Introduction

In the third part of the Research Track 2 course assignment, a statistical analysis has to be carried out concerning the behaviour of a robot within an arena consisting of gold and silver tokens. The gold tokens make up the perimeter of the area and represent the obstacles to be avoided. The silver tokens, on the other hand, are the ones the robot must reach and move, until it completes an entire turn (https://github.com/AliceRivi14/Assignment1_RT1).

This statistical analysis is done by comparing the code written by the students and the code written by Professor Recchiuto (https://github.com/CarmineD8/python_simulator/tree/rt2).

Data Collection

To collect the data, three maps with silver tokens placed in different positions were considered and both robots were subjected to ten tests:

- 1^{st} map: 7 tokens
- 2^{nd} map: 10 tokens
- 3^{rd} map: 5 tokens

For each run, three parameters are considered:

- distance to obstacles.
- time taken to complete an entire lap.
- times the robot crashes/hits an obstacle/changes direction incorrectly.

Before starting the tests, the speed and reading time of the robot was changed in the student's code to be the same as that used by the professor, in order to achieve a more consistent analysis.

Data Analysis

In statistical analysis, the terms null hypothesis and alternative hypothesis are commonly employed. The notion that if we evaluate method A and method B in terms of superiority and proceed under the presumption that both are equally effective is what we refer to as the null hypothesis.

In contrast, we can think that approach A is better or approach B is worse, in which case we are putting out a different theory. H_0 stands for the null hypothesis, while Ha stands for the alternate hypothesis.

If our sample data reject this null hypothesis, we should draw another conclusion. We arrive at the alternative hypothesis after rejecting the null hypothesis. The set of alternatives to the null hypothesis is referred to as the alternative hypothesis in other words. Accepting H_0 entails rejecting H_a, while rejecting H_0 entails accepting H_a.

Distance to obstacles

For each path, the average distance the robot maintains to the obstacles was calculated, regardless of whether they are to its right or left.

In all column chart, it is quite visible how the professor's robot maintains a greater average distance to obstacles than the student's robot. This can therefore lead us to think that the professor's robot identifies obstacles earlier and avoids them more easily.

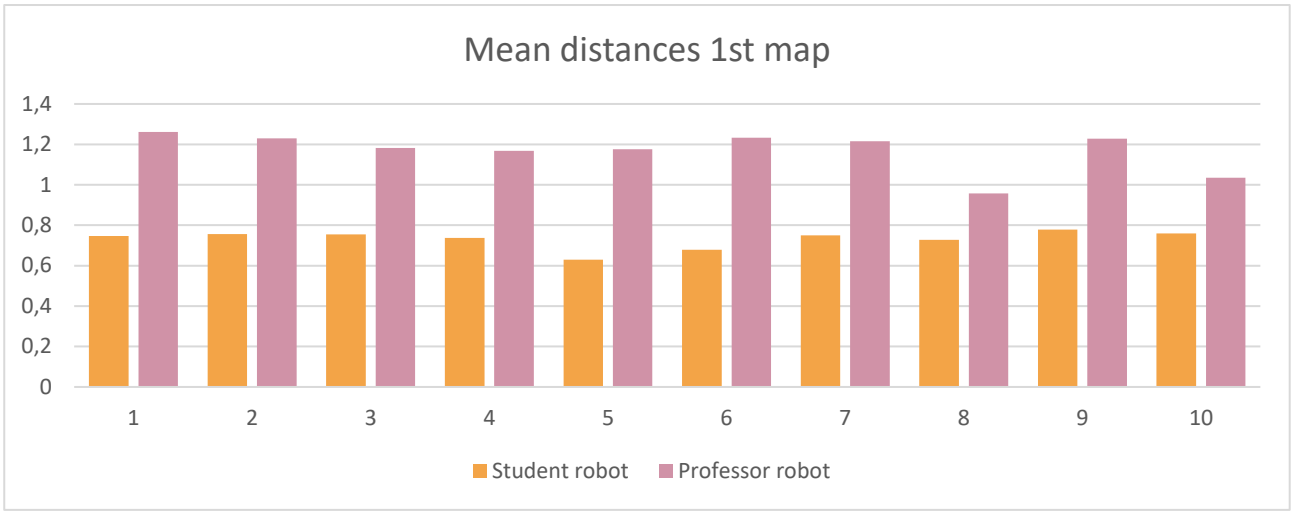

Figure 1 - Distances to obstacles in the 1st map

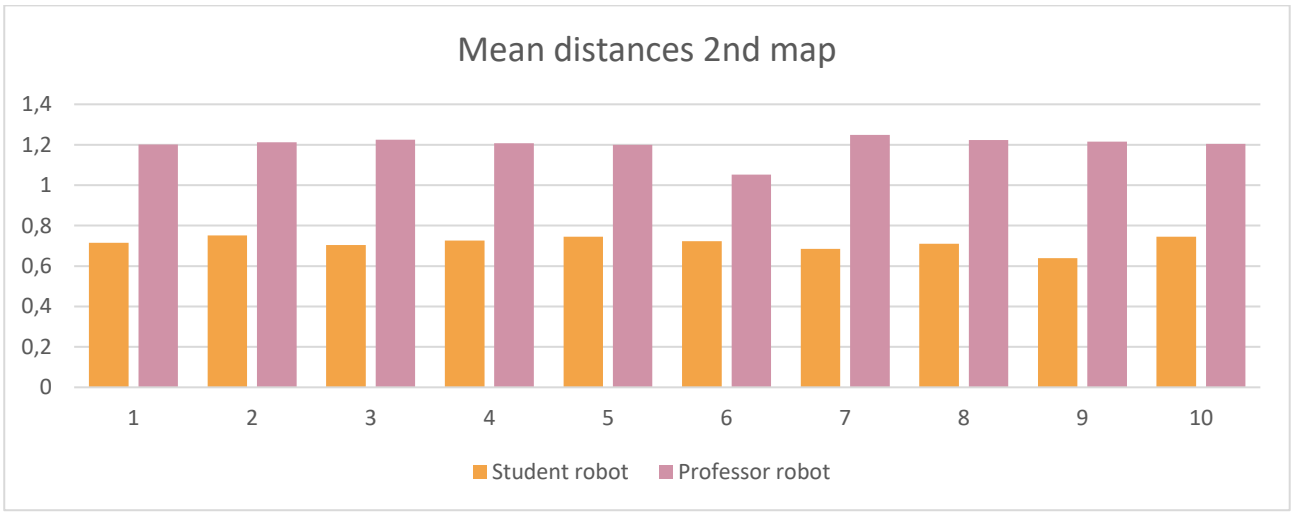

Figure 2 - Distances to obstacles in the 2nd map

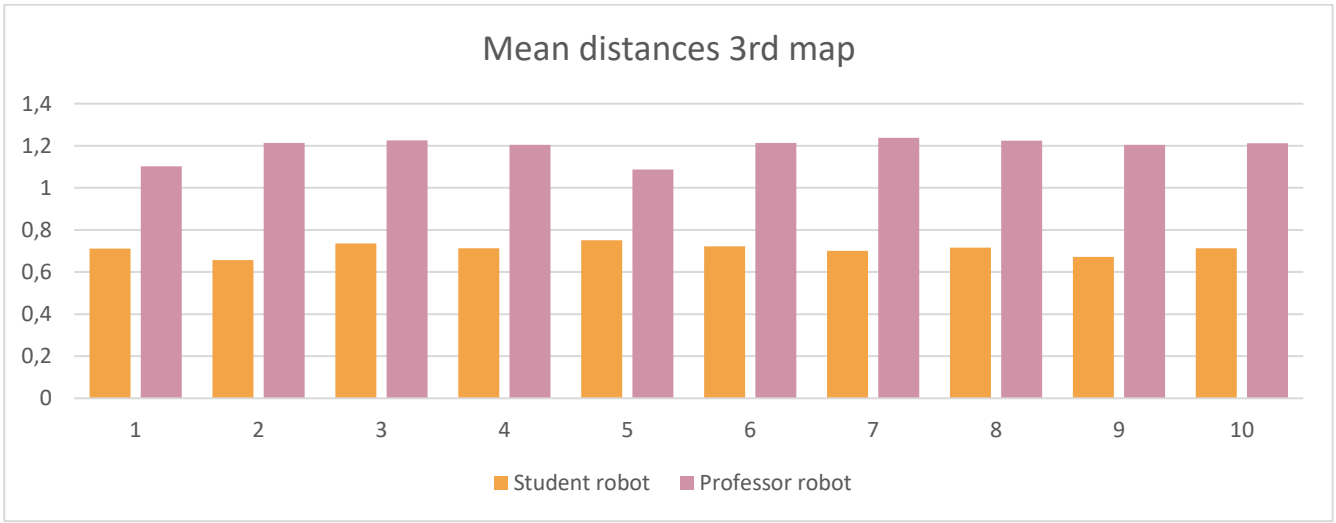

Figure 3 - Distances to obstacles in the 3rd map

Time to complete an entire lap

For obvious reasons, the data on the time taken by the robots only concern cases in which the entire route was completed, whereas laps in which the robot reversed its direction or crashed were eliminated.

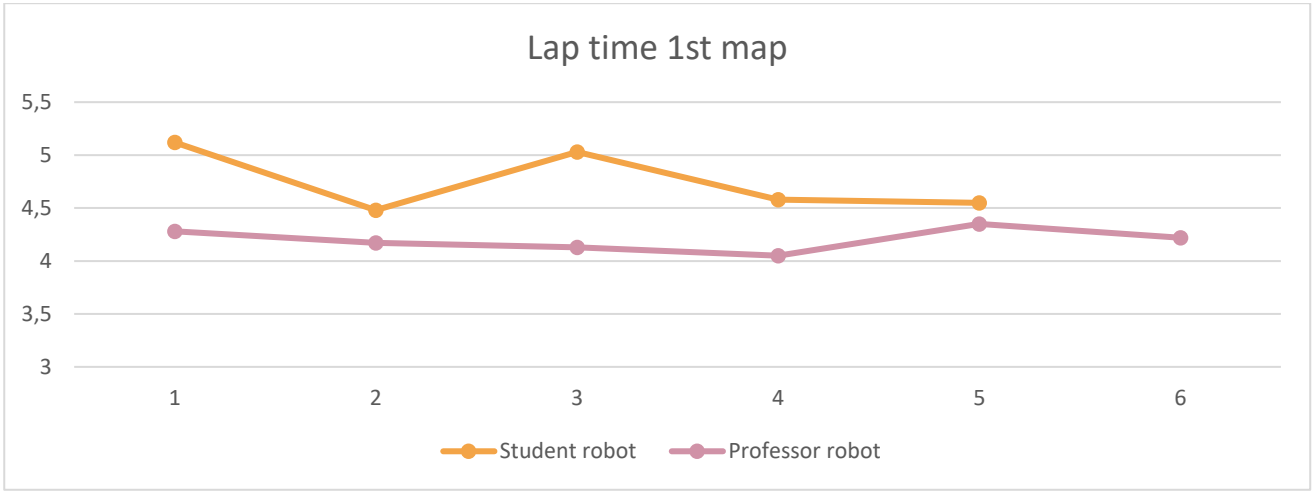

Figure 4 - Times to complete an entire 1st map lap

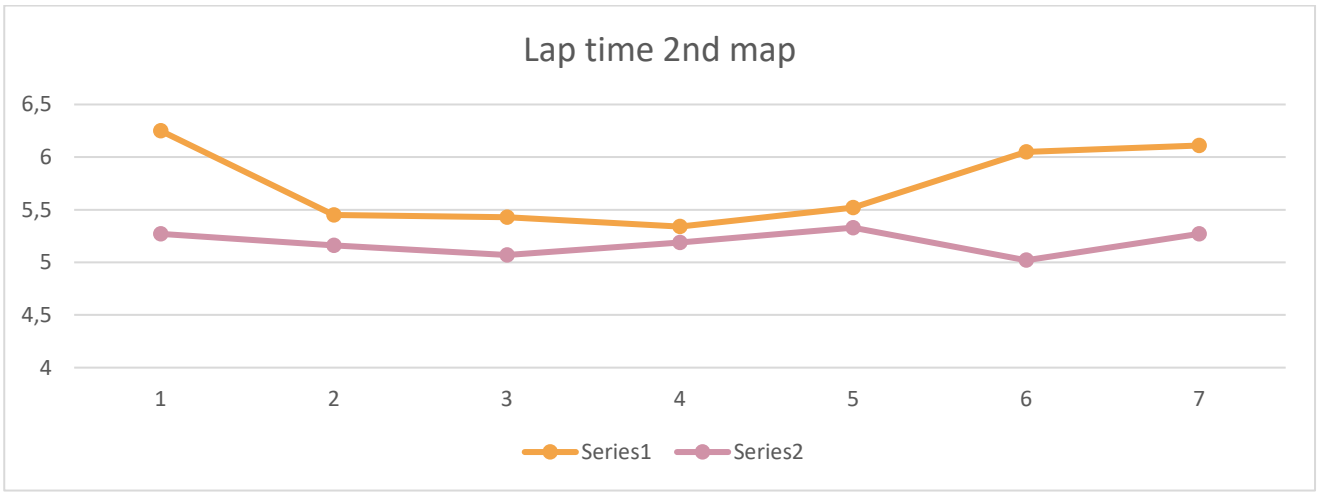

Figure 5 - Times to complete an entire 2nd map lap

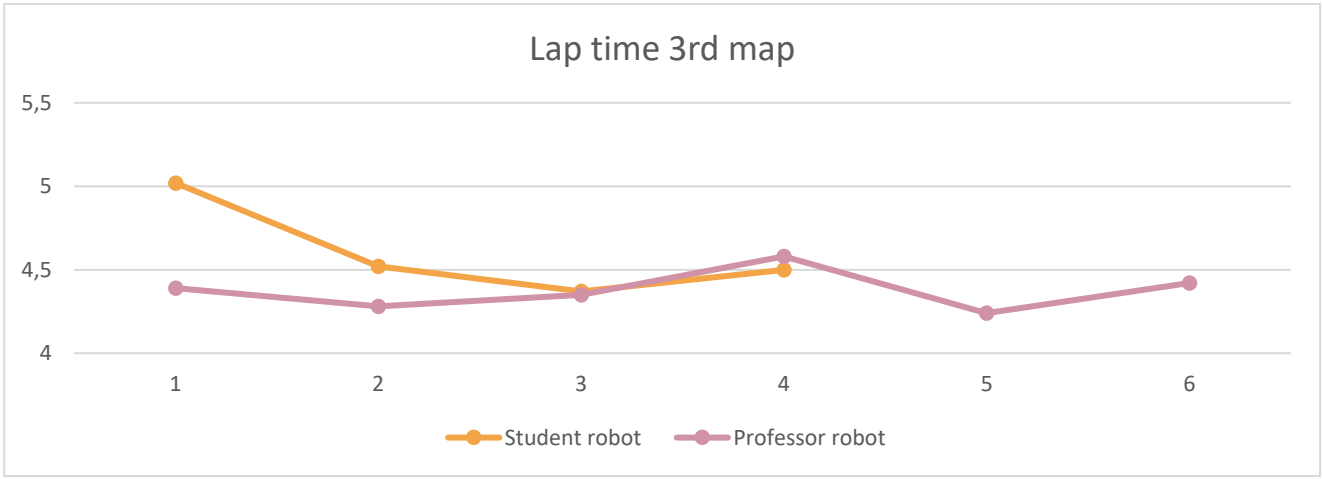

Figure 6 - Times to complete an entire 3rd map lap

Using line graphs above, we can verify that the teacher's robot can finish a lap faster than the student's robot. Checking each lap, we can see that this is due to the longer times taken by the student robot in making the turns on the course.

From the graphs, we can also see that the student robot completes fewer laps than the professor robot, especially on the path with few tokens.

Times when the robot did not complete a lap

As we can see from the bar graph below, both robots had problems completing all 10 rounds.
This may be due to:

- a collision between the robot and an obstacle.
- a crash of the robot.
- the wrong change of direction of the robot.

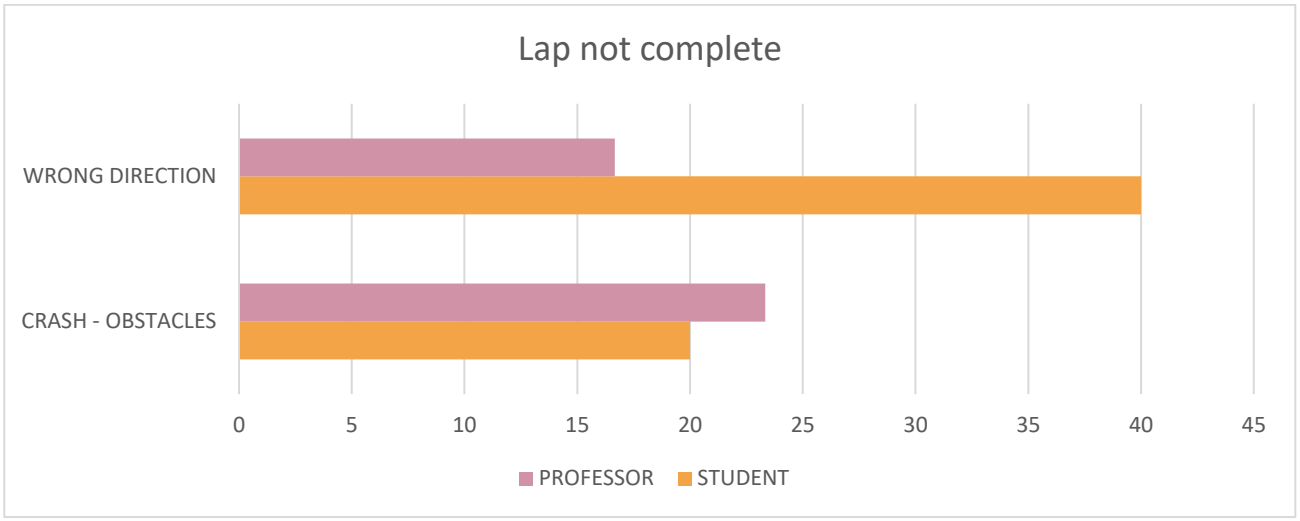

Figure 7 - Times when the robot did not complete a lap

The professor's robot still seems to perform better than the student's robot. Analysing each turn, it was noted that the student's robot, especially in the first and last map, has a problem choosing the right direction in the indicated area. By adding even just one token at that point, the problem is solved because the robot has more reference points and is better able to orient itself in carrying out its task.

Conclusion

Through this statistical analysis, we can conclude that the teacher's robot performs better in every field than the student's robot.

Thus, the algorithm written by the professor guarantees:

- greater safety against obstacles.
- a shorter time required to complete a complete turn, with any type of map.
- a lower possibility of error.

Analysing the professor's code, in fact, one can see a greater number of parameters controlling the robot's position and orientation compared to both the now and silver tokens, thus confirming the results obtained.