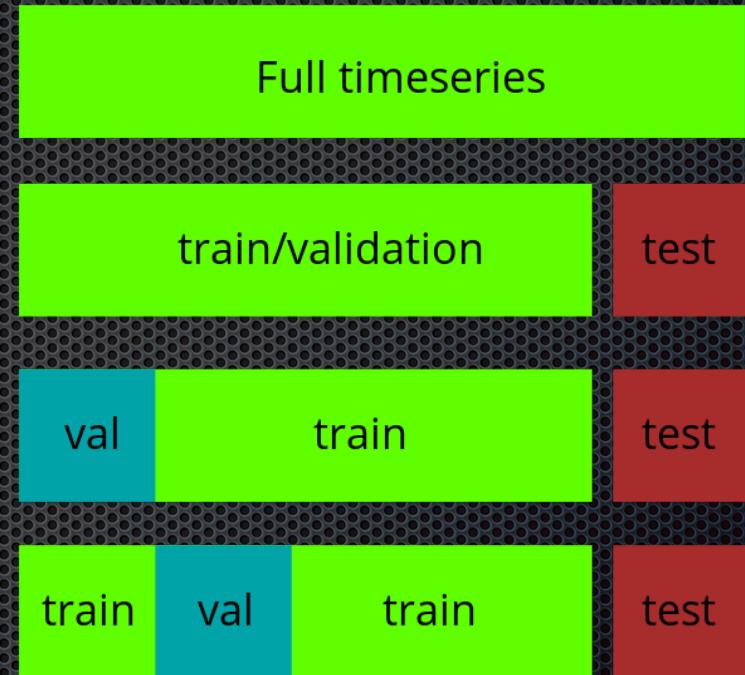
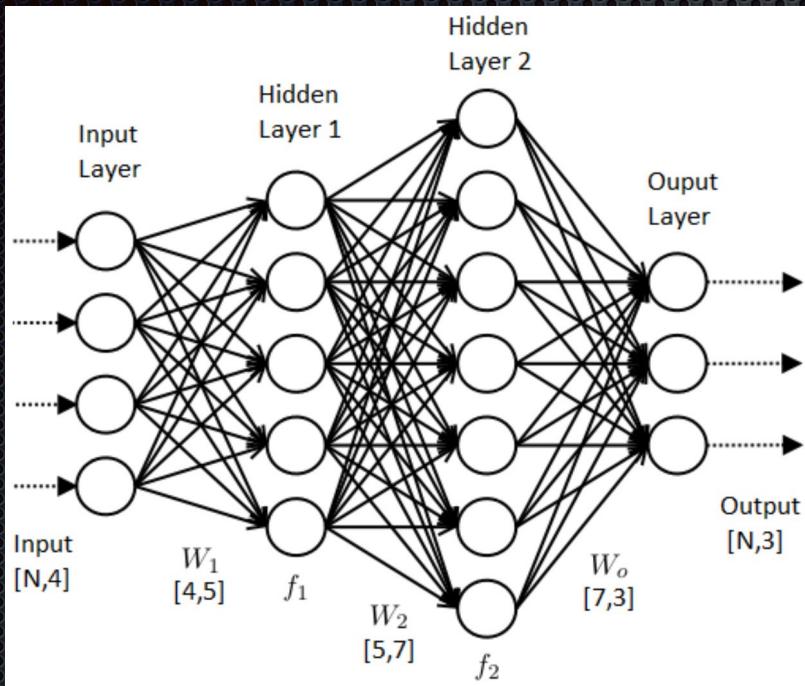


Machine Learning: Basics



Henk A. Dijkstra, CriticalEarth, April 2022

What is Machine Learning?

“Learning is any process by which a system improves performance from experience.”

- Herbert Simon

Definition by Tom Mitchell (1998):

Machine Learning is the study of algorithms that

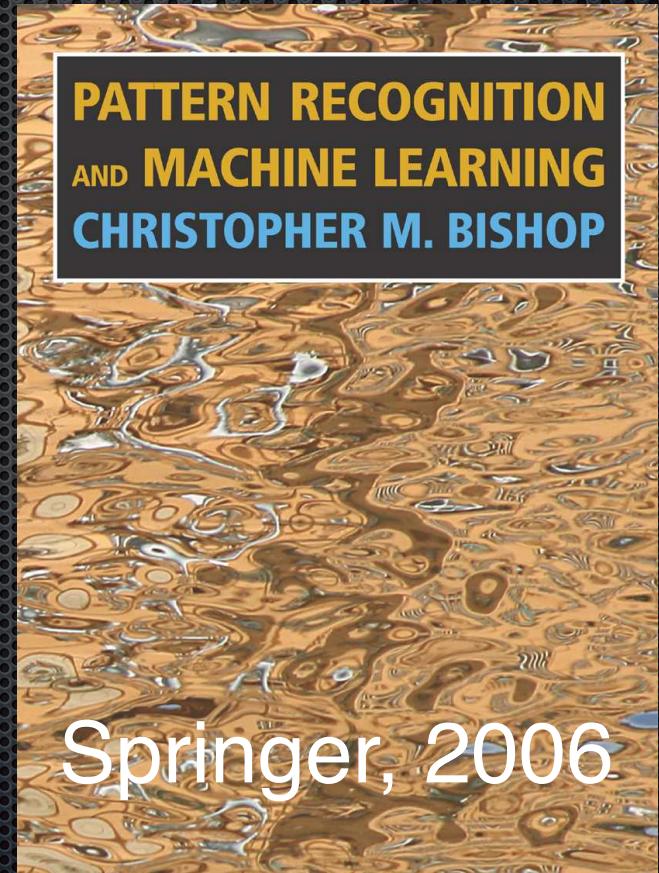
- improve their performance P
- at some task T
- with experience E .

A well-defined learning task is given by $\langle P, T, E \rangle$.

Machine Learning is a HYPE!

However, underneath the hype

- there is a beautiful research area
- with solid theoretical foundations
- and very many applications!



Types of Learning

- **Supervised (inductive) learning**
 - Given: training data + desired outputs (labels)
- **Unsupervised learning**
 - Given: training data (without desired outputs)
- **Semi-supervised learning**
 - Given: training data + a few desired outputs
- **Reinforcement learning**
 - Rewards from sequence of actions

Supervised Learning

Supervised Learning

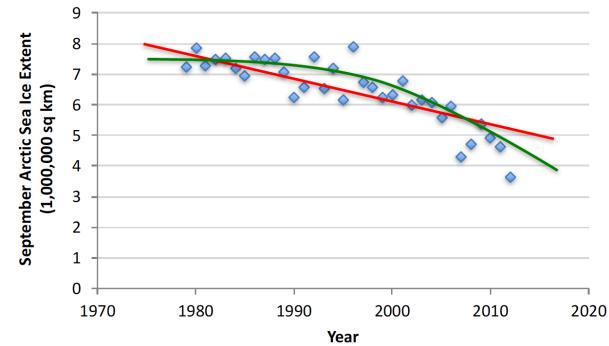
Data: (x, y)
 x is data, y is label

Goal: Learn a *function* to map $x \rightarrow y$

Examples: Classification,
regression, object detection,
semantic segmentation, image
captioning, etc.

Example:

- Given $(x_1, y_1), (x_2, y_2), \dots, (x_n, y_n)$
- Learn a function $f(x)$ to predict y given x
 - y is real-valued == regression



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Unsupervised Learning

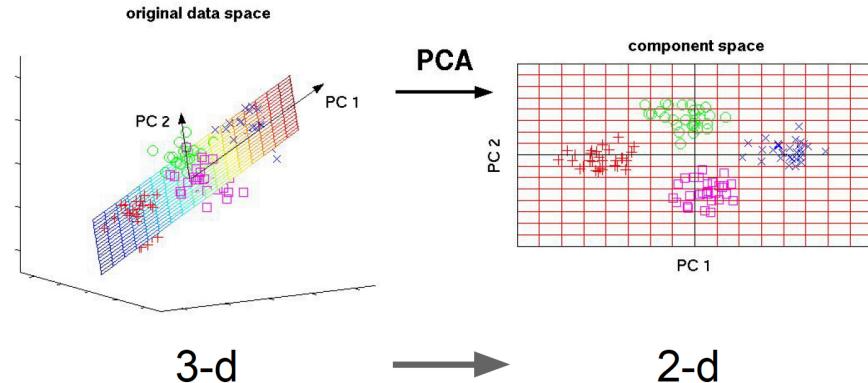
Unsupervised Learning

Data: x

Just data, no labels!

Goal: Learn some underlying hidden *structure* of the data

Examples: Clustering, dimensionality reduction, feature learning, density estimation, etc.



Principal Component Analysis
(Dimensionality reduction)

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Typical Applications

- Recognizing patterns:
 - Facial identities or facial expressions
 - Handwritten or spoken words
 - Medical images
- Generating patterns:
 - Generating images or motion sequences
- Recognizing anomalies:
 - Unusual credit card transactions
 - Unusual patterns of sensor readings in a nuclear power plant
- Prediction:
 - Future stock prices or currency exchange rates

Classic example: handwriting recognition



Discussion

**Which climate research applications could benefit from ML
(also in relation to Hannah's talk)?**

**What type of problem are these
(classification, regression, other)?**