RESEARCH TRACK 2

STATISTICAL ANALYSIS

Simone Contorno

Student ID: 4638263

Robotics Engineering

University of Genoa

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ABSTRACT

Statistical analysis is a fundamental part of a project aimed at improve the performance of a previous release.
In the course ”Research Track 2” of the University of Genoa, these aspects have been analyzed; for this reason, an assignment has been assigned to the student to test their knowledge about this topic.
In this report are reported all the steps that have been followed to compare the performances of a new robot with a given solution in a virtual environment.
The program that manages the robot is a python script.

Contents

1 Assignment

The assignment consists to perform a statistical analysis on the first assignment of the course "Research Track 1", considering two different implementations (the developed one, and a given solution) and testing which one performs better in the given circuit, when silver tokens are randomly placed in the environment.
As performance evaluators may possibly consider:

- the percentage of crashes / collisions with the walls / robot going in the wrong direction;
- the average time required to finish the circuit;
- the distance from the obstacles.

In this experiment the second one has been chosen.

2 Hypothesis Testing

2.1 Null Hypothesis

The Null Hypothesis H_0 occurs when the original assumption results are not satisfied by the made tests.
In this case it occurs if the new developed robot reports an average time to finish the circuit greater or equals than the given solution.

2.2 Alternative Hypothesis

The Alternative Hypothesis H_a occurs when the original assumption results are satisfied by the made tests.
In this case it occurs if the new developed robot reports an average time to finish the circuit less than the given solution.

2.3 Level of Significance

The level of significance is the probability that the estimation is wrong (e.g. the Null Hypothesis H_0 was correct even when i rejected it).
In this case it is set to 5%.

2.4 Distribution

Since the number of data for each robot are 32, the normal distribution is adopted.

3 Data

3.1 New robot

In the Table 1a are reported the data collected about the new robot and in the Figure 1 is shown the normal distribution of them.

3.2 Given solution

In the Table 1b are reported the data collected about the given solution and in the Figure 2 is shown the normal distribution of them.

3.3 Table description

As can be seen the tables are structured in the following way:

- the first column reports the ”Token density”, thus if the map is with just one of the default token, or half, full, double of them;
- the second column reports the ”Time” in seconds of each lap;

The red value in the last row of each table is a value given by a robot error during the simulation, like the inversion of direction.
Given the fact that this experiment aimed to test just the average time to complete a race, with different map configurations, errors like this one, given by an inefficient control robot sensor, are not be taken into account for the computation of the ”Mean/Average” and ”Standard deviation” values.

Token density	Time (s)
One token	75.84
	76.16
	77.91
	77.98
	78.10
	78.23
	78.45
	79.62
Half tokens	85.14
	85.87
	86.32
	86.41
	86.47
	86.63
	86.75
	88.22
Full tokens	97.18
	97.89
	98.50
	98.63
	98.94
	99.07
	99.20
	99.78
Double tokens	117.09
	117.24
	117.36
	118.78
	119.36
	119.40
	119.55
	165.68
Mean/Average	94.58
Standard deviation	14.93

(a) New robot data.

Token density	Time (s)
One token	138.03
	138.54
	139.50
	139.86
	140.03
	141.43
	142.15
	142.17
Half tokens	144.90
	146.76
	149.92
	150.03
	150.83
	152.32
	152.03
	154.81
Full tokens	161.48
	162.14
	164.21
	164.98
	165.91
	166.12
	166.36
	166.73
Double tokens	212.22
	212.65
	213.17
	213.77
	214.20
	217.91
	221.40
	339.72
Mean/Average	165.99
Standard deviation	28.04

(b) Given solution data.

Table 1: Robots data.

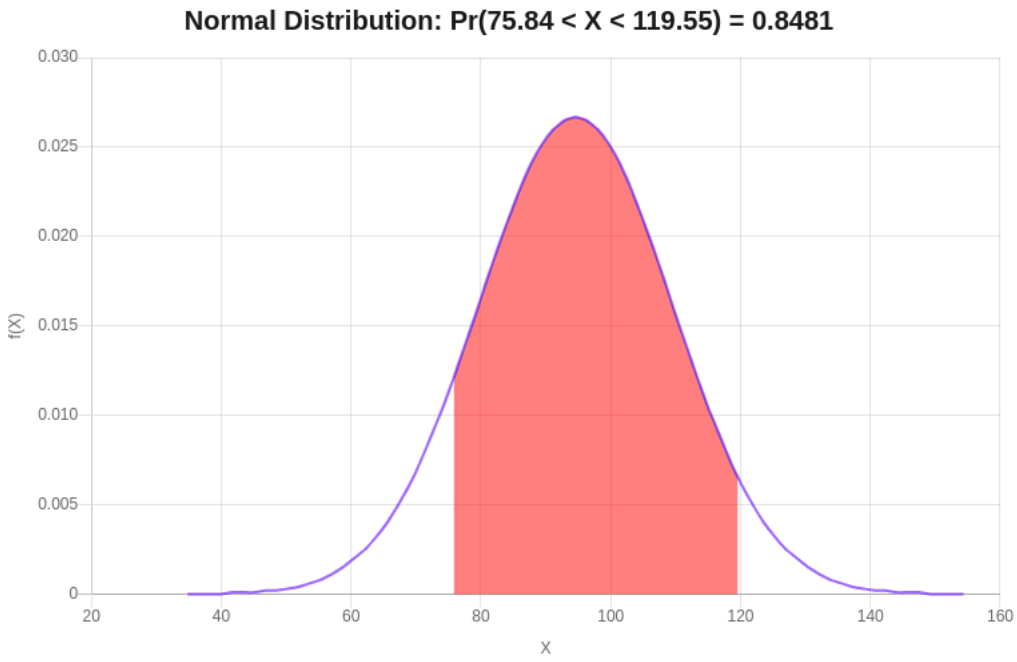


Figure 1: Normal distribution of the new robot data.

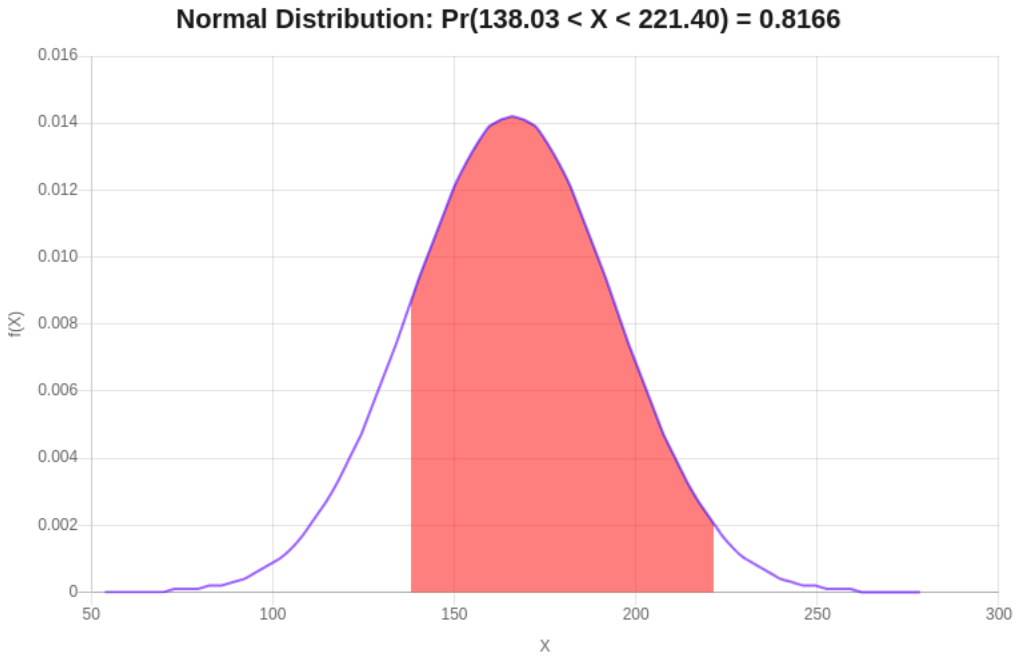
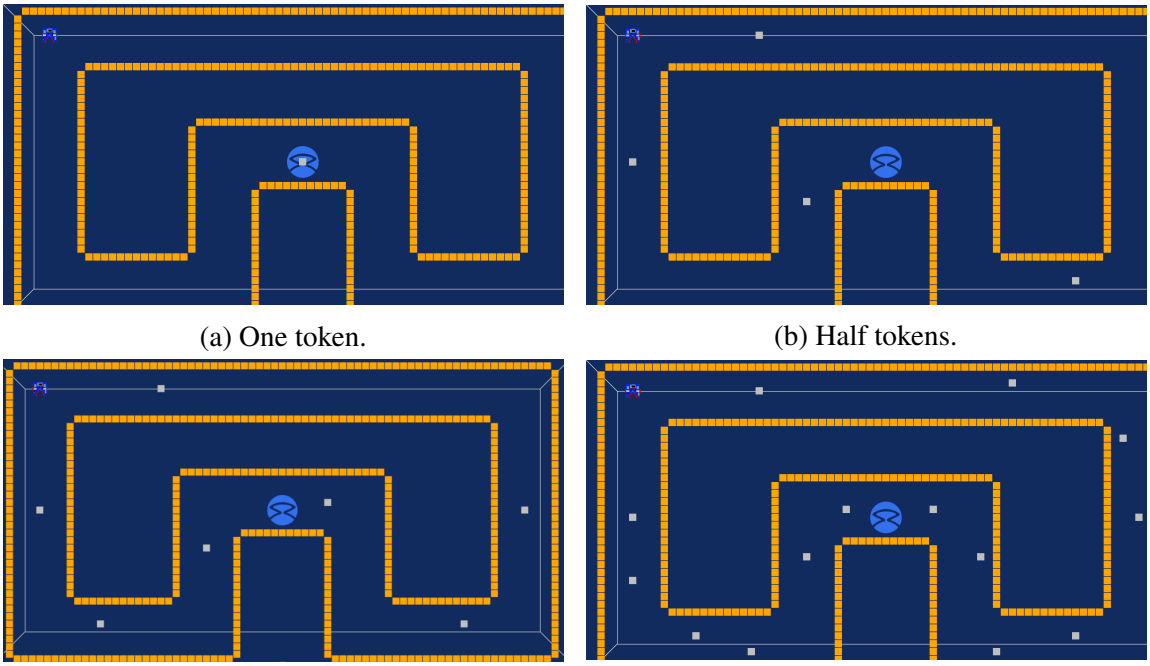


Figure 2: Normal distribution of the given solution data.

3.4 Map configuration

The different map configurations that have been used are reported in the Figure 3.



(a) One token. (b) Half tokens.

(c) Full tokens. (d) Double tokens.

Figure 3: Map configurations.

4 Z-Test

To compare the results they were taken the mean and the standard deviation of the new robot and it has computed the probability

$$Pr(T > 138.03) = 0.0018, (Z = -2.91) \quad (1)$$

where T is the average time took by the robot to perform a lap.
This means that the probability that the new robot version performs a lap with an average time greater than 138.03 seconds is very low (0,18 %).
The same result is shown in the Figure 4.

5 Conclusion

By the Z-Test result and the data reported in the tables, it is possible to conclude that the new robot version has highlighted a better performance in terms of velocity to complete a lap of the map for all the configurations that have been used, with a difference of ”Mean/Average” value of 71.40 seconds.

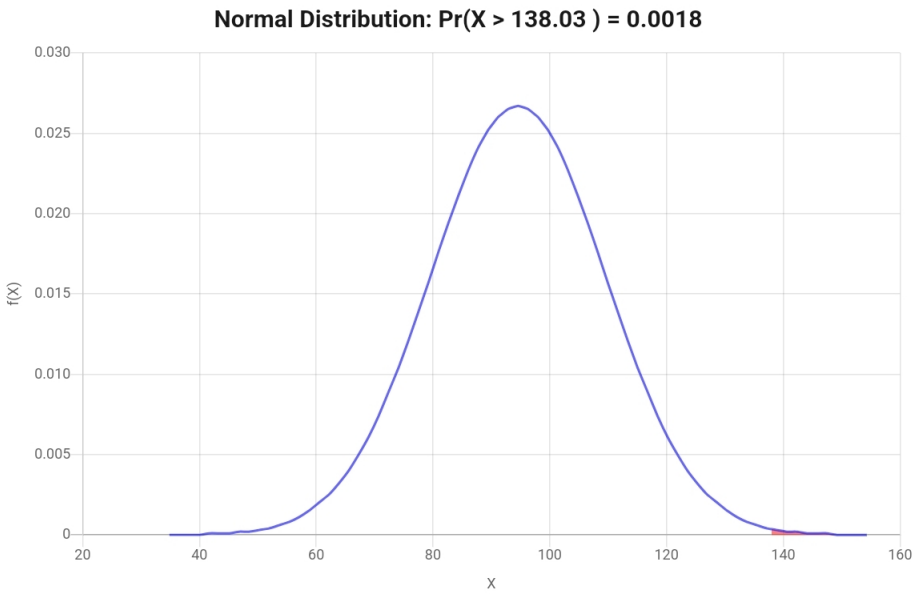


Figure 4: Z-Test.

References

[1] Prof. Carmine Tommaso Recchiuto (2022) *Fundaments of Statistics*.