

Introduction to ML & DL

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Machine Learning

Outline

- 1 What's Machine Learning?
- 2 What's Deep Learning?
- 3 About this Course...
- 4 FAQ

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① What's Machine Learning?

② What's Deep Learning?

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 - The correct answer varies in time and from person to person
- Machine learning algorithms use the *a posteriori knowledge* to solve problems
 - Learnt from *examples* (as extra input)

Example Data \mathbb{X} as Extra Input

- Unsupervised:

$$\mathbb{X} = \{\mathbf{x}^{(i)}\}_{i=1}^N, \text{ where } \mathbf{x}^{(i)} \in \mathbb{R}^D$$

- E.g., $\mathbf{x}^{(i)}$ an email

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$$\mathbb{X} = \{(\mathbf{x}^{(i)}, \mathbf{y}^{(i)})\}_{i=1}^N, \text{ where } \mathbf{x}^{(i)} \in \mathbb{R}^D \text{ and } \mathbf{y}^{(i)} \in \mathbb{R}^K,$$


- E.g., $y^{(i)} \in \{0, 1\}$ a spam label

General Types of Learning (1/2)

- **Supervised learning**: learn to predict the labels of future data points

$$X \in \mathbb{R}^{N \times D} :$$


$$\mathbf{y} \in \mathbb{R}^{N \times K} : [\mathbf{e}^{(6)}, \mathbf{e}^{(1)}, \mathbf{e}^{(9)}, \mathbf{e}^{(4)}, \mathbf{e}^{(2)}]$$


$$\mathbf{x}' \in \mathbb{R}^D :$$


$$\mathbf{y}' \in \mathbb{R}^K : ?$$

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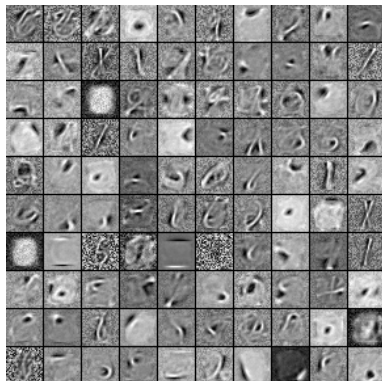
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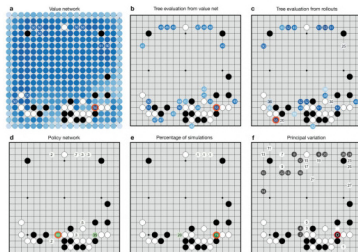
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- **Unsupervised learning**: learn patterns or latent factors in X



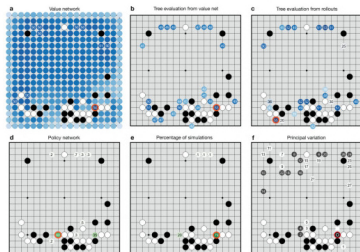
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- AlphaGo [1] is a hybrid of reinforcement learning and supervised learning
 - Supervised learning from the game records
 - Then, reinforcement learning from self-play

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- ② Model development
 - ① Assume a **model** $\{f(\cdot; \mathbf{w})\}$ that is a collection of candidate functions f 's (representing posteriori knowledge) we want to discover
 - ① f is assumed to be parametrized by \mathbf{w}

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- ③ **Training**: employ an algorithm that finds the best (or good enough) function $f^*(\cdot; \mathbf{w}^*)$ in the model that minimizes the cost function

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- ⑤ Apply the model in the real world

Example for Spam Detection

① Random split of your past emails and labels

① Training dataset: $\mathbb{X} = \{(\mathbf{x}^{(i)}, y^{(i)})\}_i$

② Testing dataset: $\mathbb{X}' = \{(\mathbf{x}'^{(i)}, y'^{(i)})\}_i$

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 - See Notation

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② **What's Deep Learning?**

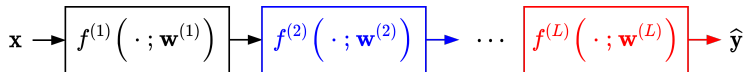
③ About this Course...

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Deep Learning

- ML where an $f(\cdot; \mathbf{w})$ has many (deep) layers

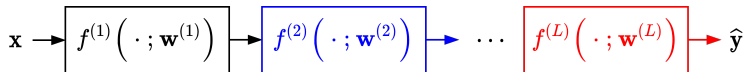
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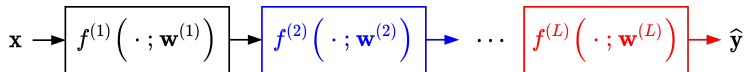


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- Pros:
 - Learns to pre-process data automatically
 - Learns a complex function (e.g., visual objects to labels)
- Cons:
 - Usually needs large data to train a model well
 - High computation costs (at both training and test time)

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Target Audience

- *Senior undergraduate* and *graduate* CS students
 - Easy-to-moderate level of theory
 - Coding and engineering (in Python)
 - Clean datasets (small & large)

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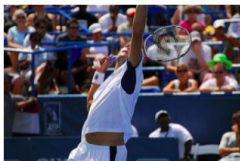
- *Senior undergraduate* and *graduate* CS students
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- No prior knowledge about ML is needed

Topics Covered

- Supervised, unsupervised learning, and reinforcement learning

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- with *structural* output:



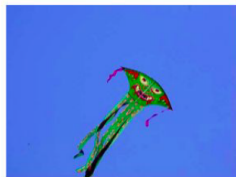
A man holding a tennis racquet on a tennis court.



Two pizzas sitting on top of a stove top oven



A group of young people playing a game of Frisbee



A man flying through the air while riding a snowboard

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- Part 5: reinforcement learning (3 weeks)
 - Value/gradients policies, action/critics, reinforce RNNs

Grading (Tentative)

- Math quiz: **20%**
 - *In the next week*
 - *You have to pass to be able to take this course: >70 or within top-70*
- Contests (x 4): **40%**
 - At the end of each part
- Assignments: **40%**
 - Come with the labs
- Bonus: **6%**
 - Math labs (x 4)
 - Optional ML topics (x 2)

Classes Info

- Lectures on Tue (2 hours)
 - Concepts & theories
 - with companion videos
- Labs on Thu (1 hour)
 - Implementation (in Python) & engineering topics
- TA time: 1:20pm - 3:10pm on Mon at Delta 723
- More info can be found in the [course website](#)

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Q: Is this a light-loading course or heavy-loading one?

*A: Should be **very heavy** to most students. Please **reserve your time***

FAQ (2/2)

Q: What's the textbook?

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Q: Why some sections are marked with “” or “**” in the slides?*

A: The mark “*” means “can be skipped for the first time reader,” and “**” means “materials for reference only”

TODO

- Assigned reading:
 - Calculus
 - Get your feet wet with Python

Reference I

- [1] D. Silver, A. Huang, C. J. Maddison, A. Guez, L. Sifre, G. Van Den Driessche, J. Schrittwieser, I. Antonoglou, V. Panneershelvam, M. Lanctot, et al.
Mastering the game of go with deep neural networks and tree search.
Nature, 529(7587):484–489, 2016.