UNIVERSITÀ DEGLI STUDI DI GENOVA

Research Track 2

Assignment 3

Tomasz Strzesak

S5714359

Erasmus student

1. Introduction

Goal of Assignment number 3 was to make a statistical analysis, that was focusing on first assignment from the last semester. In this assignment, robot is searching for silver token, if he finds it he goes to it and pick it up and then he starts searching for golden token. If he finds it, he approaches it and release next to it a silver token. When the robot places all the silver tokens next to golden ones the program finishes and a message "End of algorithm!" is shown on the screen.

Picture 1. Robot's environment

Statistical analysis was conducted comparing the implementation of my algorithm and my friend Jack McKenna (S5734072). We decided to compare time performance of our algorithms to find out which one is better.

2. Hypothesis

We need to formulate two hypothesis: null hypothesis and alternative hypothesis. If we are to compare method A with method B about its superiority and if we proceed on the assumption that both methods are equally good, then this assumption is termed as the null hypothesis. As against this, we may think that the method A is superior or the method B is inferior, we are then stating what is termed as alternative hypothesis. The null hypothesis is generally symbolized as H_0 and the alternative hypothesis as H_a. In our case null hypothesis means that time performance in our algorithms is the same and alternative hypothesis means, that time performance in our algorithms is different from each other. We assume, that null hypothesis in our case is false and alternative hypothesis is true, which means that we will verify that time performance in our algorithms is diverse. During our statistical analysis we will perform T – Test. T-Test, also known as Student's Test, is based on t-distribution and is considered an appropriate test for judging the significance of a sample mean or for judging the significance of difference between the means of two samples in case of small sample(s) when population variance is not known (in which case we use variance of the sample as an estimate of the population variance). The relevant test statistic, t, is calculated from the sample data and then compared with its probable value based on t-distribution at a specified level of significance for concerning degrees of freedom for accepting or rejecting the null hypothesis. However, it is still based on the assumption of normality i.e., the source of data is considered to be normally distributed.

3. Experiment

Experiment was conducted in following way: our environment of robot was consisted of 3 silver boxes and 3 golden boxes. At the beginning we started to measure the time by function:

```
start = time.time()
```

At the end of algorithm, when robot managed to put all silver boxes next to golden ones, we invoked the function:

```
end = time.time()
```

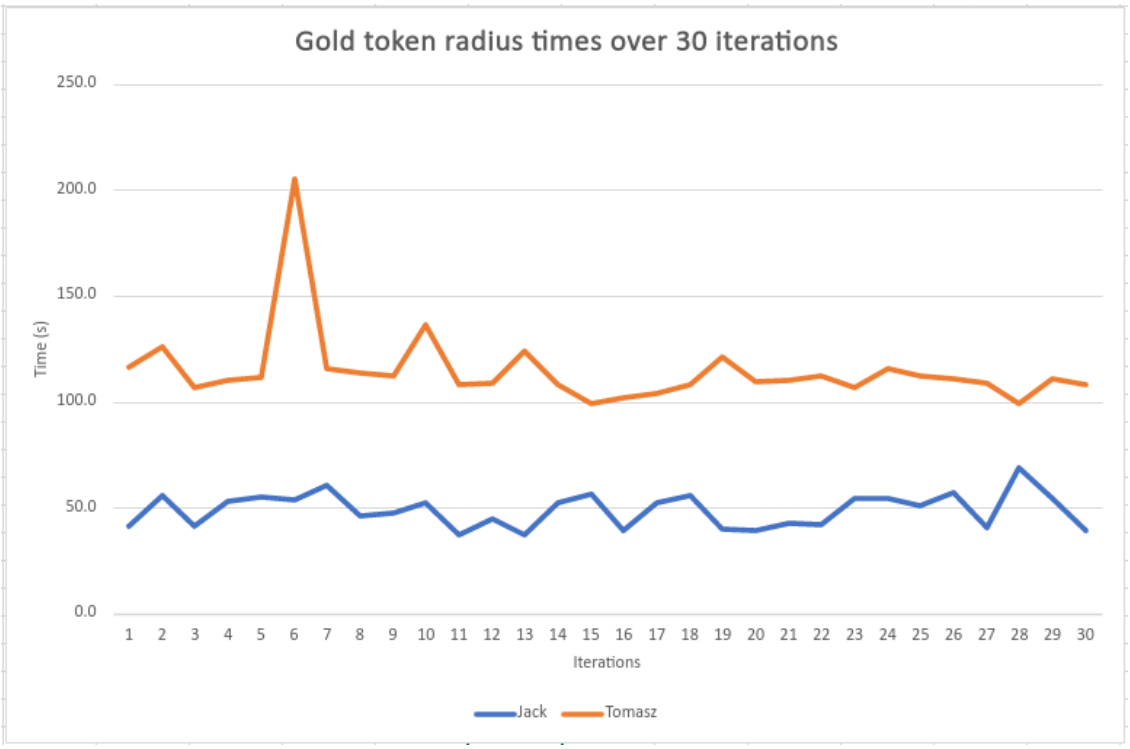
and we computed the time by subtracting:

```
total_time =end – start
```

and we printed performance time in CLI. We conducted 30 performances of our robots for a randomly generated radius of outer circle – it lead to different localization of golden boxes. We generated 30 random values using excel function, we gathered our results in a table and then we computed mean value and standard deviation. We also plot our results using excel chart.

Iteration	Jack			Tomasz	
	Radius Number	Time (s)		Radius Number	Time (s)
1	1.2	41.0		2.4	116.24
2	2.4	55.6		0.7	125.82
3	1.5	41.2		1.2	106.21
4	2.2	52.5		1.3	110.2
5	0.3	54.8		1.8	111.23
6	0.6	53.2		1.0	205.14
7	2.8	60.6		2.2	115.23
8	0.7	46.1		2.3	113.23
9	0.4	47.0		2.1	112.23
10	0.3	52.1		0.7	135.84
11	0.8	37.3		1.7	108.22
12	1.2	44.4		1.9	108.74
13	0.8	36.7		2.6	123.78
14	0.6	52.1		1.9	108.24
15	2.5	56.1		1.4	99.2
16	1.3	39.4		1.6	101.73
17	2.1	52.3		1.8	103.7
18	2.4	55.7		2.4	107.72
19	1.6	39.8		1.2	120.7
20	1.3	38.8		1.3	109.2
21	1.6	42.5		1.6	109.74
22	1.5	42.1		2.0	112.25
23	2.3	54.5		1.4	106.71
24	2.1	54.0		2.5	115.73
25	0.6	50.7		2.5	112.28
26	2.5	56.7		2.6	110.75
27	1.7	40.4		2.4	108.74
28	1.0	68.8		1.5	98.69
29	0.6	54.2		1.5	110.73
30	1.3	39.4		2.4	108.23
	Mean	48.7		Mean	114.548333
	Standard Deviation	8.059363085		Standard D.	18.7332469

Picture 2. Table with results



Picture 3. Plot

4. Analysis

First we computed the mean using following equation:

$$\bar{X} = \frac{\sum_{i=1}^{i=n} X_i}{N}$$

For my algorithm, result was $\bar{X}_T = 114.5\ s$

For Jack it was: $\bar{X}_J = 48.7\ s$

Next, we computed the standard deviation using following equation:

$$\sigma = \sqrt{\frac{\sum_{i=1}^{N} (X_i - \bar{X})^2}{N}}$$

For my algorithm, result was $\sigma_T = 18.733$

For Jack it was: $\sigma_J = 8.05$

At the end we computed the variance, which is the standard deviation squared:

Jack: $S_j = 64.947$
Mine: $S_t = 350.925$

It turned out, that Jack's algorithm is way more faster than mine. Now we need to apply T – Test to reject or confirm the null or alternative hypotheses.

First, we calculate the pooled variance using following equation:

$$\widehat{\sigma_{\overline{X_1}-\overline{X_2}}} = \sqrt{\widehat{\sigma^2_{pooled}}\left(\frac{1}{N1}+\frac{1}{N2}\right)} = 3.723$$

where N is number of iterations

Next we calculate the T – value using following equation:

$$\widehat{\sigma_{\overline{X_1}-\overline{X_2}}} = \sqrt{\widehat{\sigma^2_{pooled}}\left(\frac{1}{N1}+\frac{1}{N2}\right)} = 3.723$$

To conclude this statistical analysis, we can refer to the standard T – table using the following criteria:

Confidence level 95% (5% significance),

Degrees of freedom (DOF = (30+30)-2 = 58)

We can notice that critical value is less than our calculated T-value, so it means that we can reject the null hypothesis (H_0) and accept the alternative hypothesis (H_a)

5. Conclusion

We proved that null hypothesis in our case is false and alternative hypothesis is true – mine and Jack's algorithm's time performance are different and Jack's algorithm is faster than mine. We proved that using statistical method and we can see that on the graph and analyzing results in table.