Machine Learning

DataCrux Insights @Copyright 2018

A Few Quotes

- "A breakthrough in machine learning would be worth ten Microsofts" (Bill Gates, Chairman, Microsoft)
- "Machine learning is the next Internet" (Tony Tether, Director, DARPA)
- Machine learning is the hot new thing" (John Hennessy, President, Stanford)
- "Web rankings today are mostly a matter of machine learning" (Prabhakar Raghavan, Dir. Research, Yahoo)
- "Machine learning is going to result in a real revolution" (Greg Papadopoulos, CTO, Sun)
- "Machine learning is today's discontinuity" (Jerry Yang, CEO, Yahoo)

DataCrux Insights @Copyright 2018

Contents:

1. Introduction/Definition
2. Where and Why ML is used
3. Types of Learning

DataCrux Insights @Copyright 2018

So What Is Machine Learning?

- Automating automation
- Getting computers to program themselves
- Writing software is the bottleneck
- Let the data do the work instead!

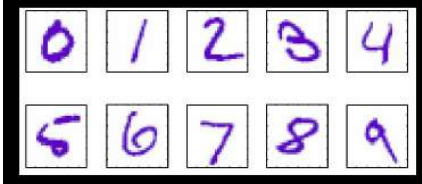
SAS definition '**Machine learning is a method of data analysis that automates analytical model building**'

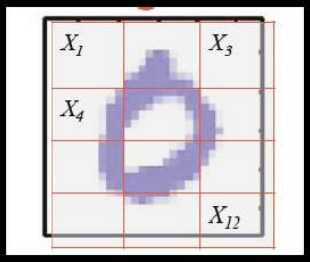
A computer program is said to 'learn' from experience E with respect to some class of tasks *T* and performance measure P, if its performance at tasks in T, as measured by P, improves with experience E

DataCrux Insights @Copyright 2018

Example:

Classification: Digit Recognition





Input (X_i) : Image Features

Output (Y): Class Labels { $y^0, y^1, . y^9$ }

Features(X_i):
Proportion of pixels in
Each of the 12 cells
X_i *where* $i = 1,2,\ldots,12$

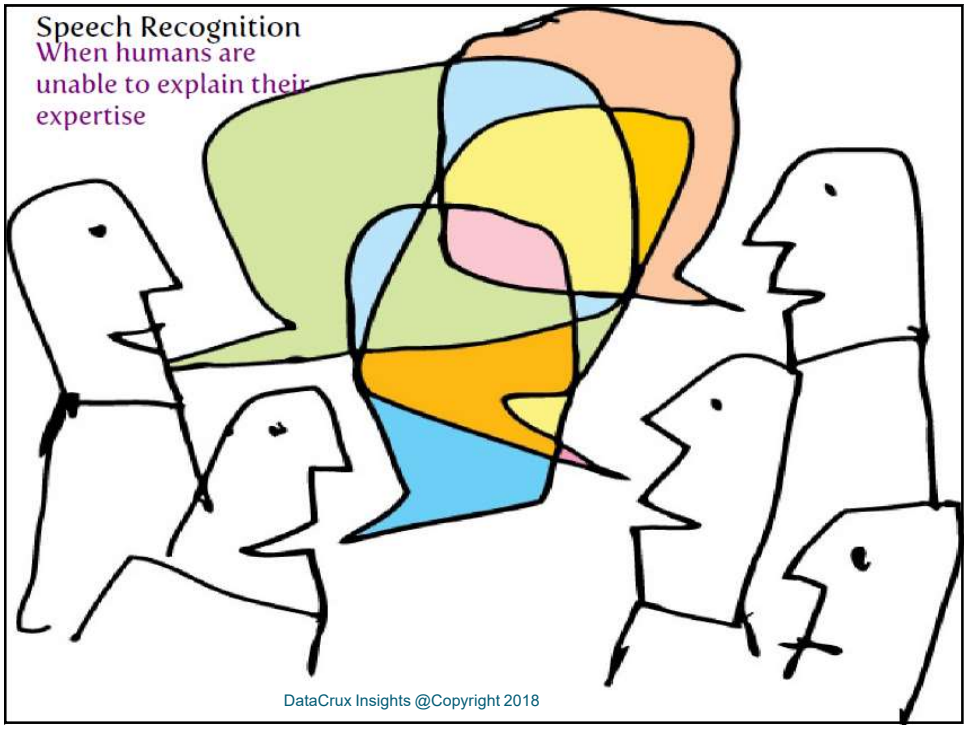
x_i^0=0-10%
x_i^1=10-20%
....

Val(Xi)=10

DataCrux Insights @Copyright 2018

No of parameters= 10^{12} - 1

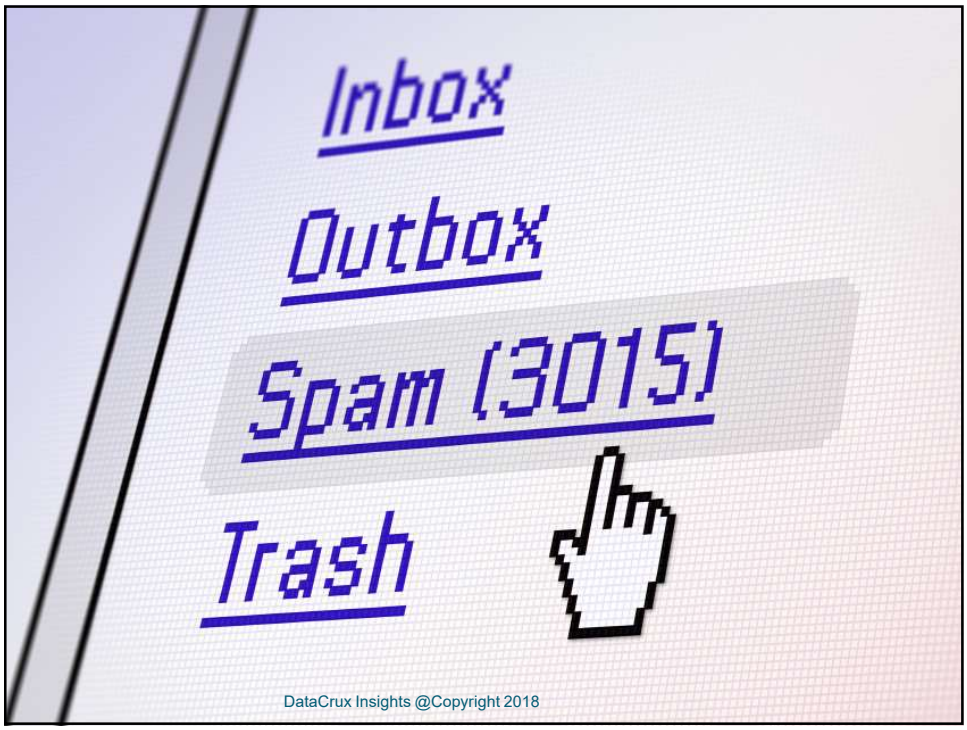
Speech Recognition
When humans are unable to explain their expertise



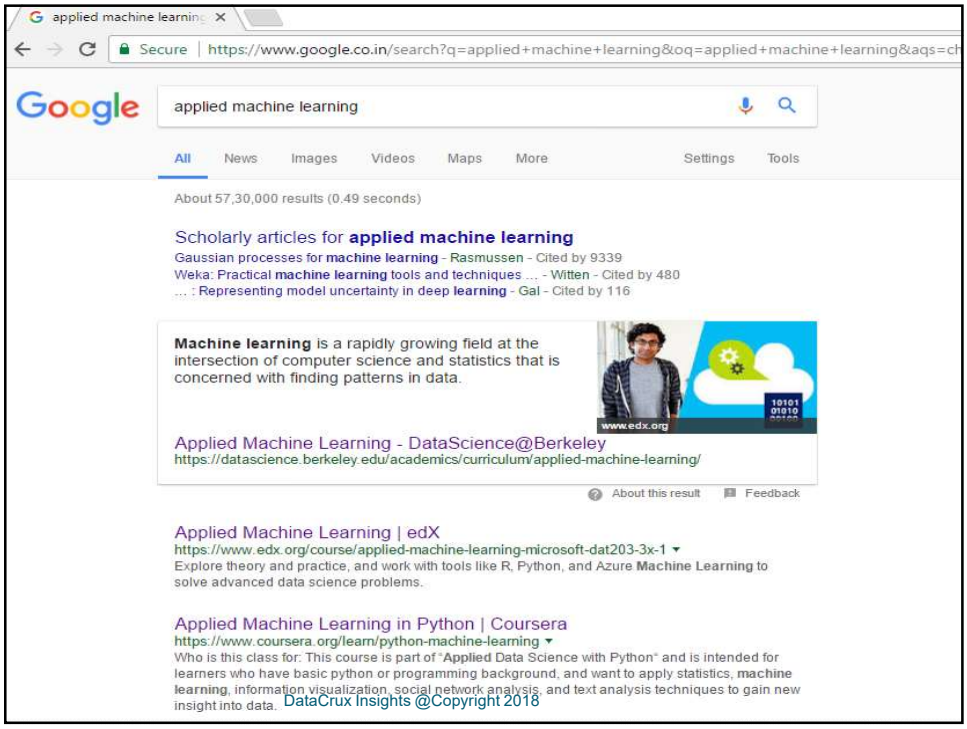
DataCrux Insights @Copyright 2018

Where ML is used...

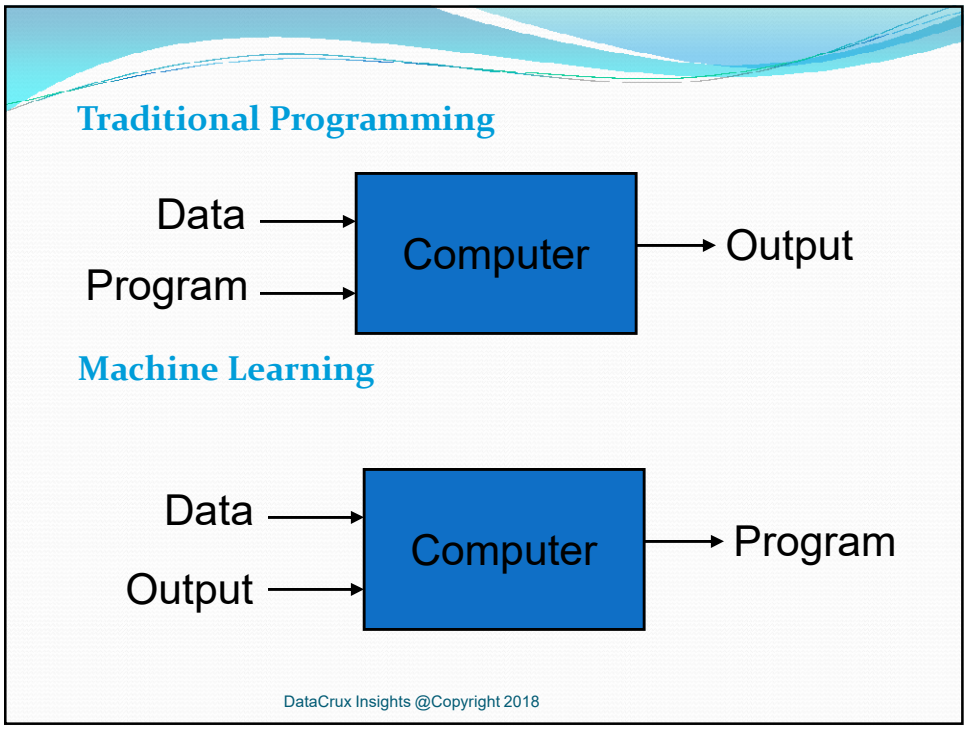
DataCrux Insights @Copyright 2018



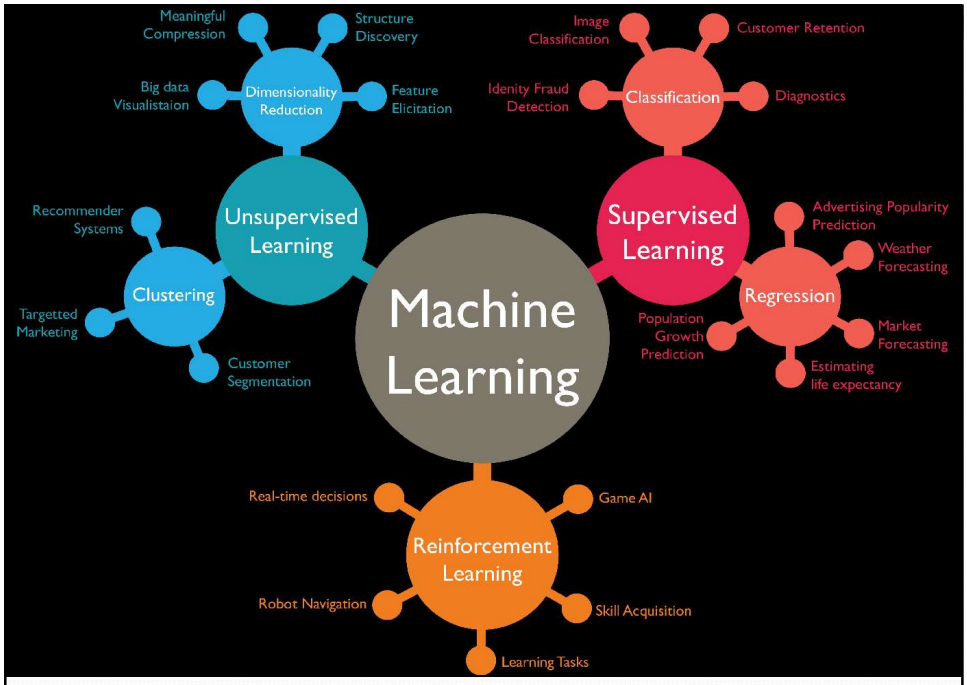
DataCrux Insights @Copyright 2018



DataCrux Insights @Copyright 2018



DataCrux Insights @Copyright 2018

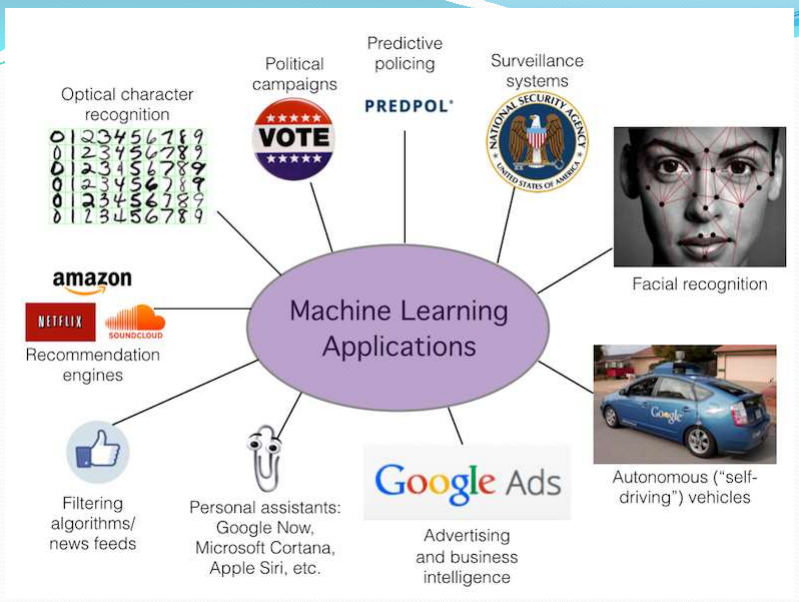


DataCrux Insights @Copyright 2018

Sample Applications

- Web search
- Computational biology
- Finance
- E-commerce
- Space exploration
- Robotics
- Information extraction
- Social networks
- Debugging

DataCrux Insights @Copyright 2018



DataCrux Insights @Copyright 2018

ML in a Nutshell

- Tens of thousands of machine learning algorithms
- Hundreds new every year
- Every machine learning algorithm has three components:
  - **Representation**
  - **Evaluation**
  - **Optimization**

DataCrux Insights @Copyright 2018

Representation

- Decision trees
- Sets of rules / Logic programs
- Instances
- Graphical models (Bayes/Markov nets)
- Neural networks
- Support vector machines
- Model ensembles
- Etc.

DataCrux Insights @Copyright 2018

Evaluation

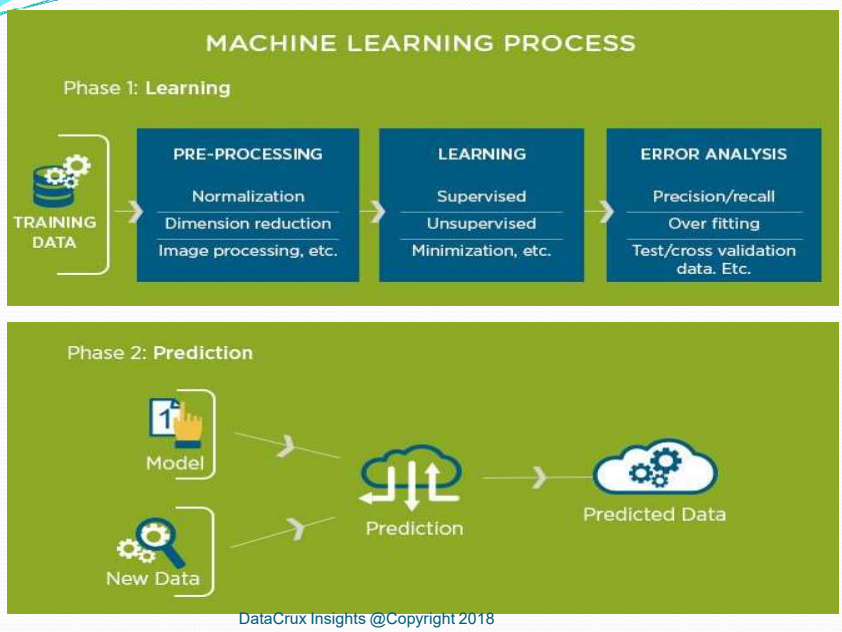
- Accuracy
- Precision and recall
- Squared error
- Likelihood
- Posterior probability
- Cost / Utility
- Margin
- Entropy
- K-L divergence
- Etc.

DataCrux Insights @Copyright 2018

Optimization

- Combinatorial optimization
  - E.g.: Greedy search
- Convex optimization
  - E.g.: Gradient descent
- Constrained optimization
  - E.g.: Linear programming

DataCrux Insights @Copyright 2018



DataCrux Insights @Copyright 2018