Course Logistics and Introduction to Machine Learning

Piyush Rai

Machine Learning (CS771A)

July 28, 2016

Course Logistics

- **Timing and Venue:** WF 6:00-7:30pm, RM 101

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- **Instructor:** Piyush Rai (Email: piyush@cse.iitk.ac.in)
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- **Auditing?** Please let me know your email id to be added to the mailing list.

Intro to Machine Learning

Machine Learning

- Creating programs that can automatically learn rules from data

  "Field of study that gives computers the ability to learn without being explicitly programmed" (Arthur Samuel, 1959)

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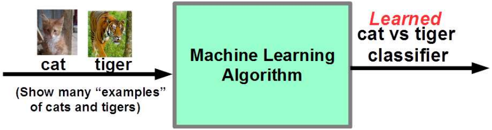

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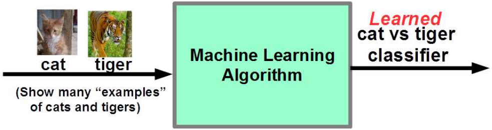

- Learned rules must generalize (do well) on future "test" data (idea of generalization; more later)

Machine Learning in the real-world

Broadly applicable in many domains (e.g., internet, robotics, healthcare and biology, computer vision, NLP, databases, computer systems, finance, etc.).

Picture courtesy: gizmodo.com,rcdronearena.com,www.wiseyak.com,www.charlesdong.com

Machine Learning in the real-world

Some real-world applications

- Information retrieval (text, visual, and multimedia searches)
- Machine Translation
- Question Answering
- Social networks
- Recommender systems (Amazon, Netflix, etc.)
- Speech/handwriting/object recognition
- Ad placement on websites
- Credit-card fraud detection
- Weather prediction
- Autonomous vehicles (self-driving cars)
- Healthcare and life-sciences
- .. and many more applications in sciences and engineering

Supervised Learning

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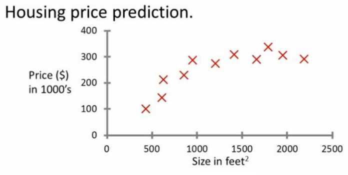

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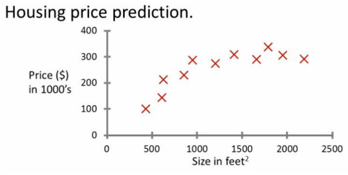
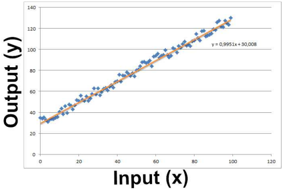
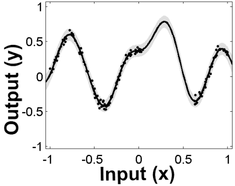


- Discrete-valued outputs (e.g., label of a hand-written digit): **Classification**

Supervised Learning: Pictorially

- Regression: fitting a line/non-linear curve





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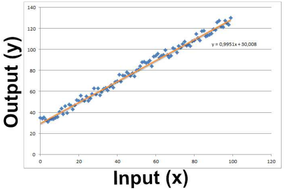

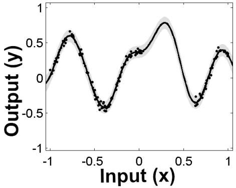

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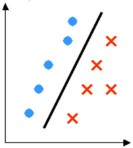

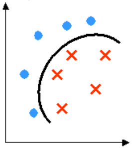

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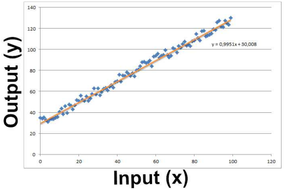

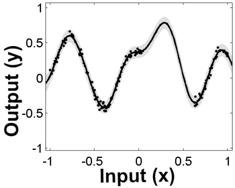

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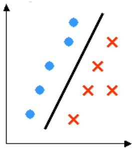
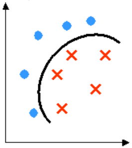
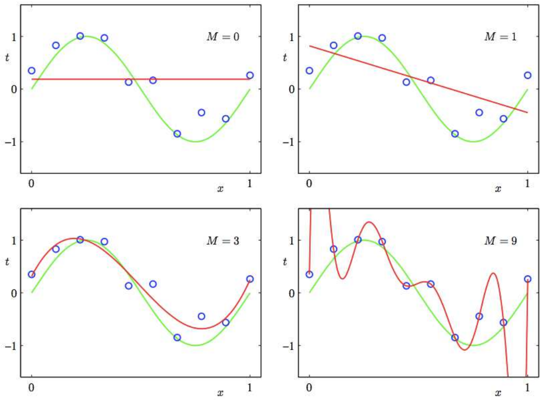




- **Generalization** is crucial (must do well on test data)

Generalization

- The right model complexity?



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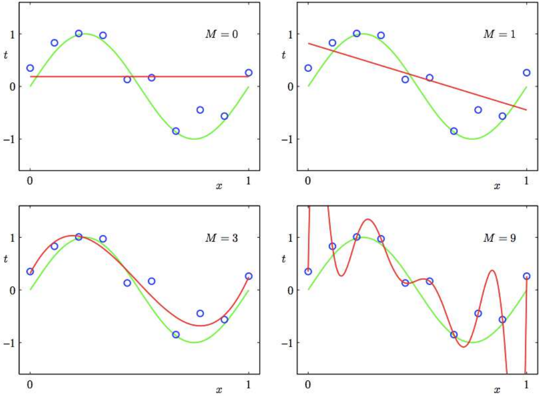

- Desired: hypotheses that are not too simple, not too complex (to avoid overfitting on training data)

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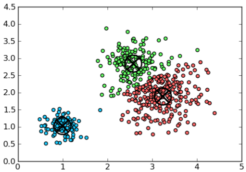
- Homogeneous groups as latent structure: **Clustering**



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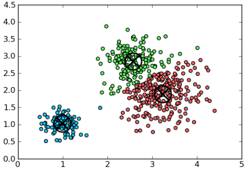
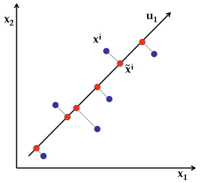
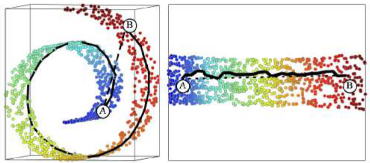


- Low-dimensional latent structure: **Dimensionality Reduction**





Unsupervised Learning: Some examples

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Topic model picture courtesy: David Blei

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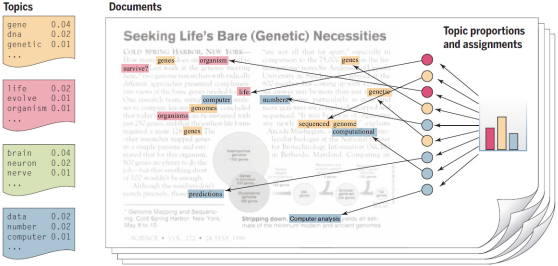

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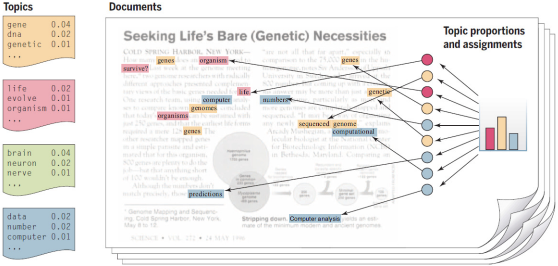

- Also used as a preprocessing step for many supervised learning algorithms (e.g., to learn/extract good features, to speed up the algorithms, etc.)

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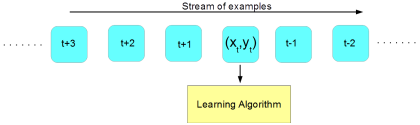
Some Other Learning Paradigms

- **Online Learning**
  - Learning with one example (or a small minibatch of examples) at a time



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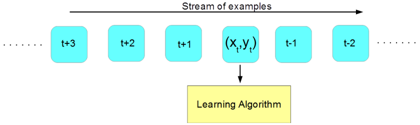
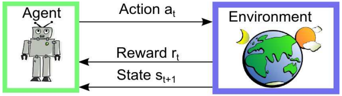


- **Reinforcement Learning**
  - Learning a "policy" by performing actions and getting rewards



Reinforcement Learning Setup

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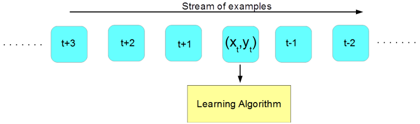

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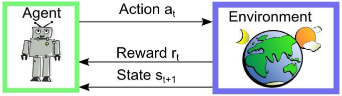

Reinforcement Learning Setup

- **Transfer/Multitask Learning**
  - Leveraging knowledge of solving one problem to solve a new problem

(Tentative) List of topics

- Supervised Learning
  - nearest-neighbors methods, decision trees
  - linear/non-linear regression and classification
- Unsupervised Learning
  - Clustering and density estimation
  - Dimensionality reduction and manifold learning
  - Latent factor models and matrix factorization
- Online Learning
- Learning Theory
- Ensemble Methods
- Deep Learning
- Learning from time-series data

Course Goals

By the end of the semester, you should be able to:

- Understand how various machine learning algorithms work
- Implement them (and, hopefully, their variants/improvements) on your own
- Look at a real-world problem and identify if ML is an appropriate solution
- If so, identify what types of algorithms might be applicable
- Feel inspired to work on and learn more about Machine Learning :-)

This class is **not** about:

- Introduction to machine learning tools/softwares