Research Track 2

Statistical Analysis

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Masters in Robotics Engineering

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Introduction

In this Research Track 2 assignment, we were asked to conduct a statistical analysis on the first assignment from the Research Track 1 course, taking into account two different implementations (our implementation and the teacher's implementation) and testing which one performs better in the given circuit when silver tokens are distributed at random in the environment.

There are two algorithms provided:

1. ***Algorithm A***: is the solution for the Research Track I course task provided by me
2. ***Algorithm B***: is the solution provided by Professor Carmine Recchiuto.

There are various approaches to compare the performance of two algorithms, and this can be done by applying two hypotheses: Ha (alternative hypothesis) and Ho (null hypothesis).

Ho refers to the situation where algorithms 1 and 2 finish a run in a specific time, and their mean duration is approximately the same. In contrast, Ha is applicable when algorithms 1 and 2 fail to complete the run in a specific time, and their mean duration is different.

Typically, a 5% difference is considered acceptable as a level of significance for a hypothesis, and if the p-value exceeds this level, the other hypothesis must be selected.

In this task, the null hypothesis will be examined first, and the experiment will involve taking samples and setting the level of significance. Both algorithms will be tested one by one using a timer, with the robot initially placed in a predetermined position and the tokens set to their default values. Since it is convenient to make assumptions by running both algorithms on the same map, a paired t-test will be used.

Implementations

In order to test my hypothesis, I conducted 30 runs of both implementations, with the position of each silver token being altered on each occasion. This step was particularly time-consuming, as I chose to manually change the position of the tokens to ensure that the number of silver tokens inside the circuit remained consistent across both implementations. I was careful to avoid placing the tokens on the other side of the golden token walls, which made it necessary to be cautious about the positioning of the silver tokens.

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

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 1: Statistics of both Algorithms

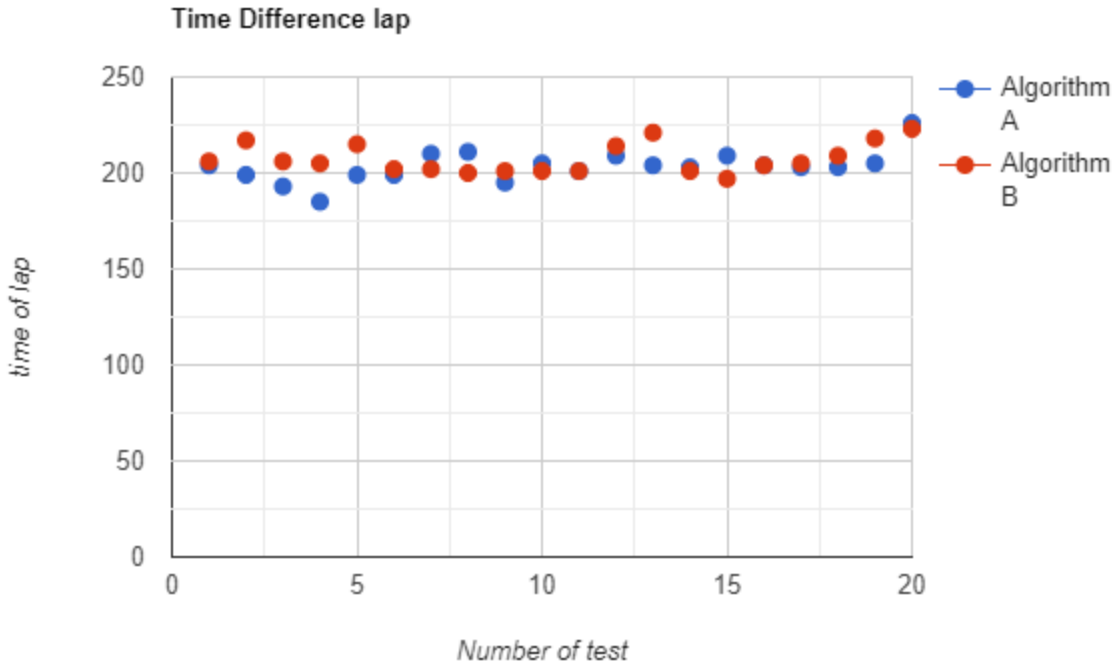

Figure 2: Time Difference Lap

Result

The experiment's sample size is 20, and the level of significance is 5%, as seen in Figure 2. The mathematical computations show that the T statistics value is less than the Table value, supporting our theory. The robot essentially meets the time under the identical circumstance; hence the null hypothesis is accepted.