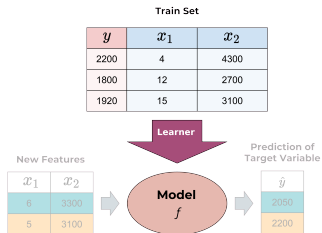
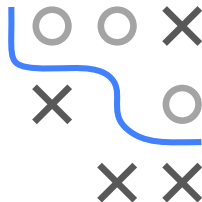


# Introduction to Machine Learning

## ML-Basics Learner



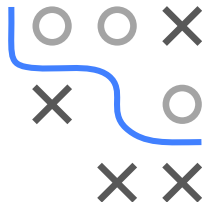
### Learning goals

- Understand that a supervised learner fits models automatically from training data
-

# 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

$n = 3$  (rows)

$p = 2$  (columns)

$x_1^{(2)}$  (points to row 2, column 1)

$x_2^{(1)}$  (points to row 1, column 2)

$y^{(3)}$  (points to row 3, column 3)

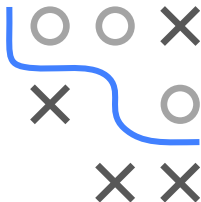
## SUPERVISED LEARNING EXAMPLE / 2

How could we construct a model from these data?

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

- 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

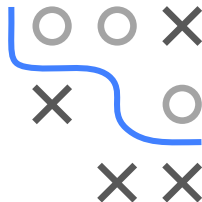
=> Obviously, this is neither feasible nor leads to a good model



# IDEA OF SUPERVISED LEARNING

**Goal:** Automatically identify the fundamental functional relation in the data that maps an object's features to the target.

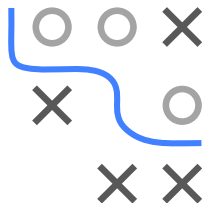
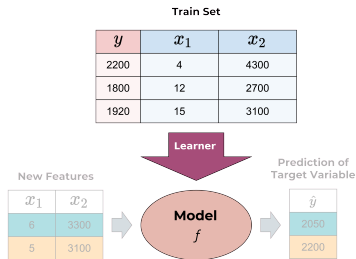
- **Supervised** learning means we make use of *labeled* data for which we observed the outcome.
- We use the labeled data to learn a model  $f$ .
- Ultimately, we use our model to compute predictions for **new** data whose target values are unknown.



# 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  $\lambda \in \Lambda$ ) to a model:

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



# LEARNER DEFINITION / 2

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  $\lambda$ .
- Learner sets parameters so that model matches data best.
- Optimal parameters  $\hat{\theta}$  or function  $\hat{f}$  is returned for later usage.

