Introduction to Machine Learning

ML-Basics
Learner

Learning goals

- Know formal definition of learner
- Understand that a learner receives training data and outputs the best model from $\mathcal{H}$

SUPERVISED LEARNING EXAMPLE

Imagine we want to investigate how working conditions affect productivity of employees.

- It is a **regression** task since the target *productivity* is continuous.
- We collect data about worked minutes per week (*productivity*), how many people work in the same office as the employee in question, and the employee's salary.

Features x		Target y
People in Office (Feature 1) x_1	Salary (Feature 2) x_2	Worked Minutes Week (Target Variable)
4	4300 €	2220
12	2700 €	1800
5	3100 €	1920

$n = 3$

$p = 2$

$x_1^{(2)}$ $x_2^{(1)}$ $y^{(3)}$

IDEA OF SUPERVISED LEARNING

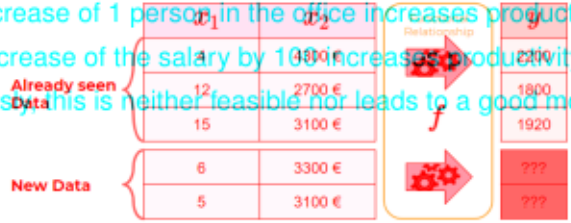
Goal: Identify the functional relationship that maps features to target.

We could investigate the data manually and come up with a simple, hand-crafted rule such as

- **Supervised** learning means we use *labeled* data to learn model f.
- Later, we use model f to predict y for new, *unlabeled* data.

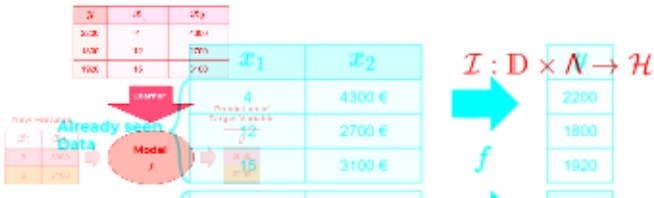
- The baseline productivity of an employee with salary 3000 and 7 people in the office is 1850 minutes
- A decrease of 1 person in the office increases productivity by 30
- An increase of the salary by 100 increases productivity by 10

=> Obviously, this is neither feasible nor leads to a good model



LEARNER DEFINITION

- Algorithm for finding f is called **learner** / **learning algorithm** / **inducer**.
- The learner is our means of picking the best element from the hypothesis space $\mathcal{H}$ for given training data.
- Formally, it maps training data $\mathcal{D} \in \mathbb{D}$ (plus a vector of **hyperparameter** control settings $\boldsymbol{\lambda} \in \Lambda$) to a model:



- Practically, we often construct a mapping

$$\mathcal{I} : \mathbb{D} \times \Lambda \to \Theta$$

LEARNER DEFINITION

- The algorithm for finding our f is called **learner**. It is also called **learning algorithm** or **inducer**.
- We prescribe a certain hypothesis space, the learner is our means of picking the best element from that space for our data set.
- Formally, it maps training data $\mathcal{D} \in \mathbb{D}$ (plus a vector of **hyperparameter** control settings $\boldsymbol{\lambda} \in \boldsymbol{\Lambda}$) to a model:

$$\mathcal{I} : \mathbb{D} \times \boldsymbol{\Lambda} \rightarrow \mathcal{H}$$

LEARNER DEFINITION

As pseudo-code template it would work like this:

- Learner has a defined model space of parametrized functions $\mathcal{H}$.
- User passes data set $\mathcal{D}_{\text{train}}$ and control settings $\boldsymbol{\lambda}$.
- Learner sets parameters so that model matches data best.
- Optimal parameters $\hat{\boldsymbol{\theta}}$ or function $\hat{f}$ is returned for later usage.