

Introduction to Machine Learning

Introduction: Supervised Learning & Learning Tasks



Learning goals

- Understand the idea of supervised learning
- Know examples of supervised learning
- Understand the difference between the regression and classification task

IDEA OF SUPERVISED LEARNING

- **Goal:** Identify the fundamental functional relation in the data that maps an object's features to the target.
- Ideally, we would have full knowledge about the data-generating process and thus be able to specify this mapping function precisely.
- However, in practical applications we don't know this mapping and we must try to **learn** the mapping function: for objects with certain patterns or properties, some values of the target are much more likely than others.
→ We call such an assumed mapping a **model** f .

IDEA OF SUPERVISED LEARNING

- **Supervised** learning means we make use of *labeled* data, i.e., observations for which we already know the target.
- We try to construct f automatically from a set of labeled data.
→ The algorithm for finding f is called **learner**.
- Using the learned model, we can make **predictions** of the target, based on the features of our data.
- Knowing the “truth” allows us to test how well we have grasped the nature of the underlying mapping: we just need to compare our predictions to the actually observed values.

SUPERVISED LEARNING EXAMPLE (1)

House Prices

Aim: Predict the price for a house in a certain area

Features x				Target y
square footage of the house	number of bedrooms	swimming pool (yes/no)	...	house price in US\$
1,180	3	0	...	221,900
2,570	3	1	...	538,000
770	2	0	...	180,000
1,960	4	1	...	604,000



SUPERVISED LEARNING EXAMPLE (2)

Length-of-stay in a hospital

Aim: Predict the number of days a single patient has to stay in hospital at the time of admission

Features x					Target y
diagnosis category	admission type	gender	age	...	Length-of-stay in the hospital in days
heart disease	elective	male	75	...	4.6
injury	emergency	male	22	...	2.6
psychosis	newborn	female	0	...	8
pneumonia	urgent	female	67	...	5.5



SUPERVISED LEARNING EXAMPLE (3)

Risk category in life insurance

Aim: Predict one of five risk categories (**classification**) for a life insurance customer to determine the insurance premium

Features x				Target y
job type	age	smoker	...	risk group
carpenter	34	1	...	3
stuntman	25	0	...	5
student	23	0	...	1
white-collar worker	39	0	...	2



SUPERVISED LEARNING EXAMPLE (4)

Imagine you want to investigate how salary and workplace conditions (*features*) affect productivity of employees (*target*) – a standard **regression** task. Therefore, you collect data about their worked minutes per week (productivity), how many people work in the same office as the employees in question, and the employees' 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

$p = 2$

$x_1^{(2)}$

$n = 3$

$x_2^{(1)}$

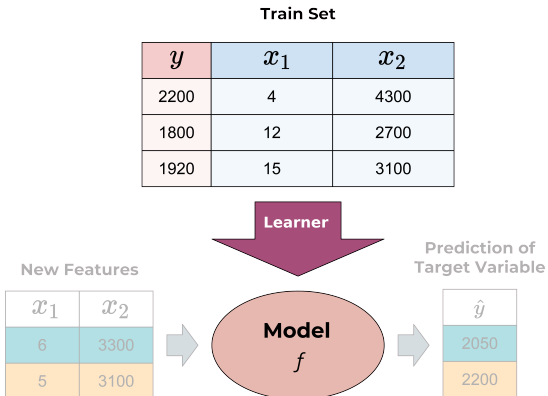
$y^{(3)}$

SUPERVISED LEARNING EXAMPLE (4)

- For our observed data we know which outcome is produced.
- For new employees we can only observe the features but not the target.
- We use the labeled data to learn the model f .
- Ultimately, we use our model to compute predictions for **new** data whose target values are unknown.



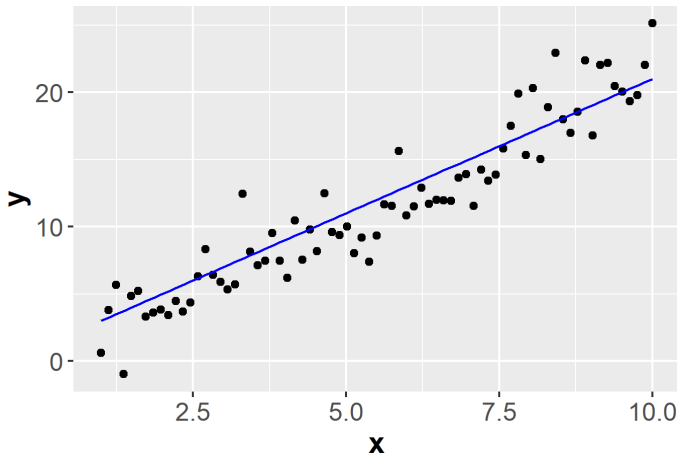
SUPERVISED LEARNING EXAMPLE (4)



TASKS IN SUPERVISED LEARNING

In general, supervised learning comes in two flavors we call **tasks**:

- **Regression**: Given features \mathbf{x} , predict corresponding output from $\mathcal{Y} \in \mathbb{R}^m$.



TASKS IN SUPERVISED LEARNING

- **Classification:** Assign an observation with features \mathbf{x} to one class of a finite set of classes $\mathcal{Y} = \{C_1, \dots, C_g\}, g \geq 2$ (details later).

