

# INTRODUCTION

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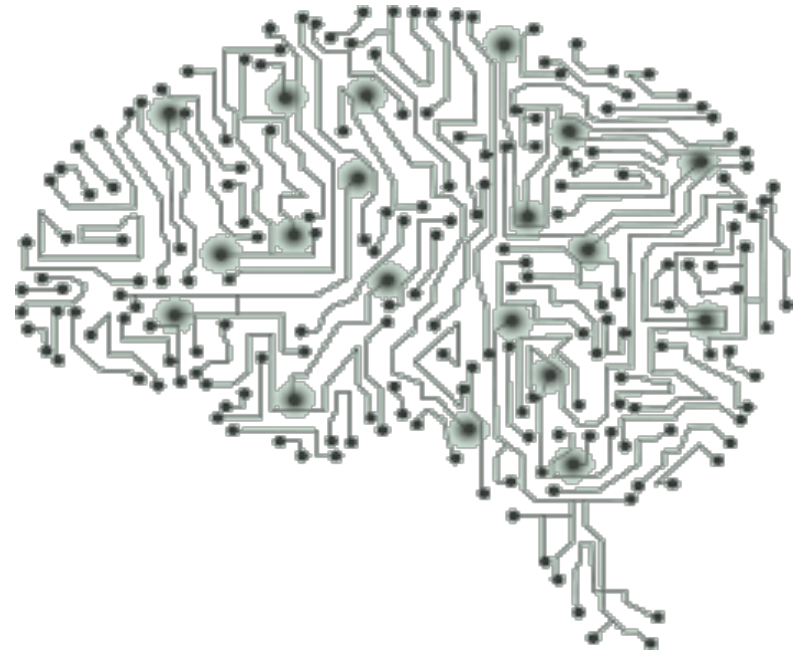
Machine Learning

Supervised learning

Unsupervised learning

# Syllables

- I. Introduction
  - What is machine learning ?
  - Learning Paradigms
  - Elements of a learning task
- II. Linear Regression
- III. Logistic Regression
- IV. Decision Trees
- V. Clustering
- VI. Neural Networks
- VII. Model selection



# What is machine learning ?

Machine Learning is a field of study that gives computers the **ability to learn without being explicitly programmed.**

Arthur Samuel (1959)

# What is learning ?

- Progressively improve performance on a specific task
- Learning in other Sciences

# What is machine learning ?

Machine Learning is a field of study that gives computers the **ability to learn without being explicitly programmed.**

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Well-posed Learning Problem: A computer program is said to learn from **experience E** with respect to some **task T** and some **performance measure P**, if its performance on T, as measured by P, improves with experience E.

Tom Mitchell (1998)

# An example

Suppose your email program watches which emails you do or do not mark as spam, and based on that learns how to better filter spam. What is the task  $T$  in this setting?

## Task

Classifying emails as spam or not spam

## Experience

Watching you label emails as spam or not spam

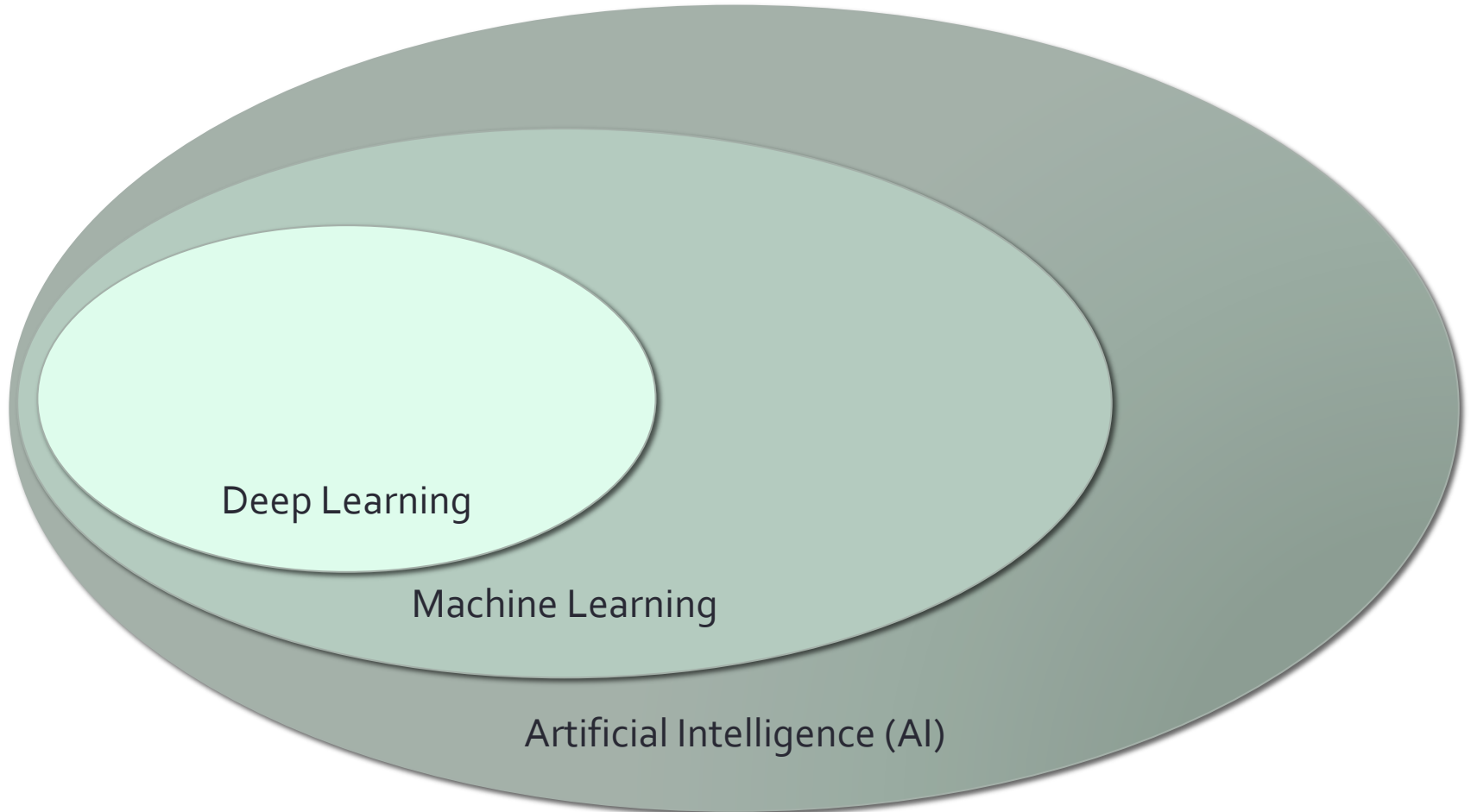
## Performance Measure

The number (or fraction) of emails correctly classified as spam/not spam

# Elements of a learning task

- Collection of **training data**
- A class of **learning models**. Often defined by the free model parameters in a learning model with a fixed structure
- Selection of a **cost function** which is a function of the data and the free parameters; a good model has a low cost
- Optimizing the cost function via a **learning rule** to find the best model in the class of learning models under consideration.

# Terminology





# Learning paradigms

- **Supervised Learning**

Supervised learning: the data is presented to the algorithm with example inputs and their associated outputs. This can be either a classification or a regression problem.

- **Unsupervised Learning**

no labels are given to the learning algorithm. The goal is to discover groups in the data (clustering) or to determine the distribution of data within the input space (density estimation). Techniques for dimensionality reduction, such as feature extraction, can also be considered to be unsupervised learning algorithms.

- **Reinforcement Learning**

software agents ought to take actions in an environment so as to maximize some notion of cumulative reward.

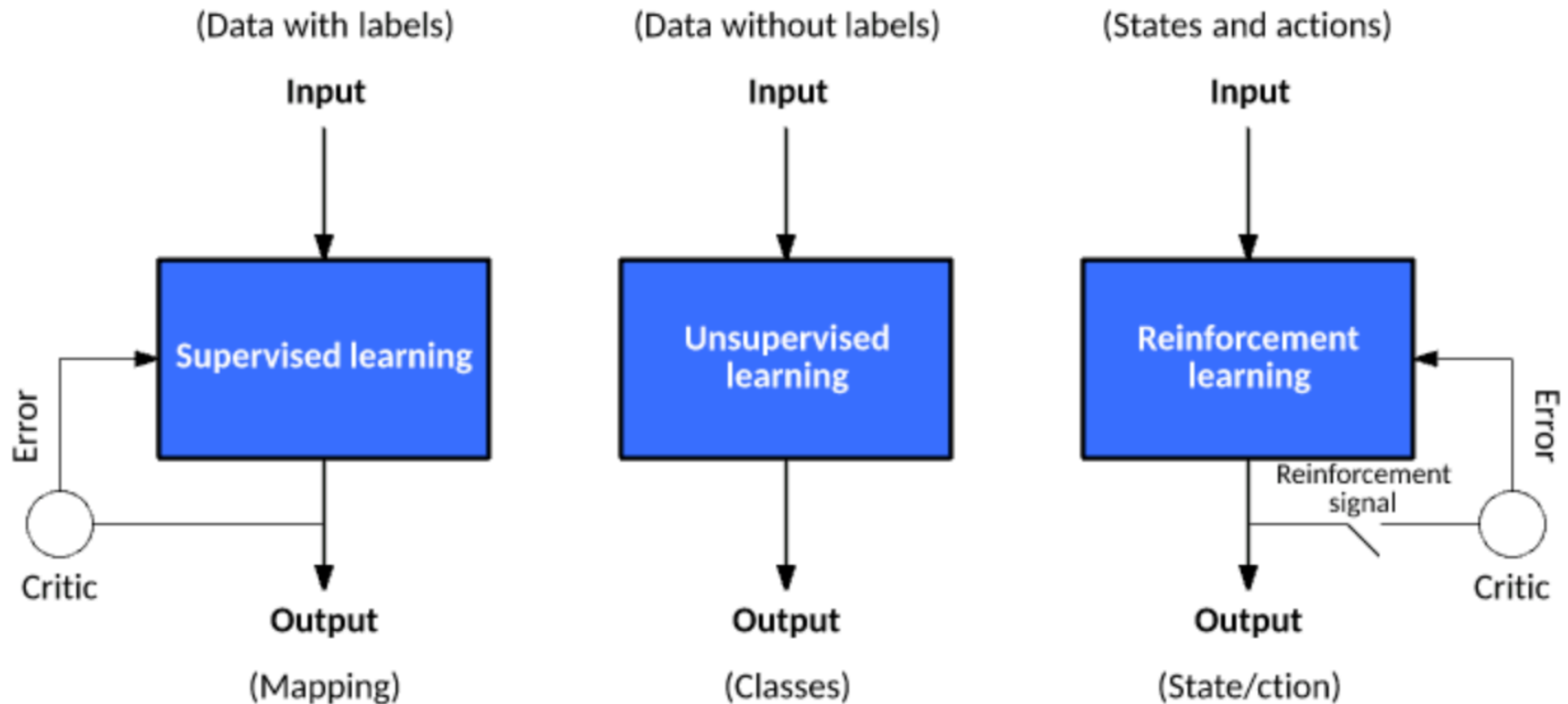
# Supervised Learning



like  
love good one  
can get  
something even things  
new number  
already someone  
morning  
please  
think  
didn't  
got  
send much  
know  
feel great  
anything  
said place  
long coming  
yet  
day phone  
lunch  
water  
table  
pill  
pursue  
say  
first let  
concentrate  
can hey  
dun  
sent  
see  
still  
tonight  
want going  
really  
have  
also week  
work  
miss  
well  
dorm  
give  
thought  
make back  
year class reply  
ask  
year  
ill  
just  
sorry  
day  
way  
that  
come  
life  
went  
night  
last  
miss  
late  
time  
later  
hours  
around  
message  
need  
tomorrow  
happy



# Learning Paradigms



# Types of supervised learning



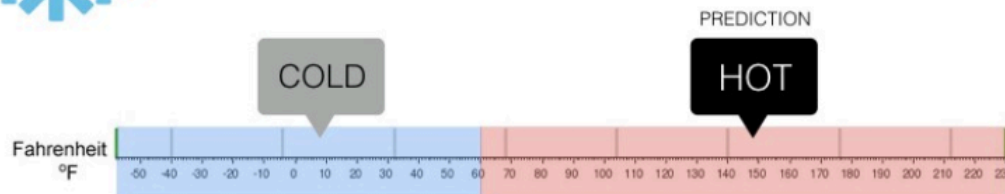
## Regression

What is the temperature going to be tomorrow?

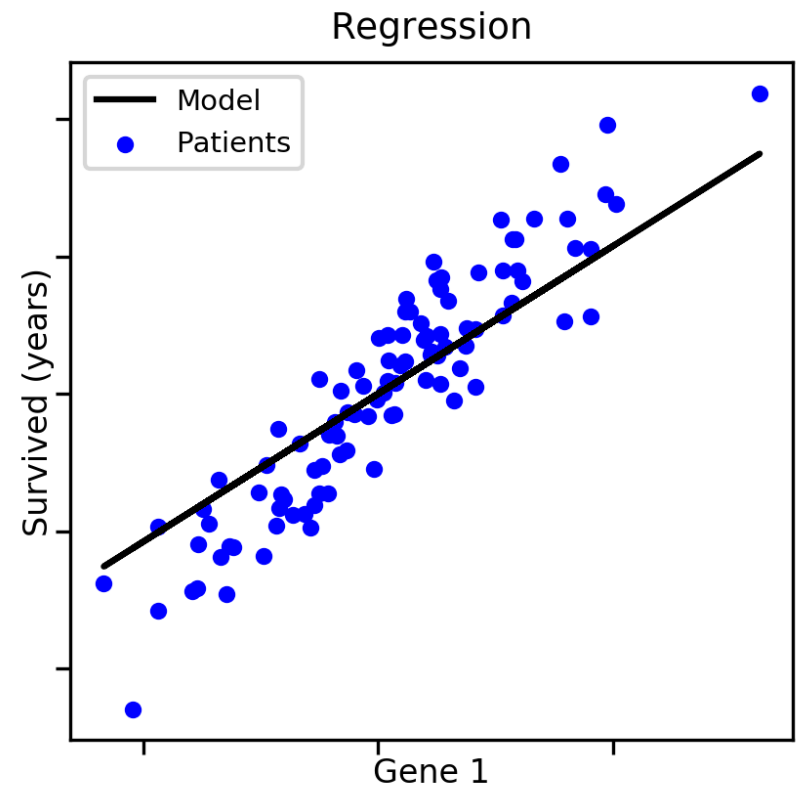
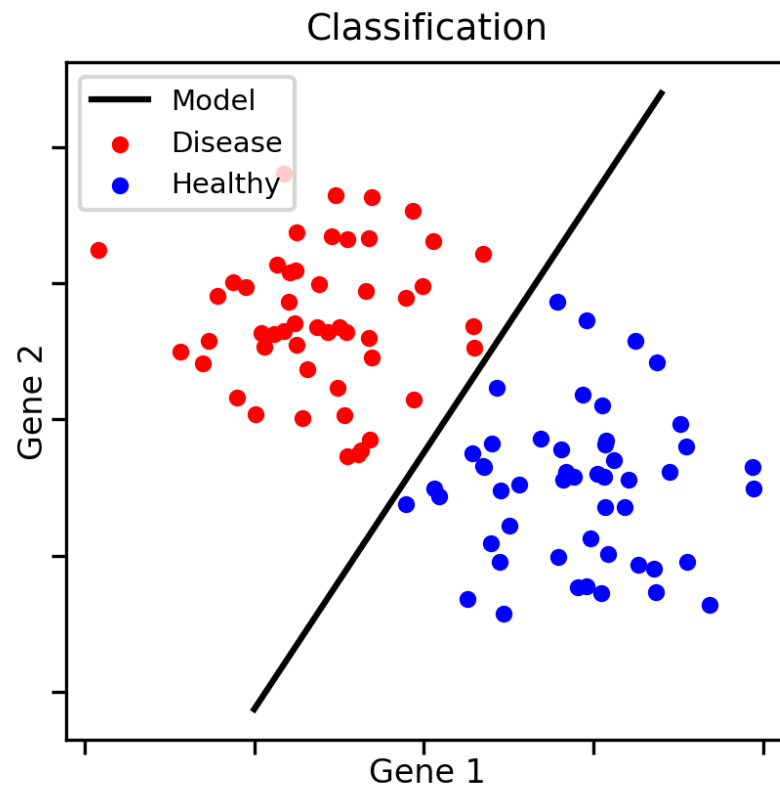


## Classification

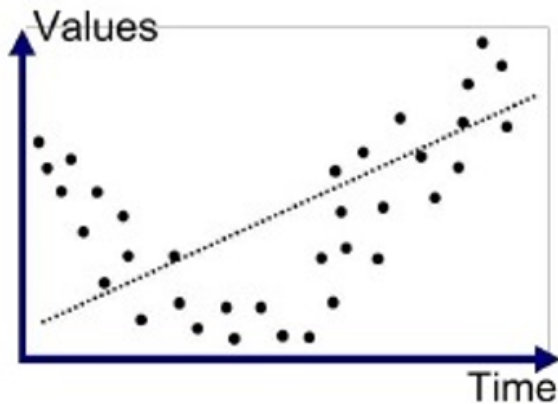
Will it be Cold or Hot tomorrow?



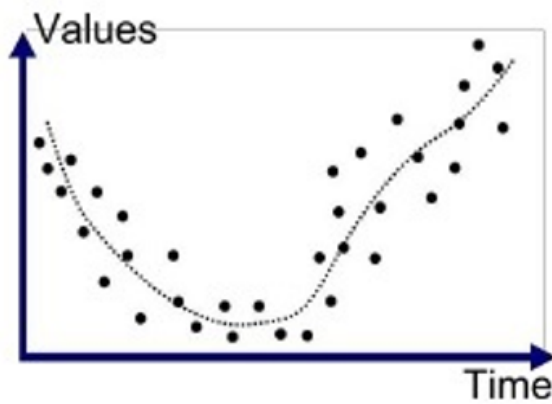
# Types of supervised learning



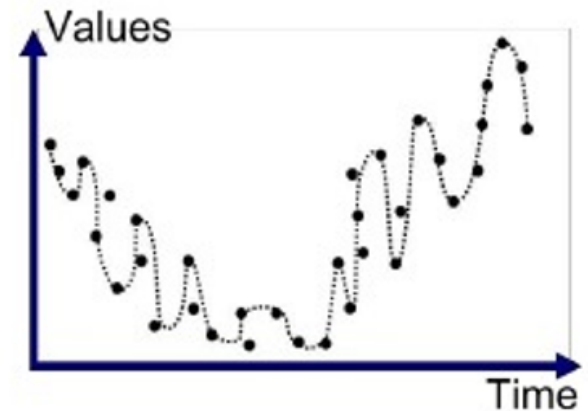
# Over- and Underfitting



Underfitted

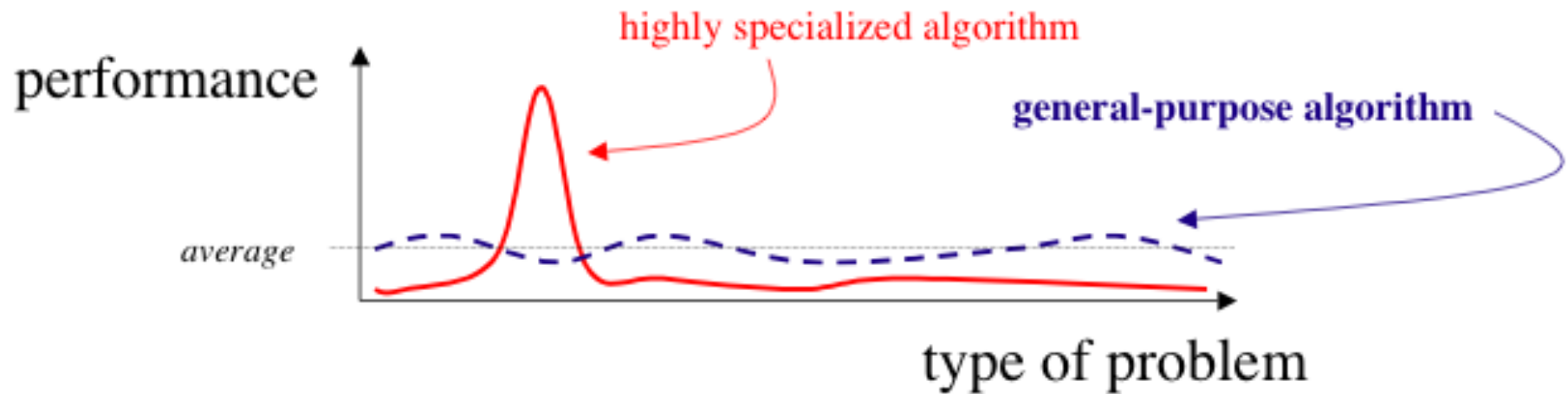


Good Fit/Robust



Overfitted

# No-free lunch theorem

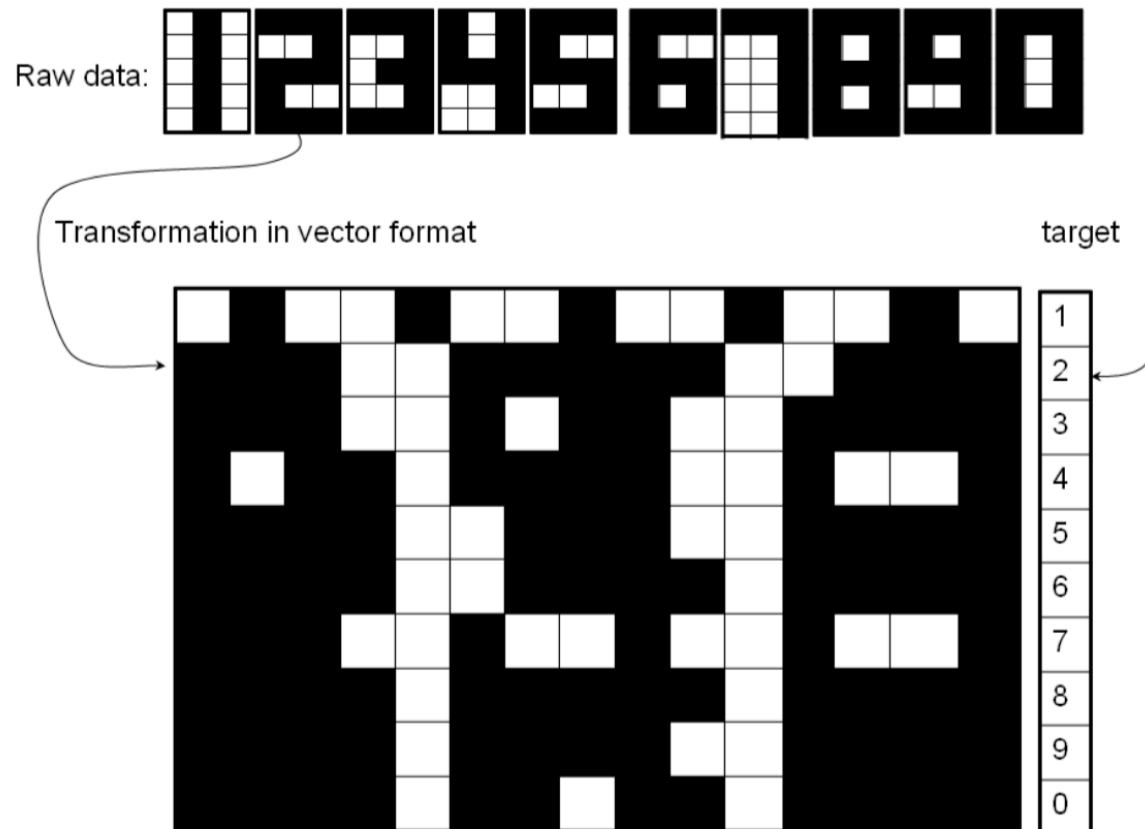


# Example: Digit Classification (I)

- *Goal*: Classification of printed or handwritten digits
- *Application*: automatic reading of postal codes
- A task in the field of optical character recognition



# Example: Digit Classification (II)



# Example: Digit Classification (II)

