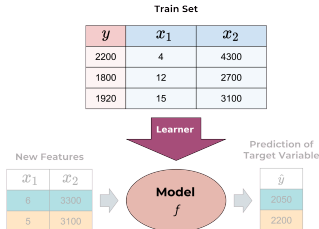


Introduction to Machine Learning

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.

The diagram shows a table with 3 rows and 3 columns. The first two columns are grouped under 'Features x' and the third under 'Target y'. The first column is 'People in Office (Feature 1) x1' and the second is 'Salary (Feature 2) x2'. The third column is 'Worked Minutes Week (Target Variable)'. The data rows are: (4, 4300 €, 2220), (12, 2700 €, 1800), and (5, 3100 €, 1920). Annotations include: a bracket on the left indicating n=3 rows; a bracket at the bottom indicating p=2 features; and three circles labeled x1^(2), x2^(1), and y^(3) with arrows pointing to the values 4, 4300 €, and 1920 respectively.

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

$n = 3$

$p = 2$

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

SUPERVISED LEARNING EXAMPLE

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.

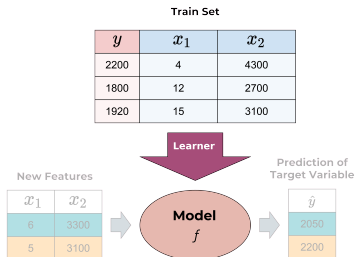
- **Supervised** learning means we make use of *labeled* data for which we observed the outcome.
- We use the labeled data to learn a model f .
- Ultimately, we use our model to compute predictions for **new** data whose target values are unknown.



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

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

