EECS 348: Machine Learning (in 25 minutes or less)

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Machine Learning

- "The study of computer programs that improve automatically with experience" T. Mitchell *Machine Learning*, 1998
- Used heavily in:
 - Bioinformatics, robotics, marketing/advertising, recommendations systems, information retrieval, fraud detection, handwriting/speech recognition, etc., etc...

Example Machine Learning Tasks

• How likely is person **x** to default on a loan?

• What is the location of robot **x**?

• Is a given Web page **x** about "baseball?"

Learning a function from examples

- Given: examples of a function *f* for various inputs x:
 - $-\{({\bf x}_1,f({\bf x}_1)),\,...,\,({\bf x}_n,f({\bf x}_n))\}$
- Goal: Estimate f
 - Input $\mathbf{x} = (x_1, ..., x_d)$; individual features x_i
 - Output f(x)
- Probably the most common machine learning task formulation (though there are others)

Learn function from $\mathbf{x} = (x_1, ..., x_d)$ to $f(\mathbf{x}) \in \{0, 1\}$ given labeled examples $(\mathbf{x}, f(\mathbf{x}))$



Representation

- In general, inputs and outputs can be
 - Nominal (e.g. Gender)
 - Ordinal (e.g. small, medium, large)
 - Numeric (e.g. Years of Education, probability of credit default, etc.)
- Predicting a nominal output: classification
 - Thus, predicting whether a document is about politics or sports is an instance of **Text Classification**
- Predicting a numeric output: regression (typically continuous)

Which classifier is best?

Learn function from $\mathbf{x} = (x_1, ..., x_d)$ to $f(\mathbf{x}) \in \{0, 1\}$ given labeled examples $(\mathbf{x}, f(\mathbf{x}))$



Which classifier is best?

Answer: you don't know

Solutions:

- 1) try many and compare
- 2) Use domain knowledge

What does it mean for an ML algorithm to perform well?

- Metrics
 - Lots of possibilities
 - Classification: **accuracy**, precision, recall, cost, etc.
 - Accuracy = fraction of examples x where algorithm's predicted f(x) matches true classification
 - Regression: mean squared error, etc.

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What does it mean for an ML algorithm to perform well?

- We want to know how our algorithm will perform on *new* inputs
 - So, test on a set of examples from disjoint from training (e.g. 80% train, 20% test)

How to do Machine Learning

- 1) Pick a feature representation for your task
- 2) Compile data
- 3) Choose a machine learning algorithm
- 4) Train the algorithm
- 5) Evaluate the results
- 6) Probably: go to (1)

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Feature Engineering

- The art of machine learning
 - Features should be predictive and (relatively) independent
- How likely is person **x** to default on a loan?
 - FICO score
 - Income
 - Education Level
 - Assets
 - Social Security Number