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

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Outline

My Background

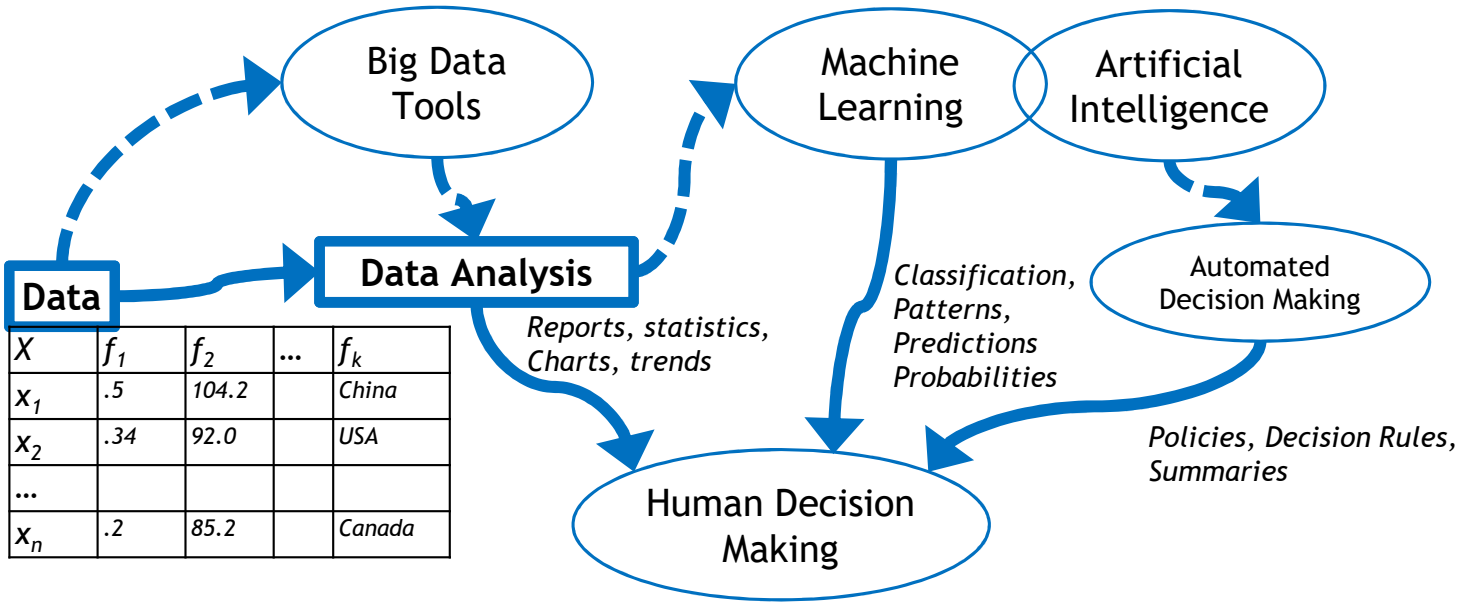
- Waterloo : Assistant Professor, ECE Department since 2015
- PhD at UBC in Computer Science with Prof. David Poole
- Postdoc at Oregon State University
- UW ECE ML Lab:
  `https://uwaterloo.ca/scholar/mcrowley/lab`
- Waterloo Institute for Complexity and Innovation (WICI)
- Research Fellow at Element^{AI}
- 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

Data, Big Data, Machine Learning, AI, etc, etc,



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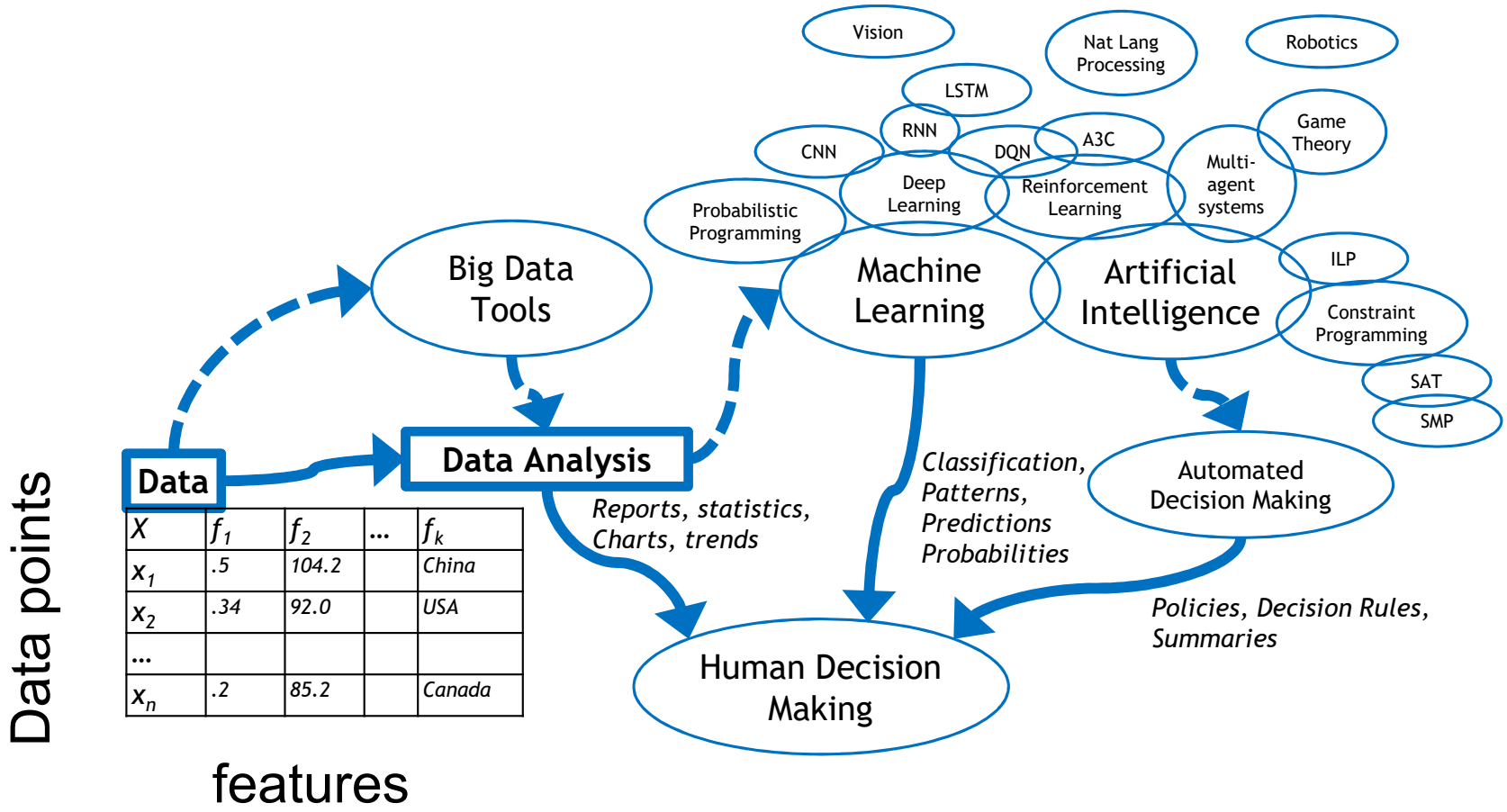

Major Types/Areas of AI

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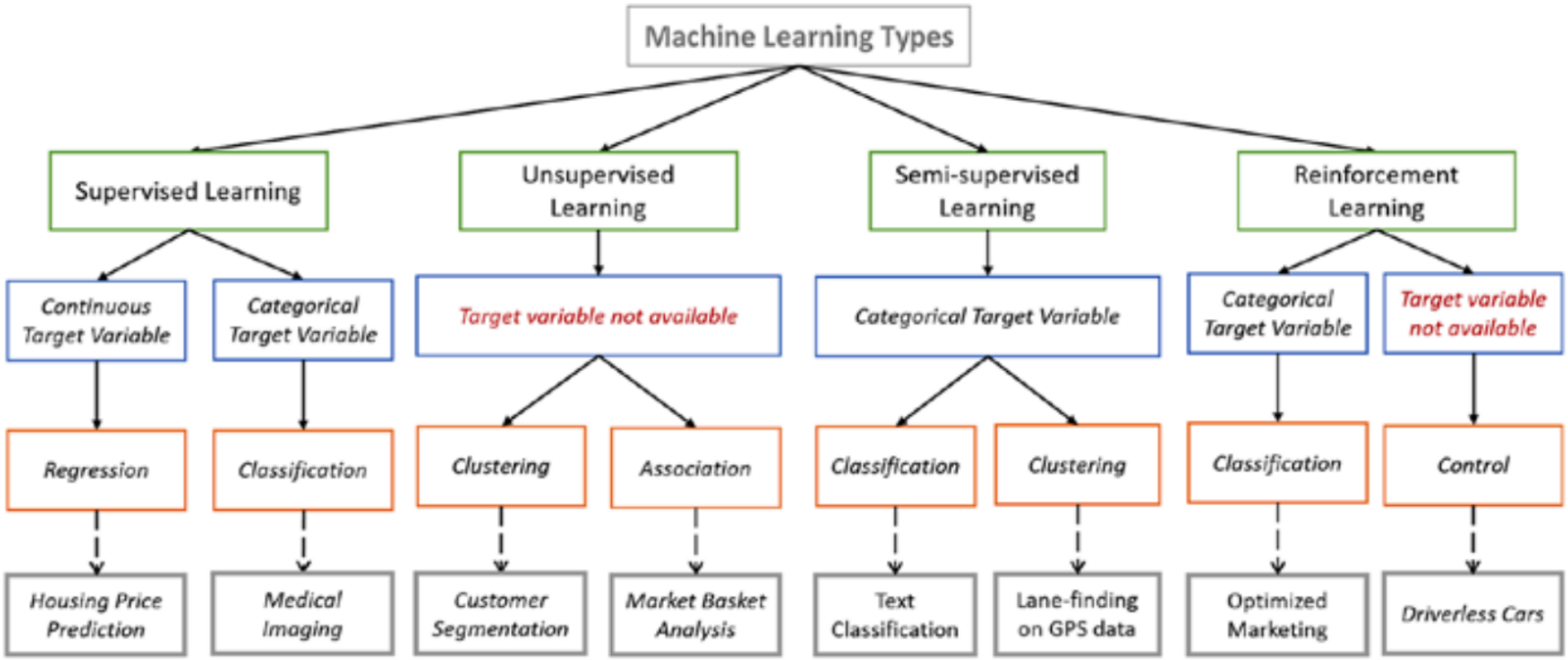
- Search Based Heuristic Optimization (A*)
- Evolutionary computation (genetic algorithms)
- Logic Programming (inductive logic programming, fuzzy logic)
- Probabilistic Reasoning Under Uncertainty (bayesian networks)
- Computer Vision
- Natural Language Processing
- Robotics
- **Machine Learning**

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

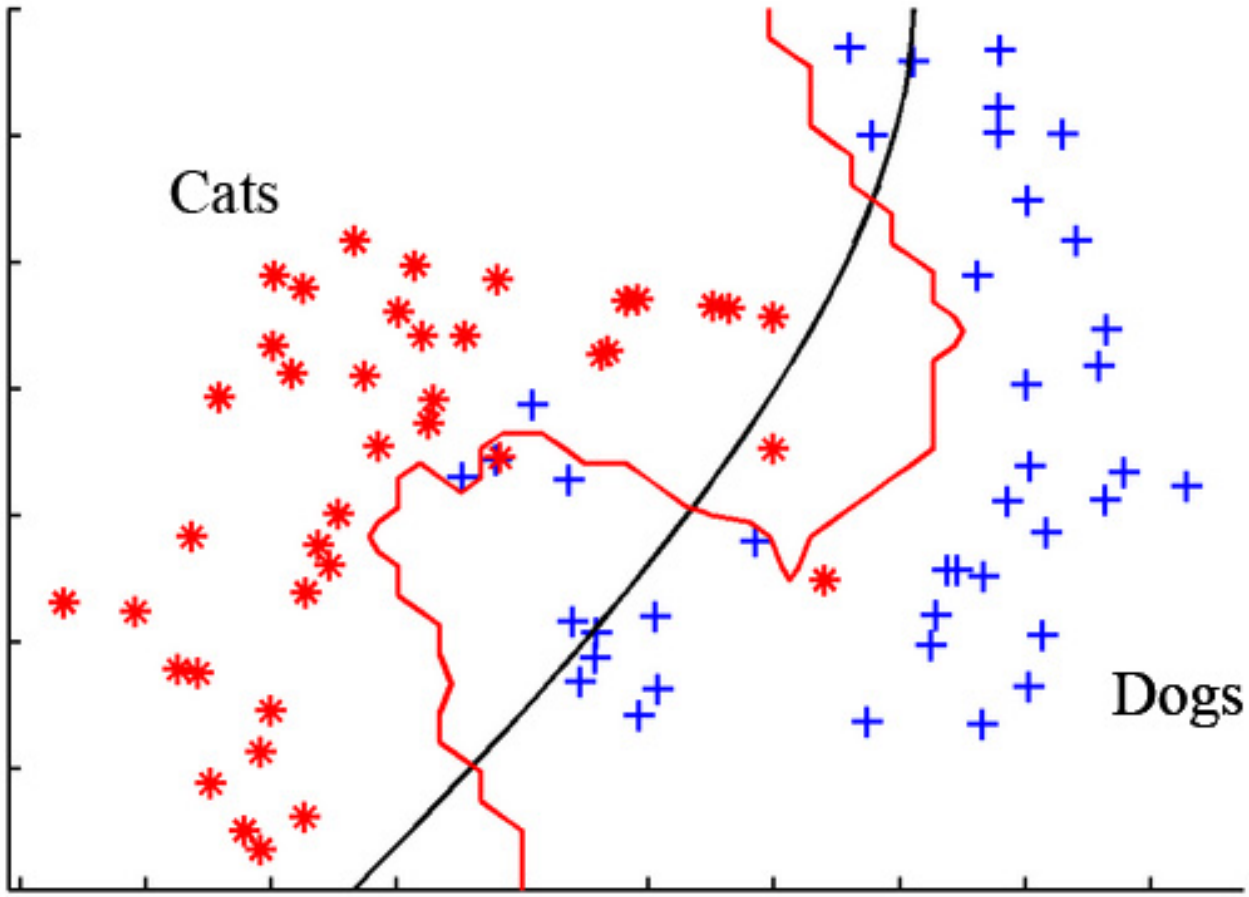
Deep Learning: methods which perform machine learning through the use of multilayer neural networks of some kind. Deep Learning can be applied in any of the three main types of ML:

- **Supervised Learning** : very common, enourmous improvement in recent years
- **Unsupervised Learning** : just beginning, lots of potential
- **Reinforement Learning** : recent (past 3 years) this has exploded, exspecially 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

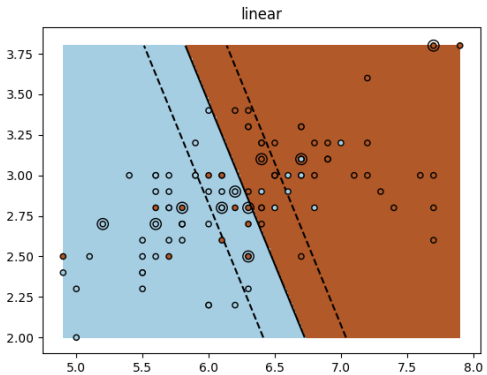
Classification

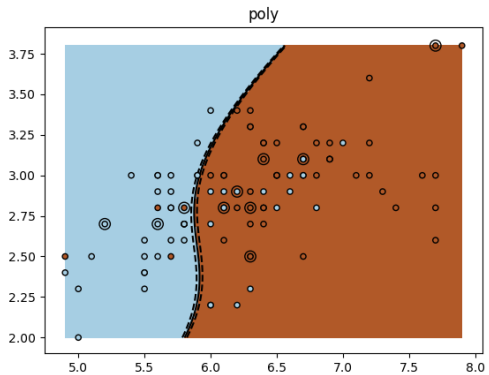
- Supervised
- Uses labeled data
- Requires training phase
- Domain sensitive
- Easy to evaluate (you know the correct answer)
- Examples: Naive Bayes, KNN, SVM, Decision Trees, Random Forests

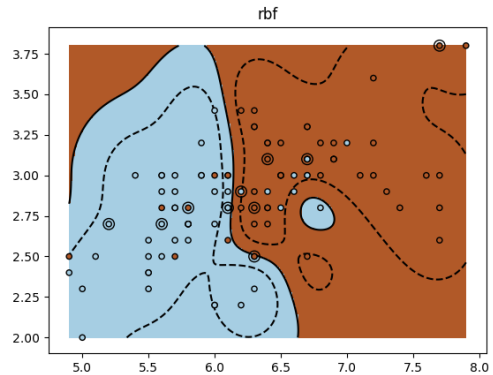
Classification Performance Depends on the Algorithm

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

- popular until dawn of deep learning in past few years
- core idea: find a dividing hyperplane
- many variations: plane can be linear, polynomial, gaussian, high-dimensional







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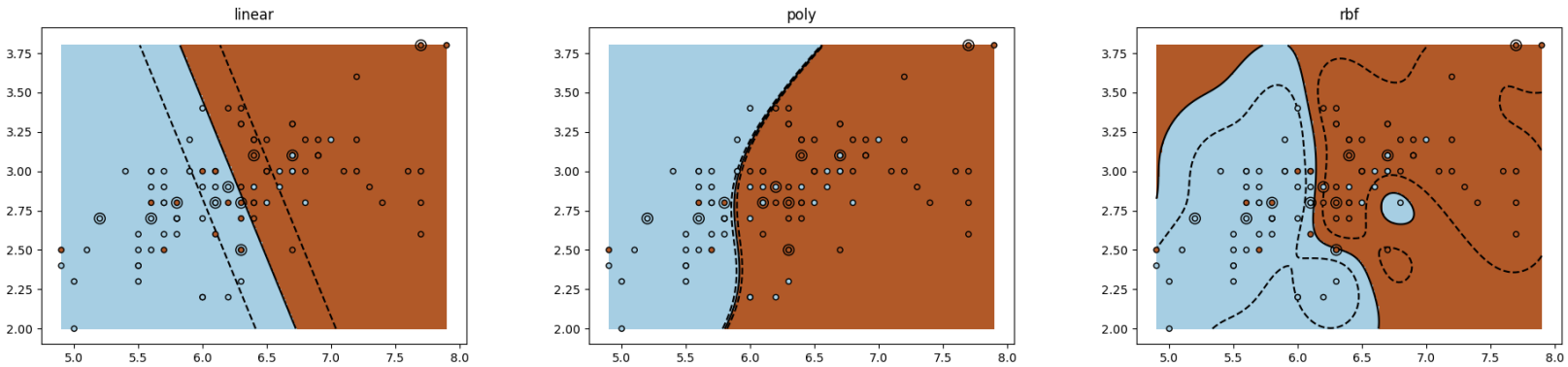

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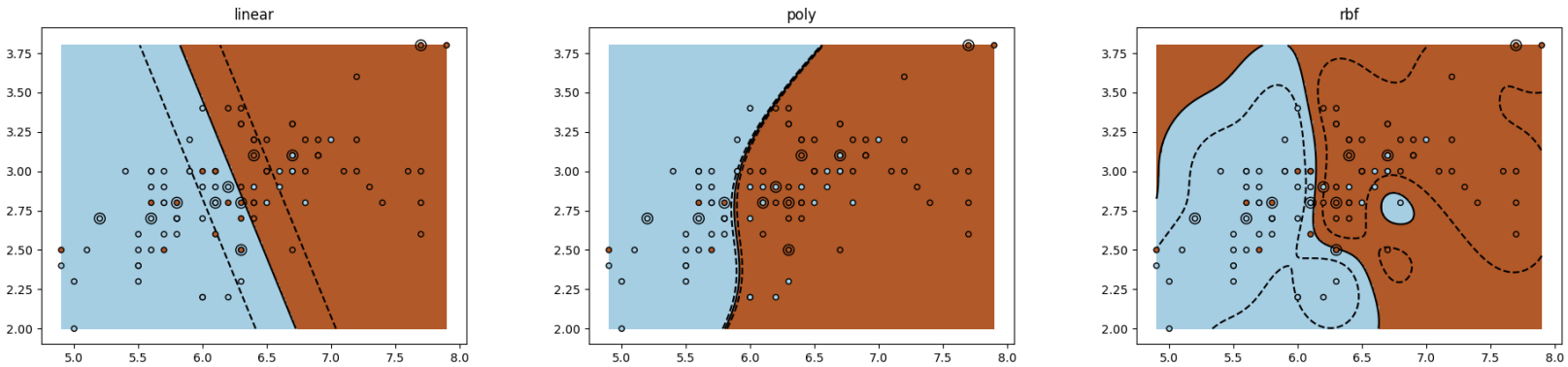

So what is the "right" approach? Experimentation!

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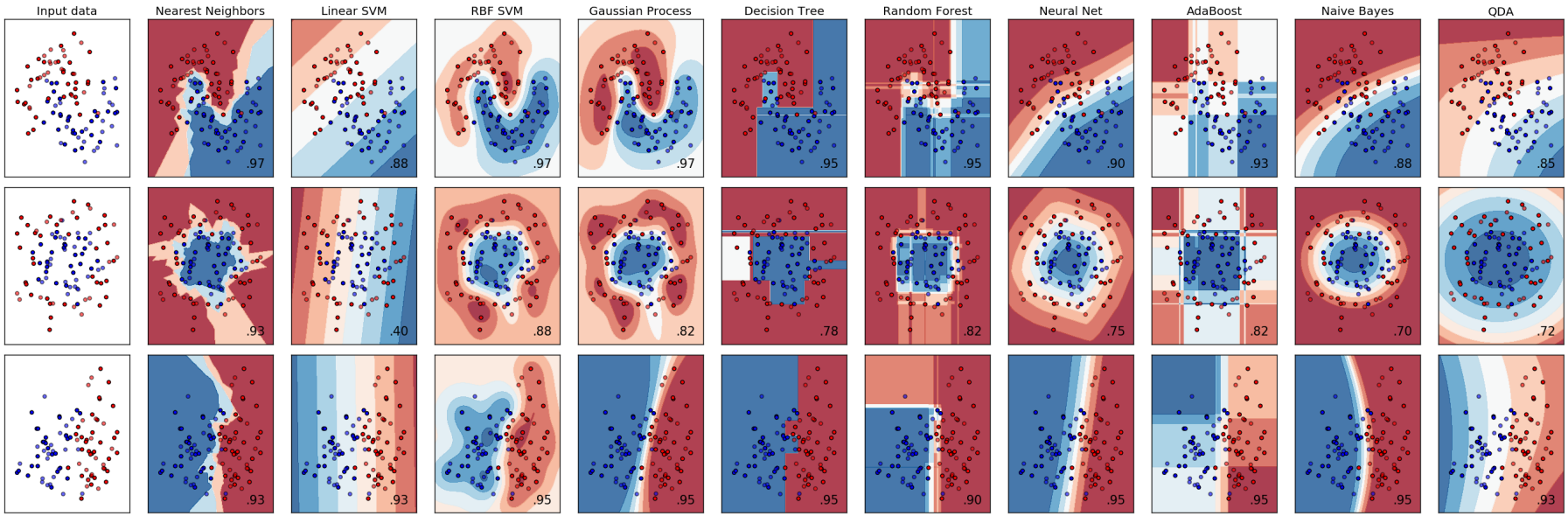

So choose carefully...

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