Machine Learning

Informatics Engineering Study Program
School of Electrical Engineering and Informatics

Institute of Technology Bandung

Course Overview

Lecturers

- Masayu Leylia Khodra (K1)

  masayu@staff.stei.itb.ac.id
- Nur Ulfa Maulidevi (K2)

  ulfa@itb.ac.id
- Fariska Zakhralativa Ruskanda (K3)

  fariska@informatika.org

Objectives For Students – IF3270

- CPMK1. Menjelaskan perbedaan jenis pembelajaran supervised learning dan reinforcement learning
- CPMK2. Mengimplementasikan algoritma backpropagation untuk Feed Forward Neural Network dan forward propagation untuk Convolutional dan Recurrent Neural Networks
- CPMK3. Menganalisis jenis pembelajaran yang tepat untuk kasus persoalan/ aplikasi tertentu
- CPMK4. Melakukan evaluasi terhadap kinerja suatu algoritma pembelajaran pada kasus persoalan tertentu

Program Educational Objectives (PEO) - IF

1. Our graduates will have successful careers in their profession in informatics or related fields.
2. Our graduates will successfully pursue graduate study or engage in professional development.
3. Our graduates will demonstrate leadership and play active roles in the improvement of their community, especially in the development of new tools, technologies and methodologies.

Student Outcome - IF

Graduates of the program will have an ability to:

1. An ability to analyze a complex computing problem and to apply principles of computing and other relevant disciplines to identify solutions.
2. An ability to design, implement, and evaluate a computing-based solution to meet a given set of computing requirements in the context of the program’s discipline.
3. An ability to communicate effectively in a variety of professional contexts.
4. An ability to recognize professional responsibilities and make informed judgments in computing practice based on legal and ethical principles.
5. An ability to function effectively as a member or leader of a team engaged in activities appropriate to the program’s discipline.
6. An ability to apply computer science theory and software development fundamentals to produce computing-based solutions.

Course Description

- Credits: 3 credit points (3*45 hours/semester)
- Prerequisites:
  - IF2123 Linear Algebra & Geometry
  - IF3170 Artificial Intelligence
- Grading Components:
  - Midterm & Final Test
  - Quizzes
  - Project Assignments
  - Exercises
  - Lab Work

Attending classes (obligatory)

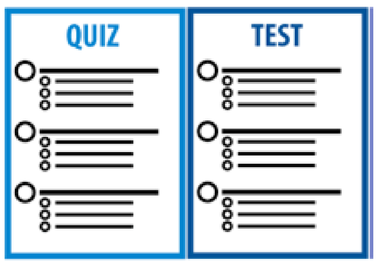
3 hours/week:

Monday 11.00-11.50;
Thursday 09.00-10.40

Project assignments (groups): w3, w10

Lab works: w4,7,11,14

Exercises



Quizzes: w5, 13

Midterm test: w8

Final test: w16

General Rules

Midterm Test & Final Test:

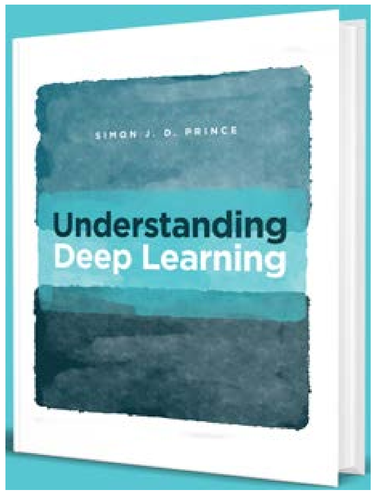
- **obligatory, if not attending → grade E**
- **Additional test only for students who stay in hospital (doctor recommendation) / have "force majeure" → proof is required (from doctor, guardian)**

Any act of *cheating* will result grade "E" (for all components)

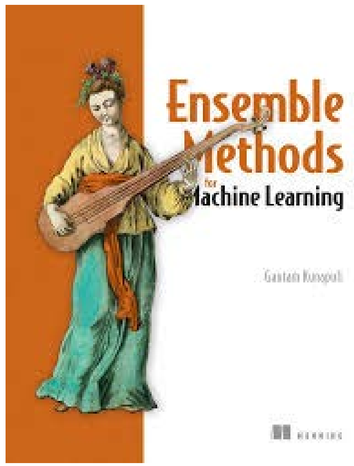
- Include helping to *cheat*
- Include cheating for assignment: "E" for all members (for all groups involved)
  - Maintain integrity between group members
- Rules for using Generative AI → explicitly written in every assignment

To pass this course, a student must have "no zero" in every component

Textbooks, LMS, Communication Channel



Prince, S. J. (2023). *Understanding deep learning*. MIT press.



Kunapuli, G. (2023). *Ensemble methods for machine learning*. Simon and Schuster.

Mitchell, T., Machine Learning, 1997, McGraw-Hill

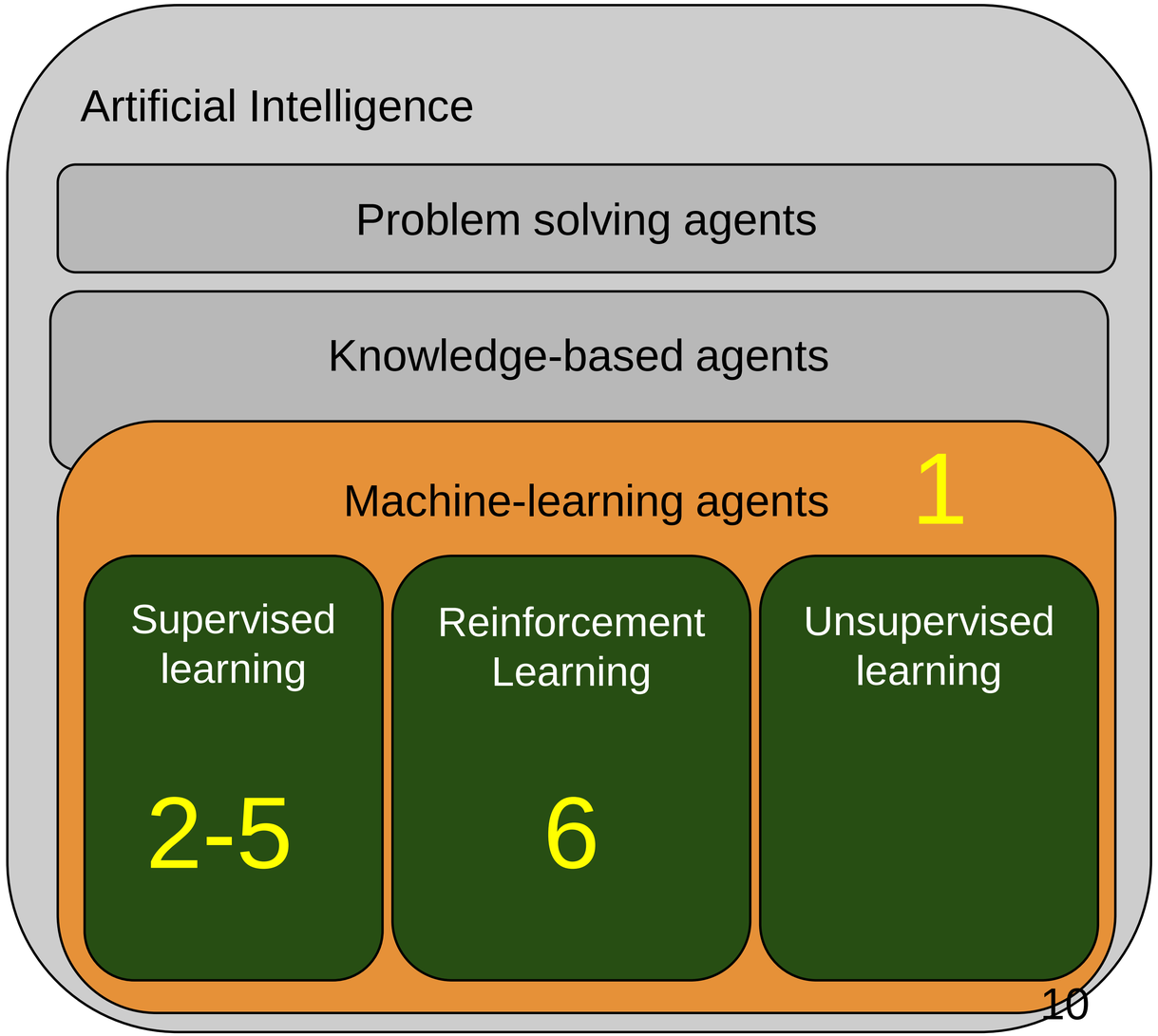
Course Website:
https://edunex.itb.ac.id/courses

- Modules : IF3270 Parent Class
  Token: JKXNPH (16 March 2025)
- Discussion for each class:
  IF3270-0x (x = class number)

Communication:
Join Ms Teams IF3270 Pembelajaran Mesin dengan kode: dtexpkg

Courses contents

1. Machine Learning Overview: w1
2. Ensemble Methods: w1
3. Perceptron, Artificial Neural Networks (FFNN, CNN, RNN): w2-12
4. Transformers: w13
5. Semi supervised learning: w14
6. Reinforcement learning: w15



Machine Learning Overview

Jobs on The Rise 2024 in Indonesia

6. Machine Learning Engineer

Kegiatan pekerjaan: Machine Learning Engineer merancang dan mengembangkan model machine learning, menerapkan algoritma kecerdasan buatan dan sistem yang dapat berjalan sendiri untuk berbagai produk dan aplikasi. **| Keahlian utama:** TensorFlow, Machine Learning, Deep Learning **| Industri paling umum:** Jasa TI dan Konsultan TI, Teknologi, Informasi, dan Internet, E-Learning Provider **| Lokasi lowongan kerja paling banyak:** Area DKI Jakarta, Bandung dan Sekitarnya, Malang dan Sekitarnya **| Median tahun pengalaman:** 1.8 tahun **| Paling banyak transisi dari posisi:** Data Scientist, Software Engineer, Data Engineer

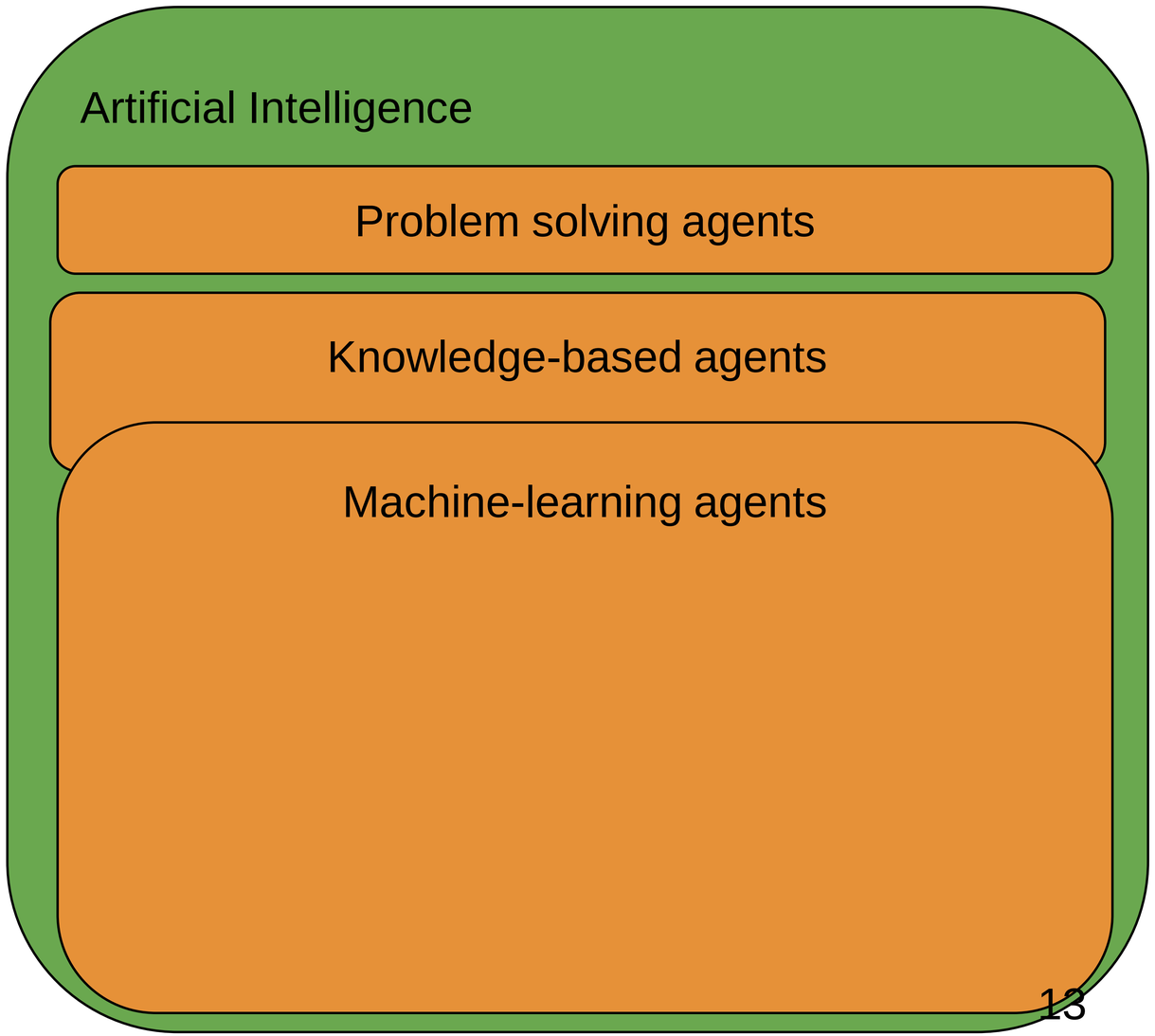
https://id.linkedin.com/pulse/linkedin-jobs-rise-2024-15-posisi-pekerjaan-yang-semakin-wbz0c

Key Responsibilities:

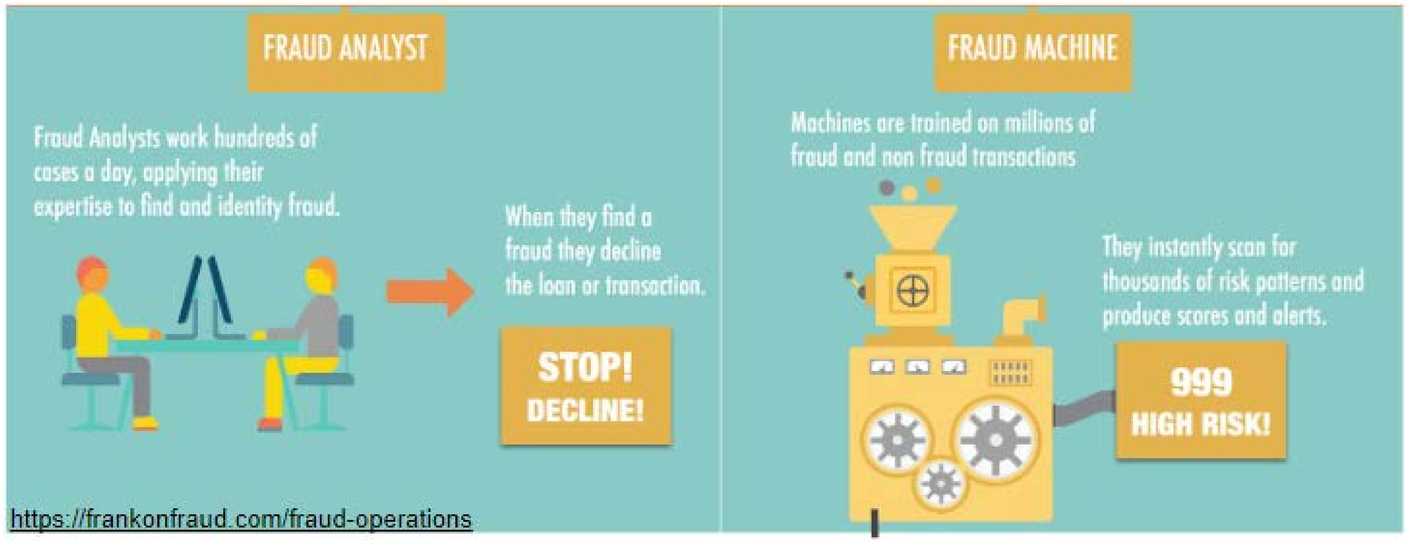
- Design, develop, and train machine learning and deep learning models
- Experiment with different architectures and configurations to optimize model performance
- Integrate AI models into existing systems and applications
- Deploy models into production environments and ensure their proper functioning
- Optimize models for performance, scalability, and cost-effectiveness
- Conduct research to explore new methodologies and techniques for LLM optimization
- Work closely with data engineers, business intelligence, software engineers, product managers and management
- …
- Document the development process, models, and algorithms
- ..

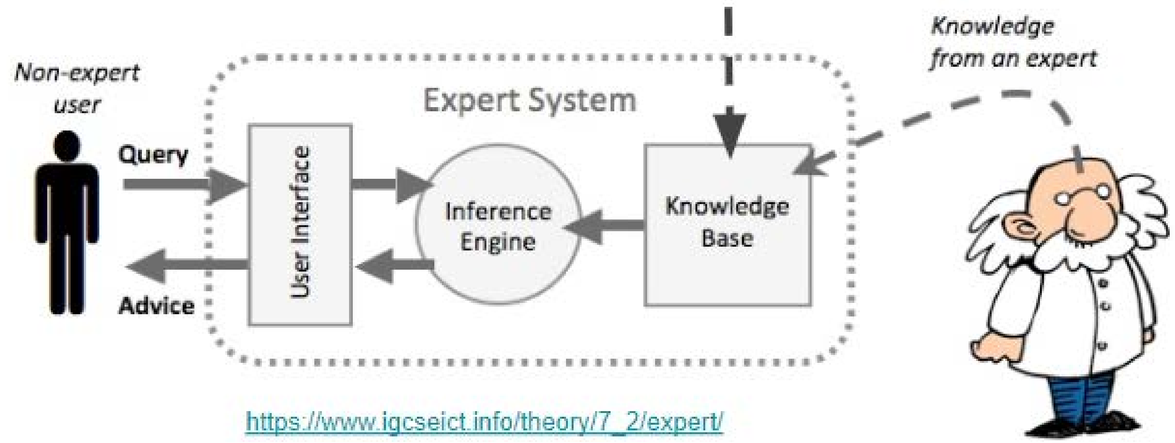
AI vs ML ?

https://www.pastest.com/blog/medical-revision/4-facts-you-should-know-about-memory-recall/



ML in Knowledge-based System

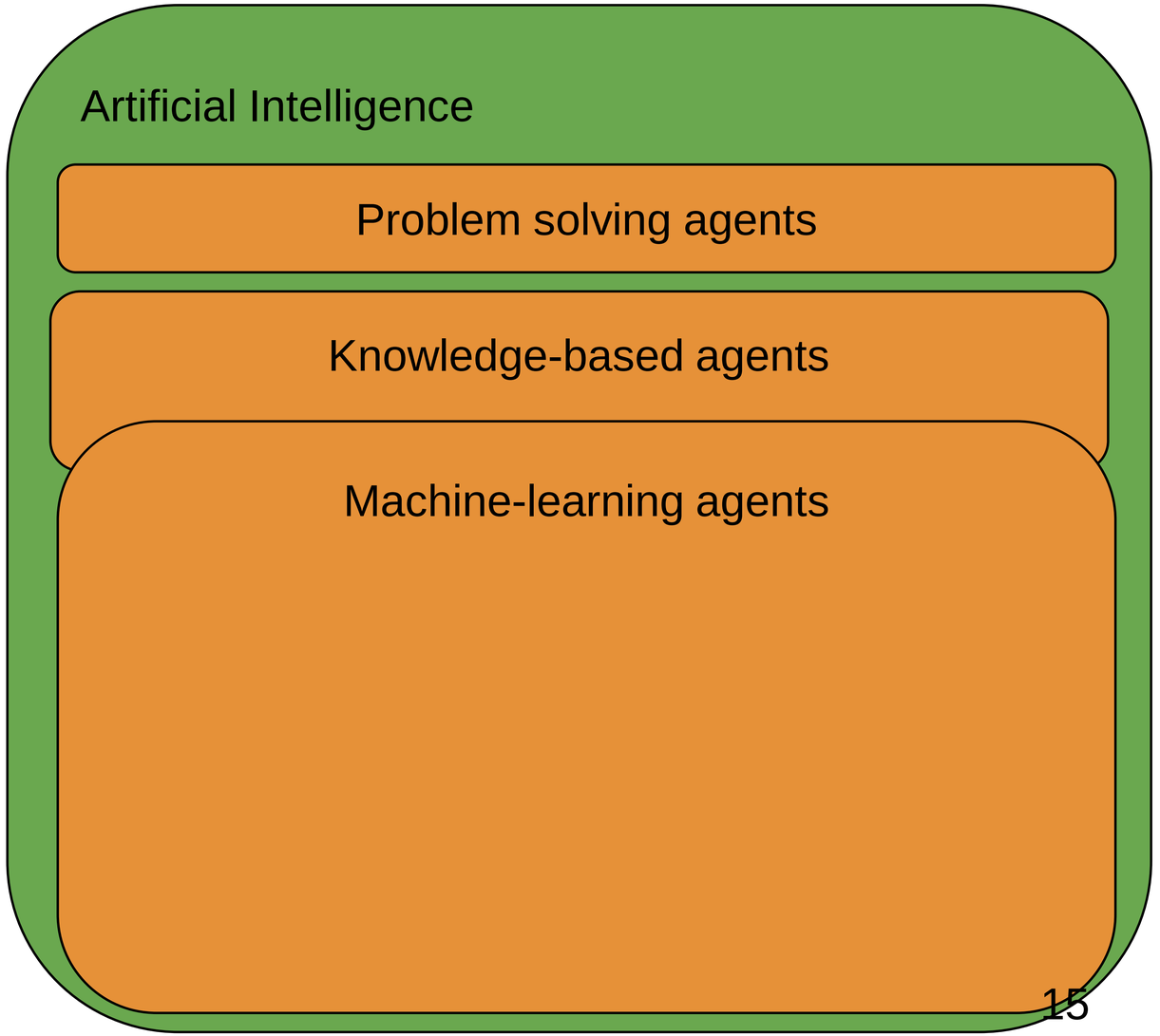




An automatic knowledge acquisition technique in knowledge-based system

Knowledge is result of generalization process (inductive reasoning) in the form of data patterns

ML Definition ?

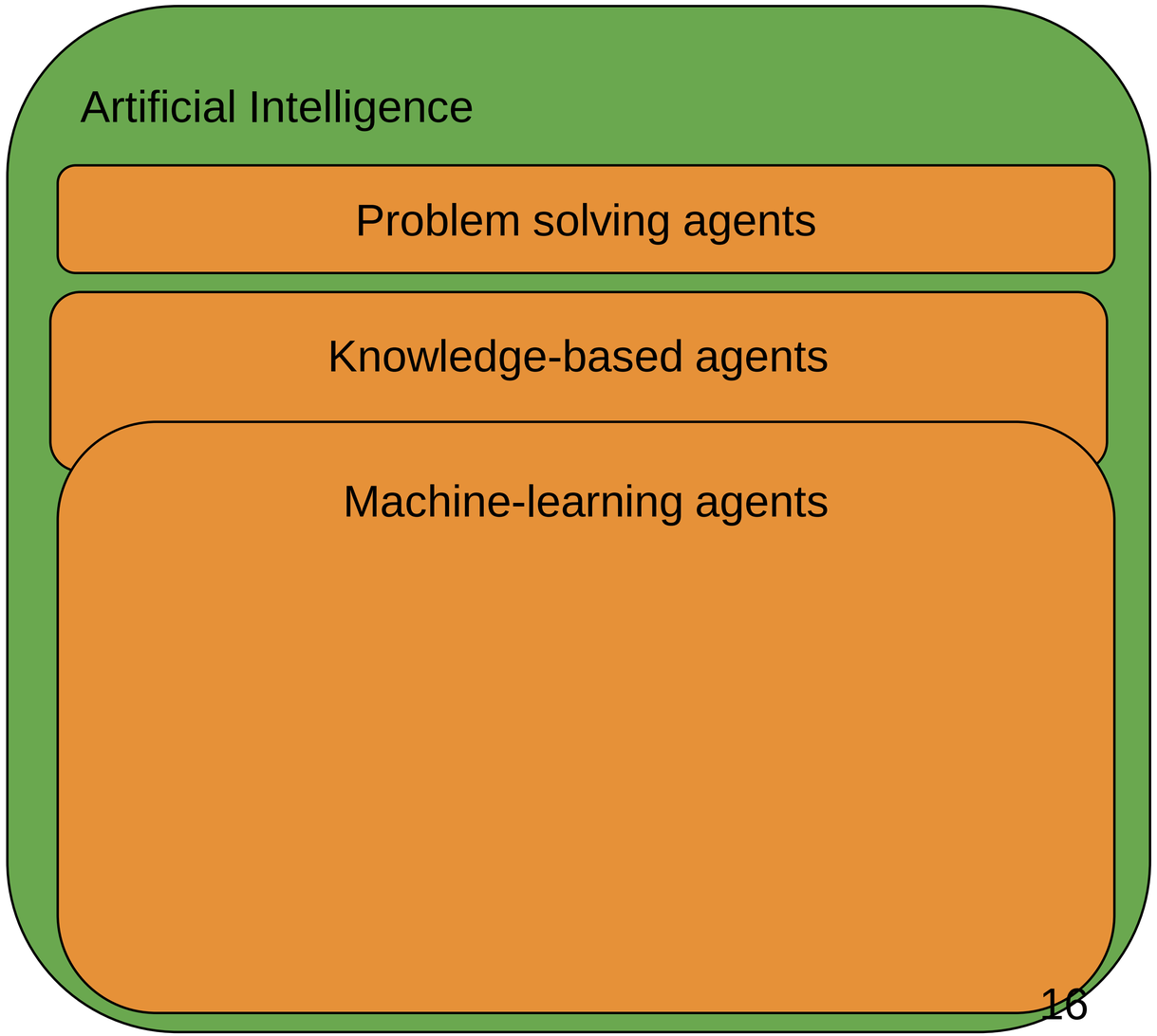


ML Definition

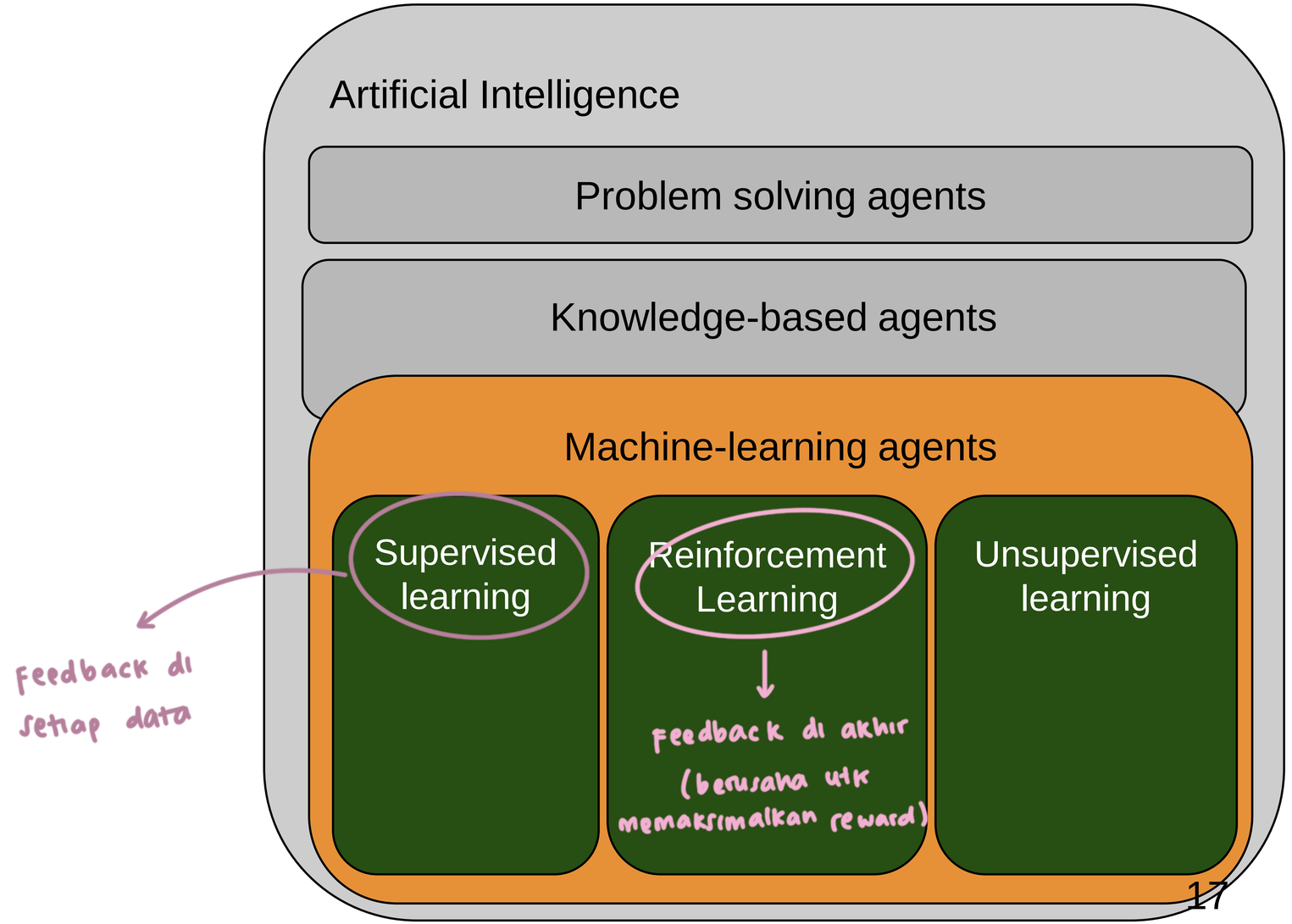
Tom Mitchell (1998):

a computer program is said to learn from experience E with respect to some class of tasks T and performance measure P, if its performance at tasks in T, as measured by P, improves with experience E.

Kelleher et al. (2015): an automated process that extracts patterns from data



Learning Types



Learning Types

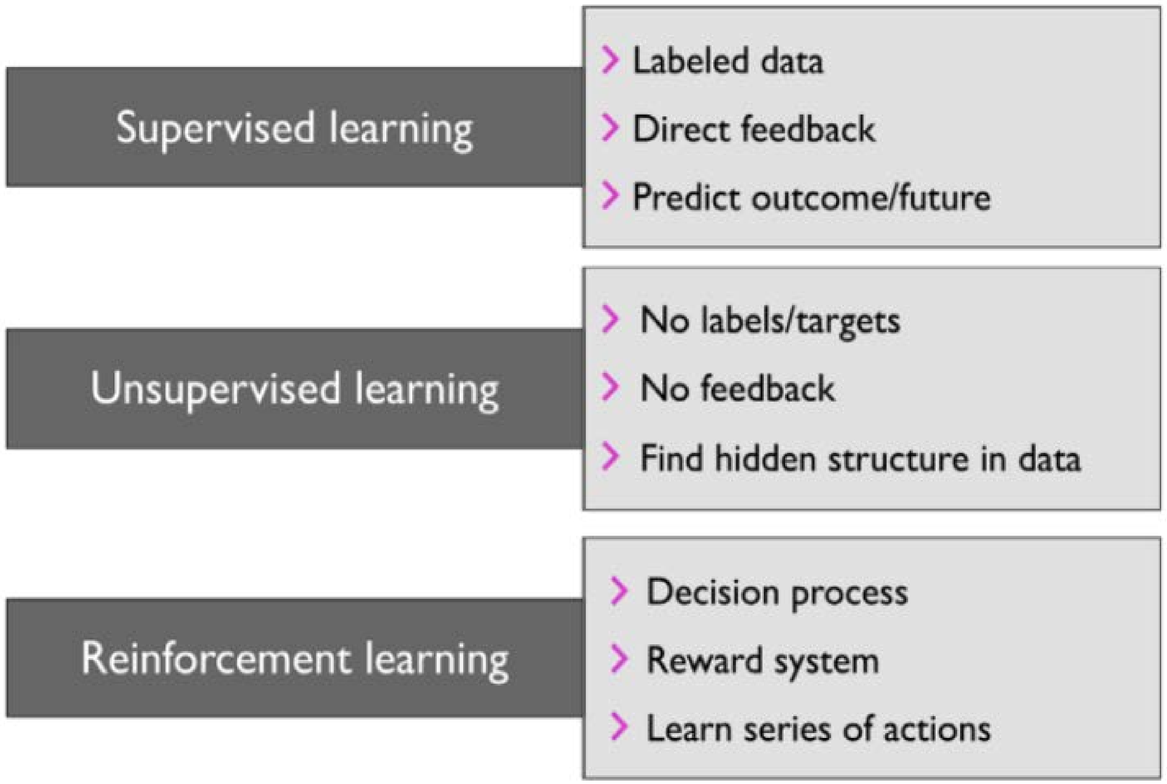


Figure 1.1: The three different types of machine learning

Supervised learning is the process of modeling the relationship between the data inputs and the labels.
Task: classification, regression

Unsupervised learning is the process of exploring the structure of data to extract meaningful information without the guidance of a known outcome variable or reward function.
Task: clustering, market basket analysis

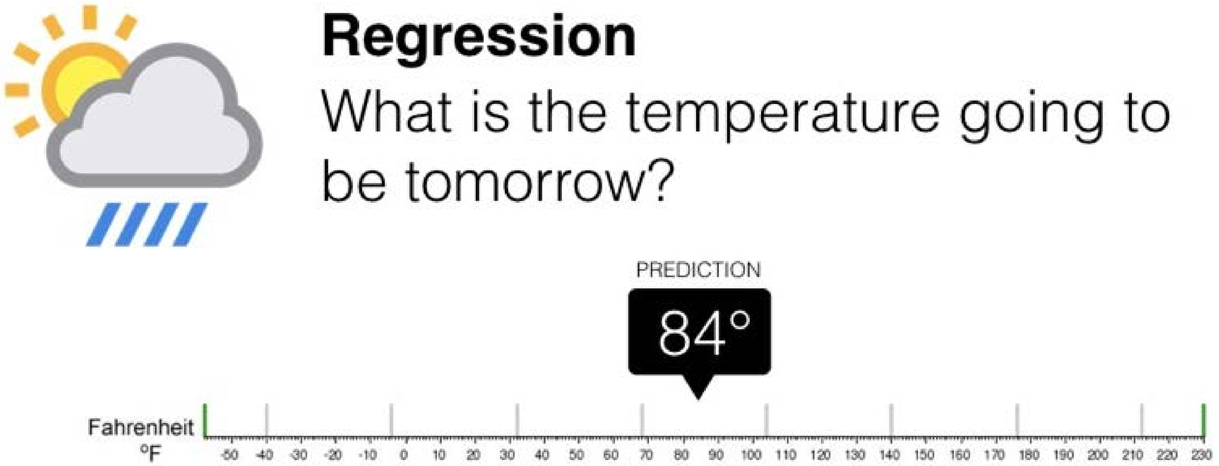
Reinforcement learning develop a system (agent) that improves its performance based on interactions with the environment.

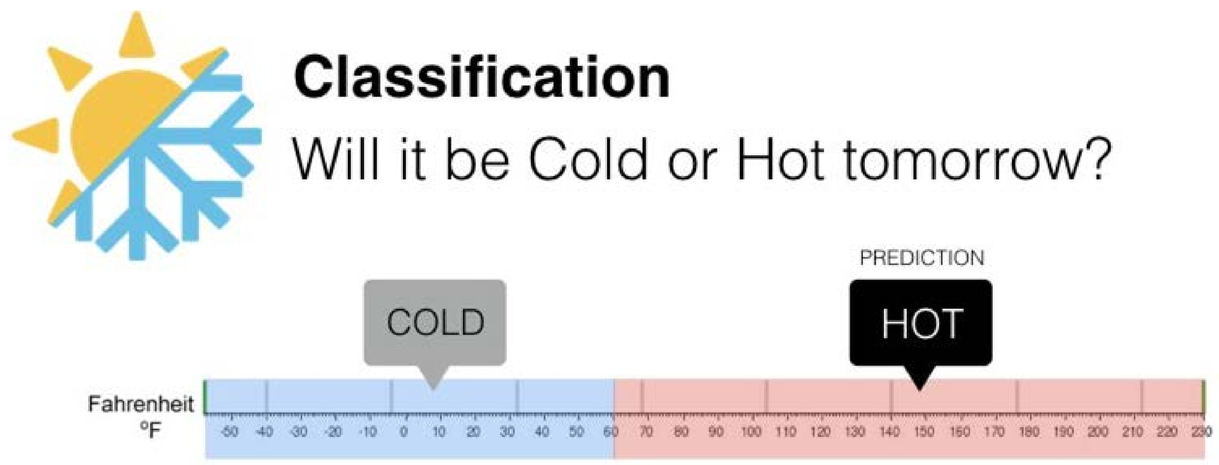
Raschka, S., Liu, Y. H., & Mirjalili, V. (2022). *Machine Learning with PyTorch and Scikit-Learn: Develop machine learning and deep learning models with Python*. Packt Publishing Ltd.

Regression vs Classification

Target function f: data → label

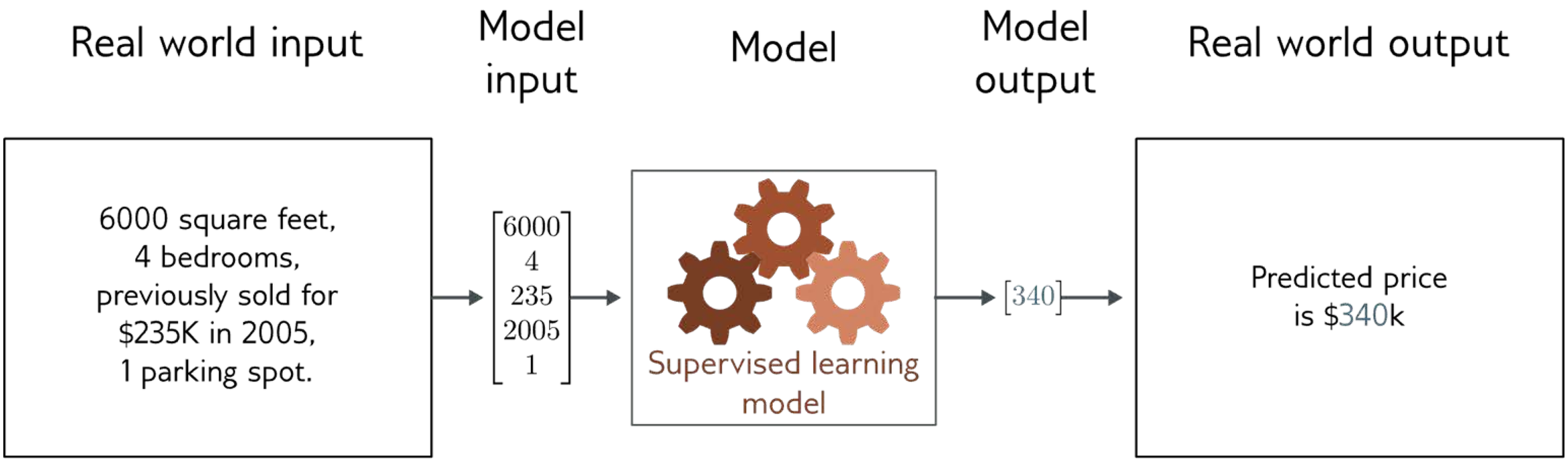
- Regression: domain (label) is numeric output kontinu
- Classification: domain (label) is a finite set of values output diskrit



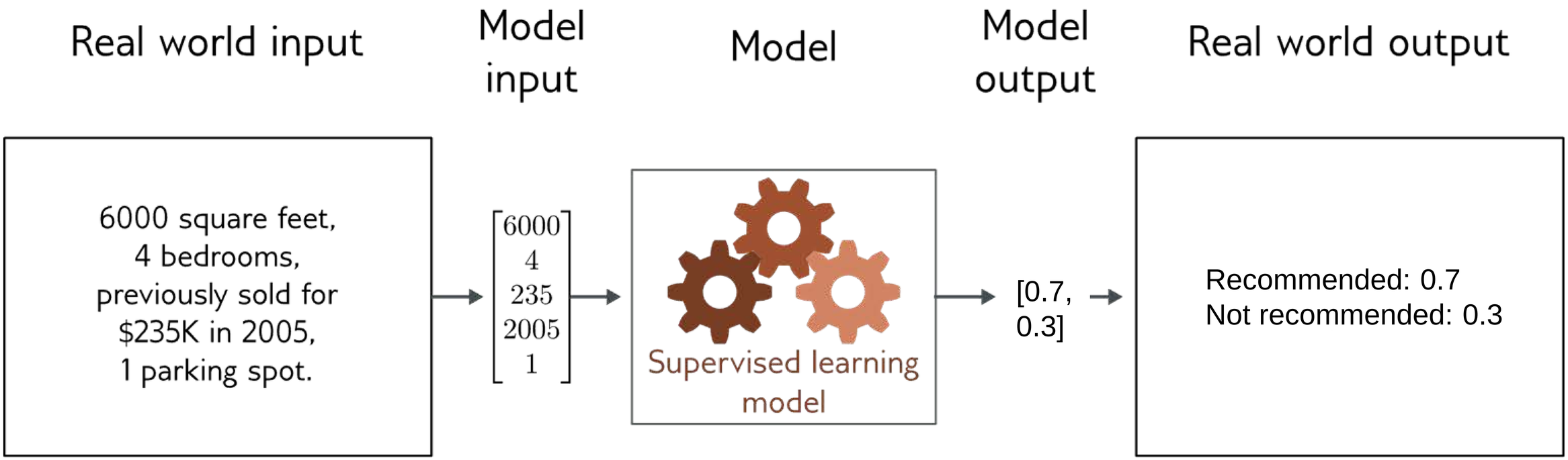


Sumber gambar: https://medium.com/@ali_88273/regression-vs-classification-87c224350d69

Regression


Real world input
Model input
Model
Model output
Real world output
6000 square feet,
4 bedrooms,
previously sold for
$235K in 2005,
1 parking spot.
6000
4
235
2005
1
Supervised learning model
340
Predicted price
is $340k

Classification



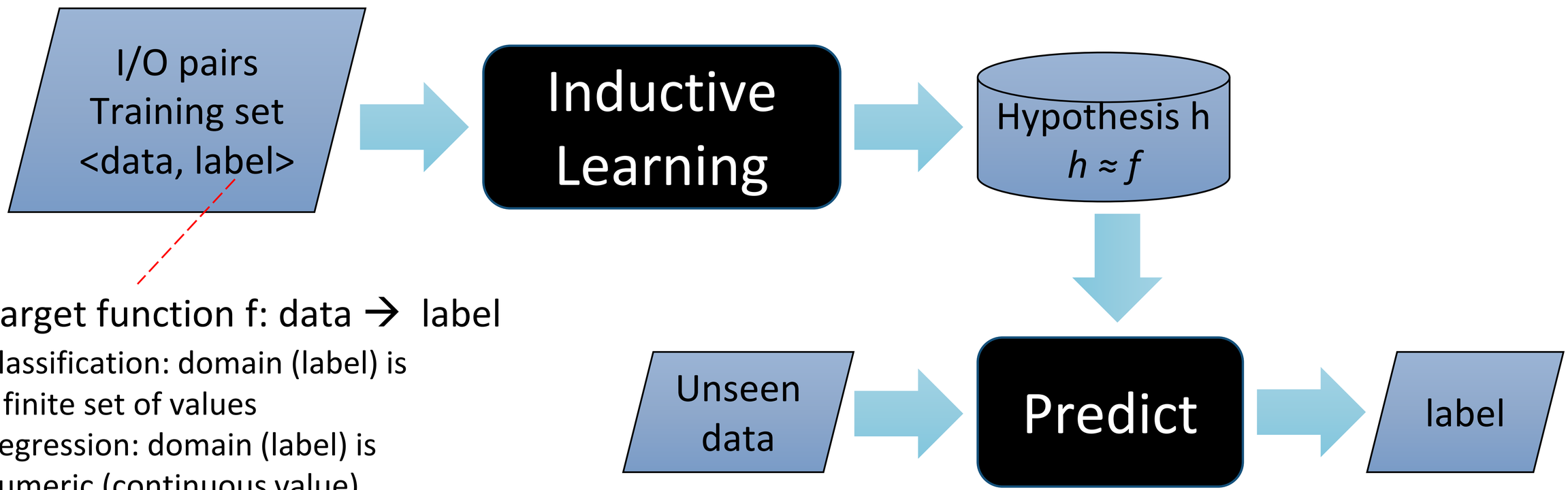
algoritma yg menghasilkan peluang yg jk dijumlah

hasilnya 1 ⟶ Naive Bayes

Logistic Regression

Supervised Learning

Learning a (possibly incorrect) general function from specific input-output pairs is called <u>inductive learning</u>



Target function f: data → label

Classification: domain (label) is a finite set of values

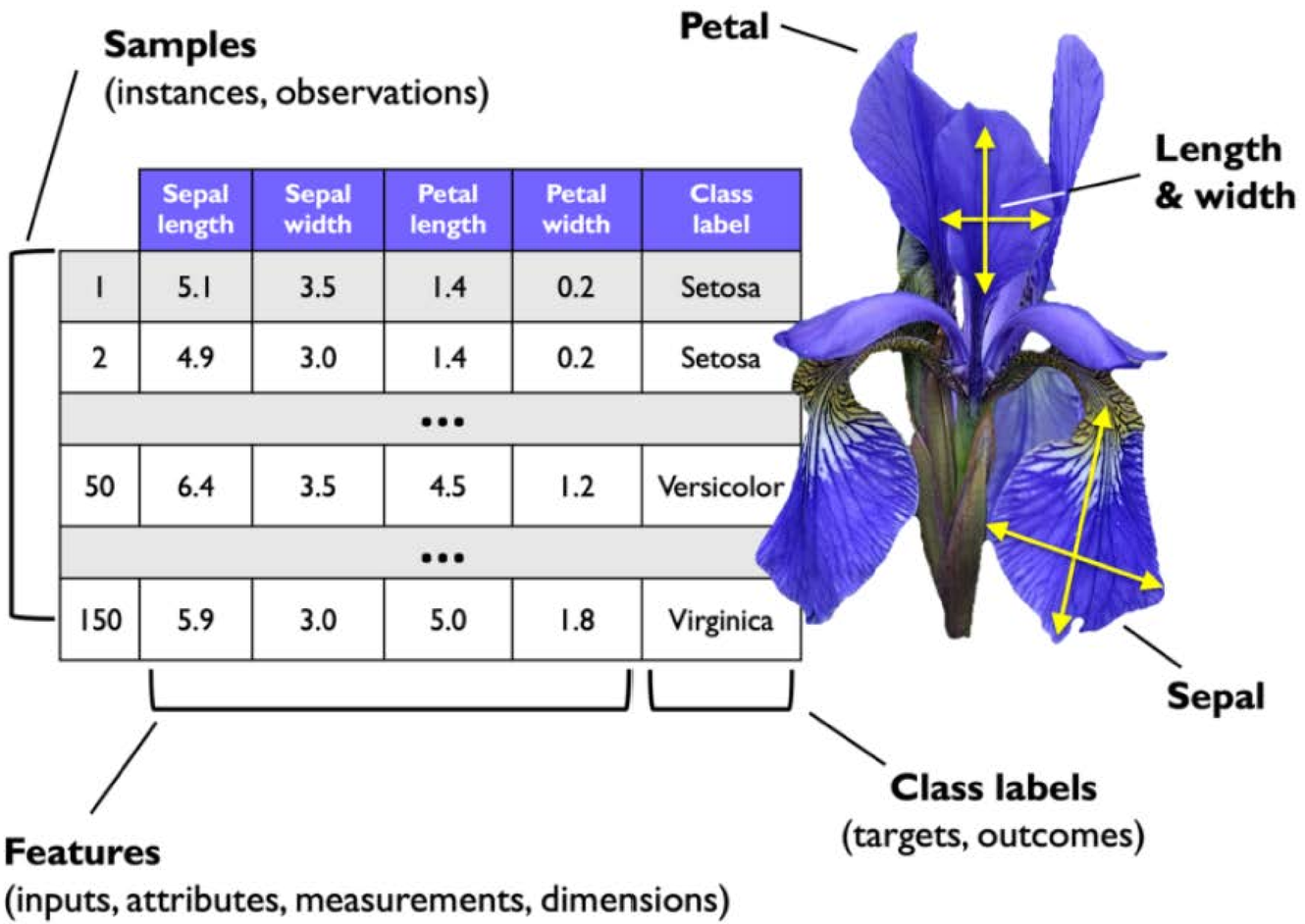
Regression: domain (label) is numeric (continuous value)

Basic Terminology

- Feature
- Target/class labels
- Pattern
- Training
- Training example
- Loss function

mengukur output model dgn output sebenarnya

$$\text{loss} : \frac{1}{2} \sum_i (y_i - \hat{y}_i)^2$$



	Sepal length	Sepal width	Petal length	Petal width	Class label
1	5.1	3.5	1.4	0.2	Setosa
2	4.9	3.0	1.4	0.2	Setosa
...					
50	6.4	3.5	4.5	1.2	Versicolor
...					
150	5.9	3.0	5.0	1.8	Virginica

Figure 1.8: The Iris dataset

Raschka, S., Liu, Y. H., & Mirjalili, V. (2022). *Machine Learning with PyTorch and Scikit-Learn: Develop machine learning and deep learning models with Python*. Packt Publishing Ltd.

Dataset to Pattern (Learning or Training)

feature set | label

outlook	temp.	humidity	windy	play
sunny	hot	high	false	no
sunny	hot	high	true	no
overcast	hot	high	false	yes
rainy	mild	high	false	yes
rainy	cool	normal	false	yes
rainy	cool	normal	true	no
overcast	cool	normal	true	yes
sunny	mild	high	false	no
sunny	cool	normal	false	yes
rainy	mild	normal	false	yes
sunny	mild	normal	true	yes
overcast	mild	high	true	yes
overcast	hot	normal	false	yes
rainy	mild	high	true	no

Inductive Learning

Naive Bayes

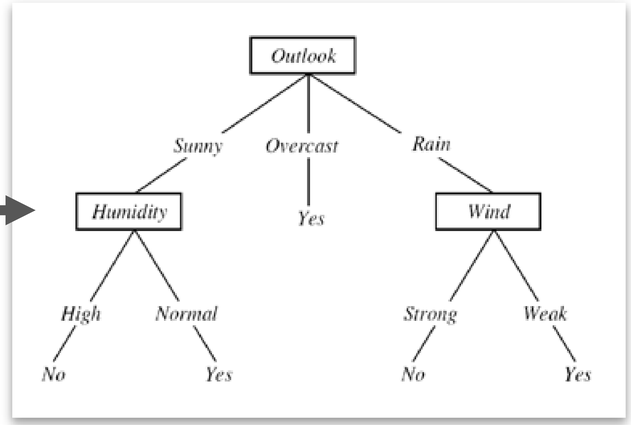
$P(a_i|v_j)$

	outlook		temperature		humidity		windy	
	yes	no	yes	no	yes	no	yes	no
sunny	2/9	3/5	hot	2/9	2/5	high	3/9	4/5	false	6/9	2/5
overcast	4/9	0/5	mild	4/9	2/5	normal	6/9	1/5	true	3/9	3/5
rainy	3/9	2/5	cool	3/9	1/5						

$P(v_j)$

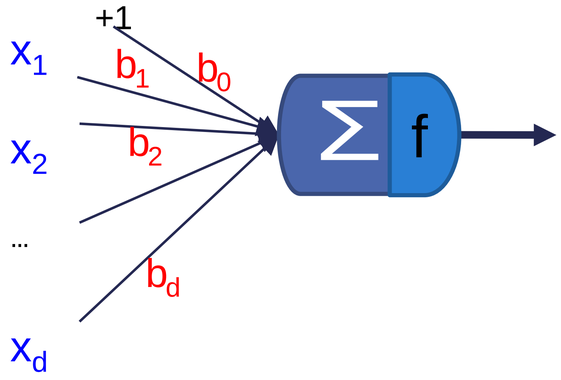
play	
yes	no
9/14	5/14

Decision Tree Learning



Logistic Regression

SVM



Pattern to Decision (Inference)

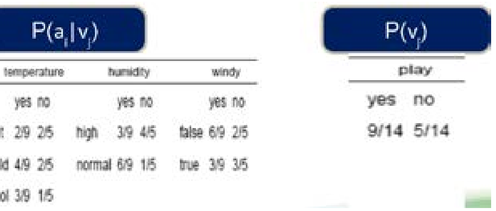
Naive Bayes Model

$P(a_i|v_j)$

	outlook		temperature		humidity		windy	
	yes	no	yes	no	yes	no	yes	no
sunny	2/9	3/5	hot 2/9	2/5	high 3/9	4/5	false 6/9	2/5
overcast	4/9	0/5	mild 4/9	2/5	normal 6/9	1/5	true 3/9	3/5
rainy	3/9	2/5	cool 3/9	1/5				

$P(v_j)$

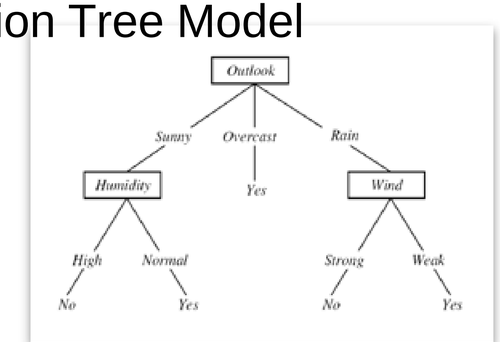
play	
yes	no
9/14	5/14



Predict

prediction

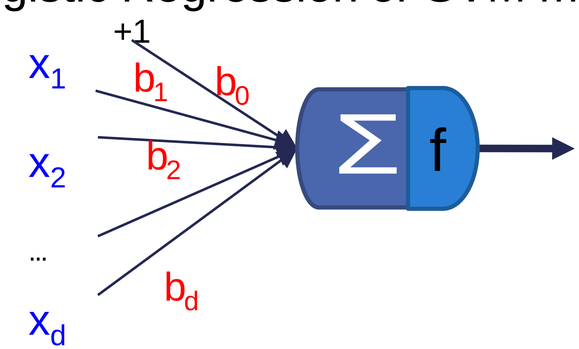
Decision Tree Model



Predict

prediction

Logistic Regression or SVM model



Predict

prediction

Image classification

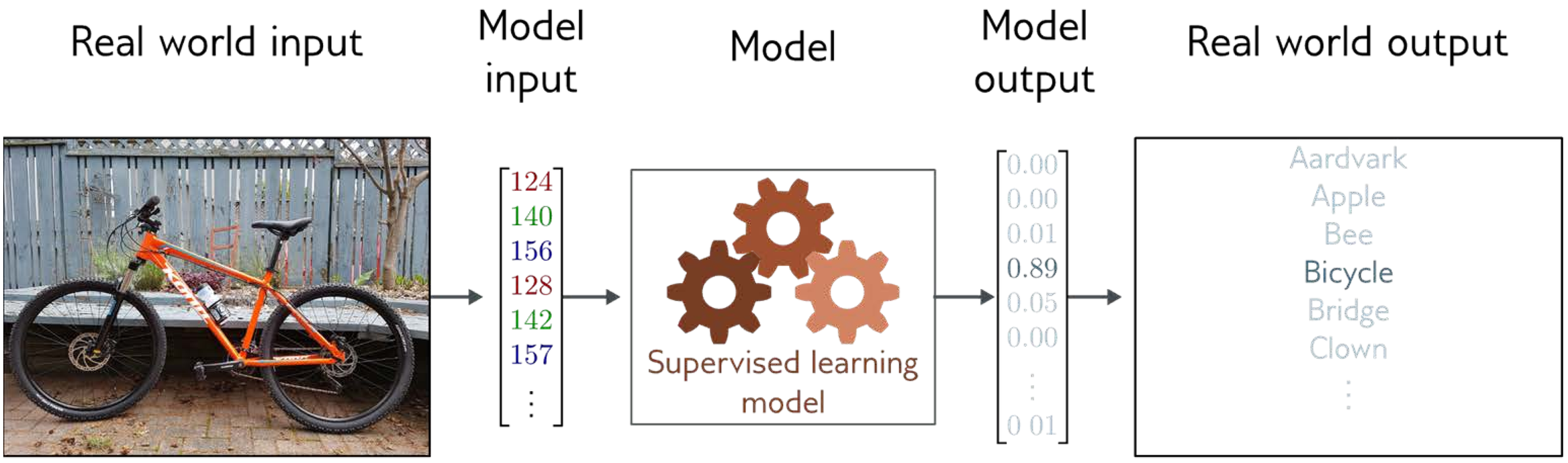
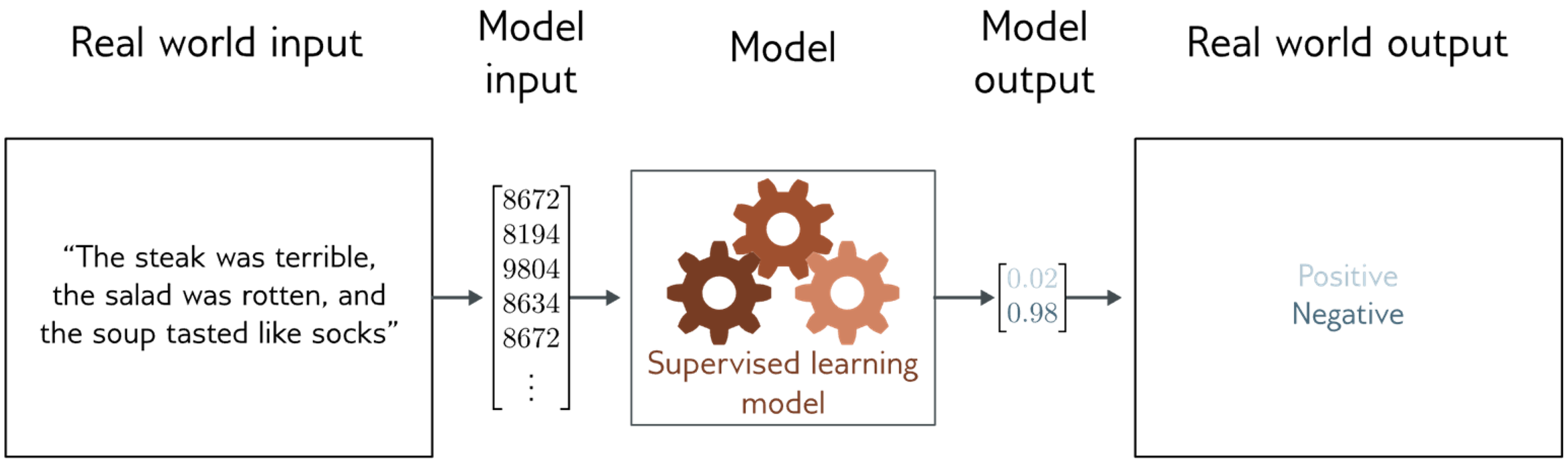


Image encoder: convolutional layer pada Convolutional Neural Network

Text classification



Text as sequence of token, learned by Recurrent Neural Network (incl. LSTM, GRU, ReGU) or Transformer network

Design ML System

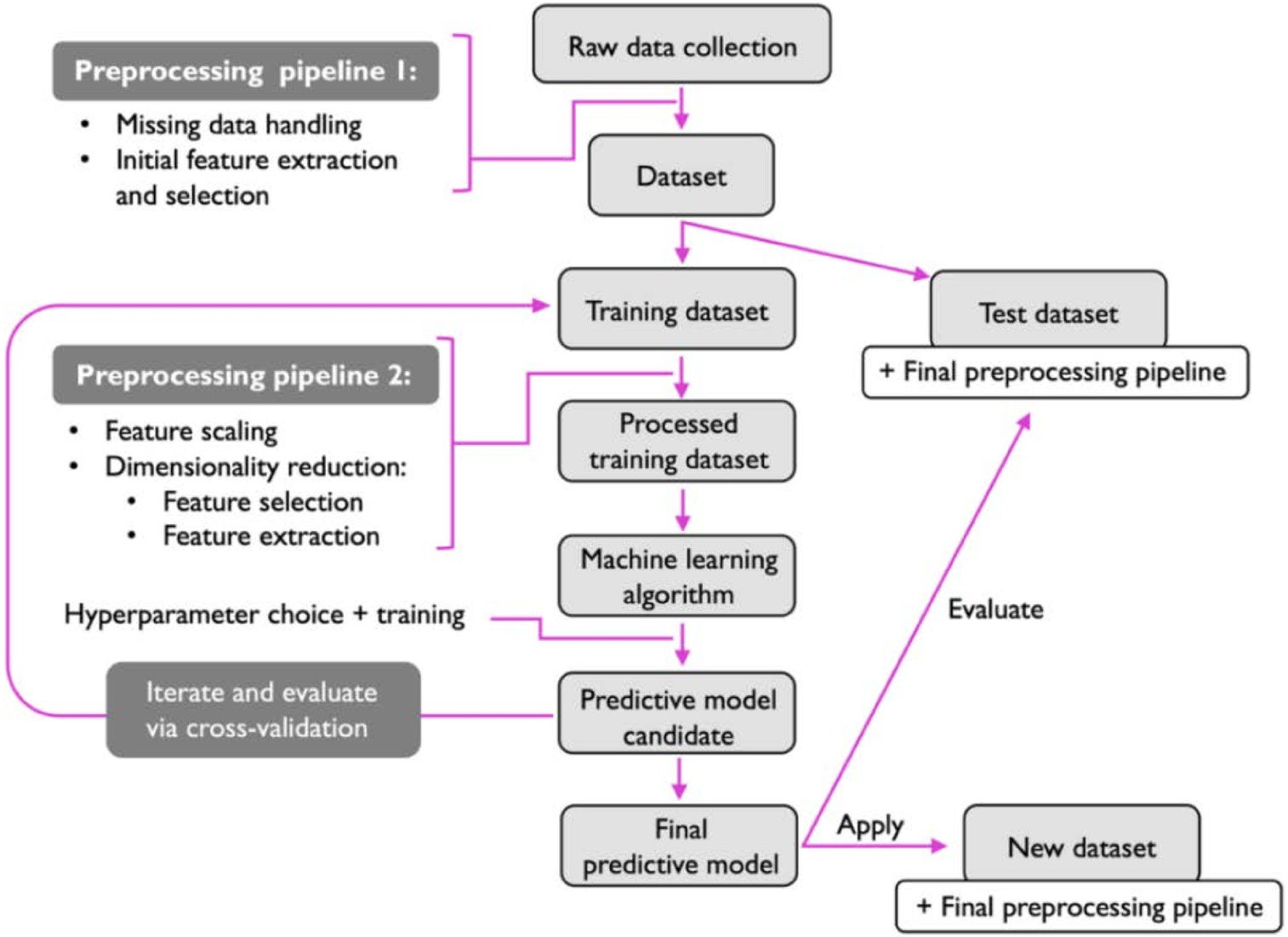


Figure 1.9: Predictive modeling workflow

Raschka, S., Liu, Y. H., & Mirjalili, V. (2022). *Machine Learning with PyTorch and Scikit-Learn: Develop machine learning and deep learning models with Python*. Packt Publishing Ltd.

Questions ?

Next: Ensemble Methods

random forest

xg boost