Università di Genova

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Masters in Robotics Engineering

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Research Track II

Statistical Analysis

1. Introduction

In this assignment of Research Track II, the statistical analysis of two implementations are going to be studied. The main objective of the task is to drive a robot autonomously by grasping the objects, which are the silver tokens, and putting them behind itself; and by avoiding obstacles, which are golden tokens. In Figure 1, the map of the environment has been presented as well as the robot itself and tokens are shown.

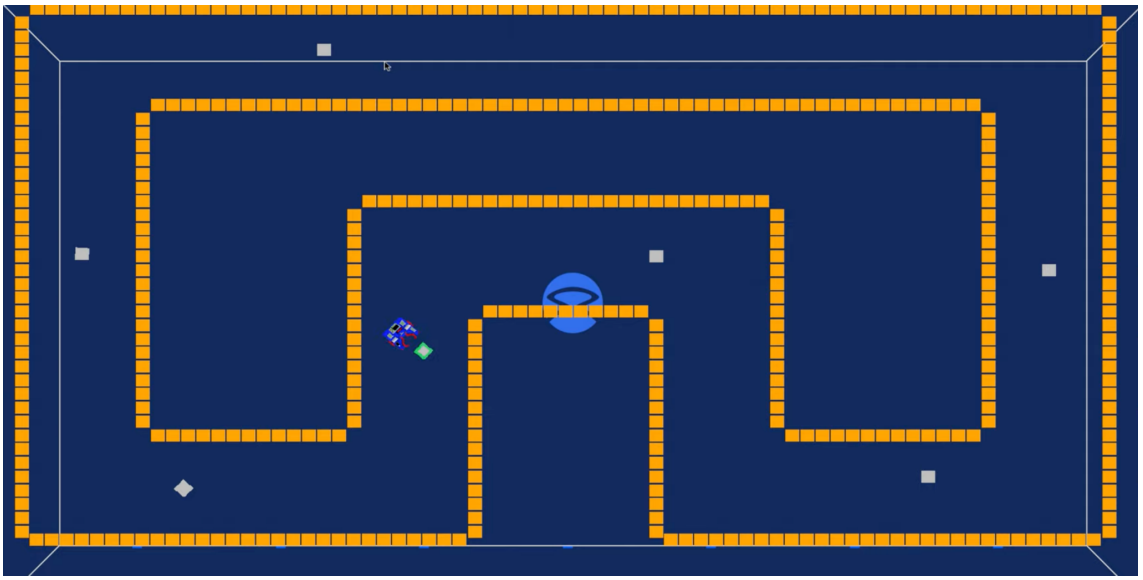

Figure 1. The map of the environment of robot

There are two algorithms provided:

1. First algorithm: is the solution for the Research Track I course task provided by Bauyrzhan Zhakanov
2. Second algorithm: is the solution provided by professor Carmine Recchiuto.

2. Theory

There are several ways to compare the algorithms based on their performance by using two hypotheses: Ha (alternative hypothesis) and Ho (null hypothesis). To differentiate one hypothesis from another, it is better to understand which nature of each of them:

Ho - The robot from Algorithm 1 and 2 finish the run in a particular time, so their mean are more or less equal

Ha - The robot from Algorithm 1 and 2 don't finish the run in a particular time, so the mean is not equal.

Usually, The difference of 5% as a level of significance in a hypothesis is acceptable, otherwise, the other hypothesis must be chosen.

In this particular task, the null hypothesis is going to be tested first. Since all parameters as level of significance is set and samples from the experiment will be taken, the experiment can be started.

Using the timer for both cases, both algorithms are going to be tested one by one. The position for the robot is set initially and the tokens are set by default. Since running both algorithms in the same map is convenient to make assumptions, then paired t-test is chosen.

This paired t-test should either accept Ho (null hypothesis) or reject it. The steps for this test is described below:

1. The difference between first and second algorithms, where the formula can be easily calculated: $d = time\_algo1 - time\_algo2$

2. the mean of this difference: $\bar{d}$
3. the standard deviation of this difference: $std(d)$
4. the standard error of the mean difference: $se(\bar{d}) = \frac{\bar{d}}{\sqrt{samples}}$
5. T-statistics: $T = \frac{\bar{d}}{se(\bar{d})}$
6. T from table based on its sample size and a level of significance

3. Results

As it can be observed from Figure 2, the sample size of the experiment is 20 and the level of significance is 5%. Based on the mathematical calculations, the T statistics value is lower than the Table value, which provides the acceptance of our hypothesis. In conclusion, the No hypothesis is accepted and the robot more or less satisfies the timing in the same condition.

Sampling	1st Algorithm	2nd Algorithm	Difference	Mean	Std	Std error	T	T_TABLE
1	199	202	3	4.05	9.356682104	2.092217723	1.935745002	2.086
2	195	201	6					
3	210	202	-8					
4	205	201	-4					
5	211	200	-11					
6	199	215	16					
7	185	205	20					
8	193	206	13					
9	199	217	18					
10	204	206	2					
11	226	223	-3					
12	205	218	13					
13	203	209	6					
14	203	205	2					
15	204	204	0					
16	209	197	-12					
17	203	201	-2					
18	204	221	17					
19	209	214	5					
20	201	201	0					

Figure 2. The statistics of both algorithms