UNIVERSIDADE CATÓLICA PORTUGUESA

BRAGA

Machine Learning

Session 25 - T

Multi-task and Multi-label Learning

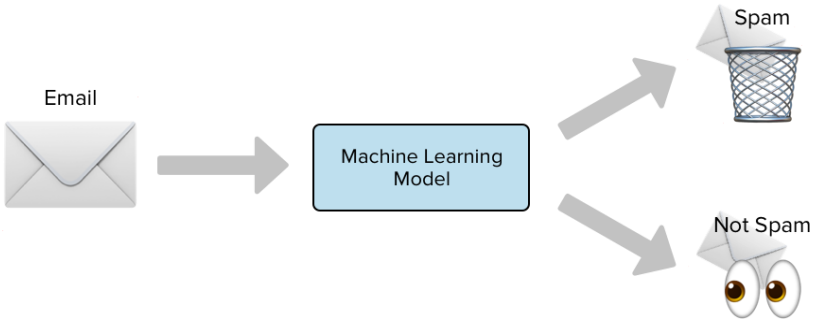
Degree in Applied Data Science

2024/2025

Concept of Tasks in Machine Learning

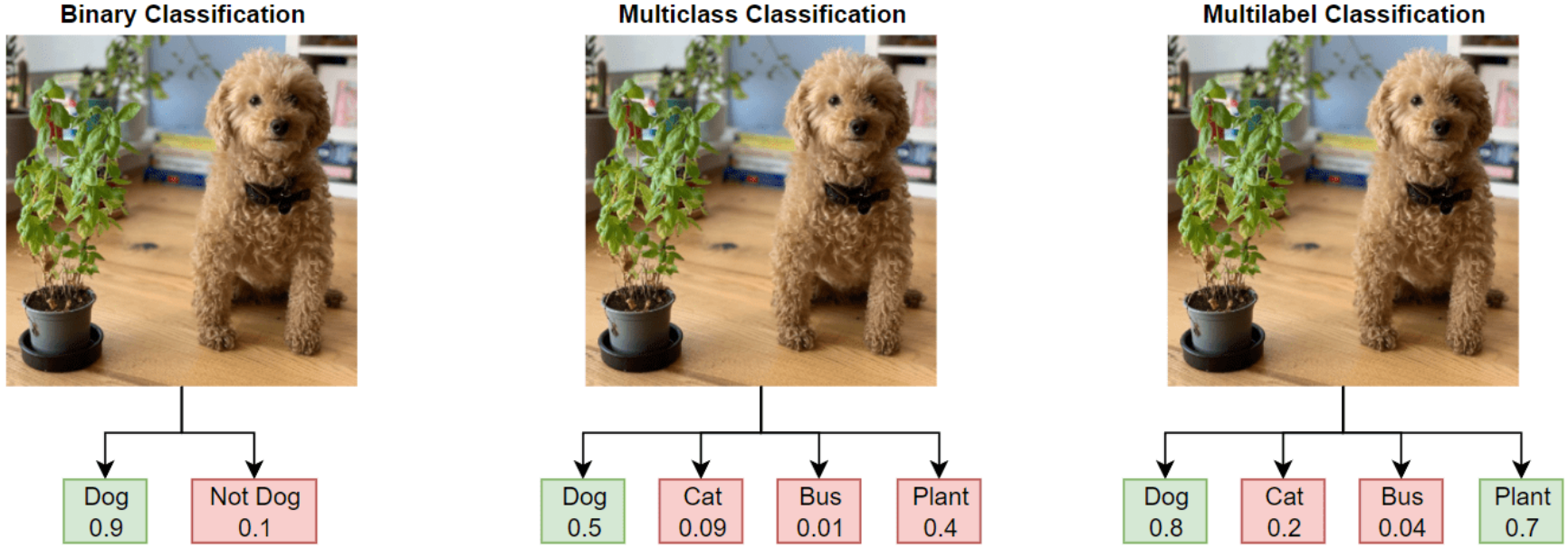
- A task in machine learning is a specific **objective that the model aims to achieve**, such as **classifying images** or **predicting prices;**

- Examples of Tasks:
  - **Classification** (e.g., image classification)
  - **Regression** (e.g., predicting house prices)



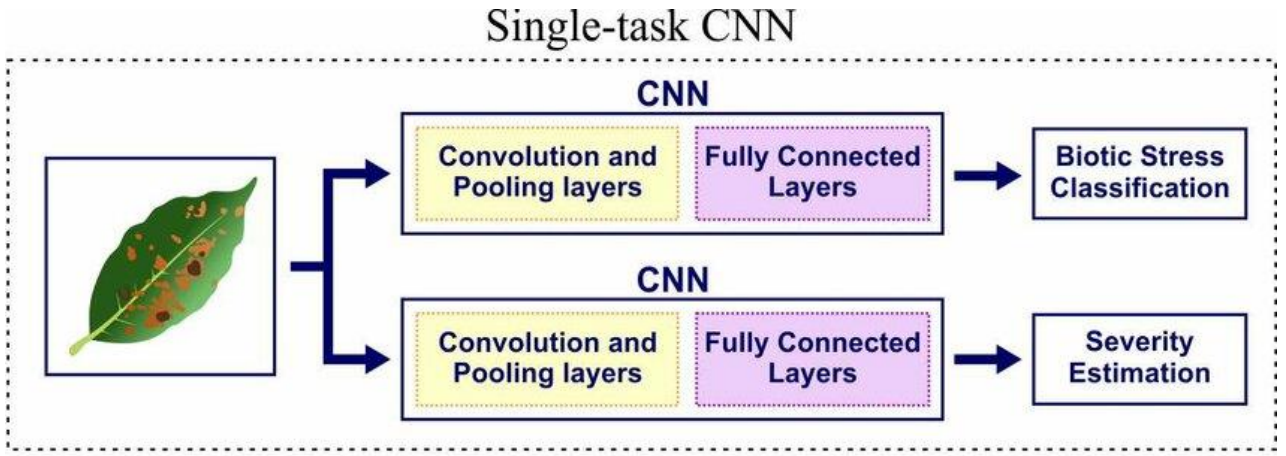
Concept of Label in Machine Learning

- The **output** or result associated with an input, can be **one or multiple per task**;
- Examples:
  - **Single label**: Classifying a image as a dog;
  - **Multi-label**: Classifying a image as both a dog and a plant.



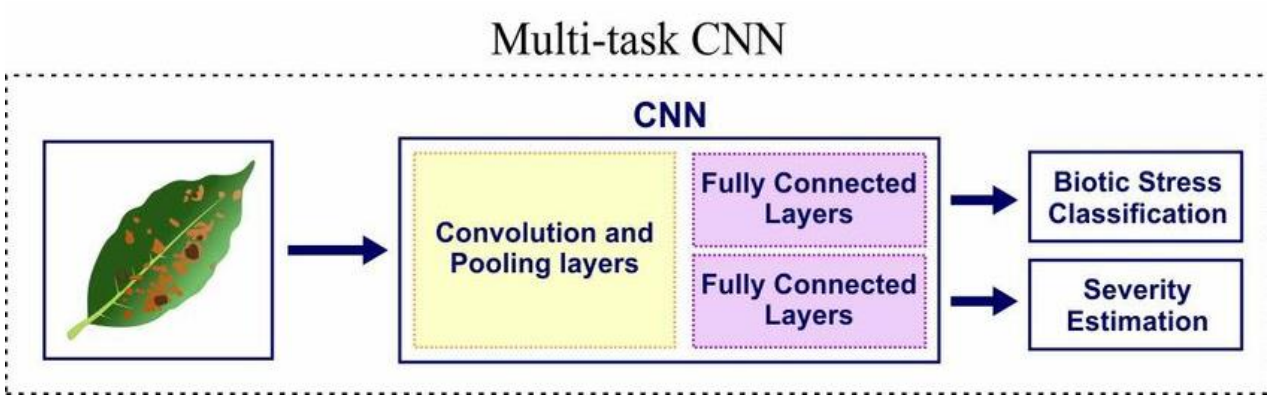
Single-Task Learning

- Models are trained to perform **one task at a time.**



Multi-Task Learning

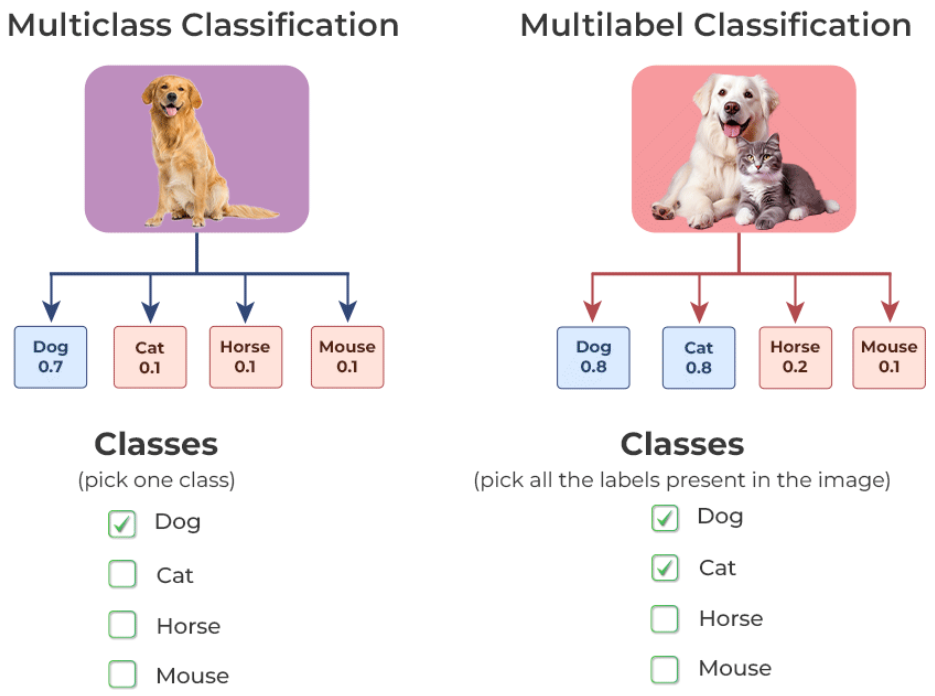
- An approach where a model **learns multiple tasks simultaneously**, sharing representations;
- Benefits:
  - **Improved generalization**;
  - **Efficiency** in learning;
  - **Shared information** among tasks.



Multi-Label Learning

- A **single task** where each instance can have **multiple labels;**

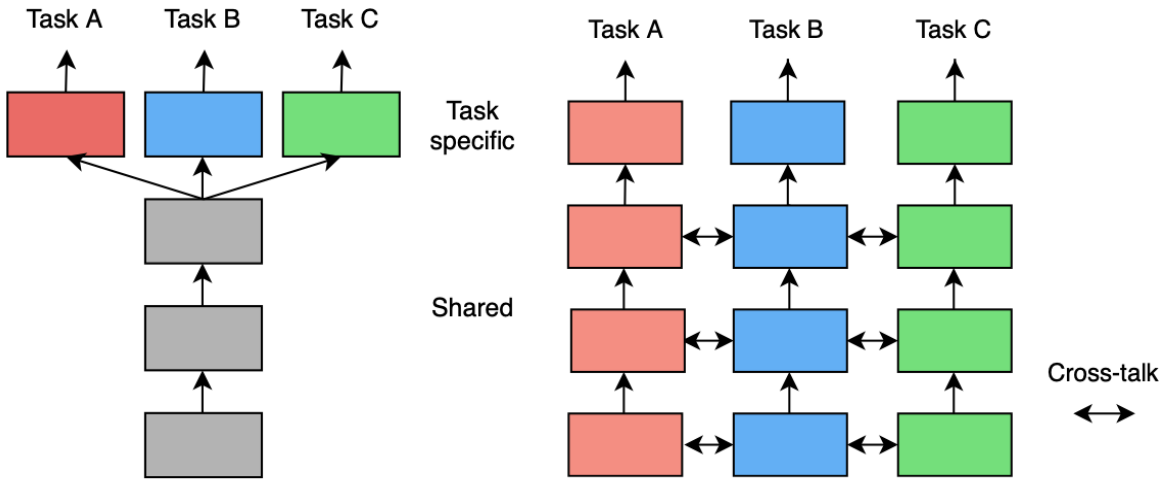
- Benefits:
  - Captures more **complex relationships** in data;
  - Reflects **real-world scenarios** where items bolong to multiple categories.



Types of Multi-Task Learning

- **Hard parameter sharing**: shared hidden layers with **task-specific output layers**;

- **Soft parameter sharing**: each task has its parameters but **regularization** is used to keep them **similar**;



(a) Hard parameter sharing (b) Soft parameter sharing

Resources

- Crawshaw, M. (2020). Multi-Task Learning with Deep Neural Networks: A Survey (Version 1). arXiv. https://doi.org/10.48550/ARXIV.2009.09796

- Tarekegn, A. N., Ullah, M., & Cheikh, F. A. (2024). Deep Learning for Multi-Label Learning: A Comprehensive Survey (Version 2). arXiv. https://doi.org/10.48550/ARXIV.2401.16549