Learning From Data
Lecture 15
Reflecting on Our Path - Epilogue to Part I

What We Did
The Machine Learning Zoo
Moving Forward

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Our Plan

1. What is Learning?
   Output $g \approx f$ after looking at data $(x_n, y_n)$.

2. Can We do it?
   $E_{in} \approx E_{out}$ simple $H$, finite $d_{vc}$, large $N$
   $E_{in} \approx 0$ good $H$, algorithms

3. How to do it?
   Linear models, nonlinear transforms
   Algorithms: PLA, pseudoinverse, gradient descent

4. How to do it well?
   Overfitting: stochastic & deterministic noise
   Cures: regularization, validation.

5. General principles?
   Occam’s razor, sampling bias, data snooping

6. Advanced techniques.

7. Other Learning Paradigms.

Learning From Data: It’s A Jungle Out There

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Reflecting on Our Path: 2/10

Theoretical concepts
Practical theory
Practice

1. Recap: Three Learning Principles
   - Occam’s razor: simpler is better; falsifiable.
   - Sampling bias: ensure that training and test distributions are the same, or else acknowledge/account for it. You cannot sample from one bin and use your estimates for another bin.
   - Data snooping: you are charged for every choice influenced by $D$. Choose the learning process (usually $H$) before looking at $D$.

   We know the price of choosing $g$ from $H$.

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Reflecting on Our Path: 3/10

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Reflecting on Our Path: 4/10

Theory
Navigating the Jungle: Paradigms

**THEORY**

- VC-analysis
- bias-variance
- complexity
- Bayesian
- Rademacher
- SRM

**TECHNIQUES**

- Models:
  - linear
  - neural networks
  - SVM
  - similarity
  - Gaussian processes
  - graphical models
  - bilinear/SVD

- Methods:
  - regularization
  - validation
  - aggregation
  - preprocessing

**PARADIGMS**

- supervised
- unsupervised
- reinforcement

- active
- online
- unlabeled
- transfer learning
- big data

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- supervised
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**Moving Forward**

1. What is Learning?
   - Output $y \approx f$ after looking at data $(x_n, y_n)$.

2. Can We do it?
   - $E_{in} \approx E_{out}$
   - simple $H$, finite $d_{vc}$, large $N$
   - $E_{in} = 0$ good $H$, algorithms

3. How to do it?
   - Linear models, nonlinear transforms
   - Algorithms: PLA, pseudoinverse, gradient descent

4. How to do it well?
   - Overfitting: stochastic & deterministic noise
   - Cures: regularization, validation

5. General principles?
   - Occam's razor, sampling bias, data snooping

6. Advanced techniques
   - Similarity, neural networks, SVMs, preprocessing & aggregation

7. Other Learning Paradigms.
   - Unsupervised, reinforcement