UNIVERSITÀ DEGLI STUDI DI GENOVA

DIBRIS

DEPARTMENT OF COMPUTER SCIENCE AND TECHNOLOGY,
BIOENGINEERING, ROBOTICS AND SYSTEM ENGINEERING

RESEARCH TRACK 02

Third Assignment

Statistics

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1 Assignment description

The sample is a portable robot simulator developed by Robotics engineering students. Where the robot is asked to arrange the silver and golden tokens such that all silver tokens and placed next to the golden ones.

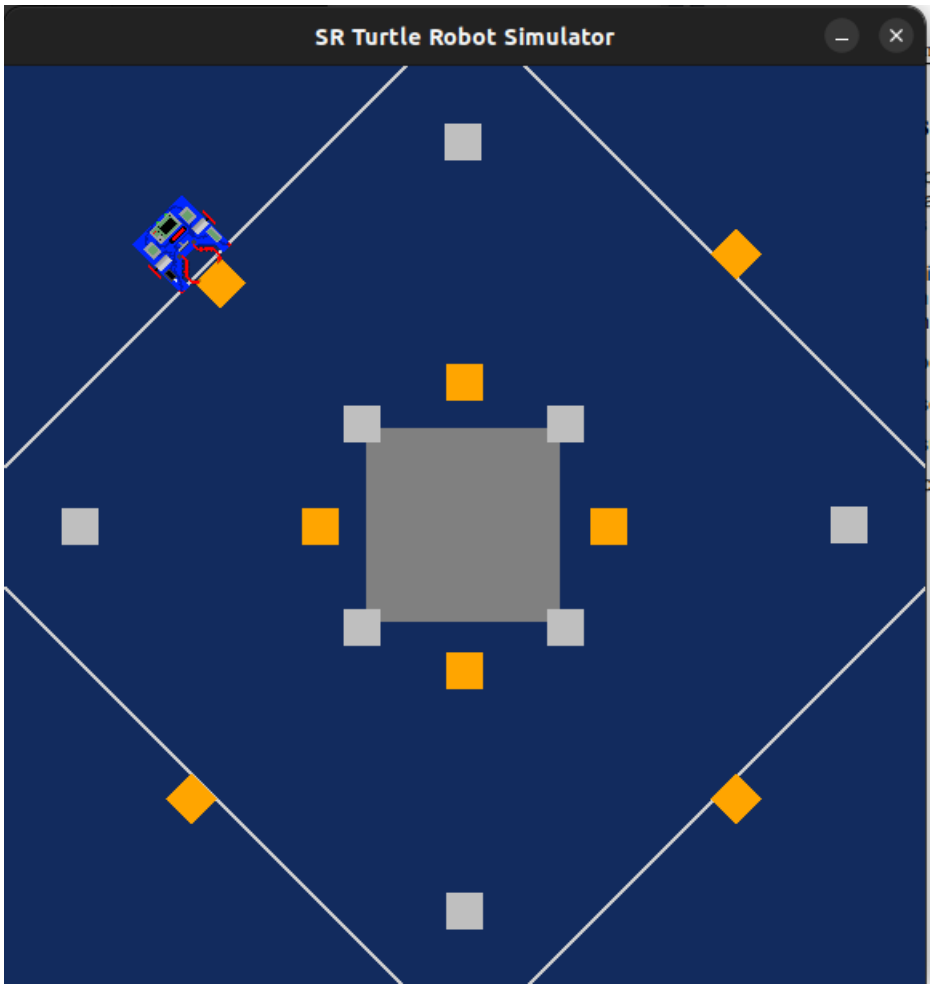

Figure 1: Arena

In this assignment, we will compare and test two codes implemented for ”Assignment 01” from Research Track 01. The comparison is based on efficiency (The code that manages to arrange the tokens). The arenas and other parameters have been changed compared to **”Assignment 01”** of **Research Track 01**. We have increased the number of tokens to 8 instead of 6 and arranged several **Golden** and **Silver** tokens in the inner and outer circles of the model.

The main objective is to implement:

- Hypotheses made analysis (null hypothesis and alternative hypothesis).
- Description and motivation of the experimental setup (types of experiments, number of repetitions).
- Results.
- Discussion of the results with statistical analysis-Conclusion (is the hypothesis proven?).

Aicha’s robot: `https://github.com/AichaAbbad/AichaAbbad-researchtrack_assignment_01.git`
Ines’s robot: `https://github.com/Fritta013/Research-Track-Assignment-1.git`

2 General Efficiency Analysis

2.1 Aicha's code

After testing Aicha's with the new arena, we noticed that the robot couldn't finish its task and it only managed to pair 5 tokens out of 8 in total. However, since the code was not well designed to recognize the previously visited tokens. The robot only managed to pair 3 tokens at the end.

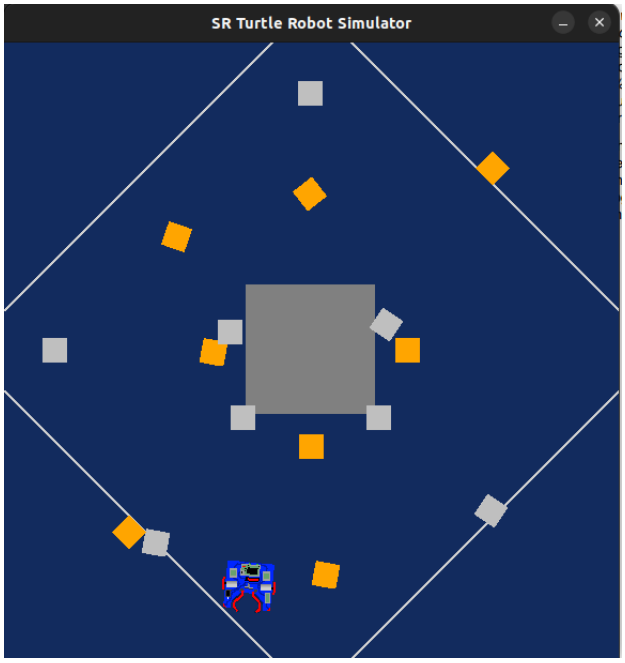

Figure 2: Aicha's code

2.2 Ines's code

After testing Ines's with the new arena, we noticed that the robot only managed to arrange 5 tokens out of 8 in total. The robot was more efficient at recognizing the previously visited tokens. However, it didn't manage to pair the rest of the tokens.

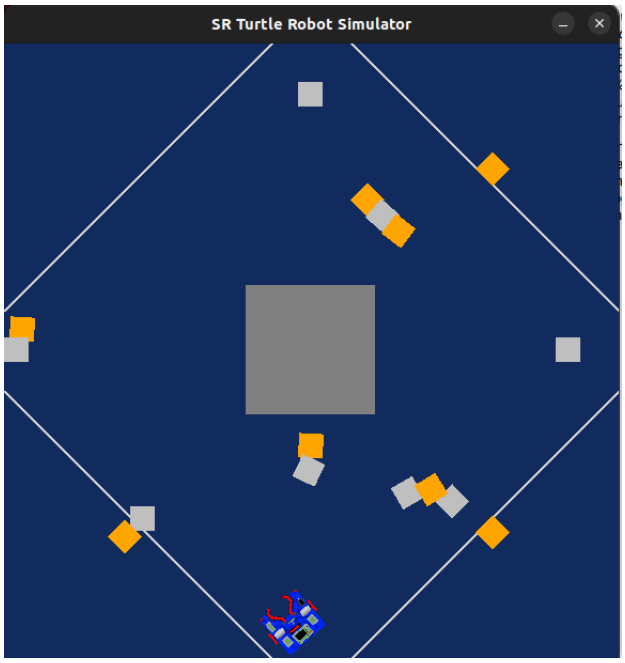

Figure 3: Ines's code

This analysis is not sufficient to decide which Algorithm is more efficient. Hence, we need to do a *Hypothesis analysis*.

3 Hypothesis Analysis

3.1 Null Hypothesis Analysis:

The Hypothesis made is:

" There is no significant difference in the performance between Aicha's and Ines's robots."

Here, we assumed that both algorithms lead to the same result in terms of performance ($\mu_{\text{Aicha}} = \mu_{\text{Ines}}$). Both robots managed to pair the same number of tokens. The tokens are considered as *paired* if the robot managed to take the silver token and place it near a golden one. What happens later to it is none of our concerns.

3.2 Alternative Hypothesis Analysis:

The Hypothesis made is.

"The robot designed by Ines is superior in performance than the robot designed by Aicha."

Here, we assumed that the robot designed by Ines leads to better results compared to Aicha's robot ($\mu_{\text{Ines}} > \mu_{\text{Aicha}}$). The robot designed by my colleague successfully paired the tokens by utilizing its ability to recognize previously visited tokens. This enhanced the robot's performance.

We need to use a *one-tailed test*. In order to prove that *H1* is correct and reject *H0*. To test that we pick the *Paired T-Test* for our analysis.

4 Experiment:

To assess the performance of both robots, we conducted an experiment in an environment that consisted of 8 golden tokens and 8 silver tokens [4]. This deliberate selection of token quantities enabled us to make a more meaningful comparison between the two robots within the same environment. Additionally, it allowed us to evaluate how effectively both robots could handle an environment with a large number of tokens to carry. We also placed randomly silver and golden tokens in the inner and outer circles of the environment to see how each robot deals with that.

- The standard error is given by: $SE = 0.221$.
- The **t-value** is given by: $t = 2.71(For 9 DOF)$

Tokens	Number of tokens paired	Number of tokens remaining paired at the end of the execution	**difference**
Aicha's Robot	5	3	2
	5	4	1
	4	3	1
	5	4	1
	5	4	1
Ines' Robot	5	5	0
	5	5	0
	6	6	0
	3	3	0
	6	6	0
Mean	4.9	4.3	0.6
Standard deviation	0.875	1.16	0.7

Since the degree of freedom (DOF) is 9, we can look up the critical value for the desired significance level (e.g., 0.05 or 0.01) in the t-table for 9 DOF. The critical value represents the threshold beyond which we reject the null hypothesis.

Using the t-table we get *the confidence level* = 97.5 %. This means that the null hypothesis can be rejected.

5 Conclusion

For the above analysis, we can clearly see that Ines's robot gave better performance compared to the code developed by Aicha. The robot designed by Ines managed to up to pair the 6 tokens without messing with previously visited ones, compared to Aicha's robot which couldn't recognize the tokens and led to less paired tokens at the end of the simulation. The proposed work approved the alternative hypothesis proposed and rejected the null analysis.