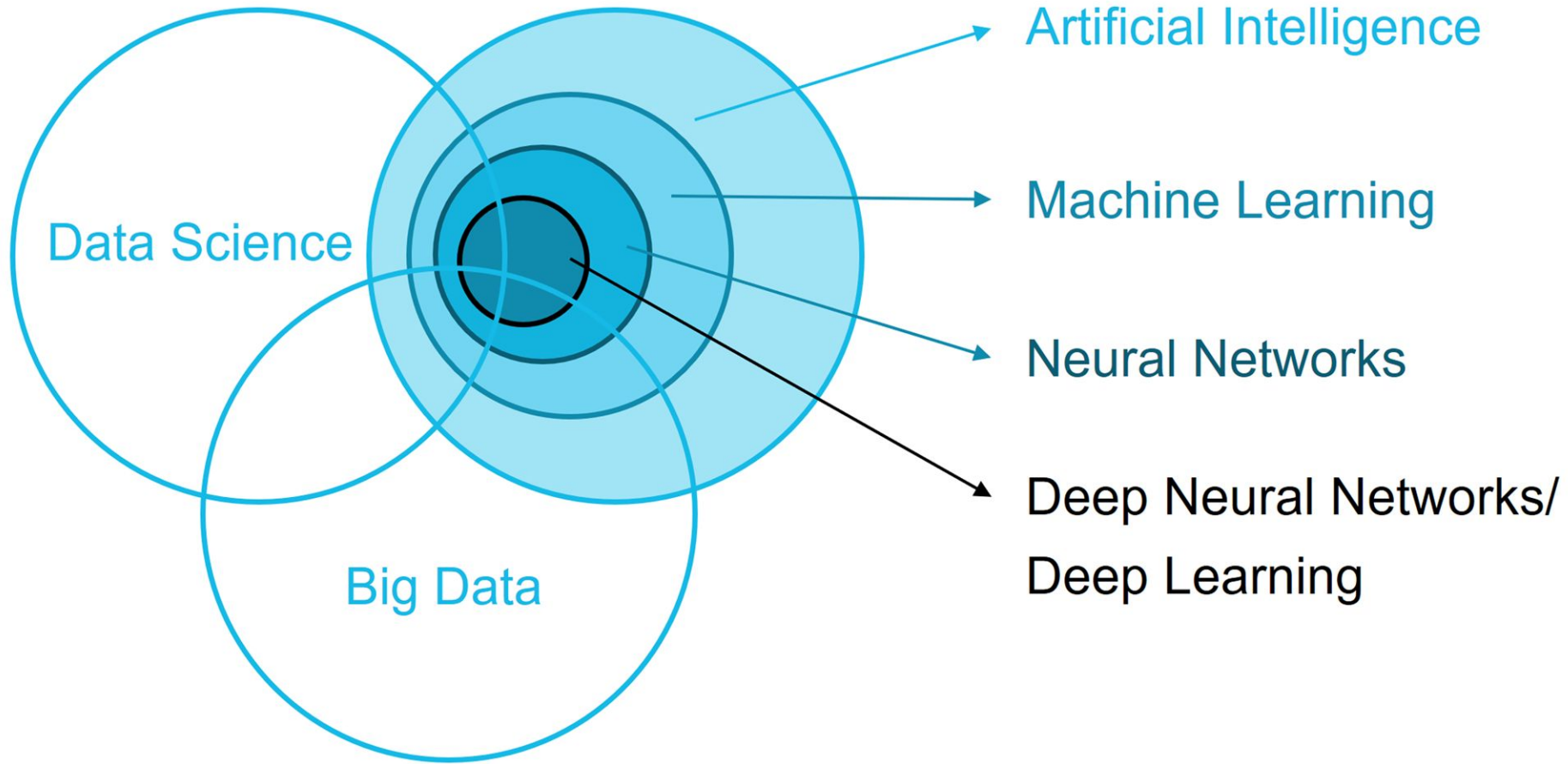


Introduction to ML

Machine Learning is the study
and production of algorithms
that can learn from
and make predictions on data



Example: Regression

Data Representation

one sample

$$X = \begin{pmatrix} 1.1 & 2.2 & 3.4 & 5.6 & 1.0 \\ 6.7 & 0.5 & 0.4 & 2.6 & 1.6 \\ 2.4 & 9.3 & 7.3 & 6.4 & 2.8 \\ 1.5 & 0.0 & 4.3 & 8.3 & 3.4 \\ 0.5 & 3.5 & 8.1 & 3.6 & 4.6 \\ 5.1 & 9.7 & 3.5 & 7.9 & 5.1 \\ 3.7 & 7.8 & 2.6 & 3.2 & 6.3 \end{pmatrix}$$

one feature

$$y = \begin{pmatrix} 1.6 \\ 2.7 \\ 4.4 \\ 0.5 \\ 0.2 \\ 5.6 \\ 6.7 \end{pmatrix}$$

outputs / labels

What is Learning?

Representation \Rightarrow Hypothesis space

Evaluation \Rightarrow Metrics

Optimization \Rightarrow how to move on the hypothesis space

Approximation

- First idea, minimize mean squared error on the full data set.

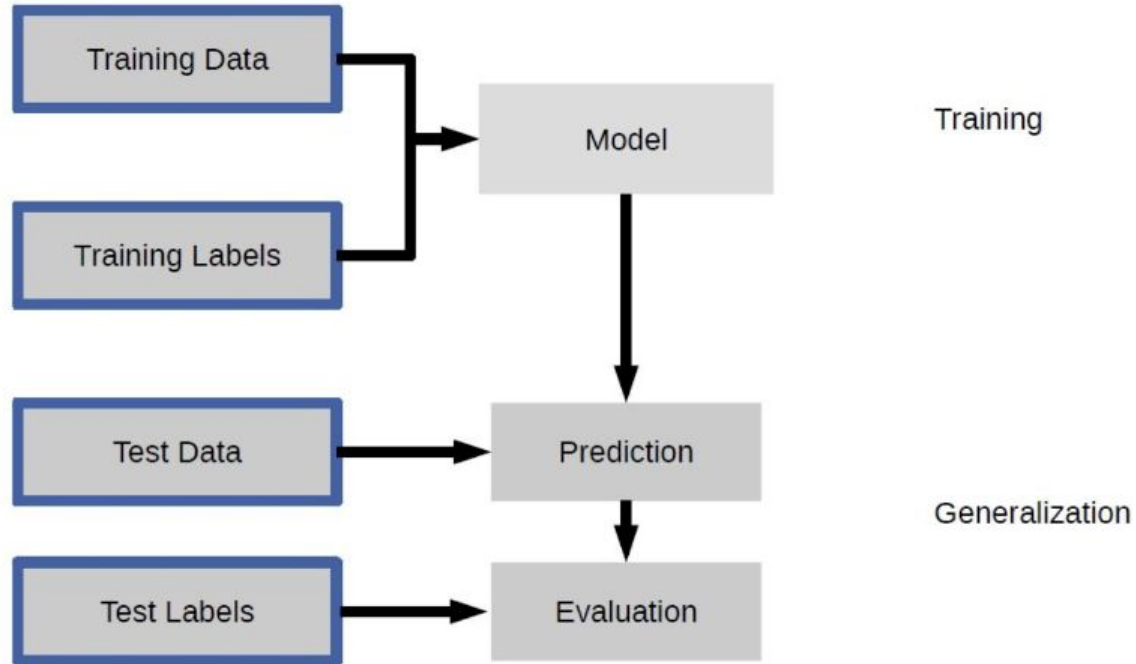
⇒ **Trivia:** what can go wrong?



Generalization

- “Memorizing” the information we have can be optimistic but misleading.
- Our model should be able to work well on unseen circumstances.
- Provided that our training data is a *representative sample* of the problem space, how can we do that?

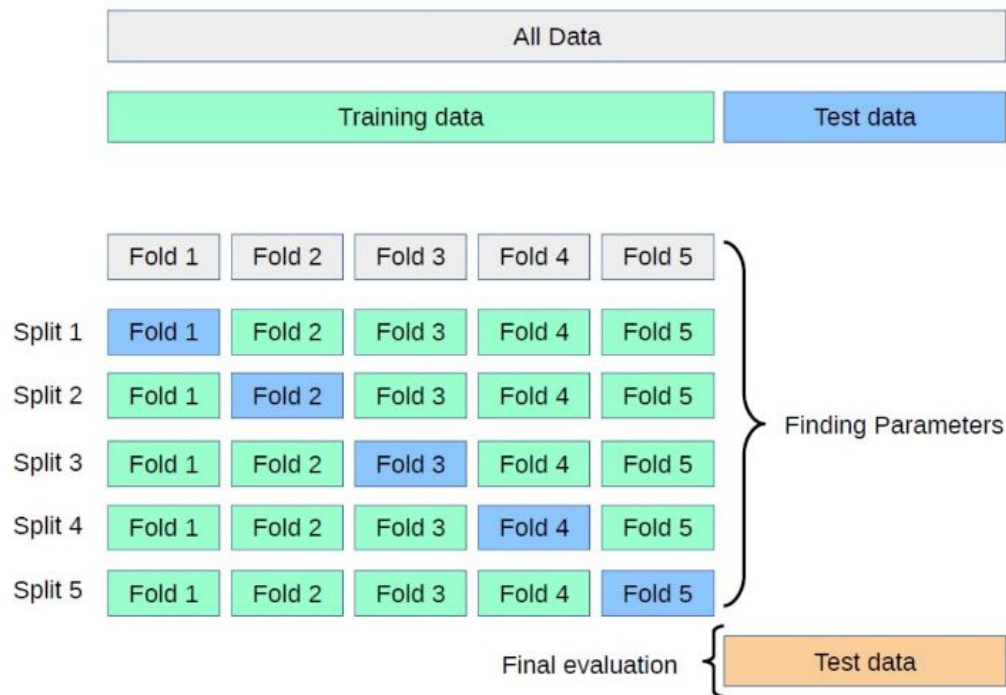
Supervised Learning

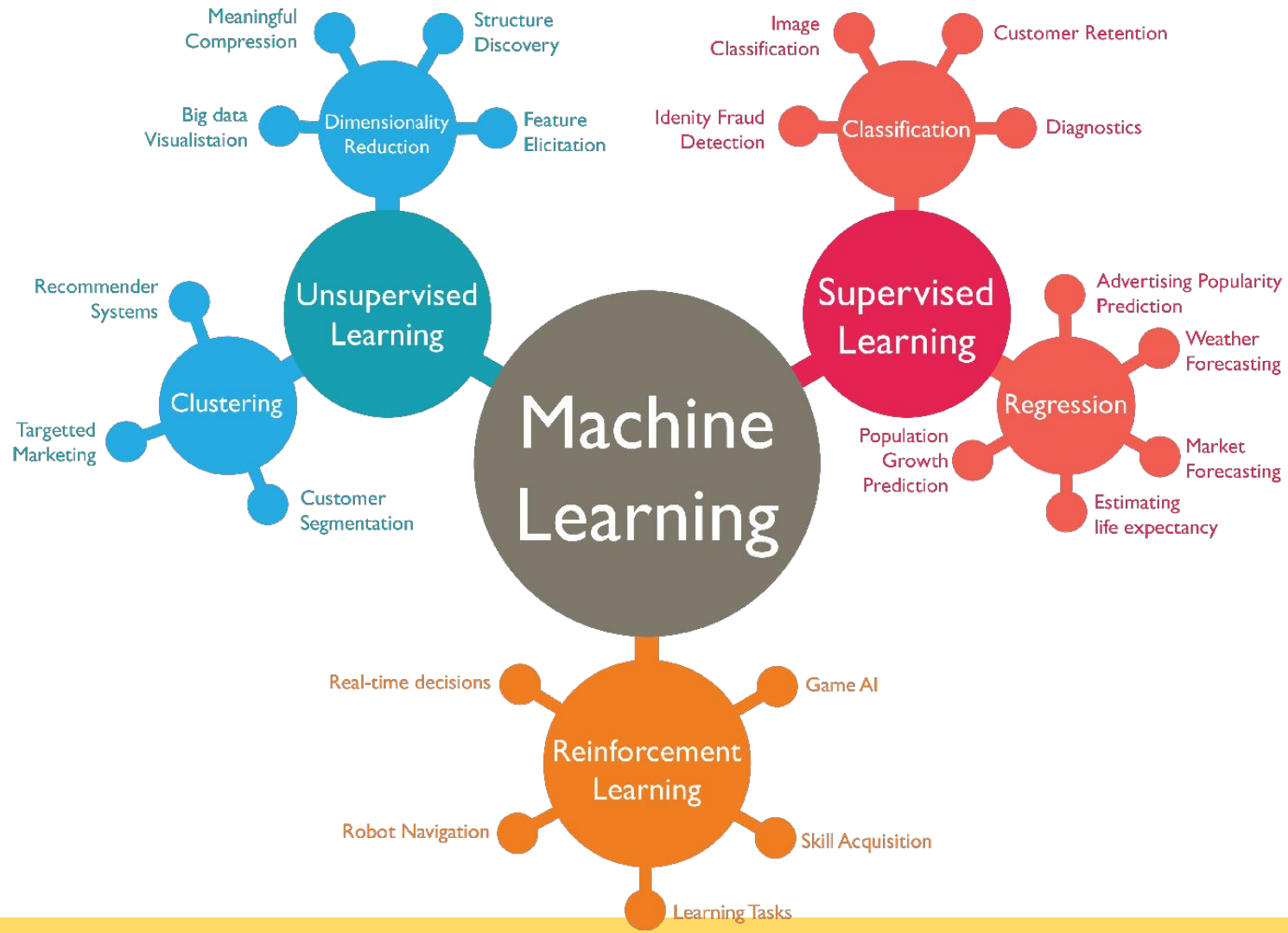


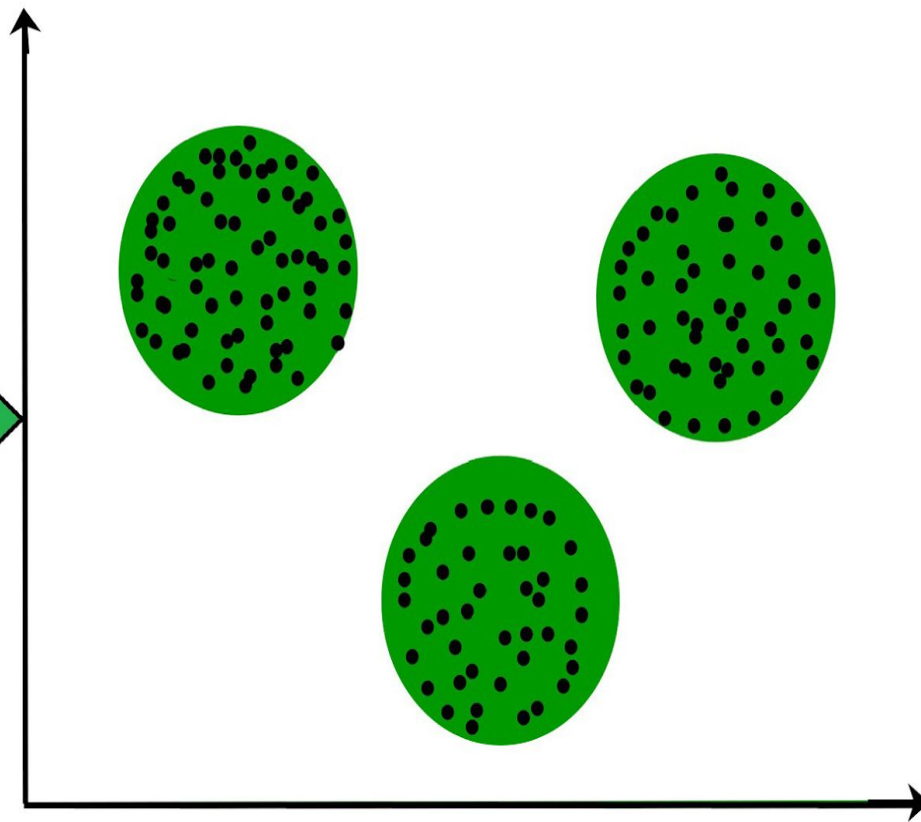
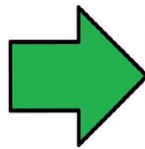
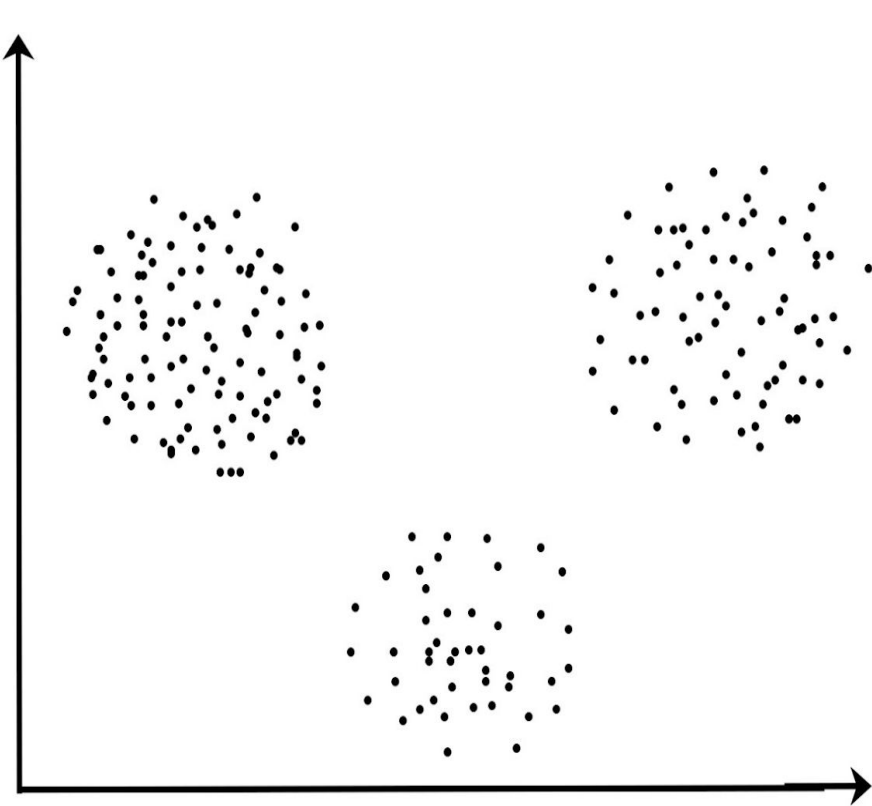
Cross Validation



Holdout Validation









Reinforcement Learning / Black-box Optimization



- Interaction of an agent in an unknown, difficult to describe environment.
- Sparse signal / Credit assignment problem
- **Requires access to real world (or at least to a simulator).**

Policy methods

- Parameterize the behaviour of the agent as a function of the state.
- Calculate obtained reward (or incurred loss).
- Generate a new parameter with an update rule that depends on the reward.



Recap

- Three types of machine learning
- Different input/output structure.
- Many applications!