UNIVERSITÀ DEGLI STUDI
DI GENOVA

RESEARCH TRACK 2
ROBOTICS ENGINEERING

Assignment: Statistics report

Fabrizio Francesco Leopardi (4816319)

1 Introduction

For the last part of the assignment of Research Track 2 i decided to compare my code with the code of a colleague of mine Giulia. The unique parameter that i based my analysis on is the time required to finish the task, anyway for the sake of completeness in excel files i created i also reported a boolean variable "ends in finite time?". This just to prove that in every simulation the code ended and no simulation was discarded because the code ended with some error. For the sake of completeness it is important to introduce here the concept of "task".

Task: The robot in the environment described in the first assignment of Research Track 1 has to place 6 silver tokens next to 6 gold tokens, initially all the silver token are placed in a circle with angle given by a random varibale uniformly distributed in the interval $[0, 2\pi)$. The same can be said for the golden tokens, being r_g the radius of the circle of the golden tokens and r_s the radius for the silver tokens the relation $r_g > r_s$ subsists.

In the following these variables will be used:

- μ_F: average time to finish the task of my algorithm
- μ_G: average time to finish the task of Giulia's algorithm

2 Hypotheses

In this small section the null hypothesis and the alternate hypotheses will be enunciated:

$H_0 : \mu_F = \mu_G$ (null hypotheses)
$H_a : \mu_F \neq \mu_G$ (alternate hypotheses)

Therefore a Two-tailed test will be conducted. Notice that indeed the hypoteses can be rewritten as:

$H_0 : \mu_F - \mu_G = 0$
$H_a : \mu_F - \mu_G \neq 0$

And i decided to apply a T-test. Notice i decided to look at the results of two different tests. The two sample test and the paired sample test. In order to reach a conclusion on which of the 2 hypotheses is more "reliable" we need to define the **levelofsignificance**. I decided for this level to set 1%

3 Experimental setup

We have already described the concept of task to be performed. Let's now describe the type of software running. The simulations are performed on the

Docker image of a macOS operating system. The processor used is a 2,3 GHz Intel Core i5 dual-core. Still if you want to double check the numbers reported in the excel files with the same architecture reported, the distribution may still be slightly different due to number of processes and type of processes running. Having noticed that, all the samples have been taken at different time of different days. In order to compute the time i added the following python code to both my and Giulia's files:

```
start=time.time()
<execute main()>
end=time.time()
print(end-start)
```

So i'm getting the time before and after executing the main and then computing the difference. In the end, i rounded the result dropping all the digits after the millisecond digit.

Number of experiments. Since the difference of the time to complete the task have to be considered i decided to create an excel file with 27 samples to see if the distribution of the difference is a bell curve. I was curious to see that in order to be sure the T-test can be applied. Anyway since by looking at the code the average speed of the robot in Giulia's code has been set to less the speed of the robot in my code i'm expected less samples to be necessary. Since i want to reach a level of significance of 1% i used 10 samples.

In the excel file statistico1 an histogram of the difference is plotted as well as the results of the Paired T-test on 27 samples which will not be commented as in principle useless. File statistico1 is more of a curiosity than a formal statistics.

In the excel file statistico2 an histrogram for each distribution is plotted and the tests with 10 samples.

4 Results

To formally prove one of the mutually exclusive hypotheses H_0 and H_a we just need one of the above mentioned tests. So we will here discuss the results of the two-tailed paired T-test over 10 samples that can be found in the excel file statistico2 in the box named "without Pooled:". After having calculated the standard error of the mean difference as the quotient of the estimated standard deviation from the dataset of the difference of the time (we do not need here the pooled estimation since we are conducting the paired T-test) to end the task the t-value was 19.48 which indeed is much greater than the value we need to

reject the null hypotheses which is (looking in the table for the T-test) 3.250. I looked at 9 DoF in the Two-sided 99% column

We therefore reject the null hypotheses H_0

As a curiosity all the other test which numerical result can be found in the excel files gave the same result.

5 Analysis

All the test conducted seem to give reason to hypotheses H_a. In fact the formal proof is not given here but indeed the hypotheses $\mu_F < \mu_G$ can be shown to be reasonable with a pretty high range of confidence. This is true even by looking at the numbers of the simulation. This is intuitively a consequence of the parameters set for the linear and angular velocity of the robot. (In the end: by looking at the numbers it can also be shown that my code is "faster" the Giulia's with high probability).

6 Conclusion

Willing to be extremely precise we can say that: "My code to perform the task described in the introduction section has PROBABLY a different mean time to execute than the Giulia's one, even though both seemed to be intuitively reliable".