DECOMPOSING
NEURAL NETWORKS

An applicant's guide to artificial learning
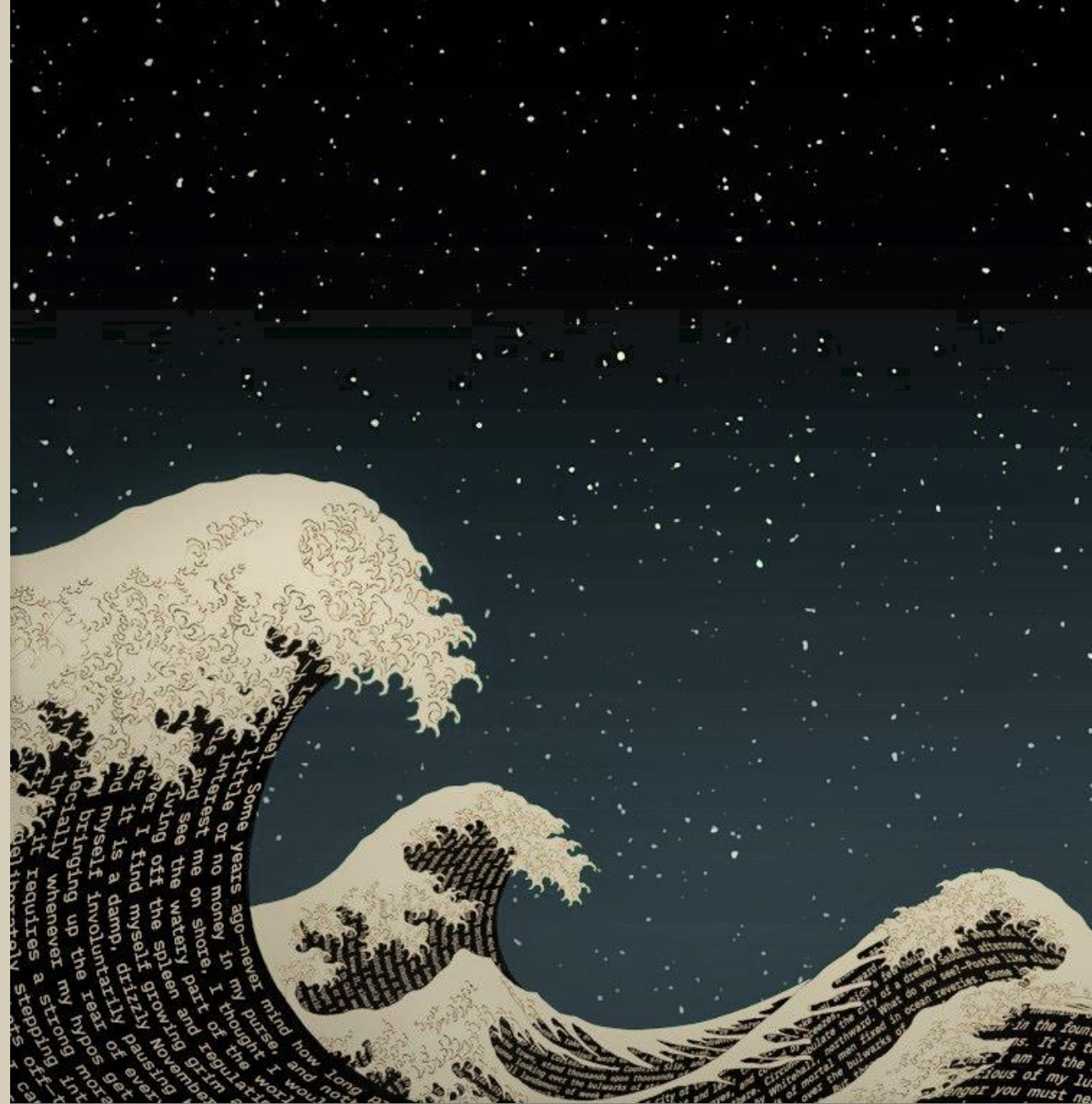18.10.2022

→ JENNIFER MATTHIESEN & TINO PAULSEN | WINTERSEMESTER 2022

LEUPHANA
UNIVERSITÄT LÜNEBURG

ABOUT
THE COURSE

— 7 Sessions, á 3,5 hours
+ weekend session in Januar

— Files and Slides on mystudy

— Consultation hours on request

GOALS OF THE COURSE

— Get a solid understanding of neural networks
   → Why are they so powerful?

— Understand their inner mechanisms
   → How do they learn?

— Critically discuss their abilities and limitations
   → What can they learn?
   → Where are the limits?

— Code :)

HOW TO PASS THE COURSE

— Take active part in the course, participate in discussions

— **SL:**

Participate at the code-camp on the weekend block (with PIZZA)

— **PL:**

Training an own neural network (based on the code developed together in the seminar) and critically reflecting it in written form
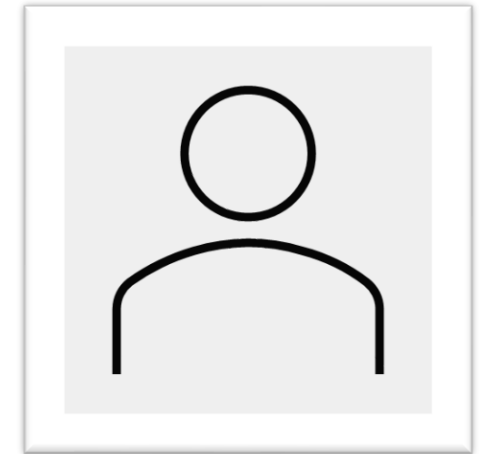
ABOUT ~~THE COURSE~~ US

Let us exploit and explore
and to find out when it does not work

JENNIFER MATTHIESEN

— Doctoral candidate in ML

— B.A. in Digital Media

— M.Sc. in Mediology

TINO PAULSEN

— Doctoral candidate in ML

— B.A. in Psychology

— M.Sc. In Management and Data Science

EXAM
COBINATION OF CODE AND ESSAY

The exam is a combination of code and essay.
You can work in groups or alone (**1-3 persons**).

— **Code**:
  — Train your own neural network (any) using data from a topic you and your group are interested in

— **Essay**:
  — Shortly describe what you did, how you trained, which data was used and why. Reflect critically your results and the limitations.

TRIED TO EXPLORE WHAT A NETWORK CAN LEARN AND WHERE ITS LIMITATIONS ARE.

EXAM
COBINATION OF CODE AND ESSAY

The exam is a combination of code and essay.
You can work in groups or alone (**1-3 persons**).

Example:

— The German language comprises three articles ("der", "die", "das").

— Research question: Can a neural network learn the according article to a subjective?

— Testing its limitations: Where does it work, where not?

— How does it decide on made-up words? How do humans decide here (questionnaire)

TRIED TO EXPLORE WHAT A NETWORK CAN LEARN AND WHERE ITS LIMITATIONS ARE.

NOW ABOUT YOU!

What is your name/pronounce?

What are your interest in…

— … digital media?

— … machine learning / AI?

— … the life outside university?

What do you expect to learn in this course?

ABOUT
THE CONTENT

— INTRO & OVERVIEW

— INTO NEURAL NETWORKS

— ABOUT DATA, CATS AND DOGS

— OPTIMISATION

— ARCHITECTURES: KNOT BY KNOT

— CRITICAL NN STUDIES/ DECOMPOSING
INFORMATION

— BRAINSTORMING/ PROJECTS

— CODE CAMP &

TODAY:
INTRODUCTION & OVERVIEW

TIME FOR
BUZZWORDS

IMAGE REGOCNITION

DEEP LEARNING

DATA SCIENCE

ARTIFICIAL

GENERALI-SATION

DATA NEURAL

INTELLIGENCE

NETWORKS

WEIGHTS AND BIASES

BIG DATA

MACHINE LEARNING

INTELLIGENT GENERATING

PREDICTIONS ALGORITHMS

https://www.menti.com/alph53bgwv4u

WHAT IS
ARTIFICIAL INTELLIGENCE
FOR YOU?

"[The automation of]" activities that we associate with human thinking, activies, such as decision-making, problem-solving, learning…"(Bellmann, 1987)

"The exciting new effort to make computers think […] machines with minds, in the full and literal sense." (Haugeland, 1985)

"The study of the computations that make it possible to perceive, reason, and act" (Winston, 1992)

"The study of mental faculties through the use of computational models" (Charniak and McDermott, 1985)

"The art of creating machines that perform functions that require intelligence when performed by people" (Kurzweil, 1990)

"The study of how to make computers do things at which , at the moment, people are better" (Rich and Knight, 1991)

"Computational Intelligence is the study of the design of intelligent agents" (Poole at al. 1998)

"AI […] is concerned with intelligent behavior of artifacts" (Nilsson, 1998)

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WITH WHICH QUOTES
DO YOU AGREE THE MOST ?

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LIKE
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WHAT IS
MACHINE LEARNING
FOR YOU?

WHAT IS
MACHINE LEARNING
FOR YOU?

SAMUEL'S
CHECKERS-PLAYER

"**MACHINE LEARNING**: FIELD OF STUDY THAT GIVES COMPUTERS THE ABILITY TO LEARN WITHOUT BEING EXPLICITLY PROGRAMMED."

ARTHUR SAMUEL(1959)

ABOUT
MACHINE LEARNING

BLACKBOX

ABOUT
MACHINE LEARNING
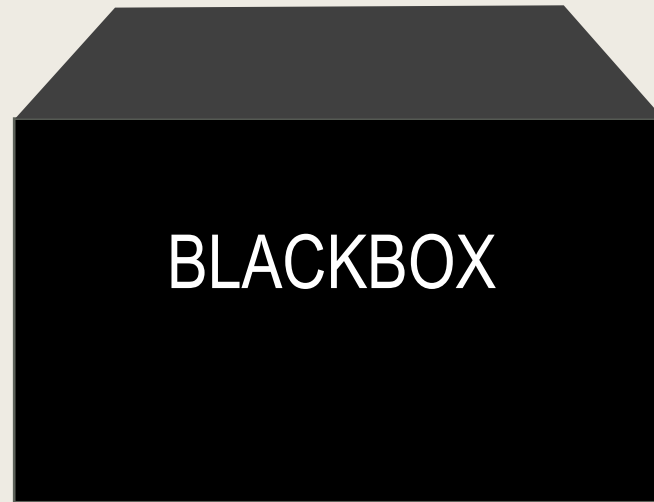
INPUT
DATA

BLACKBOX

ABOUT
MACHINE LEARNING

INPUT
DATA

BLACKBOX

OUTPUT

ABOUT
MACHINE LEARNING

INPUT
DATA

BLACKBOX
$f(x)$

Data generating function

OUTPUT

$x \in X$
DATA

BLACKBOX
$f(x)$
Data generating function

OUTPUT

ABOUT
MACHINE LEARNING

$$x \in X$$

DATA

BLACKBOX

$f(x)$

Data generating function

$$\hat{y}$$
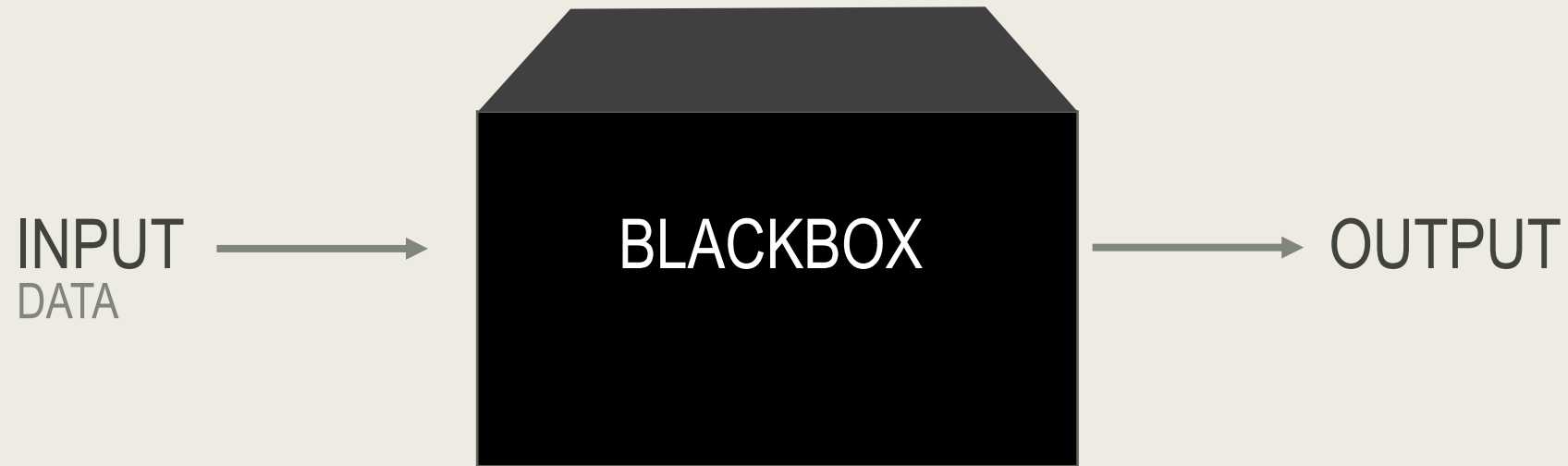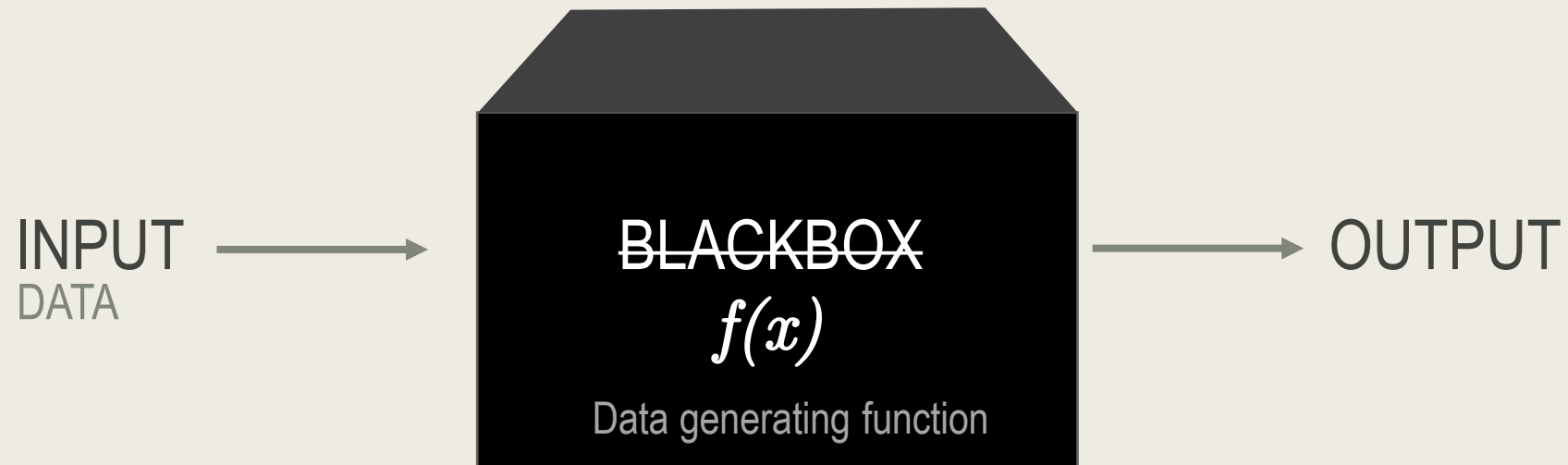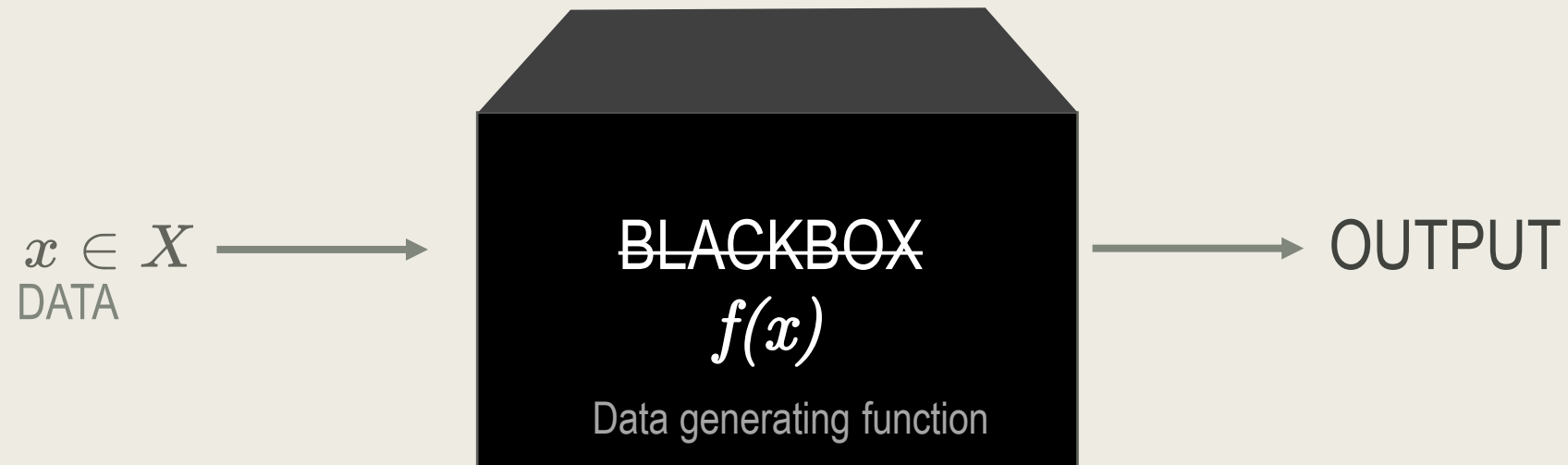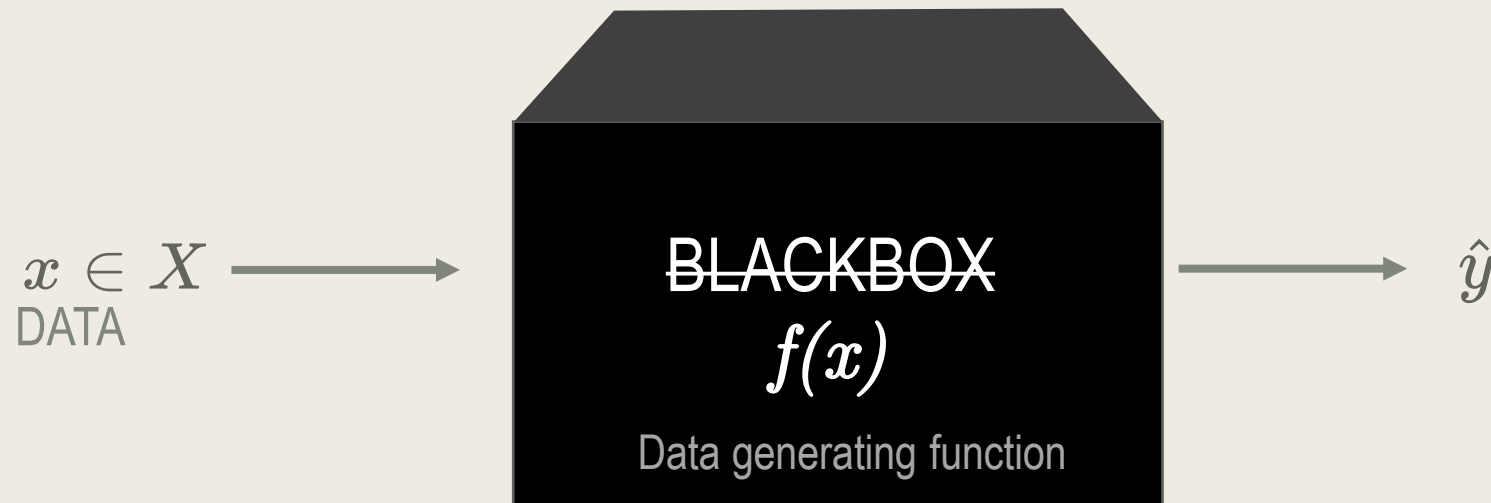
WHAT DO WE NEED FOR
MACHINE LEARNING?

WHAT DO WE NEED FOR MACHINE LEARNING?

SAMPLES/ DATA

WHAT DO WE NEED FOR
MACHINE LEARNING?

SAMPLES/
DATA

TYPES OF
MACHINE LEARNING
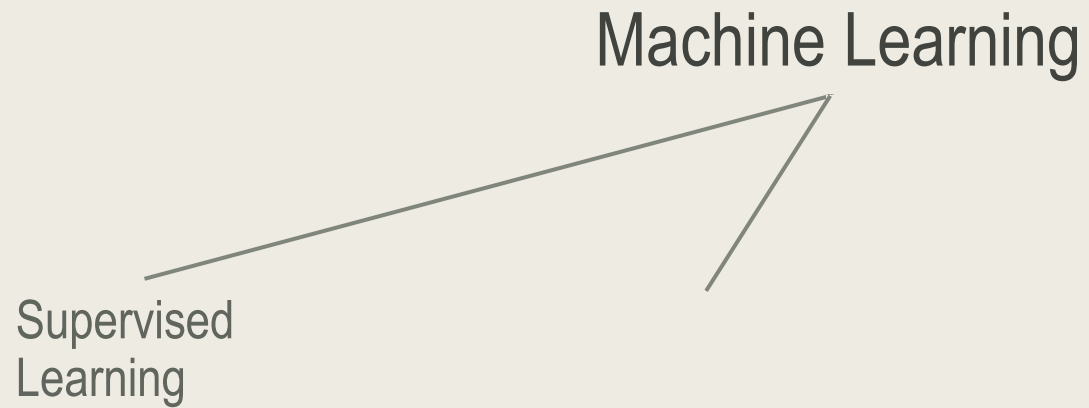
Machine Learning

Machine Learning

Supervised
Learning

TYPES OF
MACHINE LEARNING

Machine Learning

Supervised
Learning

Unsupervised
Learning

TYPES OF
MACHINE LEARNING

Machine Learning

Supervised
Learning

Unsupervised
Learning

Reinforcement
Learning

TYPES OF
MACHINE LEARNING

Machine Learning

Supervised
Learning

Semi-
supervised
Learning

Unsupervised
Learning

Reinforcement
Learning
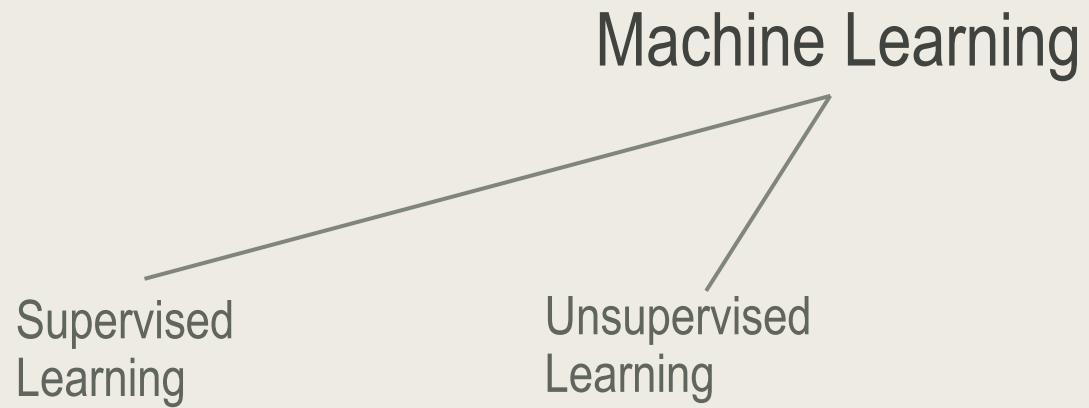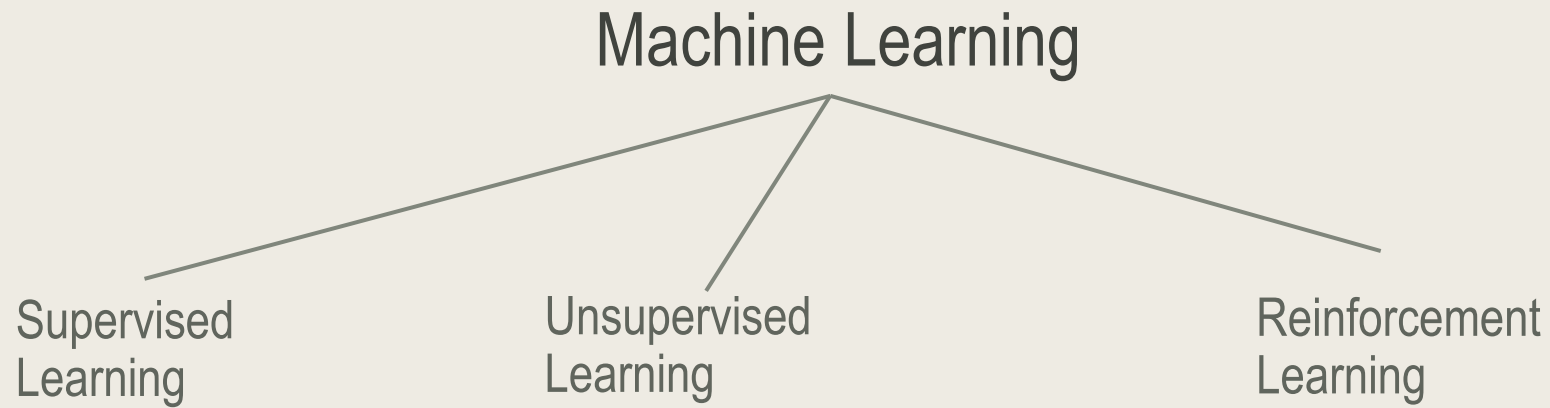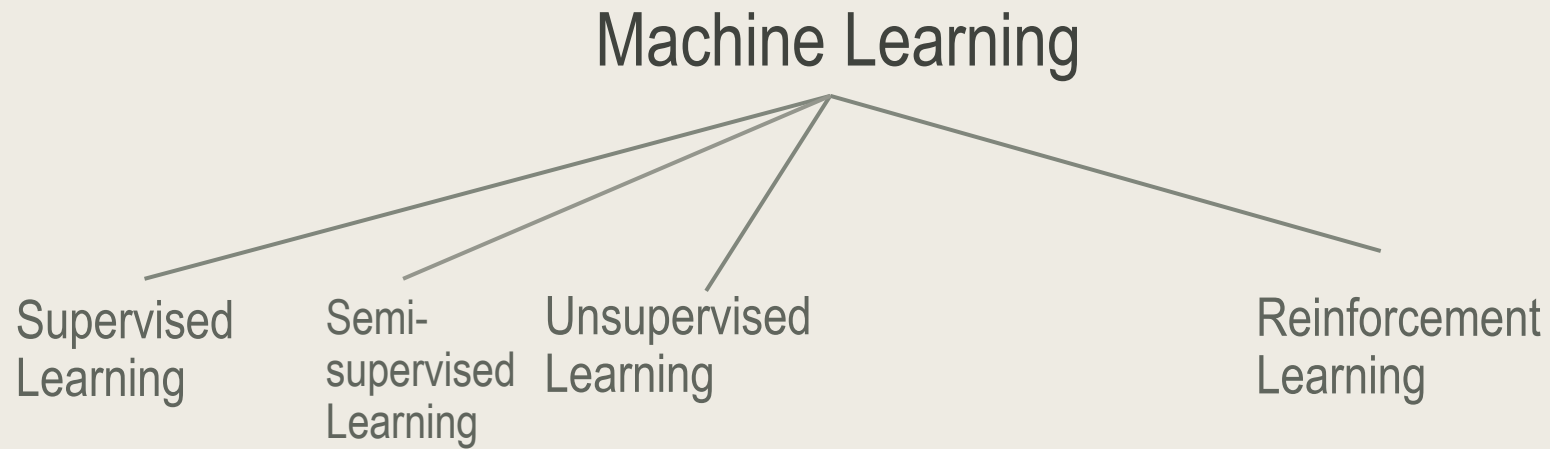
SUPERVISED
LEARNING

Labels is what we need

SUPERVISED LEARNING
USING LABELS

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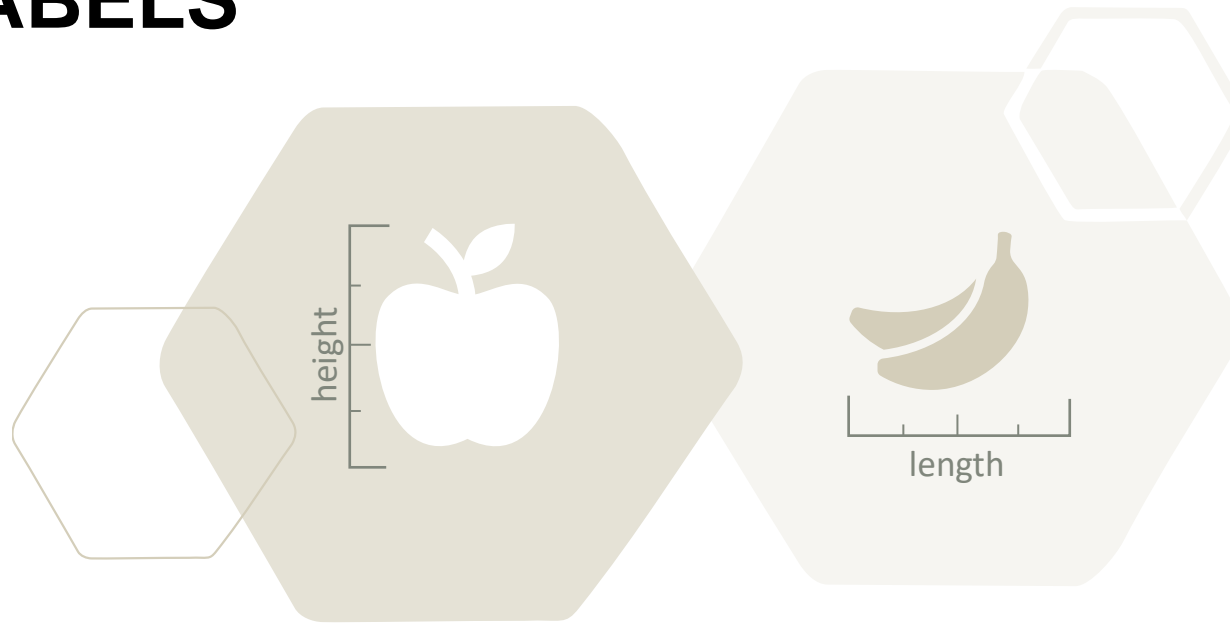
Length	Height	Fruit
6	7	Apple
13	2	Banana

SUPERVISED LEARNING
USING LABELS
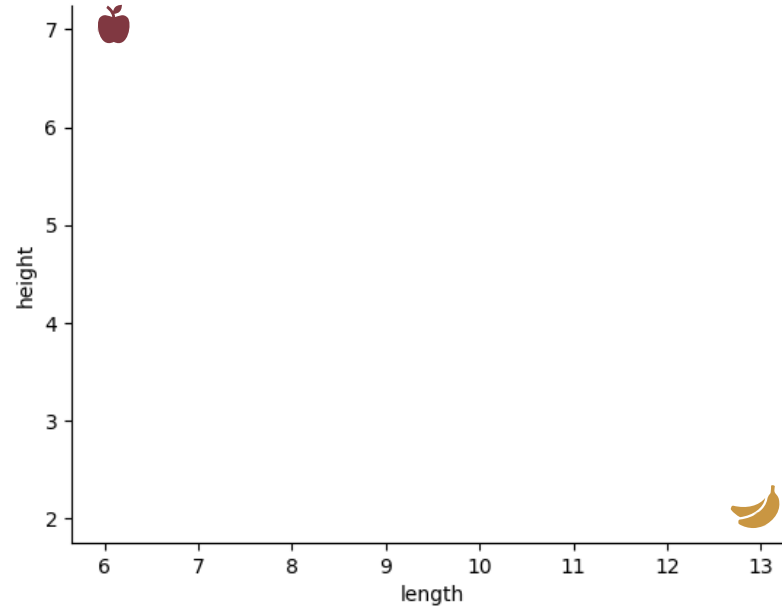
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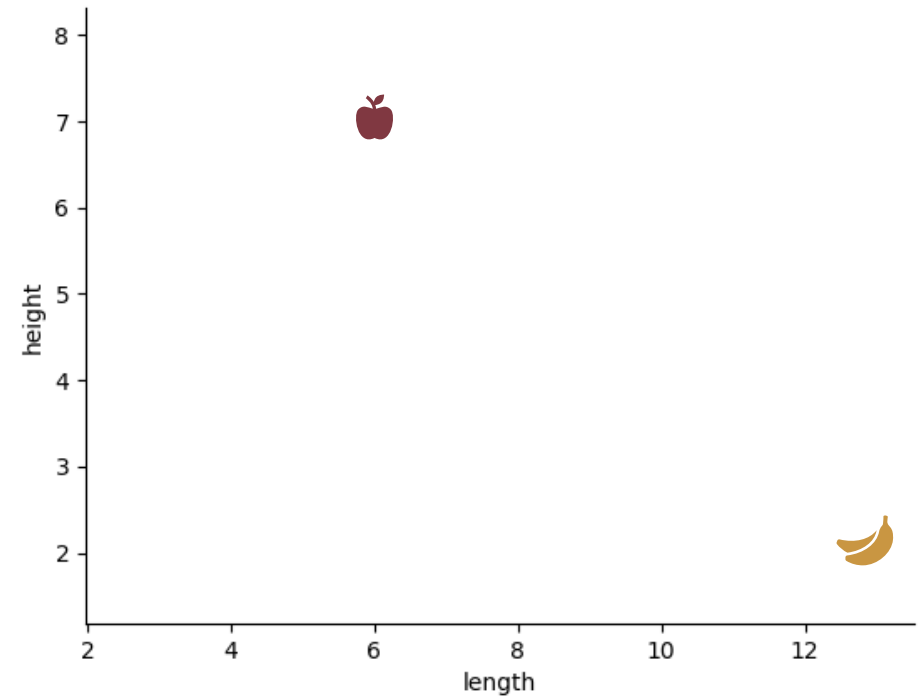
SUPERVISED LEARNING
USING LABELS

Length	Height	Fruit
6	7	Apple
13	2	Banana
5	4	Apple
7	8	Apple
6.5	5.5	Apple
2.5	2.9	Apple
11	1.5	Banana
12	2	Banana
11.5	2.5	Banana

SUPERVISED LEARNING
USING LABELS

Length	Height	Fruit
6	7	Apple
13	2	Banana
5	4	Apple
7	8	Apple
6.5	5.5	Apple
4.1	3.1	Apple
11	1.5	Banana
12	2	Banana
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SUPERVISED LEARNING
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SUPERVISED LEARNING
USING LABELS

Length	Height	WHAT COULD WE POSSIBLY DO??	Fruit
6	7		Apple
5	4		Apple
7	8		Apple
6.5	5.5		Apple
13	2		Banana
11	1.5		Banana
12	2		Banana
11.5	2.5		Banana
10.5	2.1		Banana
…	…		…

SUPERVISED LEARNING
USING LABELS

Length	Height	Weight	Soft	Fruit
6	7	82	0	Apple
5	4	61	0	Apple
7	8	99	0	Apple
6.5	5.5	73	0	Apple
13	2	146	1	Banana
11	1.5	123	1	Banana
12	2	129	1	Banana
11.5	2.5	135	1	Banana
10.5	2.1	111	1	Banana
…	…	…	…	…

SUPERVISED LEARNING
USING LABELS

Length	Soft	Fruit
6	0	Apple
5	0	Apple
7	0	Apple
6.5	0	Apple
2.5	0	Apple
13	1	Banana
11	1	Banana
12	1	Banana
11.5	1	Banana
10.5	1	Banana
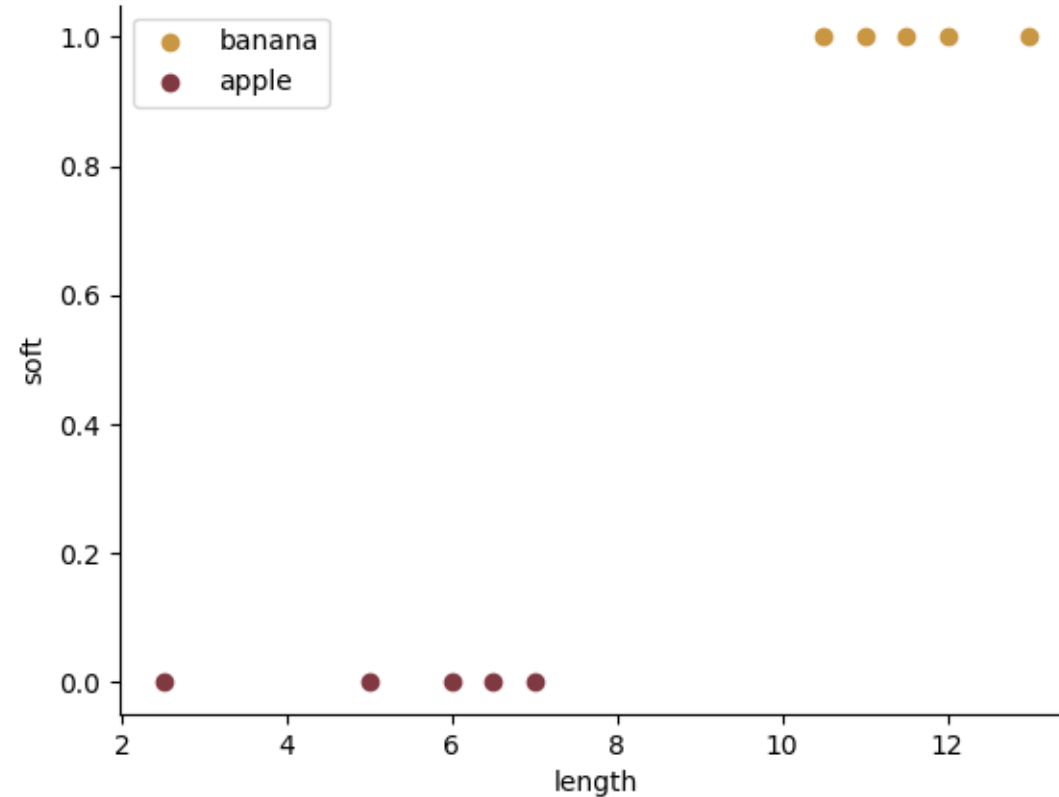
SUPERVISED LEARNING
USING LABELS

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5	0	Apple
7	0	Apple
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2.5	0	Apple
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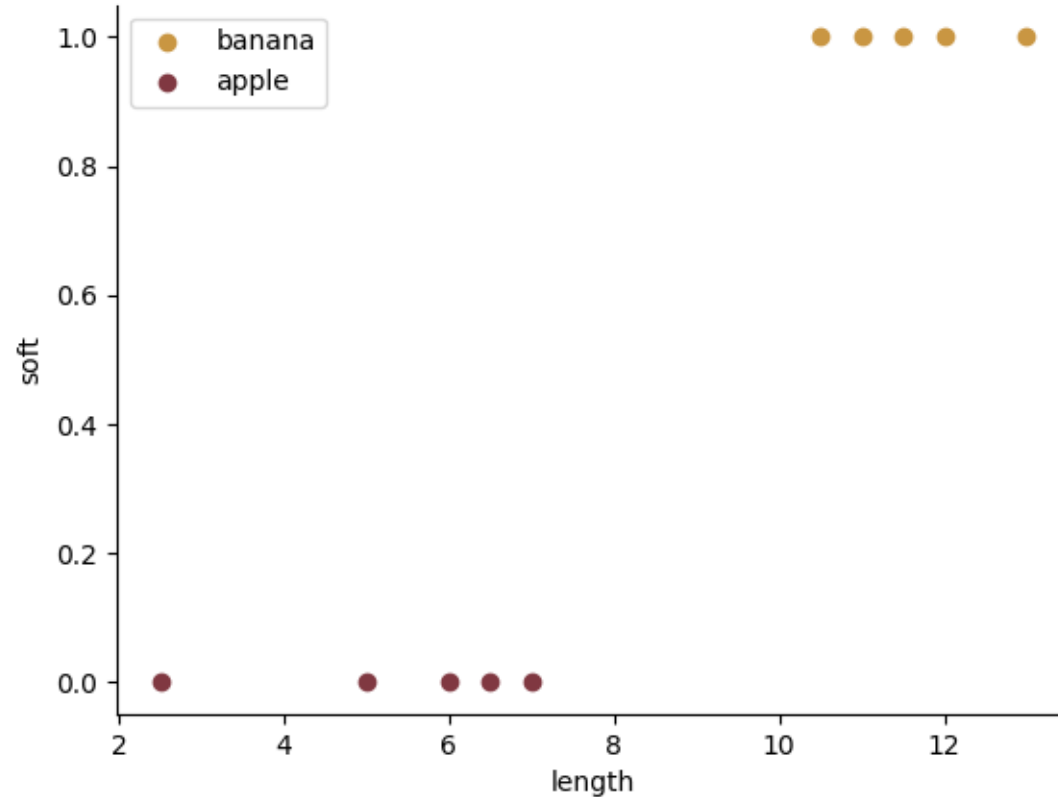
Features and feature engineering is an important influence factor in machine learning

NOT LINEAR
DECISION BOUNDARIES
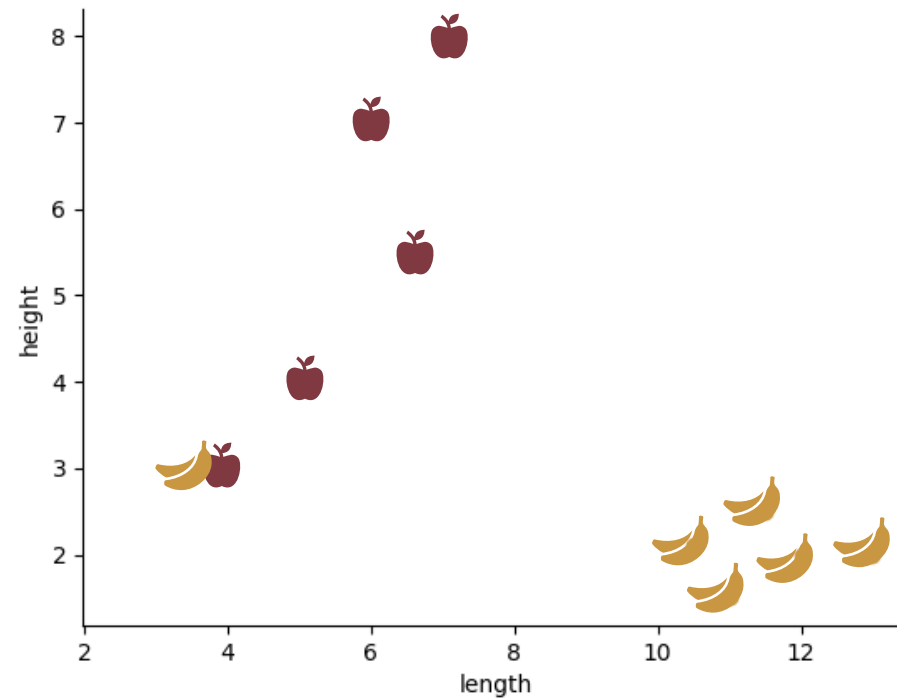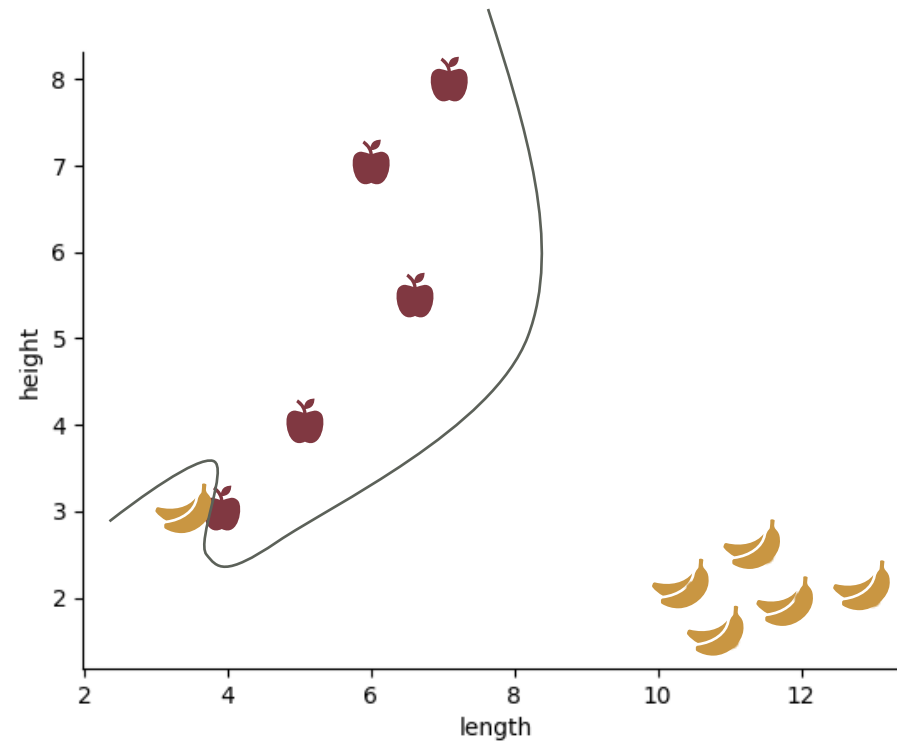
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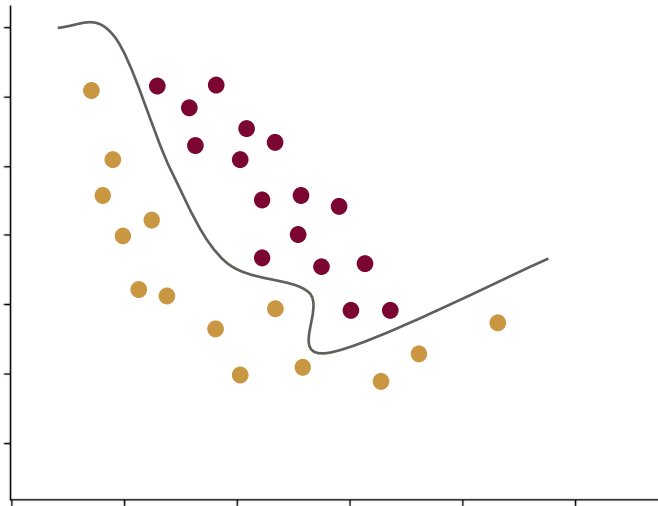
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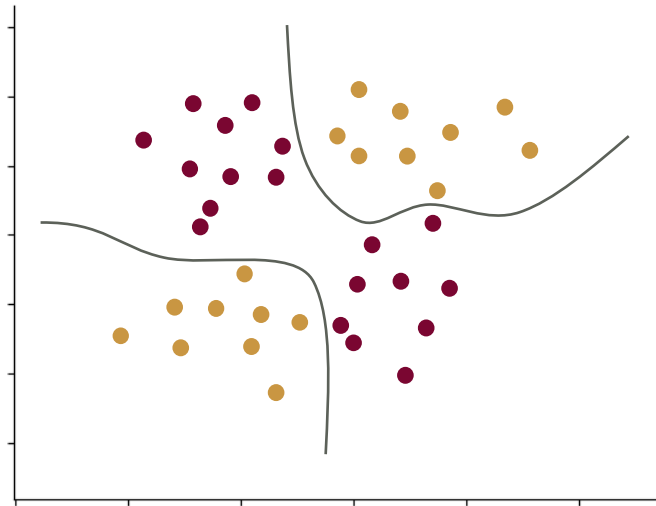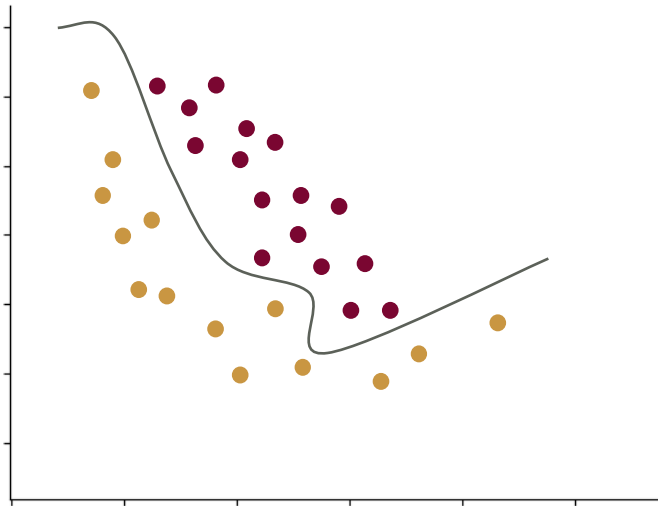
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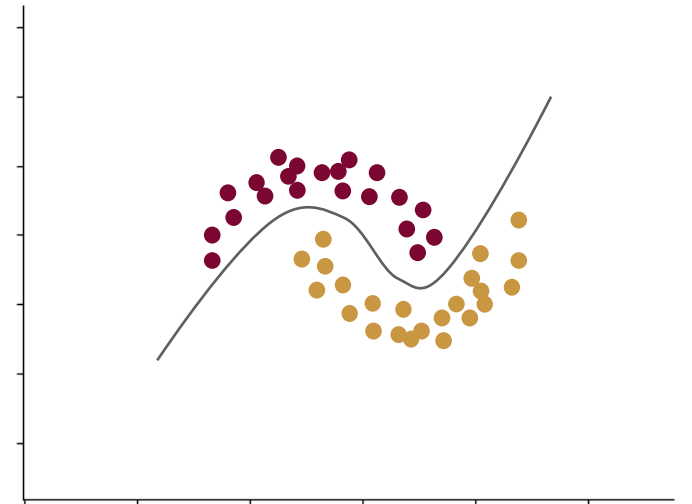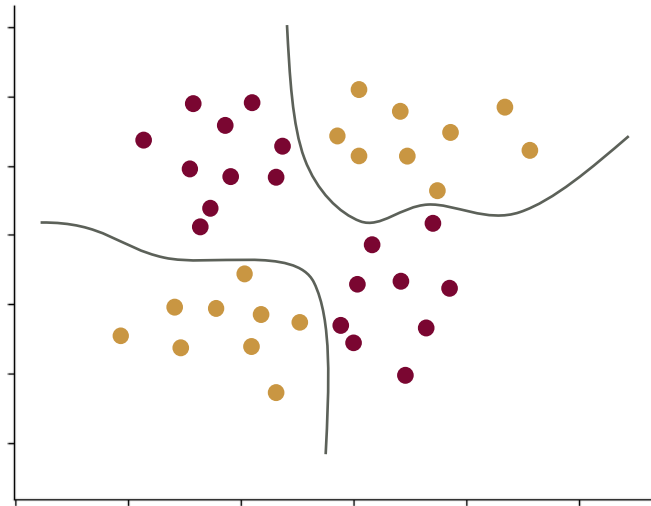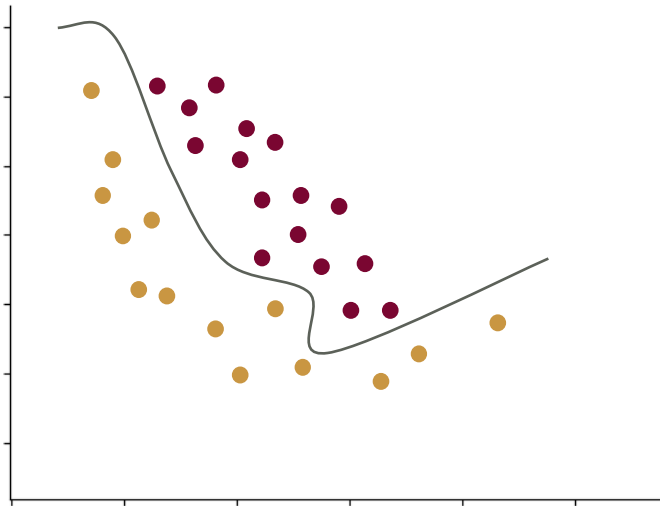
SUPERVISED LEARNING WITH NEURAL NETS

Teachable Machine

Train a computer to recognize your own images, sounds, & poses.

A fast, easy way to create machine learning models for your sites, apps, and more – no expertise or coding required.

SUPERVISED LEARNING WITH NEURAL NETS

— Go to https://teachablemachine.withgoogle.com/
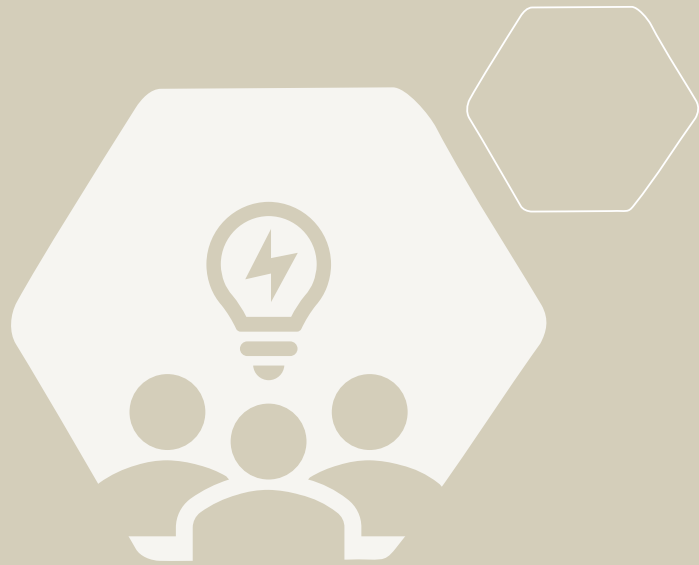
— Train your own image model (image project)

— **Choose the number of classes** you want to train.

— Record images and compile your model

— Test your model

— **What can it do? When does it break? When does it work?**
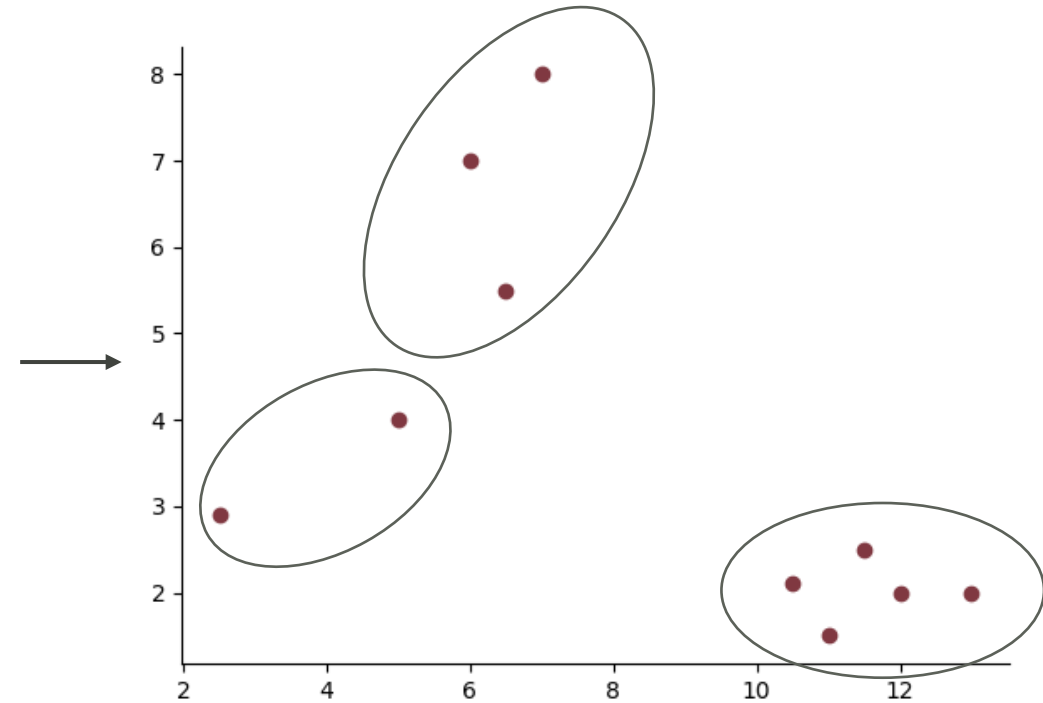
UNSUPERVISED
LEARNING
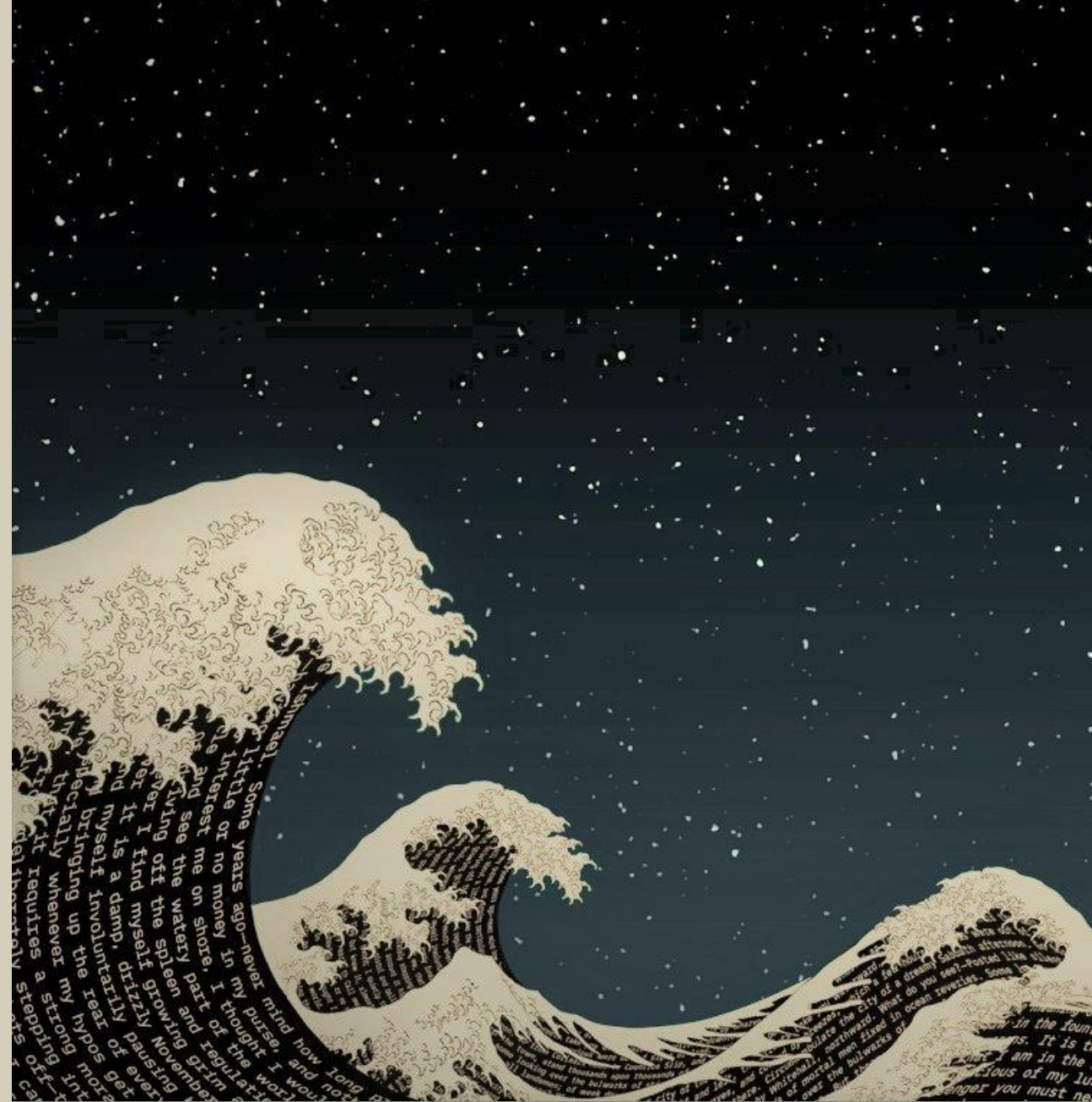
Structure counts

UNSUPERVISED LEARNING
STRUCTURE COUNTS
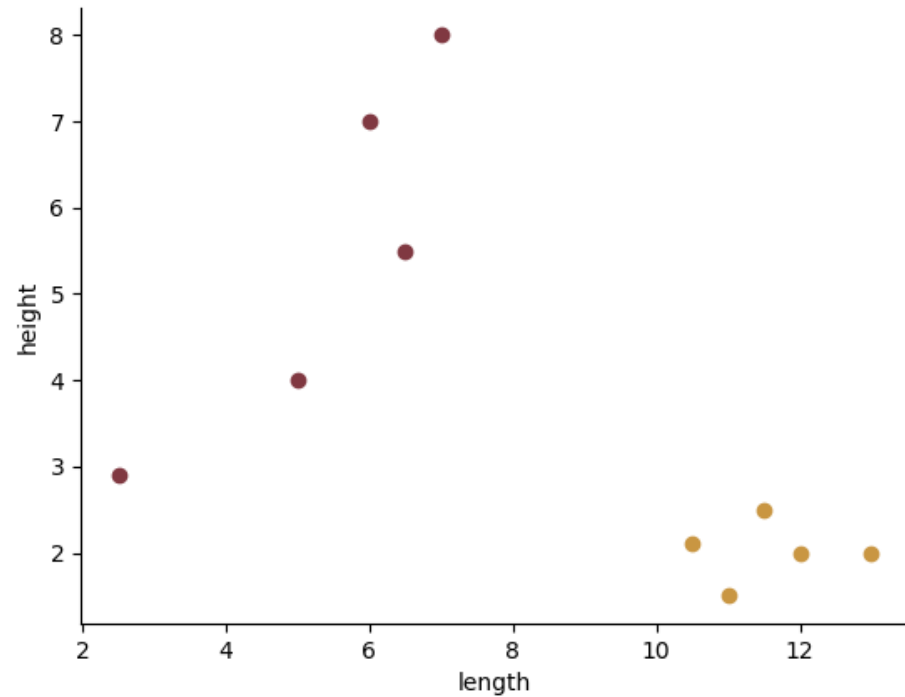
SUPERVISED

UNSUPERVISED LEARNING
STRUCTURE COUNTS

SUPERVISED

UNSUPERVISED

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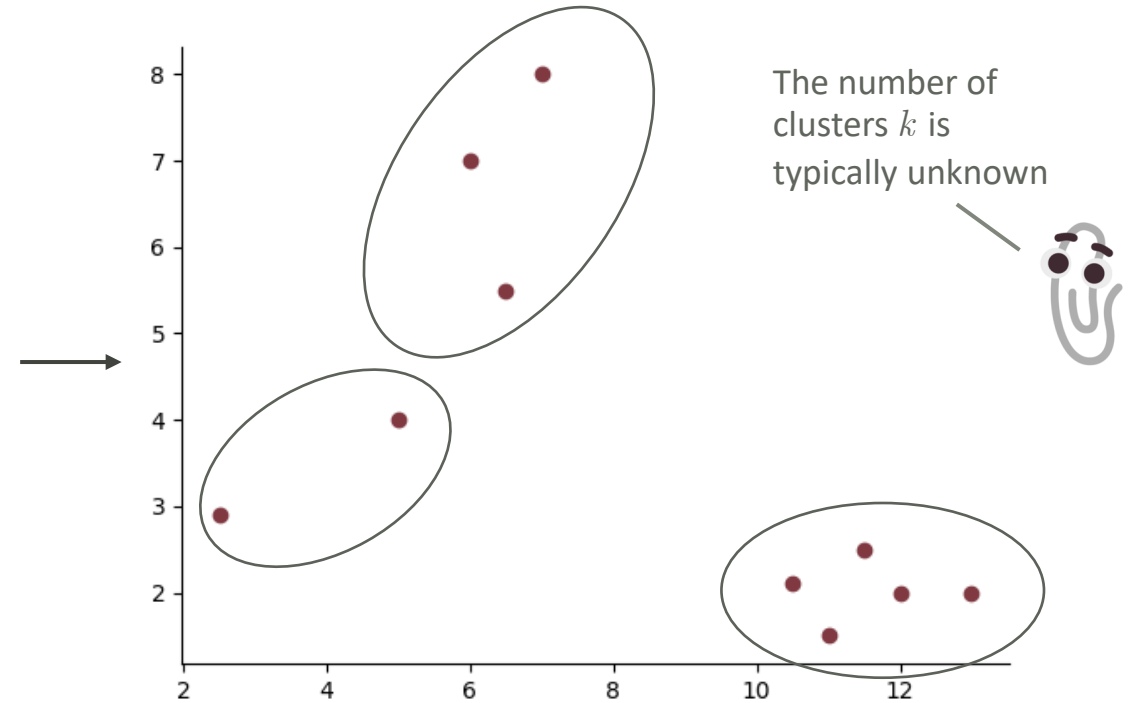
UNSUPERVISED

UNSUPERVISED LEARNING
STRUCTURE COUNTS

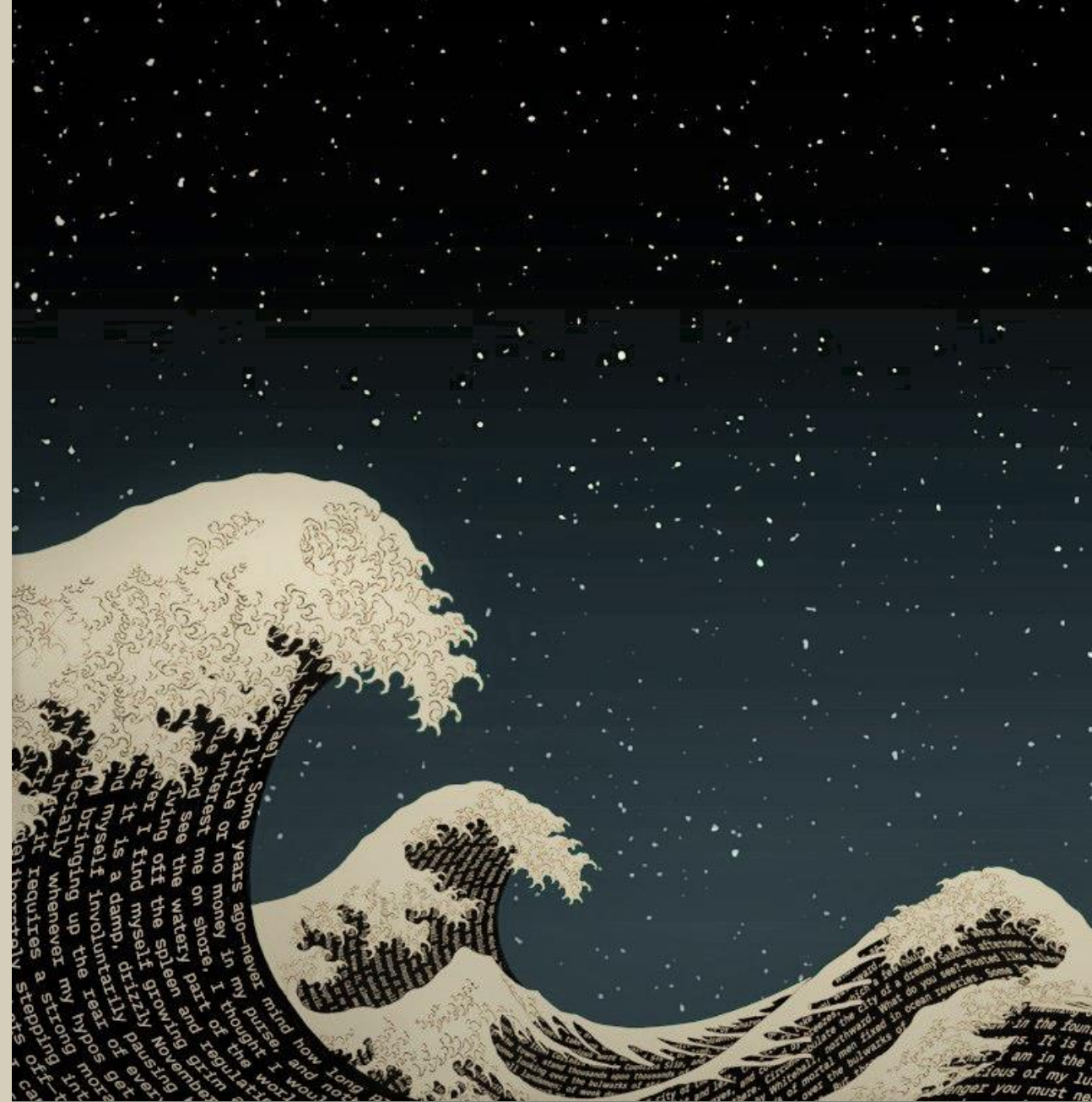
SUPERVISED

The number of clusters k is typically unknown
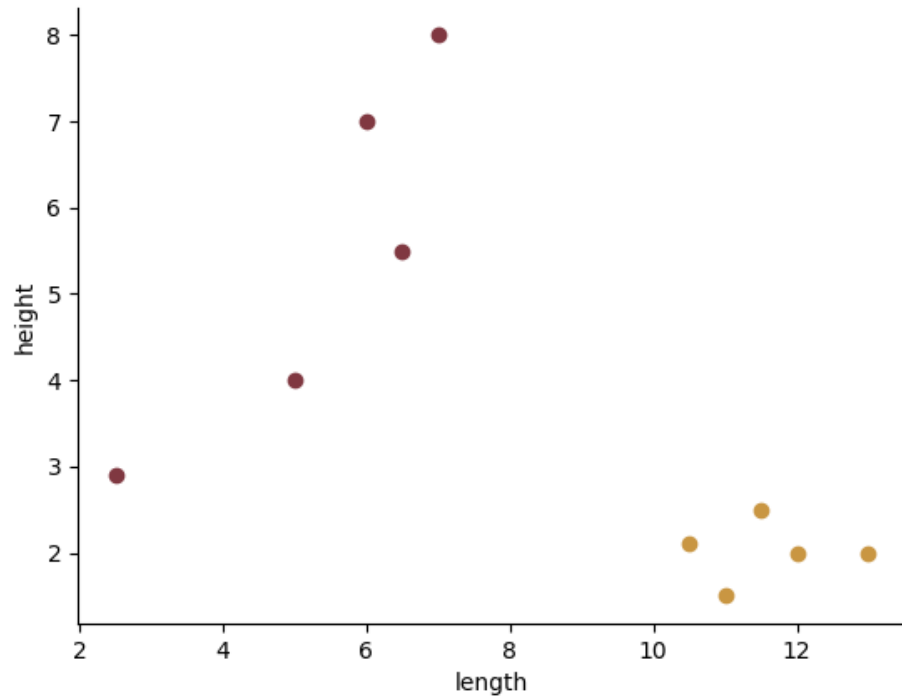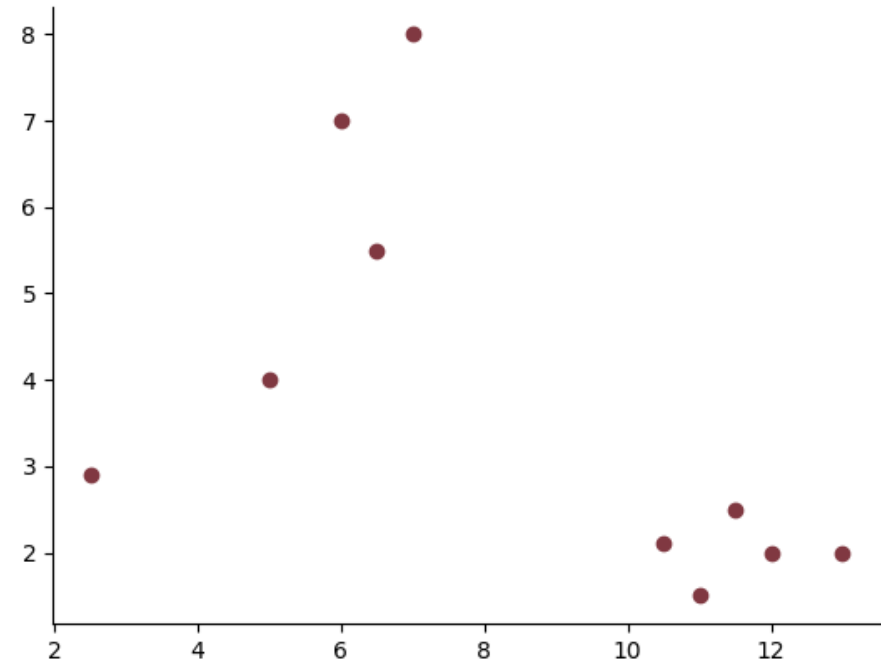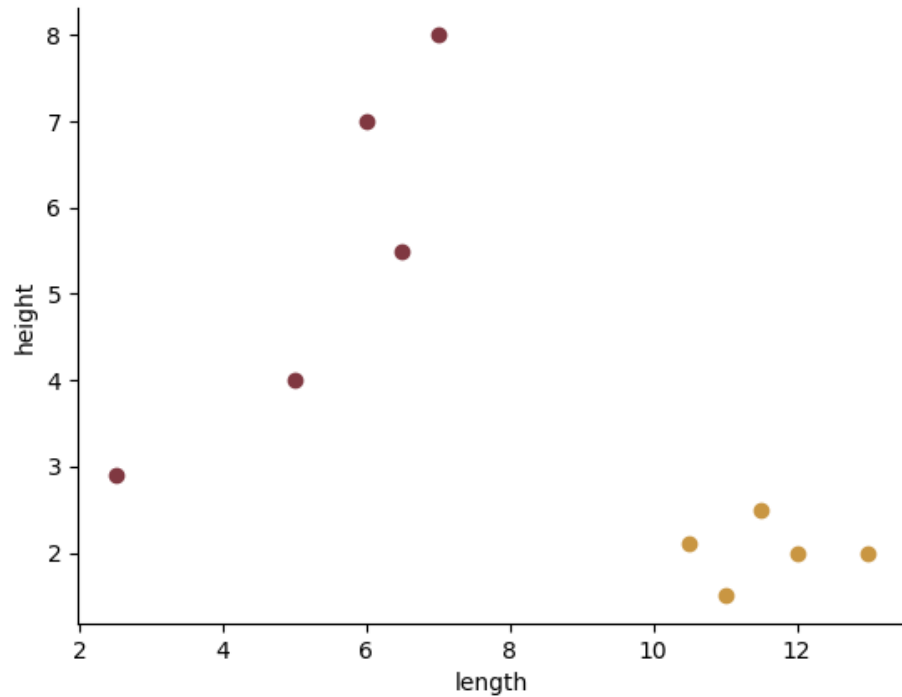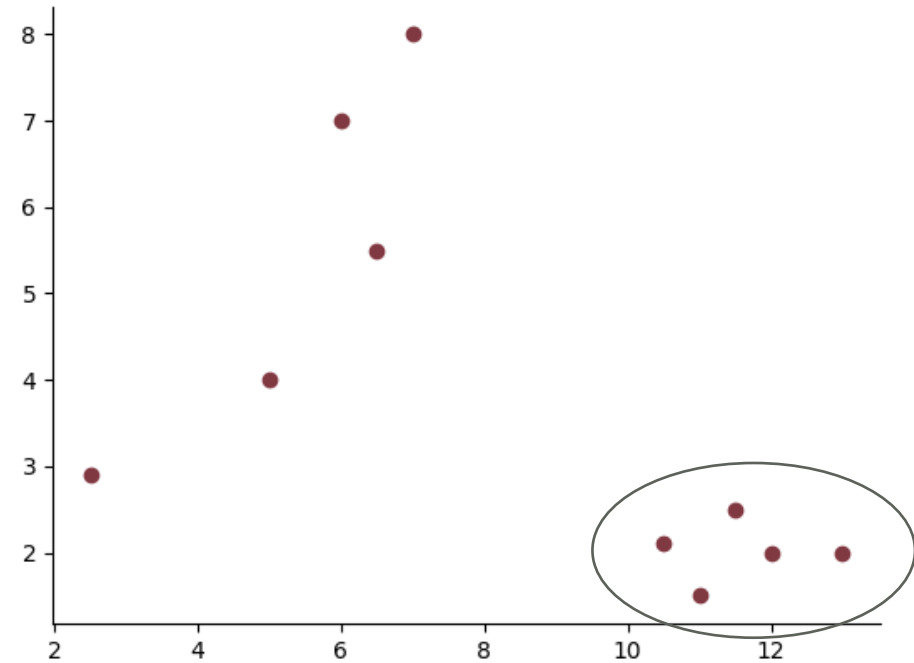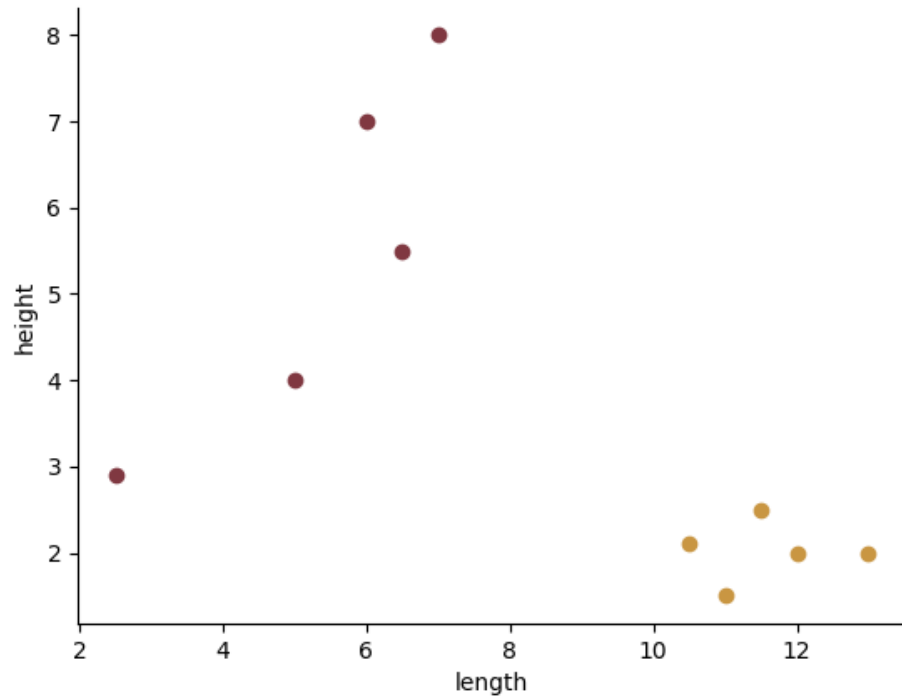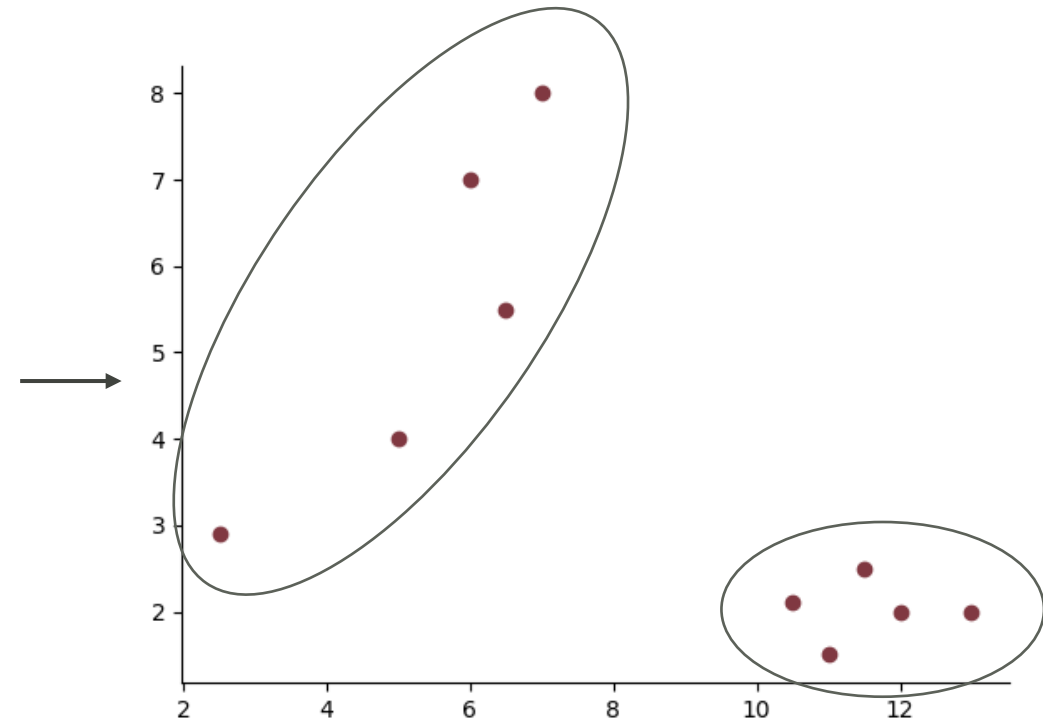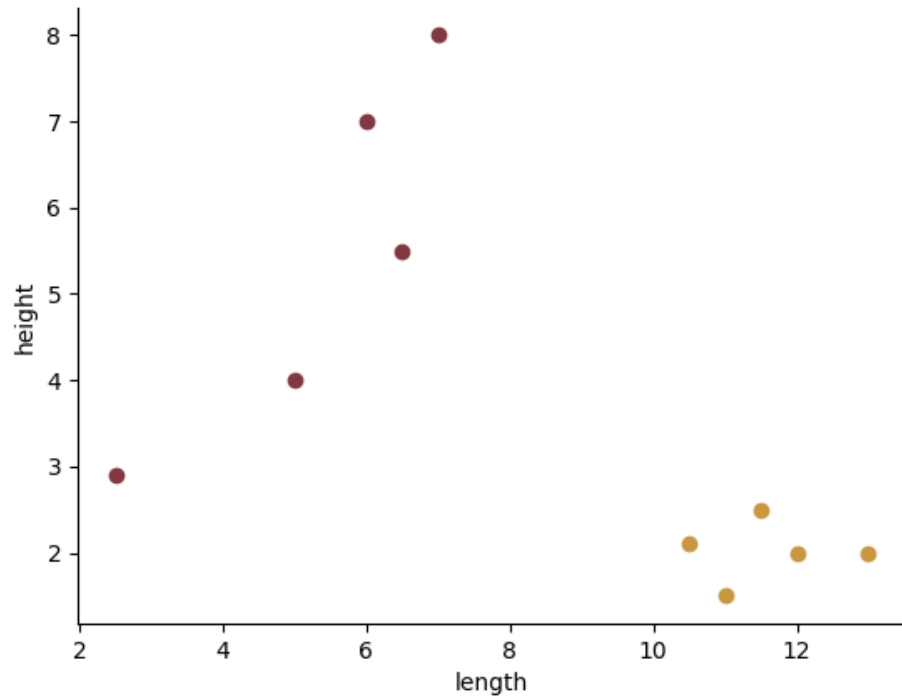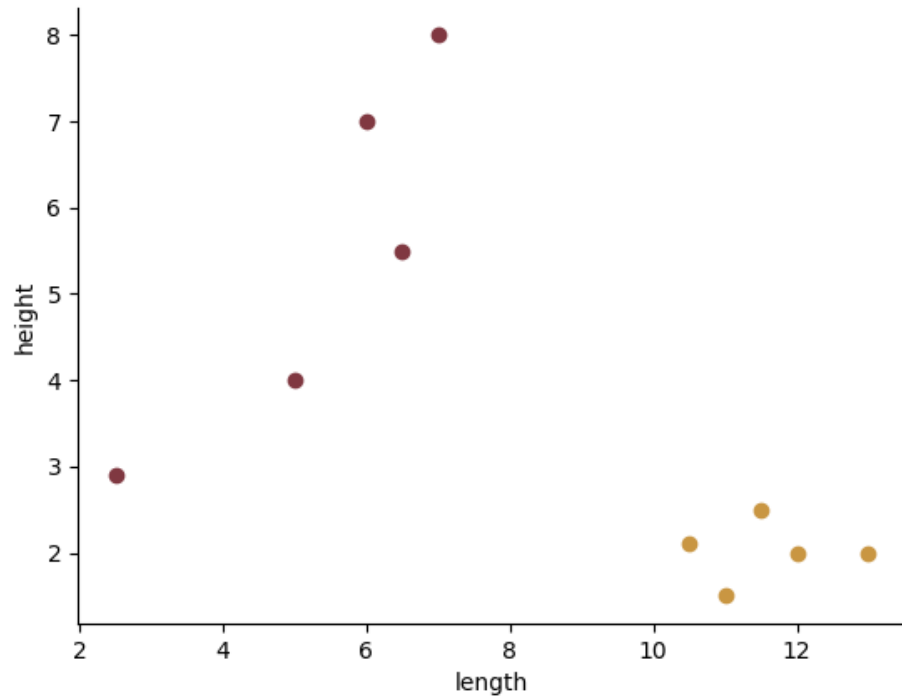
UNSUPERVISED

SEMI-SUPERVISED LEARNING

Knowing a bit, but not everything

SEMI-SUPERVISED LEARNING
KNOWING A BIT, BUT NOT EVERYTHING

SUPERVISED

UNSUPERVISED

SEMI-SUPERVISED LEARNING
KNOWING A BIT, BUT NOT EVERYTHING

SUPERVISED   SEMI-SUPERVISED   UNSUPERVISED

SEMI-SUPERVISED LEARNING
KNOWING A BIT, BUT NOT EVERYTHING

SUPERVISED   SEMI-SUPERVISED   UNSUPERVISED

WE KNOW
EVERYTHING.
(At least about the
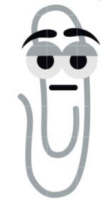class labels...)

SEMI-SUPERVISED LEARNING
KNOWING A BIT, BUT NOT EVERYTHING

SUPERVISED

SEMI-SUPERVISED

UNSUPERVISED

WE KNOW
EVERYTHING.
(At least about the
class labels...)

WE KNOW
NOTHING.
(Just that we do not
know)

SEMI-SUPERVISED LEARNING
KNOWING A BIT, BUT NOT EVERYTHING

SUPERVISED

WE KNOW
EVERYTHING.
(At least about the
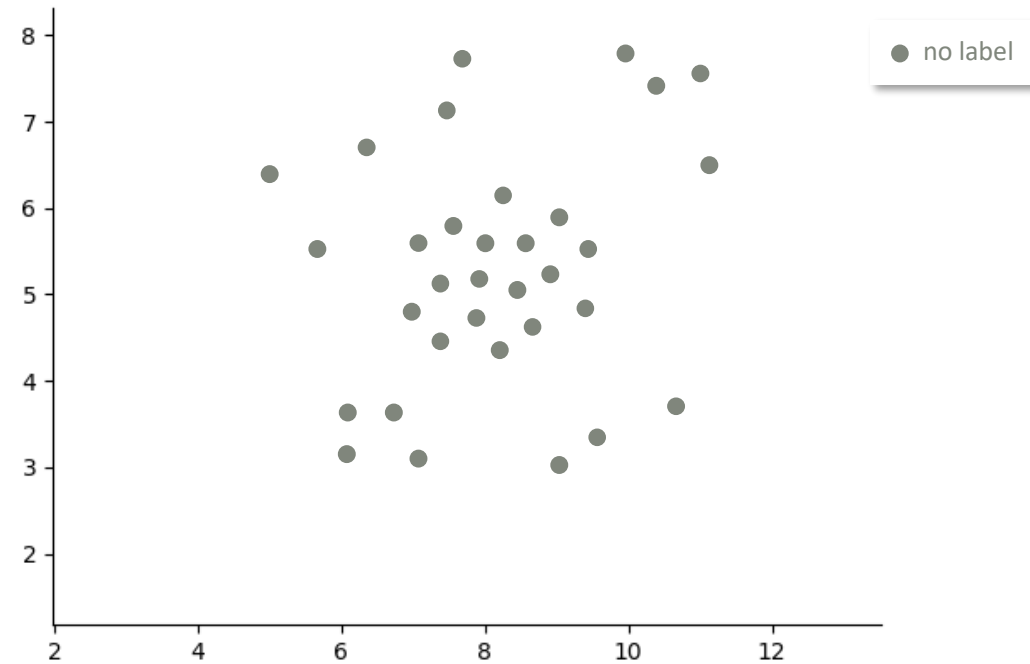class labels...)

SEMI-SUPERVISED

WE KNOW **"A BIT"**.

UNSUPERVISED

WE KNOW
NOTHING.
(Just that we do not
know)

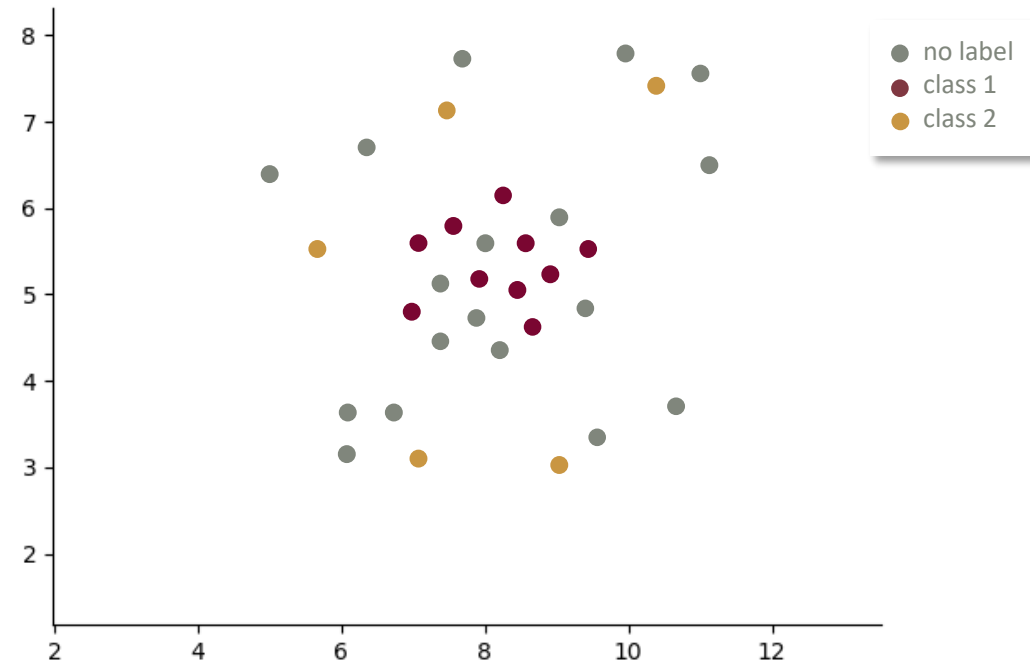# SEMI-SUPERVISED LEARNING
KNOWING A BIT, BUT NOT EVERYTHING

—**Unsupervised setup**:

—No labels are given

SEMI-SUPERVISED LEARNING
KNOWING A BIT, BUT NOT EVERYTHING

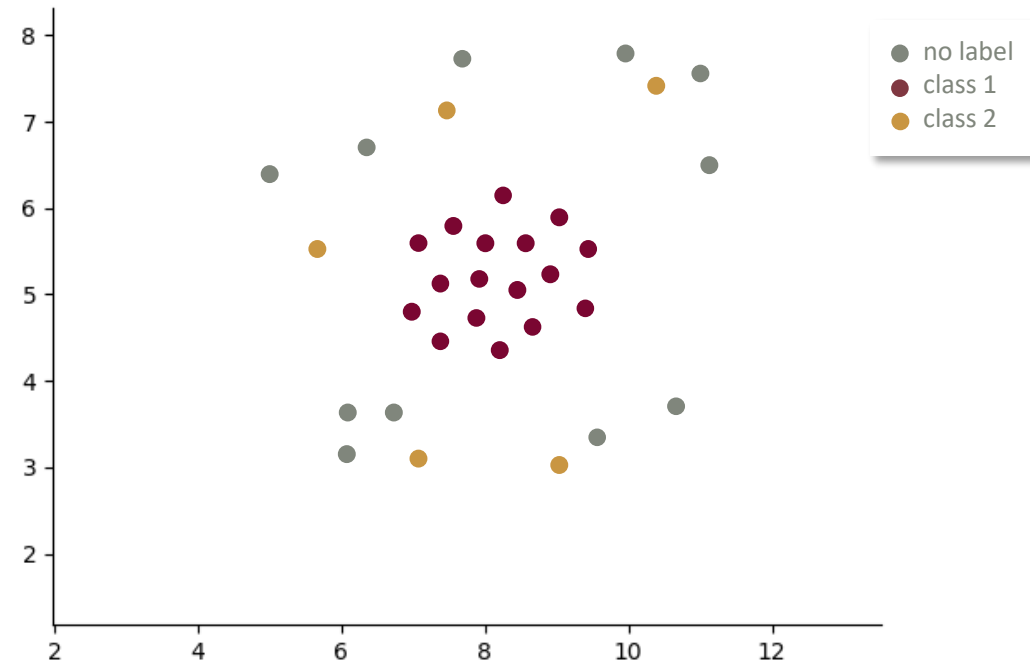—One example for a **semi-supervised setup**:

  —Some labels from two classes are given

SEMI-SUPERVISED LEARNING
KNOWING A BIT, BUT NOT EVERYTHING

——Another example for a **semi-supervised setup**:

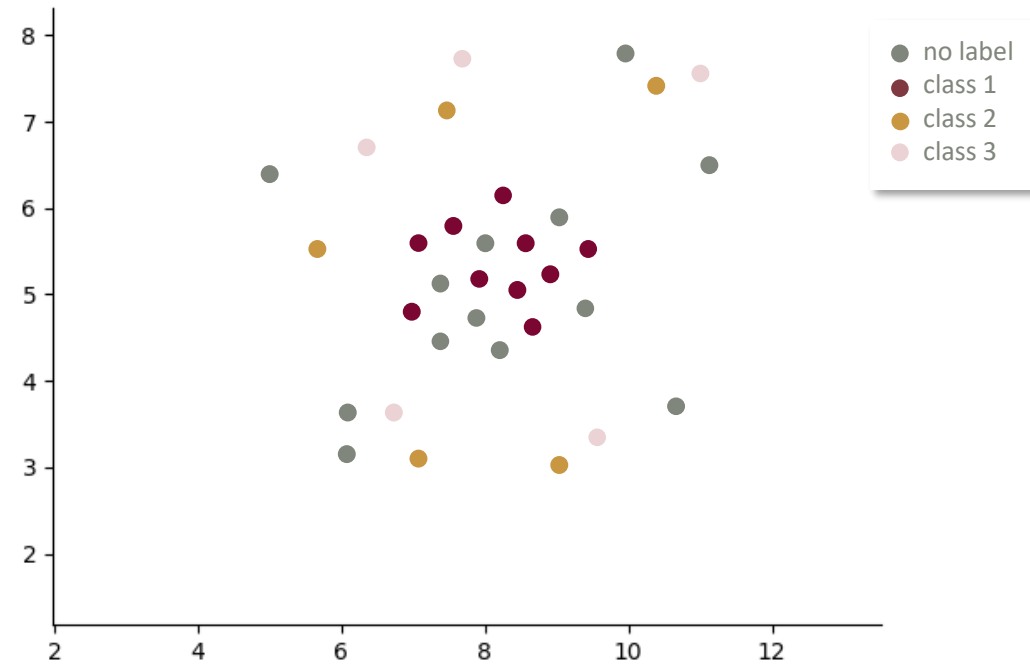 ——Labels of one class and some labels from another class are given

SEMI-SUPERVISED LEARNING
KNOWING A BIT, BUT NOT EVERYTHING

——Another example for a **semi-supervised setup**:
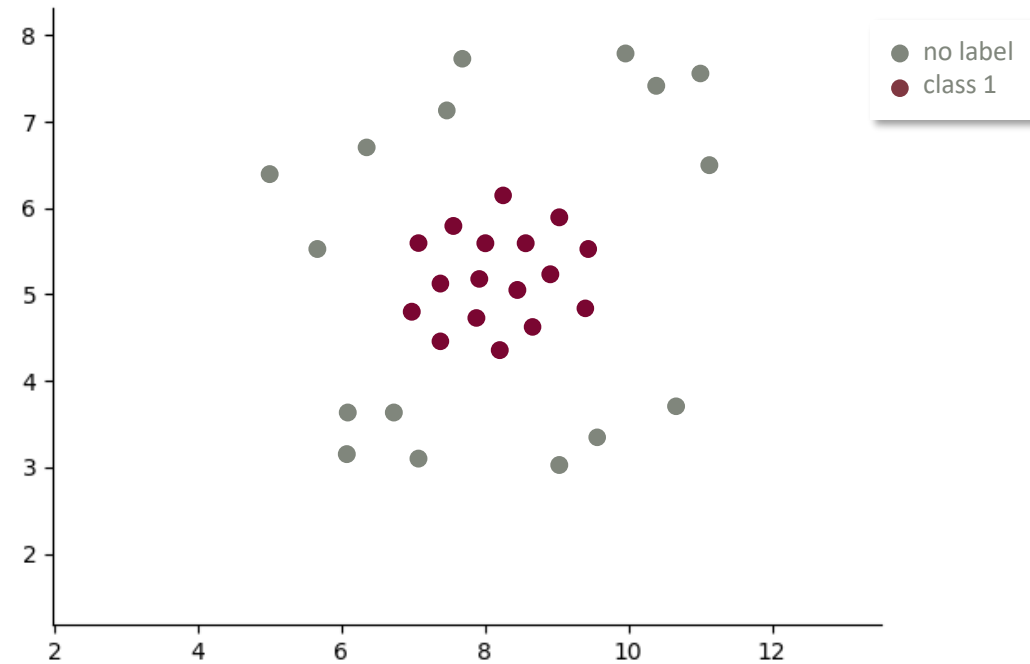
——Some labels from three classes are given

SEMI-SUPERVISED LEARNING
KNOWING A BIT, BUT NOT EVERYTHING
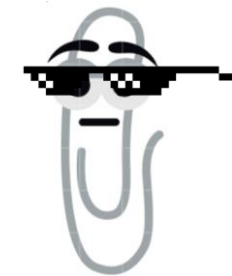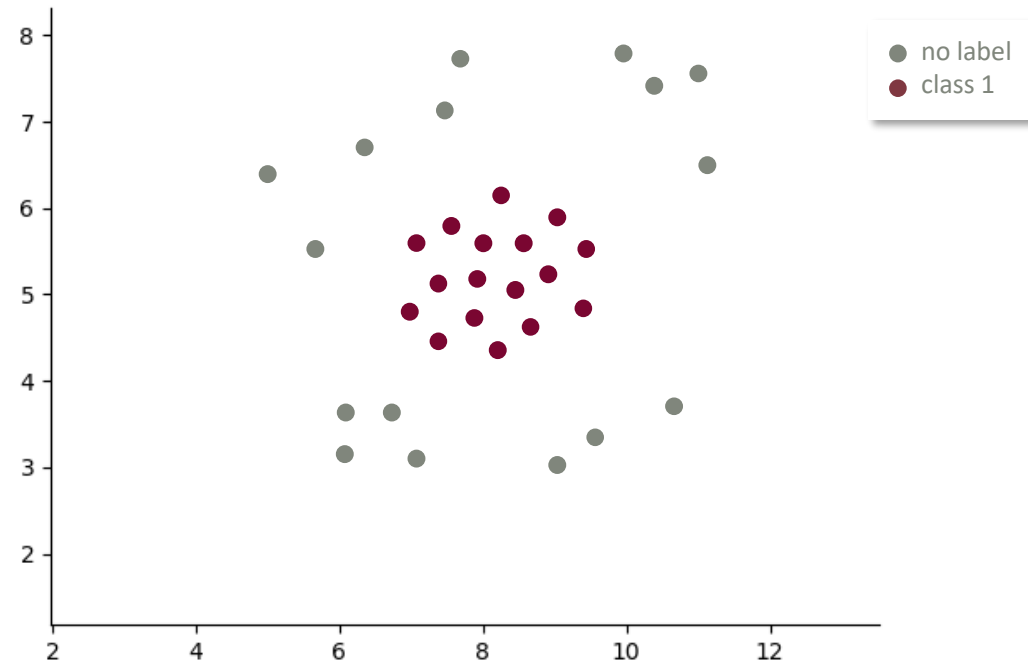
—**One-class setup**:

—Labels from one class are given

SEMI-SUPERVISED LEARNING
KNOWING A BIT, BUT NOT EVERYTHING

— **One-class setup**:

 — Labels from one
 class are given

SUMMARY OF TODAY
INTRODUCTION

— **MACHINE LEARNING** gives computers the ability to learn without being explicitly programmed

— ML requires **SAMPLES/DATA** and **FEATURES**

— **NEURAL NETWORKS** can find a non-linear decision boundary

— **SUPERVISED LEARNING**:

  — Class labels given

  — Like e.g. "The Teachable Machine"

— **UNSUPERVISED LEARNING**:

  — No class labels are given