HEIG VD | REDS Institut Reconfigurable and Embedded Digital Systems

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Artificial Intelligence for Autonomous Systems

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Lab 2 - Following a line

This lab will be graded.

Available time : **2 lab sessions**.

Please submit all your code and your `report.pdf` file on Cyberlearn before the lab session scheduled for **April 16th**.

1 Lab objectives

In this lab, you will tackle a real-case scenario for autonomous vehicles. Your goal is to develop an AI application that allows a drone to follow a white line on the floor (see Figure 1). This exercise will familiarize you with theoretical concepts, dataset construction challenges, and the evaluation of training and testing performance.

FIGURE 1 – Example of an image taken by the camera of the drone. It shows the white line the drone should follow.

2 Implementation

Implement your solution in Python using PyTorch. Refer to the FAQ of PyTorch [1] and Tutorial page [2] if needed.

2.1 Approach

Your task is to create an algorithm capable of guiding a drone along a white line on the floor. In a Python file named `lab2.py` implement a method that takes a grayscale image of shape [1,200,200] as input and outputs two 2-D points on the detected line that could be used to steer the drone (see Figure 2). You can assume there will always be a single line in the picture (but there may be other artefacts). A function should also be implemented to initialize your algorithm. Ensure your functions match the signatures below without raising any exceptions for valid inputs.

1. https://pytorch.org/docs/stable/notes/faq.html
2. https://pytorch.org/tutorials/beginner/basics/intro.html

```
init() -> your PathFinder object
detect_line(image: Array[float, shape=[1, 200, 200]]) -> Tuple[Ax: float, Ay: float, Bx: float, By: float]
```

Below is an example of how your code will be used in our evaluation script. **We will NOT change our script to match your solution or to fix potential errors.**

```
from lab2 import init
pathfinder = init()
points = [pathfinder.detect_line(image) for image in images]
```

The accuracy of your solution is important. It will be used as a key evaluation criterion.

In your PDF report (max 2 pages), explain your data choices, key solution points, and evaluation procedure. Include an image illustrating your geometrical approach.

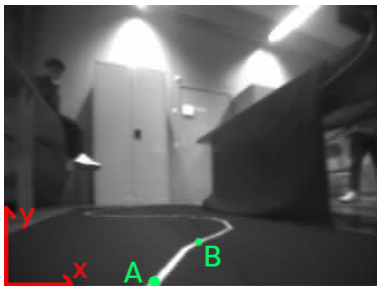

FIGURE 2 – Axes and an example of two 2-D points that could be detected for this image.

2.2 Dataset

One of the main difficulties faced during the development of AI applications is the construction of meaningful datasets. They play a critical role in training models to accurately understand and respond to complex patterns and scenarios, ultimately determining the effectiveness, reliability, and bias in AI systems. We want you to get a sense of how difficult this task might be. We put you in a real-case scenario where you have to determine which dataset to use and why. You can choose to construct your dataset synthetically or find an open-source dataset on the internet.

Provide a detailed explanation of your choices in the report.

2.3 Model Architecture

Model architectures in AI applications are fundamental because they define the structure and behavior of the AI system, shaping how it processes and learns from data. These architectures, whether they are neural networks, decision trees, or other forms, essentially act as the brains of the application. The design of a model architecture dictates its capacity to handle various tasks, such as image recognition, natural language processing, or predictive analytics. A well-designed architecture can efficiently learn from data, generalize to new, unseen scenarios, and provide accurate and reliable results.

Provide a detailed motivation for your model choice.

3 Bonus

We will evaluate each group's solution on a private test set. We will rank them and the group with the highest score will obtain a 0.4 bonus point on their lowest lab grade. Similarly the second group will get a 0.2 bonus point.