

A to Z of AI/ML: A Quick Introduction to Artificial Intelligence and Machine Learning Capabilities and Tools EngCon 2017

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Outline

Introduction

What is AI?

Neural Networks

Convolutional Neural Networks

Do you need AI/ML?

My Background

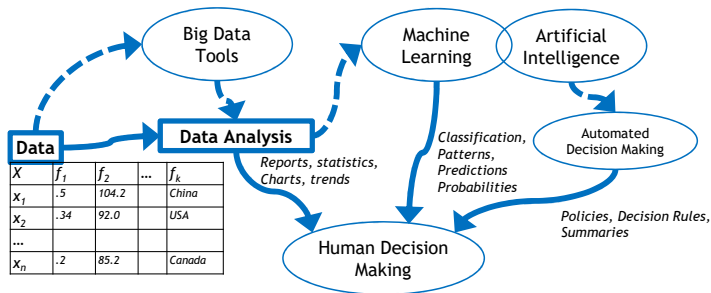
- Waterloo : Assistant Professor, ECE Department since 2015
- PhD at UBC in Computer Science with Prof. David Poole
- Postdoc at Oregon State University
- UW ECE ML Lab:
<https://uwaterloo.ca/scholar/mcrowley/lab>
- Waterloo Institute for Complexity and Innovation (WICI)
- Research Fellow at Element^{AI}
- Pattern Analysis and Machine Intelligence (PAMI)
- <http://waterloo.ai>
 - List of faculty
 - Research projects (co-op/internships)
 - List of spinoff companies from UWaterloo (good place for project ideas)

What do you think of when you hear?

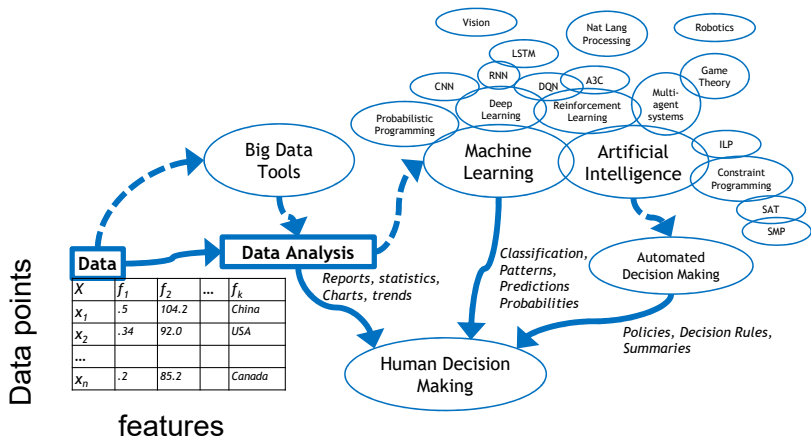
Artificial Intelligence

Machine Learning

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Major Types/Areas of AI

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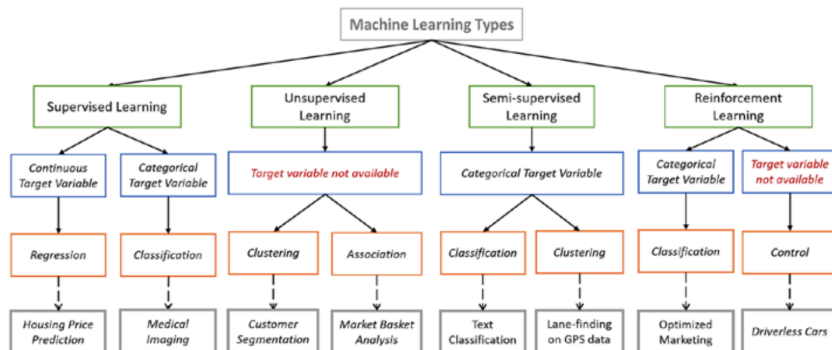
Major Types/Areas of AI

Artificial Intelligence: some algorithm to enable computers to perform actions we define as requiring intelligence. **This is a moving target.**

- Search Based Heuristic Optimization (A*)
- Evolutionary computation (genetic algorithms)
- Logic Programming (inductive logic programming, fuzzy logic)
- Probabilistic Reasoning Under Uncertainty (bayesian networks)
- Computer Vision
- Natural Language Processing
- Robotics
- **Machine Learning**

Types of Machines Learning

Machine Learning: *"Detect patterns in data, use the uncovered patterns to predict future data or other outcomes of interest"* – Kevin Murphy, Google Research.



Deep Learning

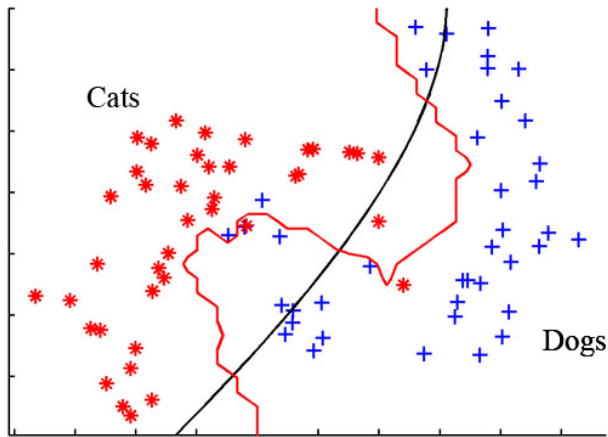
Deep Learning: methods which perform machine learning through the use of multilayer neural networks of some kind. Deep Learning can be applied in any of the three main types of ML:

- **Supervised Learning** : very common, enormous improvement in recent years
- **Unsupervised Learning** : just beginning, lots of potential
- **Reinforcement Learning** : recent (past 3 years) this has exploded, especially for video games

Increasing Complexity of Supervised ML Methods

- ① mean, mode, max, min - basic statistics and patterns
- ② prediction/regression - least squares, ridge regression
- ③ linear classification - use distances and separation of data points.
(logistic regression, SVM, KNN)
- ④ Kernel Based Classification - define a mapping from original data to a new space, allow nonlinear divisions to be found
- ⑤ Decision trees - learn rules that divide data arbitrarily (C4.5, Random Forests, AdaBoost)
- ⑥ Neural Networks - learn function using 'neurons'
- ⑦ Deep Neural Networks - same, but deep :)
- ⑧ Recurrent Neural Networks - adding links to past timesteps, learning with memory of the past
- ⑨ Convolutional Neural Networks - adding convolutional filters, good for images
- ⑩ Inception Resnets, Long-Term Short-Term Networks, Voxception Networks, oh it keeps going...

One Example of ML: Classification



Clustering vs. Classification

Clustering

- Unsupervised
- Uses unlabeled data
- Organize patterns w.r.t. an optimization criteria
- Requires a definition of similarity
- Hard to evaluate
- Examples: K-means, Fuzzy C-means, Hierarchical Clustering, DBScan

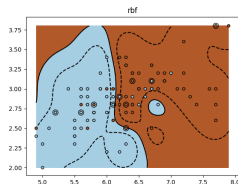
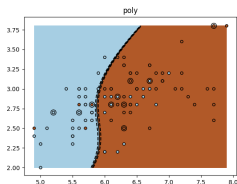
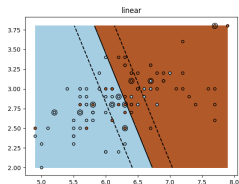
Classification

- Supervised
- Uses labeled data
- Requires training phase
- Domain sensitive
- Easy to evaluate (you know the correct answer)
- Examples: Naive Bayes, KNN, SVM, Decision Trees, Random Forests

Classification Performance Depends on the Algorithm

A good example of this choices is Support Vector Machines (SVMs).

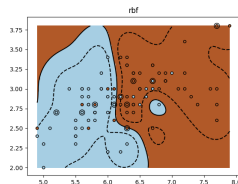
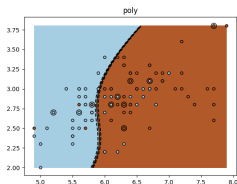
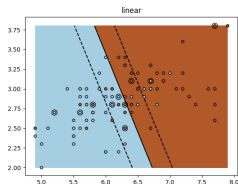
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- core idea: find a dividing hyperplane
- many variations: plane can be linear, polynomial, gaussian, high-dimensional



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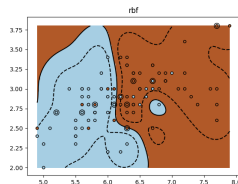
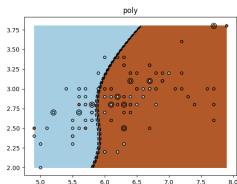
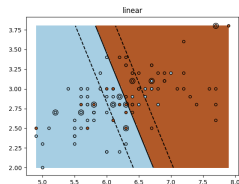


So what is the “right” approach?

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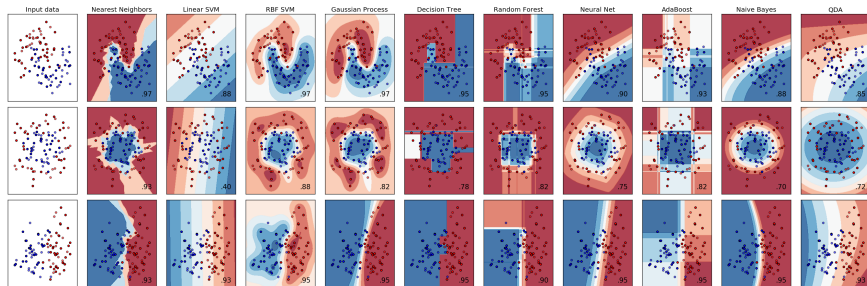
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So what is the “right” approach? **Experimentation!**

Classification Performance Depends on the Algorithm



So choose carefully...

See http://scikit-learn.org/stable/auto_examples/classification/plot_classifier_comparison.html