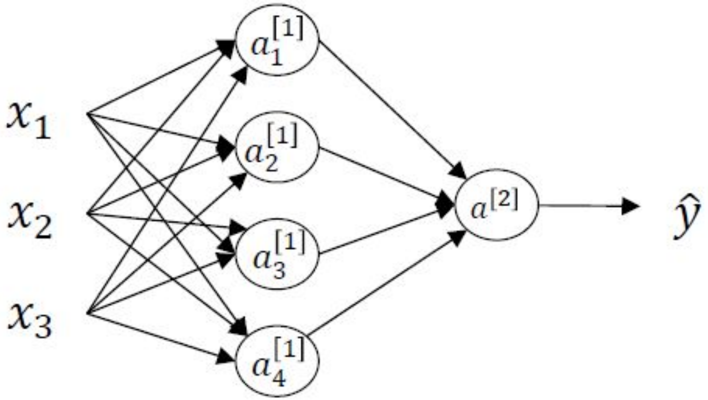
K6312 Information Mining & Analysis

Deep Learning/Deep Neural Networks

Neural Network Representation



Given input x:

$$z^{[1]} = W^{[1]}x + b^{[1]}$$

(4,1) (4,3) (3,1) (4,1)

$$a^{[1]} = \sigma(z^{[1]})$$

(4,1) (4,1)

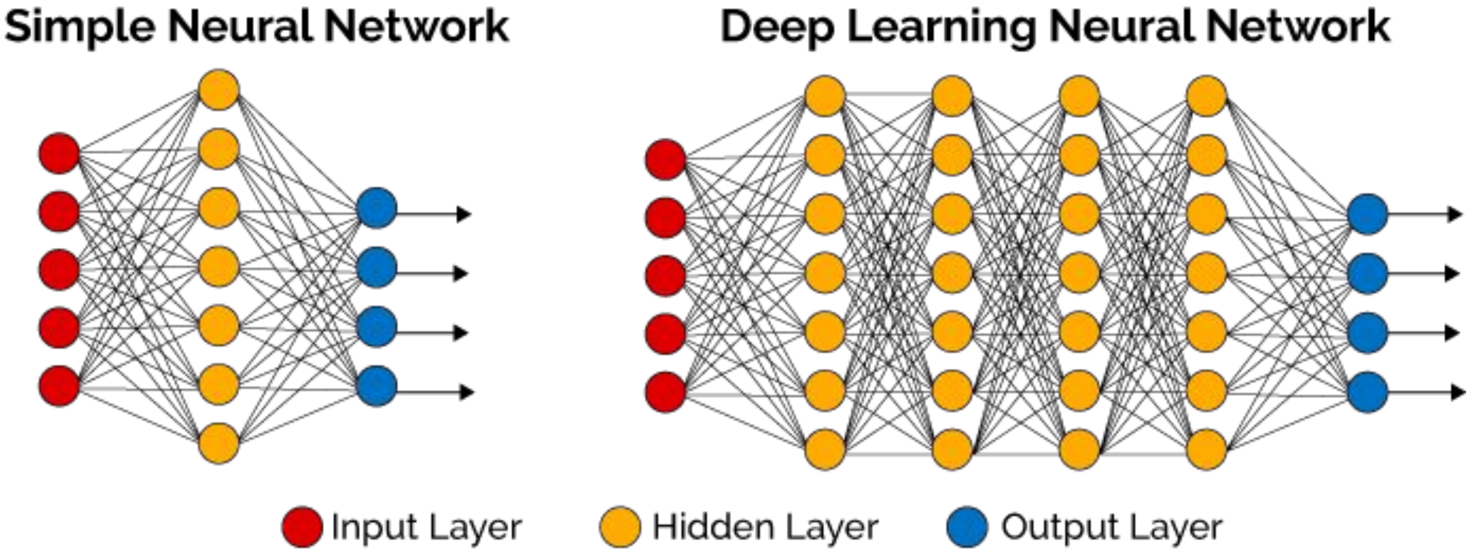
$$z^{[2]} = W^{[2]}a^{[1]} + b^{[2]}$$

(1,1) (1,4) (4,1) (1,1)

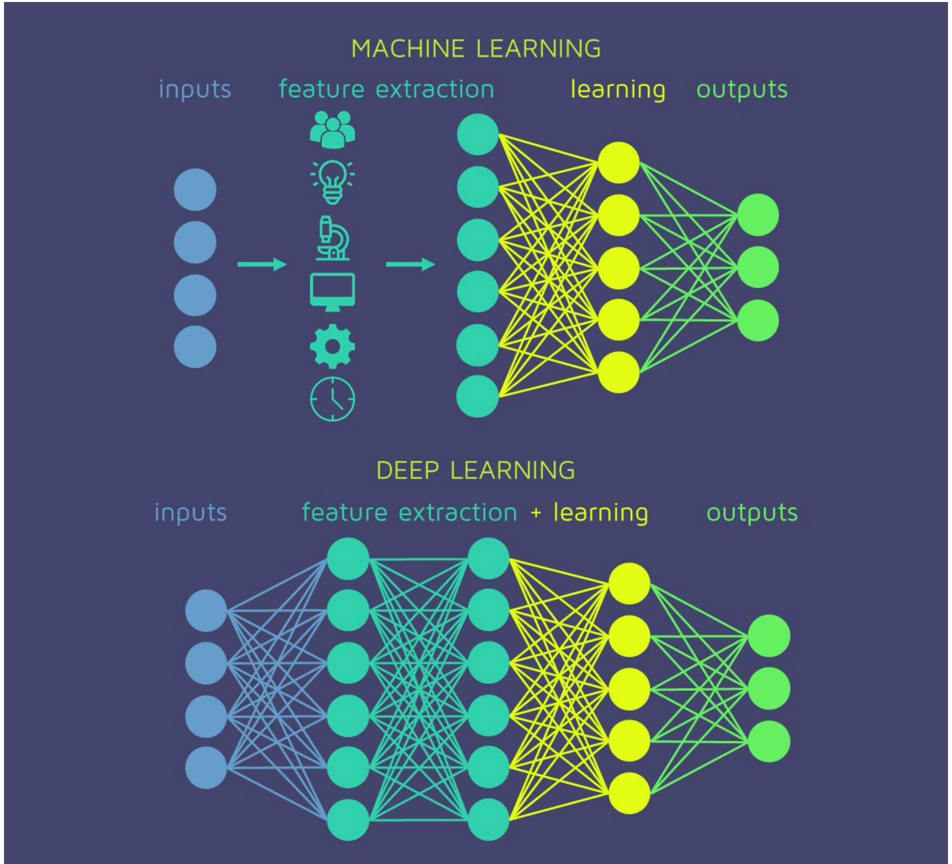
$$a^{[2]} = \sigma(z^{[2]})$$

(1,1) (1,1)

Shallow vs Deep

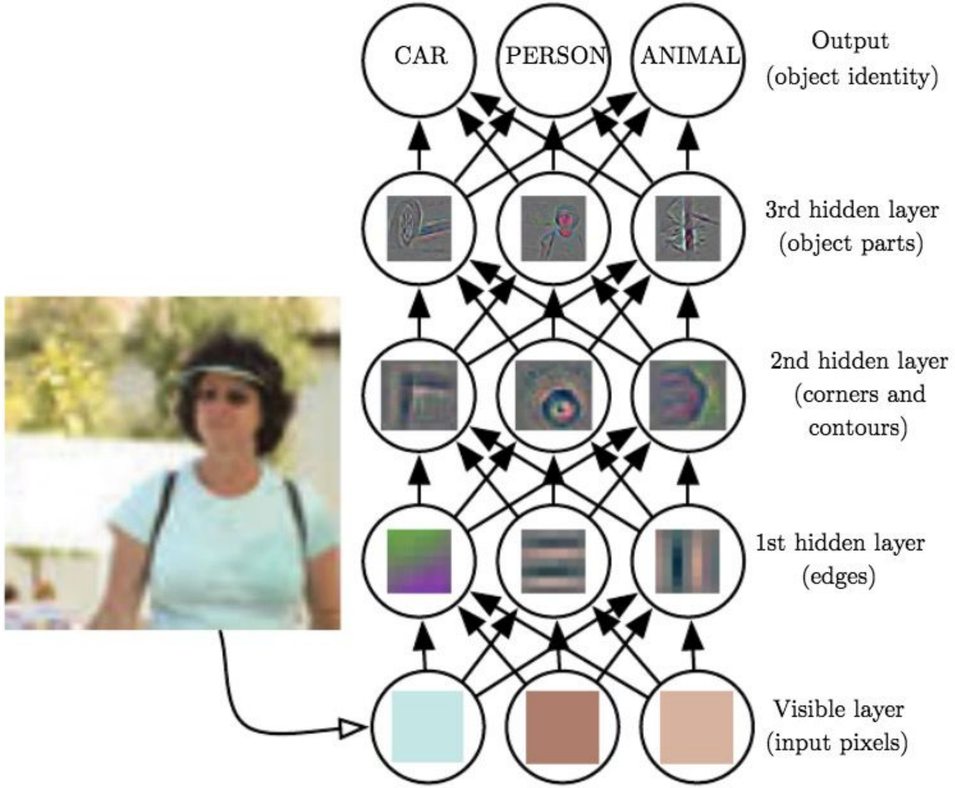


End-to-End Learning



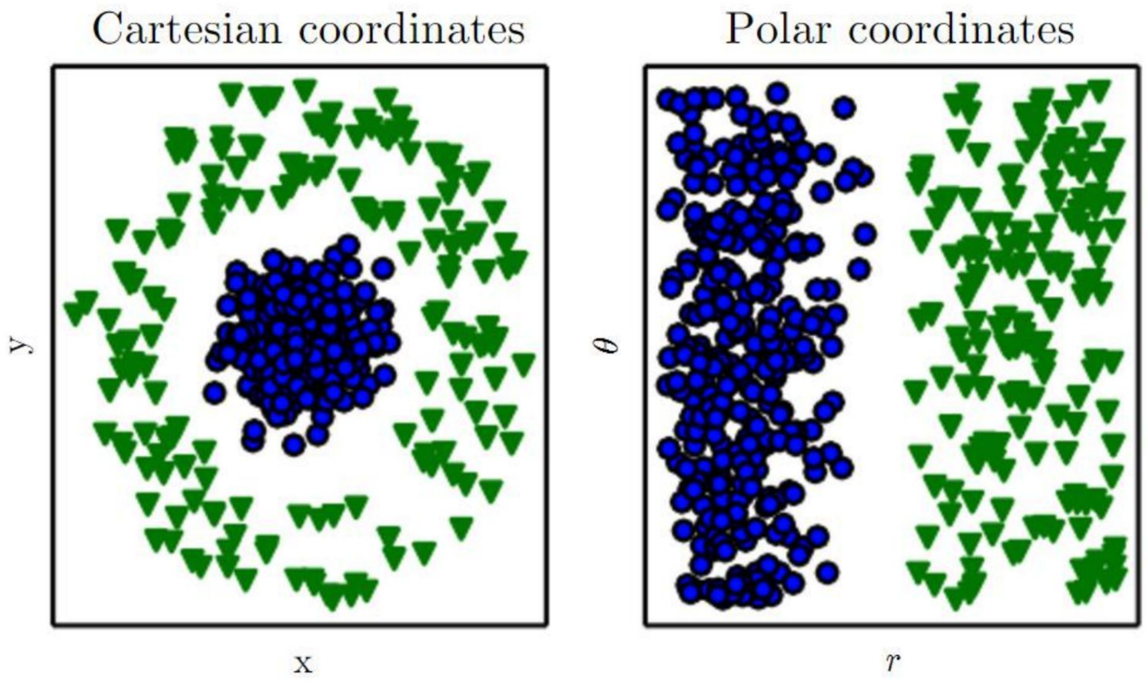
From Aporras

Representation Learning in DL

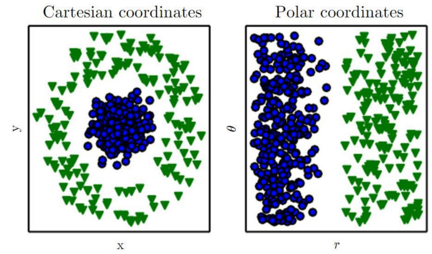


From Deep Learning (Goodfellow)

Representation Matters

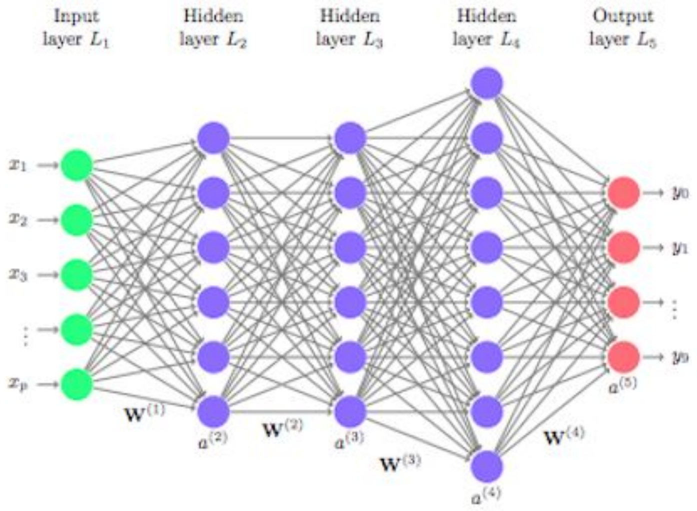


Task: Draw a line to separate the **green triangles** and **blue circles**.

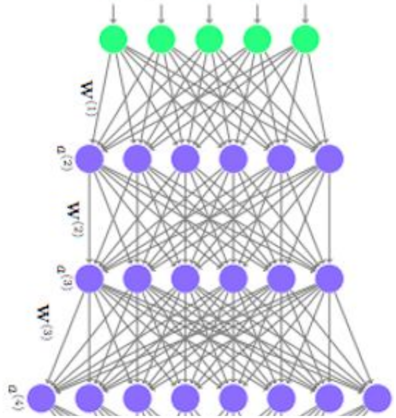


We want to project the data into the new feature/vector space that data is linearly separated

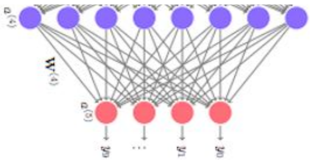
“Trick” in Deep Learning



Low-dim, Original Space

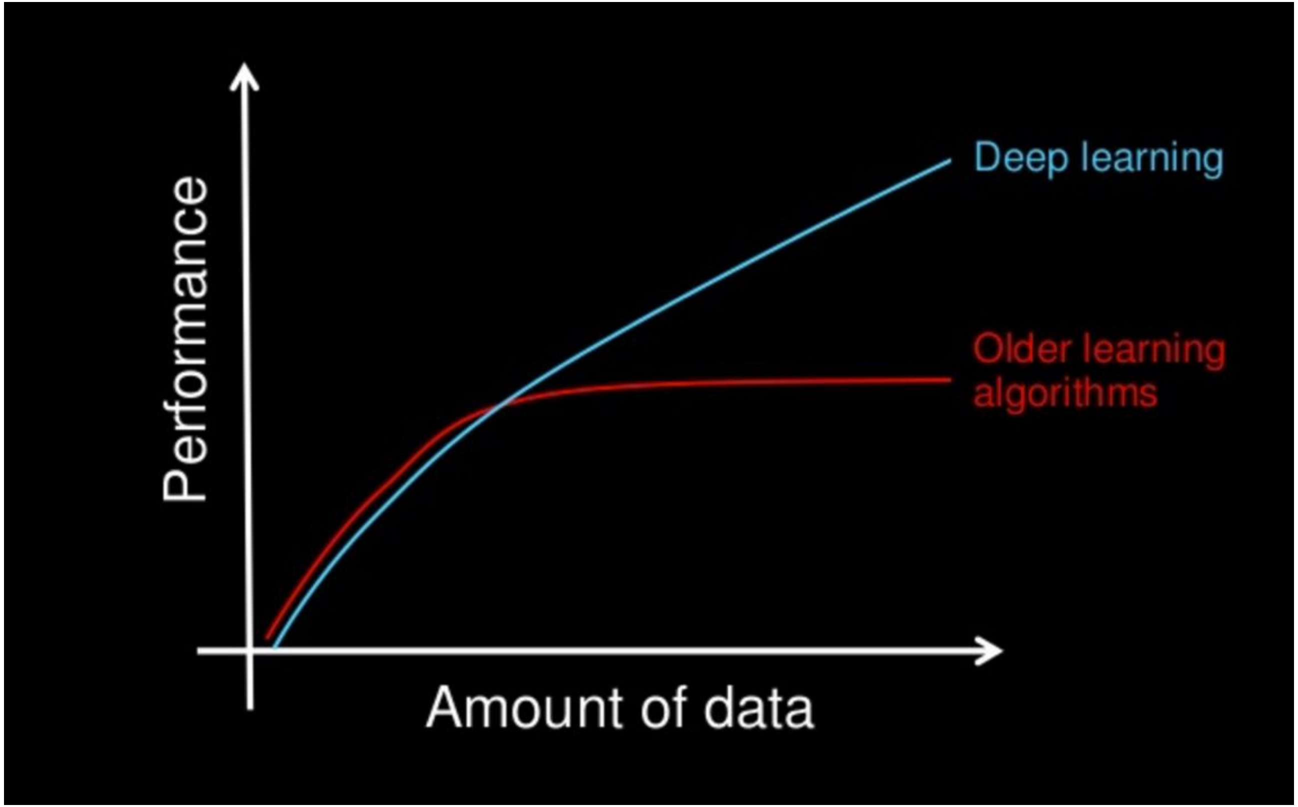


High-dim, **Linearly Separated** Space



Softmax Classifier
(Linear Model)

Why Deep Learning



From Andrew Ng

Deep Learning

- Deep learning is suitable for big data
- Deep learning is able to address unstructured data, which can learn representations from these unstructured data.

Structured

- Structured: Table (Matrix) or Tensor

Features

Labels

Player	Height (inches)	Weight (pounds)	Position
Player 1	76	225	C
Player 2	75	195	PG
Player 3	72	180	SF
Player 4	82	231	PF

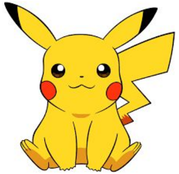
Feature Values

Data Sample

Unstructured

- The original data can not be stored in an “table”
- More abstract, more fuzzy, and more high-dimensionality

Images



Audio

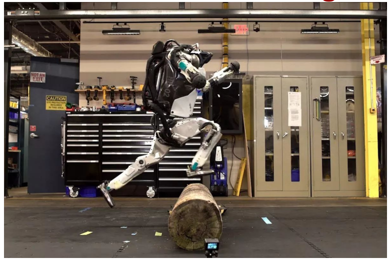
Video

Text

Content

This module provides students a deep overview of various advanced machine learning techniques applied to business analytics tasks. The focus of this course will be the key and intuitive idea behind machine learning models and hands-on examples instead of theoretical analysis. The tentative topics include machine learning pipeline, unsupervised learning, structure learning, Bayesian learning, deep learning and generative models. The programming languages used will be Python.

Environment around agent



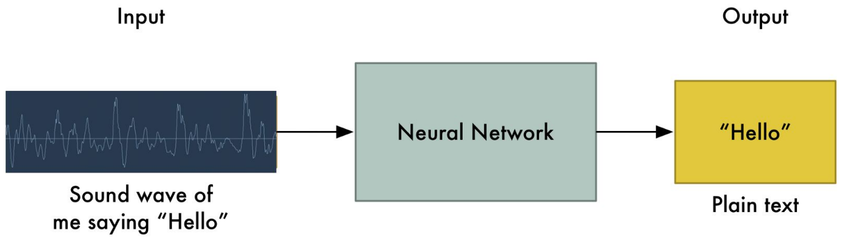
Deep Learning

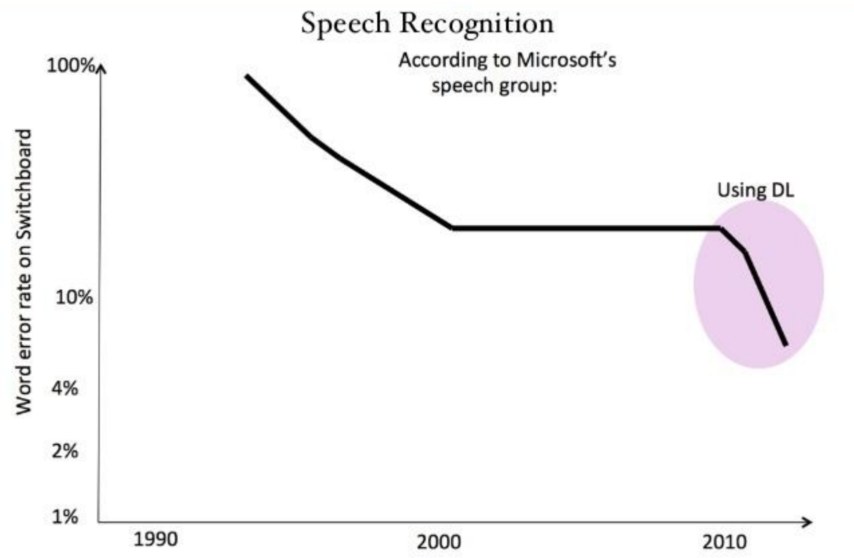
- Deep learning is a subfield of machine learning
- Most machine learning methods work well because of high-quality feature engineering/representation learning.
- Deep learning is an **end-to-end** structure, which supports automatic representation learning
- Different network structures: CNN, RNN, LSTM, GRU, Attention model, etc

Applications of DL

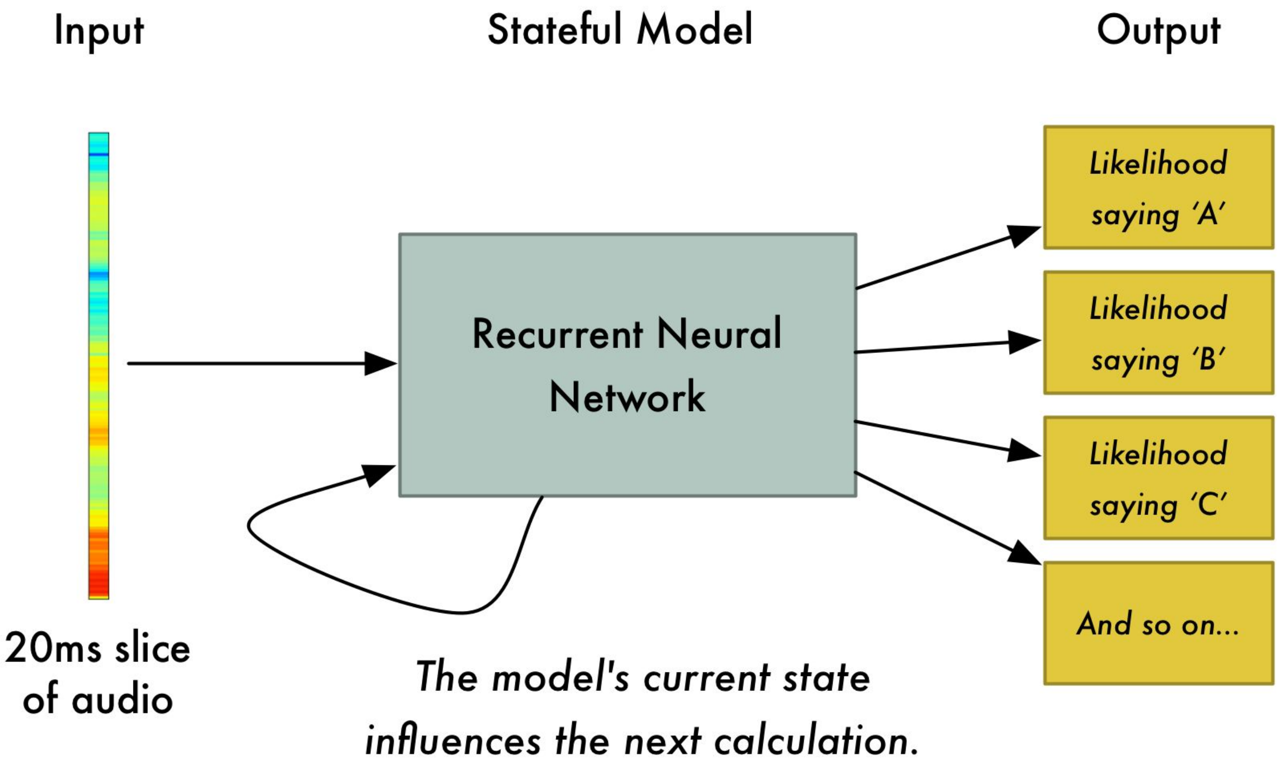
Deep Learning for Speech

The first real-world tasks addressed by deep learning is speech recognition





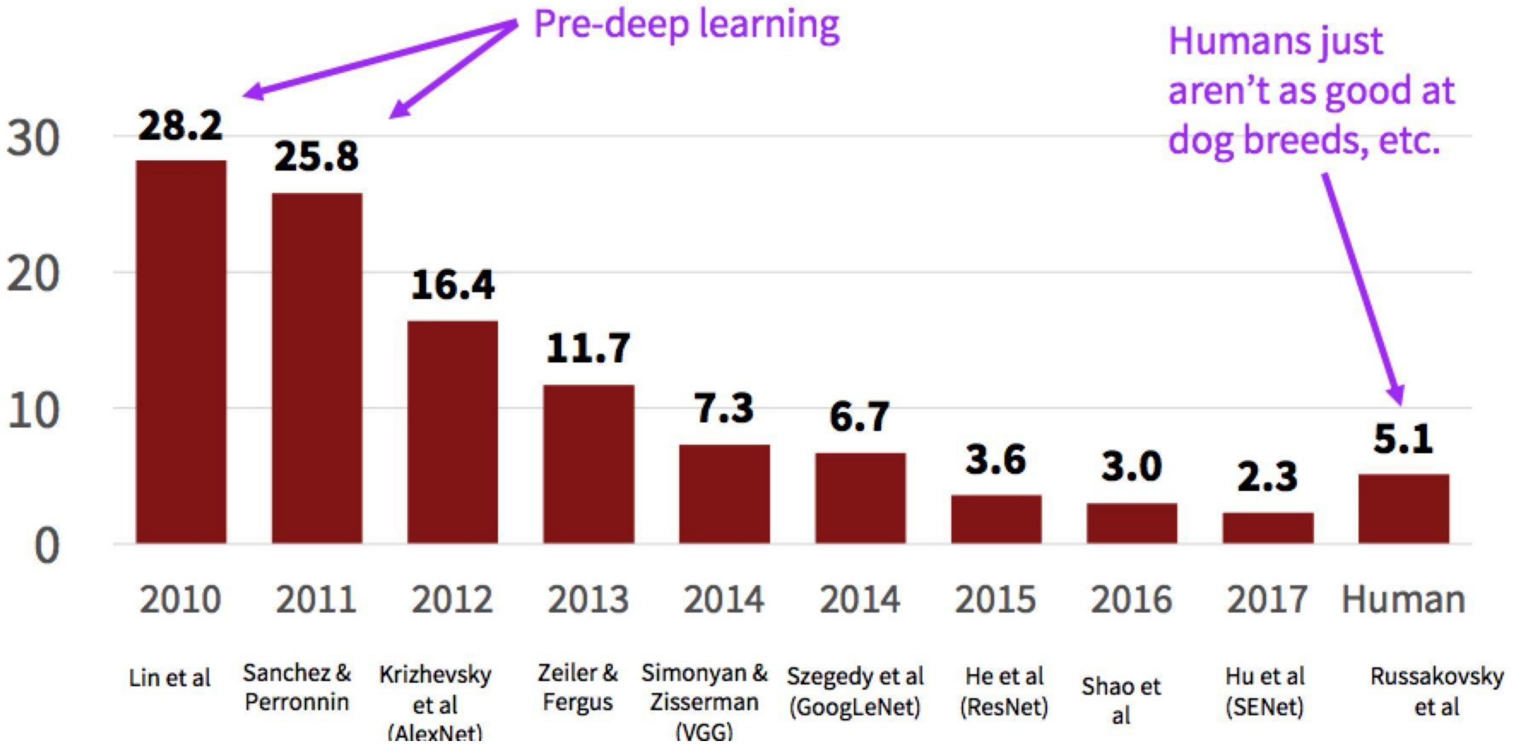
Recurrent Neural Network for Sequential Data



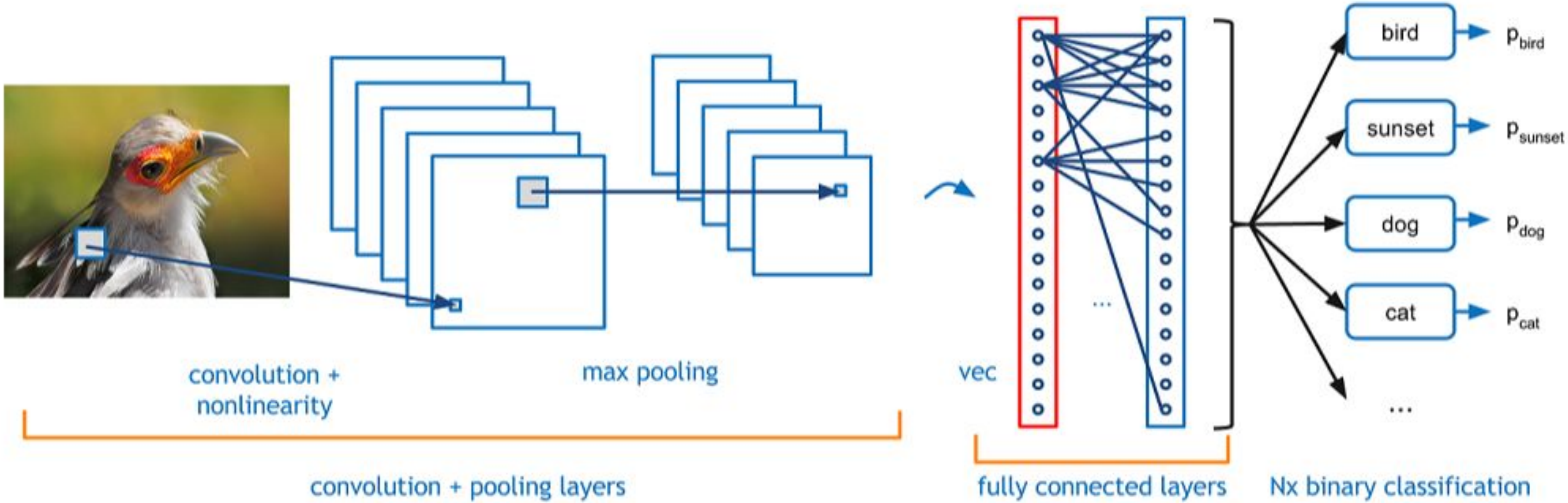
Deep Learning for Computer Vision

- Computer vision may be the most well-known breakthrough of DL.
- ImageNet Classification with Deep Convolutional Neural Networks.

ImageNet Scoreboard

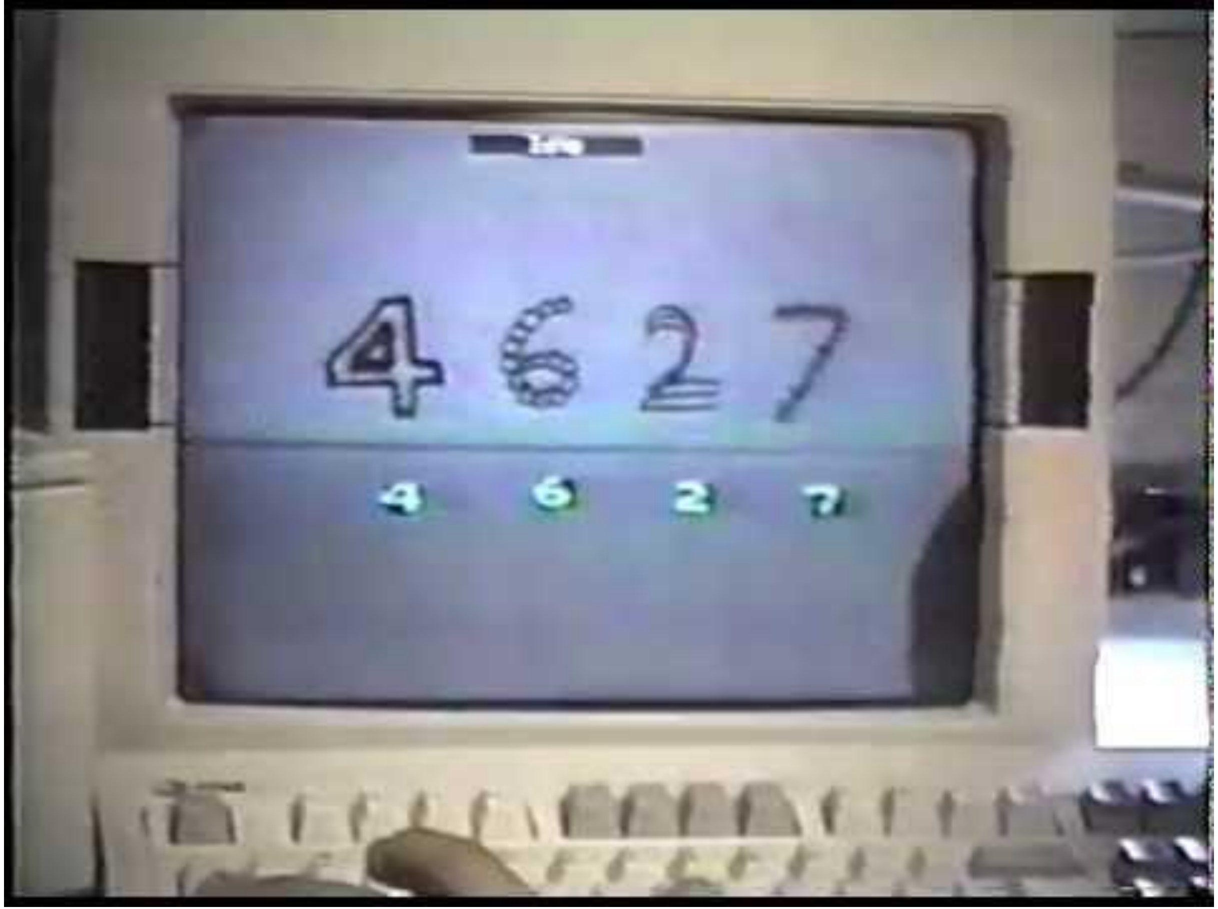


Convolutional Neural Network For Image



Extracting useful features of data

Perform a ML task (like classification based on the vectorized data)



https://www.youtube.com/watch?v=FwFduRA_L6Q

Deep Learning For Data Generation

Given training data, generate new data samples from same distribution

Examples of Photorealistic GAN-Generated Faces.

Generative Models

- Given training data, generate new samples from same distribution

Training data ~ $p_{data}(x)$

Generated samples ~ $p_{model}(x)$

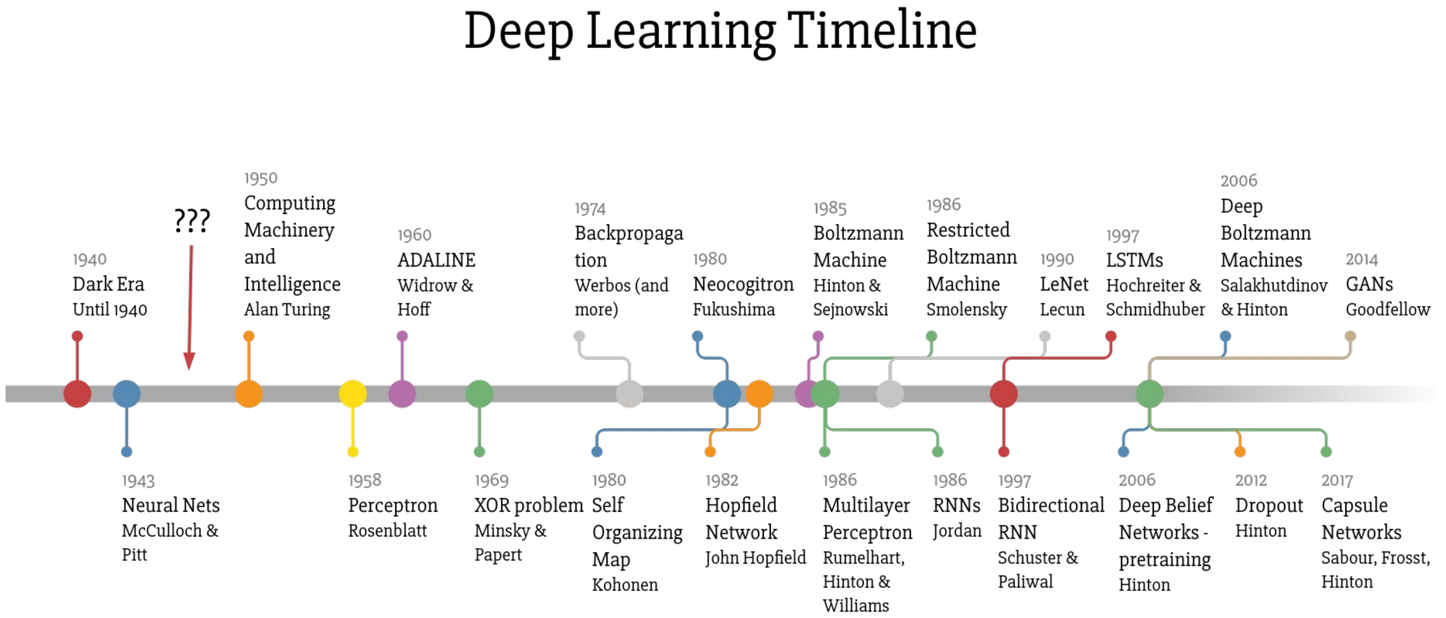
- Want to learn $p_{model}(x)$ similar to $p_{data}(x)$

- Address density estimation, a core problem in ? learning


Source Video
Detected Pose
Source to Target 1 Result

GAN progress on face generation from Ian Goodfellow

DL/NN is not New



Made by Favio Vázquez

Why is Deep Learning Powerful Now?

- Feature engineering require high-level expert knowledge, which are easily over-specified and incomplete.
- Large amounts of training data
- Modern multi-core CPUs/GPUs/TPUs
- Better deep learning ‘tricks’ such as regularization, optimization, transfer learning etc.

When DL may not Work

You need to get off your non-motor vehicle when u pass the pedestrian crossing.

detected offender

The Challenge of Deep Learning

- **Ask the right question** and **know what the answer means**:

  Image classification is not scene understanding.

- **Select, collect, and organize the right data to train on**:



Efficient Teaching/Efficient Learning

- Humans can learn from few examples

- DL/machine require thousands/millions of examples
    - Data augmentation

Limitations

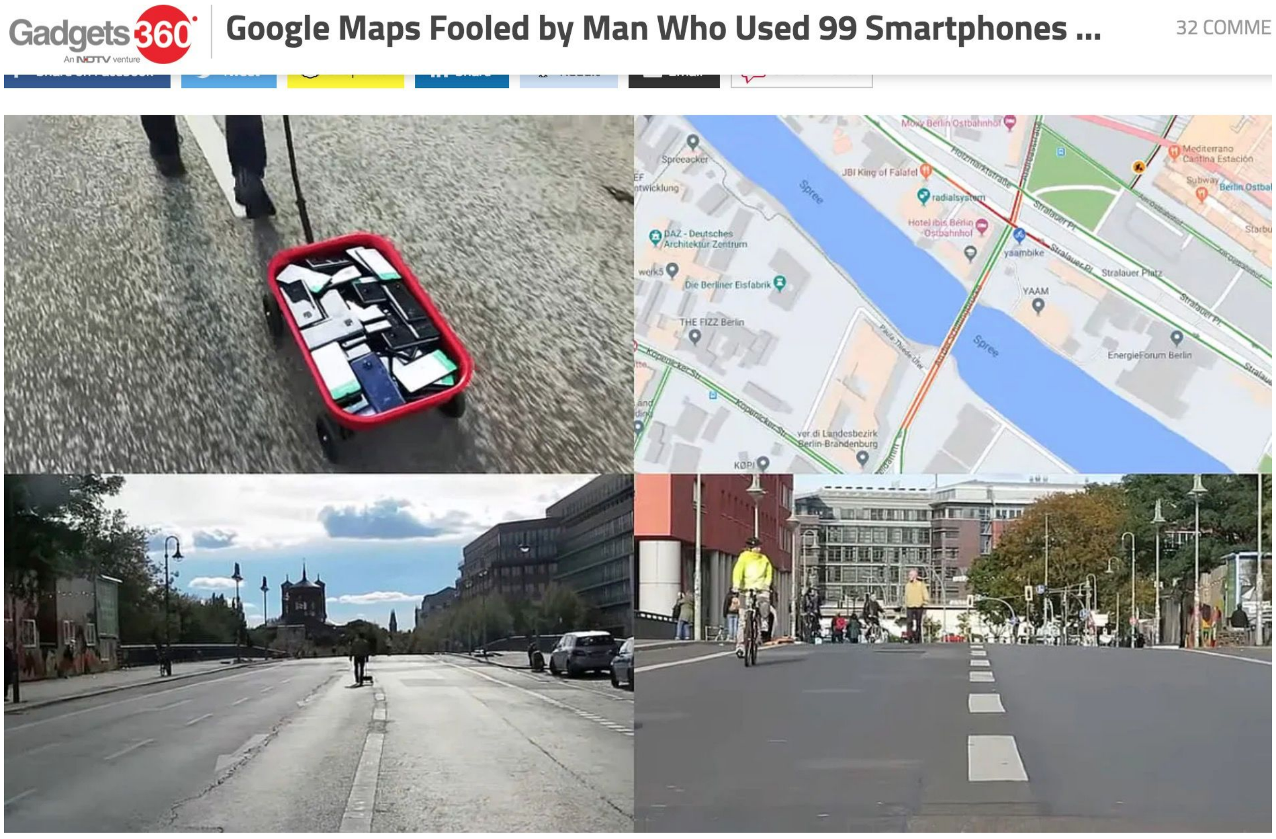
- DL always requires a large amount of annotated data

14 million *Pre-training, Transfer Learning, Data Augmentation*

- Generalization capability is low, e.g. the model that perform well on benchmarked datasets fail badly on real world images

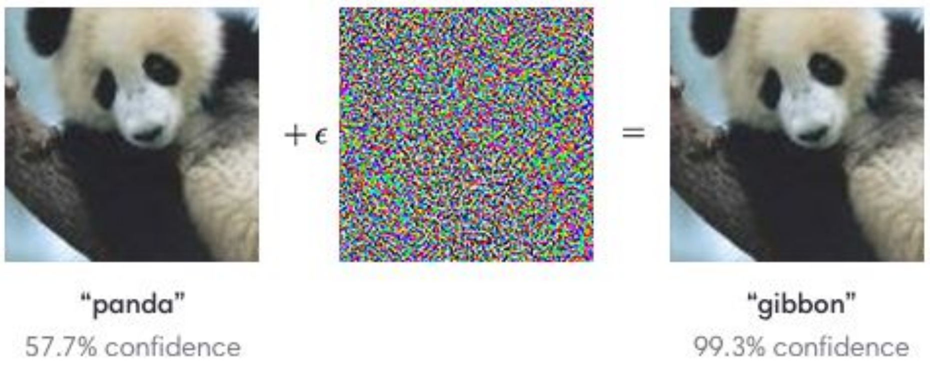
- Easily got attacked by random, tiny noise
- How to explain such huge black box

Attack Machine Learning

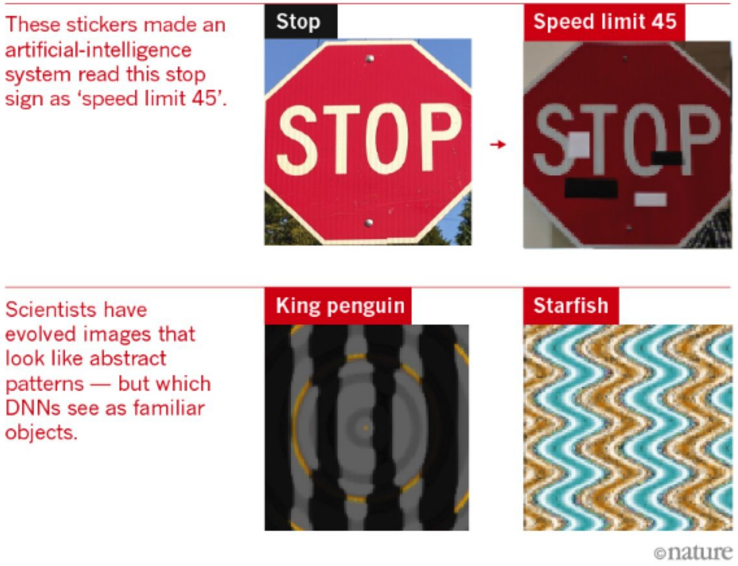


Attack Machine Learning

Adversarial Examples



Open AI



Why deep-learning AIs are so easy to fool

Three points behind Successful ML Application

Zhihua ZHOU

- Deep algorithms, i.e., deep learning
- Strong supervision information (data with high quality labels)
- Stable learning environment

Limitations of DL

Key Takeaways

- Neural Network is: 1 linear transformation 2 non-linear activation
- Gradient Descent plus Back-Propagation is used to find the model parameters of neural networks
- Deep learning: neural network with a deep structure (many layers)
- Deep learning is the method which tries to learn features by the model itself without human efforts