Machine Learning

Jake Searcy

Associate Director of AI

UNIVERSITY OF OREGON

Getting Started

https://github.com/jsearcy1/BI608-2020

UNIVERSITY OF
OREGON

Motivations

Johns Hopkins study suggests medical errors are third-leading cause of death in U.S.

https://hub.jhu.edu/2016/05/03/medical-errors-third-leading-cause-of-death/

Error=any action “that does not achieve its intended outcome” or any planned action that, for whatever reason, is not done “that may or may not cause harm to the patient.”

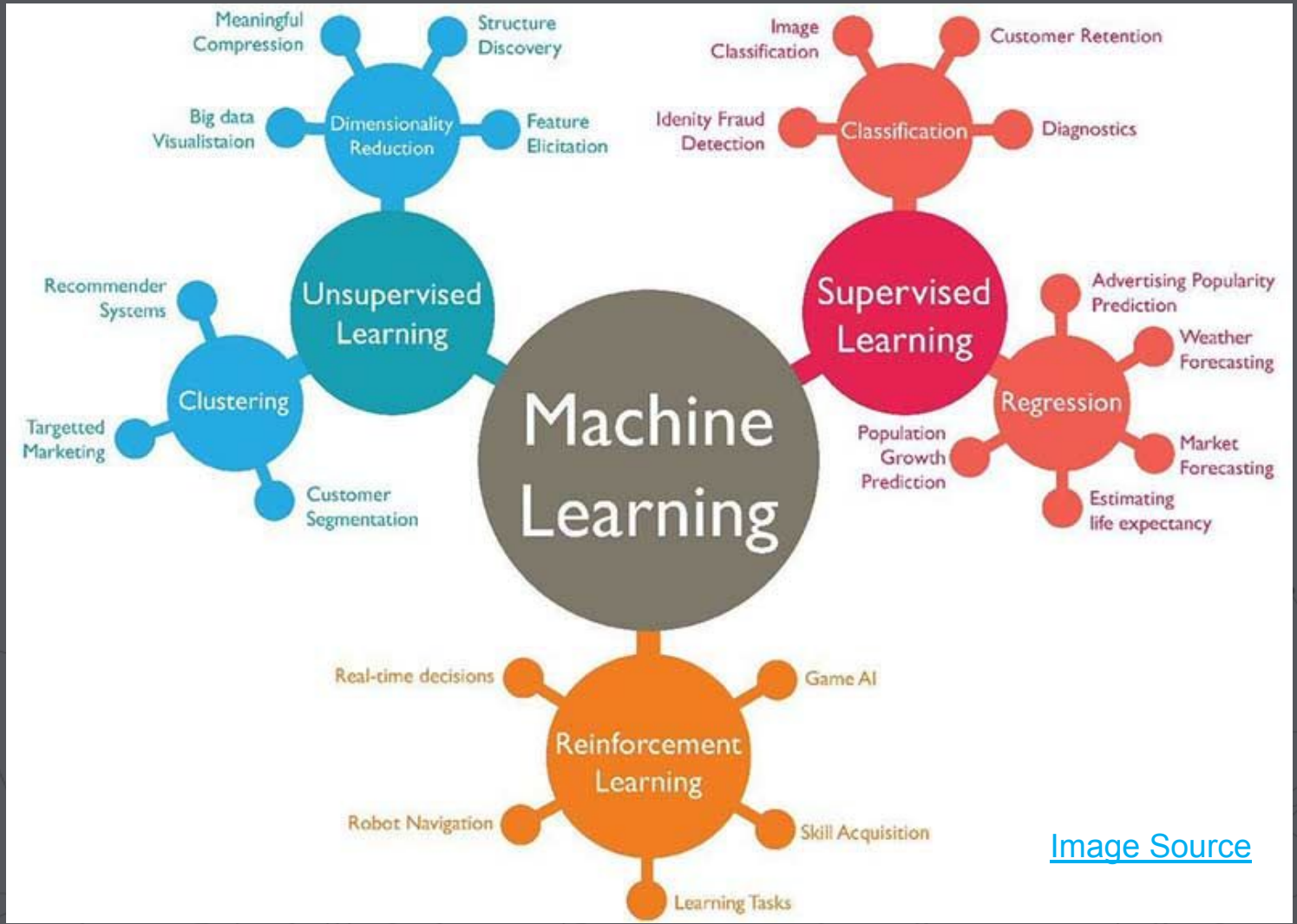
What is Machine Learning

- **Machine learning (ML) is a lot like programing**
  - It's a series of technique for telling a computer how to do something
  - Instead of writing an algorithm with code you create a system that can learn an algorithm from data

- **Often is not the right choice**
  - Training an ML model to add numbers
    - Would take a comparatively lot of work
    - And isn't would be as accurate a

- **Perfect when you have data but no algorithm**

Besides quick coding fingers, look for a personality that can cope with failure. You almost never know what you're doing, even if you think you do.
--Cassie Kozyrkov Chief Decision Intelligence Engineer at Google



What technique depends on the problem

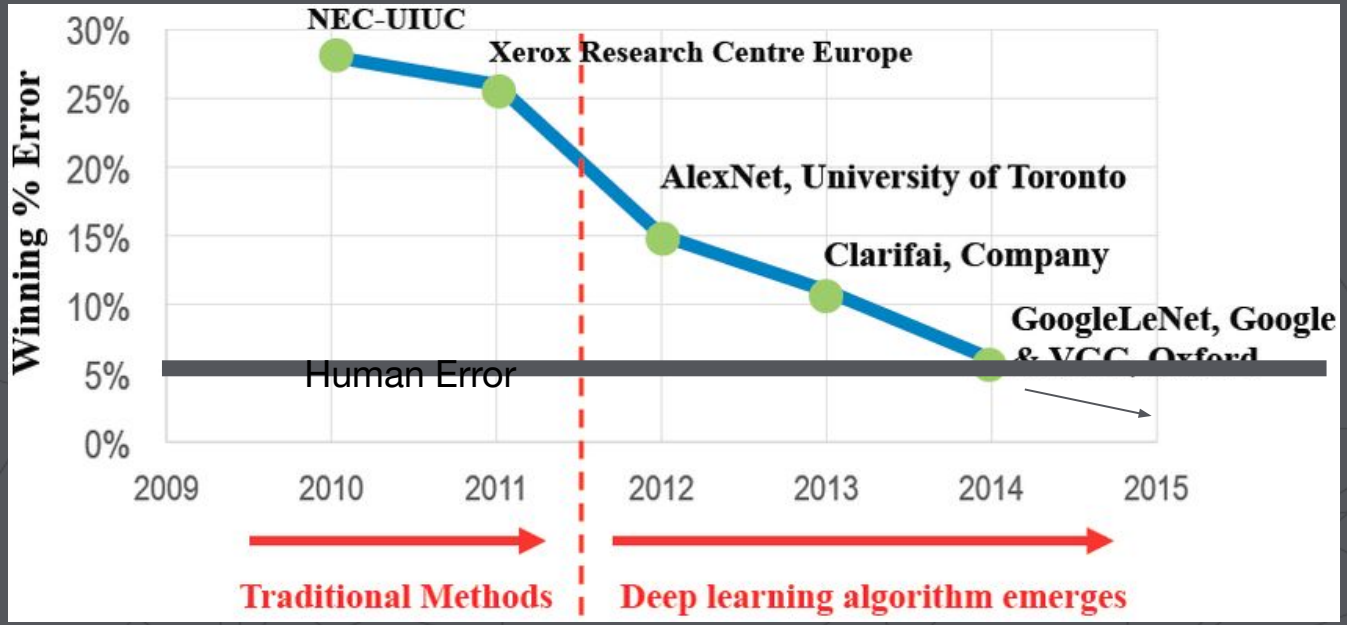
[Image Source]

Thought Experiment

How would you write an algorithm to tell the difference between cats and dogs

Images

Rule based algorithms are difficult to design images, deep learning wins Image-net Challenge: Identify the subject of an image out of 1000 classes



Still an Algorithm

- Algorithms can have bugs
  - Bugs in ML often occur in data

Vocab

- Artificial Intelligence
  - An all encompassing term for a broad field the most promising of which is currently machine learning
  - Machine Learning
    - Deep Learning - Deep Neural Networks of all forms
    - ‘Traditional’ Machine Learning - Pretty much everything else
      - Trees, SVMs, Linear Regression, Naive Bayes...
- X’s = Input variables
- Y’s = Target Variables
- Loss function - Numerical Goal of the Model

Machine Learning

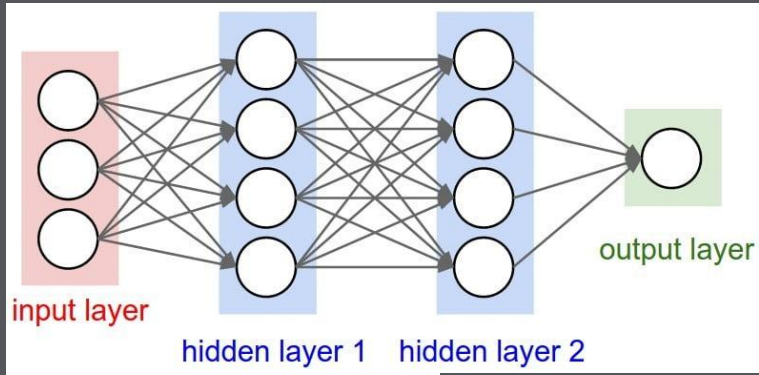
- In different works ML models try to
  - Find f(x) such that f(x) best approximates y

- Examples:
  - Given some pixels (x) tell me the probability it's a cat (y)
  - Given news articles (x) tell me a stocks value (y)

- Important Note: No prediction of causality
- Function outputs can be stochastic

Deep Learning

- Very powerful method used for a host image analysis problems
- Many layers often of different types
- Dense, Convolutional, Dropout



$$a_j^l = \sigma\left(\sum_k w_{jk}^l a_k^{l-1} + b_j^l\right)$$

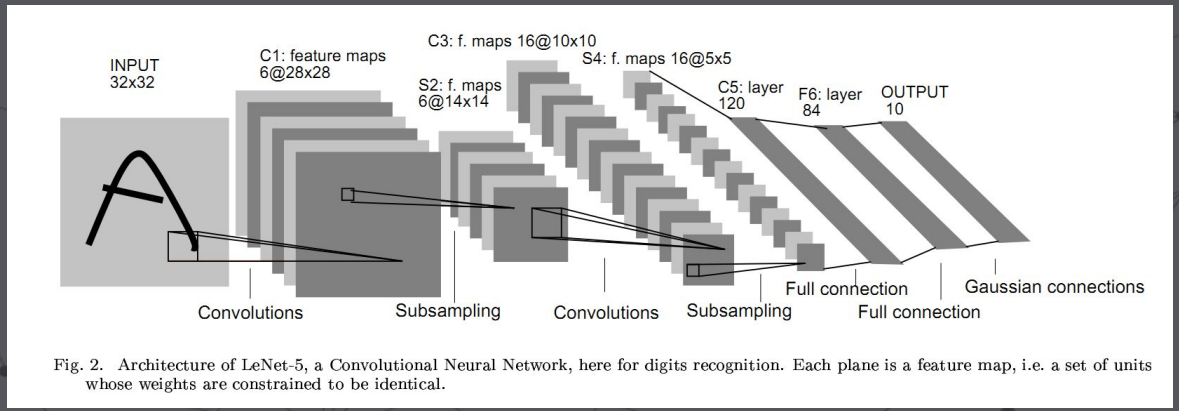
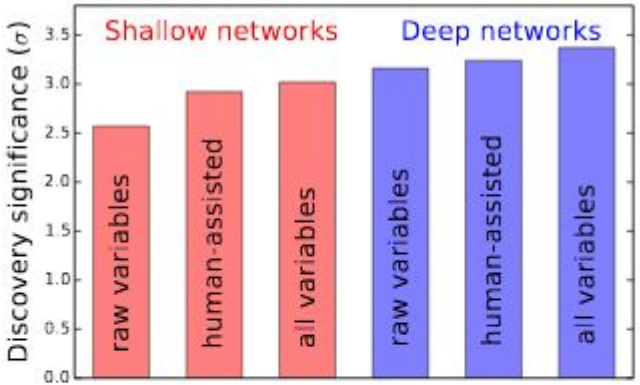


Fig. 2. Architecture of LeNet-5, a Convolutional Neural Network, here for digits recognition. Each plane is a feature map, i.e. a set of units whose weights are constrained to be identical.

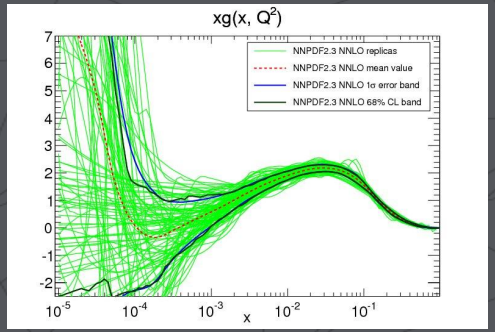
DNN Advantages

- Often can lead to better results than human crafted algorithms
  - Provided the data is sufficient
- Can ingested huge varieties of raw data with limited or no preprocessing
  - Text
  - Images
  - Sounds
  - etc.
- Can estimate uncertainties on fits without assumptions on functional forms
  - Rare due to CPU expense



10.1103/PhysRevLett.114.111801

FIG. 5. Comparison of discovery significance for the traditional learning method (left) and the deep learning method (right) using the low-level variables, the high-level variables and the complete set of variables.



Building a Network

- Deep Neural Networks are usually a stack of layers that learn how to transform input data into something useful

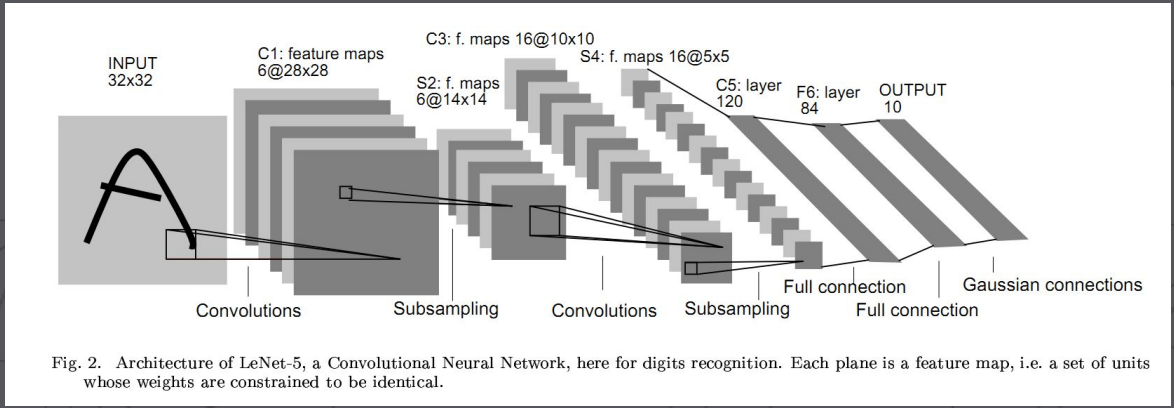


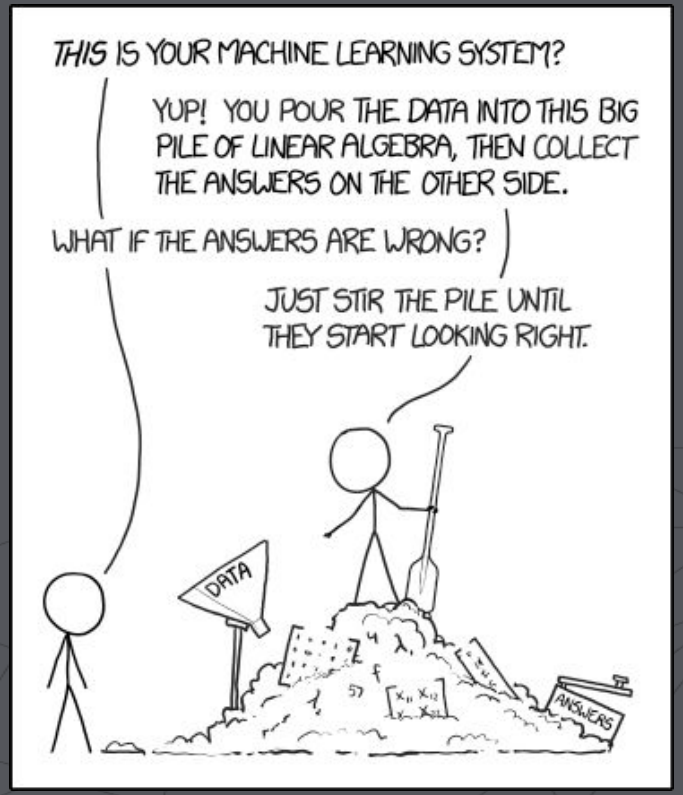
Fig. 2. Architecture of LeNet-5, a Convolutional Neural Network, here for digits recognition. Each plane is a feature map, i.e. a set of units whose weights are constrained to be identical.

The big two

The two most important blocks we'll introduce throughout the workshop

- Dense Neural Networks
  - Simplest layers and an introduction
- Convolutional neural Networks
  - Layers designed for images

How Does it Work



Software Tools

- Tons of implementations of basic ML tools
  - Matlab
  - R
  - STAT
  - SAS
- All ML research and development is happening in python
  - **Tensorflow**
  - PyTorch
- Deploying ML models in production a bit more diverse

Hardware Tools

- **GPUS**
  - Nvidia GPUs are the primary tools for machine learning
    - Primarily due to CUDA
- **CPUS**
  - Fine for smaller models, can't compete with GPUS for larger models
- Tensor Cores
  - Next generation of core highly optimized for tensor operations used in Deep Learning
    - Google's TPUs
    - Nvidia's RTX/Volta lines
      - FP16 only
- Others
  - FPGAs
  - Graph Cores and other custom chips
- As a user CPUS are a good place to start, and GPUs will be the main workhorse

Engineering

What is ‘right’

- Some things don’t work
- Lots of things work fine
- What works best depends on the dataset
- **When getting started focus on what works**

Not a Good a Car Tire

Plenty of Good Car Tries

Machine Learning Cycle

- Create/Get a dataset
- Build a model
- Train your dataset
- Evaluate
- Repeat

Use

Let’s Get Started!