

Assignment 2

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NETWORK SPEED DATA ANALYSIS



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Introduction

Network latency is a performance indicator which is used in modern computer networks. It directly effects user experience, application efficiency and service reliability. It is the amount of time taken for a packet to travel to the specified destination. [5] With technology becoming more relied on and big organisations relying on this for real-time communication for things such as video calls, instant messaging and critical business operations, even the smallest improvements in latency can make a massive difference.

The organisation for which this experiment is to be conducted upon is going to attempt to improve their latency scores by using a new routing algorithm. The aim is for the new routing algorithm to offer a solution to higher latency scores and limit the number of network spikes that the current system has shown. This report offers a detailed analysis of analysis of how each servers latency score is affected by the routing algorithm. The assignment includes a number of different tasks ranging from an investigation of the dataset, development of hypotheses and recommendations for the deployment of the routing algorithm.

Main Body

Description of the dataset

The independent variable for this experiment is which routing algorithm is used on each server. The organisation is trialling whether the new routing algorithm would improve their latency scores. In order to measure this, we would look at the latency scores. This is what would be expected to change under this trial. With this being solely numbers, it is easily comparable with the dataset. It would be assumed that the hardware is remaining the same, alongside the server configuration and size of packets sent, as it is not said otherwise.

The dataset provided shows latency measurements recorded in milliseconds for data packets transmitted through two servers. One of which is using a new routing algorithm. 84 observations have been taken with 42 for each serve. Each measurement represents the amount of time taken for a packet to travel across the network using each specific algorithm and server. These latency values provide insight into the performance and efficiency of each server allowing for a direct comparison of how the new routing algorithm affects the network latency.

Upon initial inspection of the two sets of results, it appears that Server 2 has much lower latency scores than Server 1. Most latency values for Server 1 fall within the 80ms to low 90ms range, whereas latency scores for Server 2 are much more closely related around the mid to high 70ms range. Whilst this initial observation would suggest that the new routing algorithm is an outright improvement, statistical analysis is required to approve this claim.

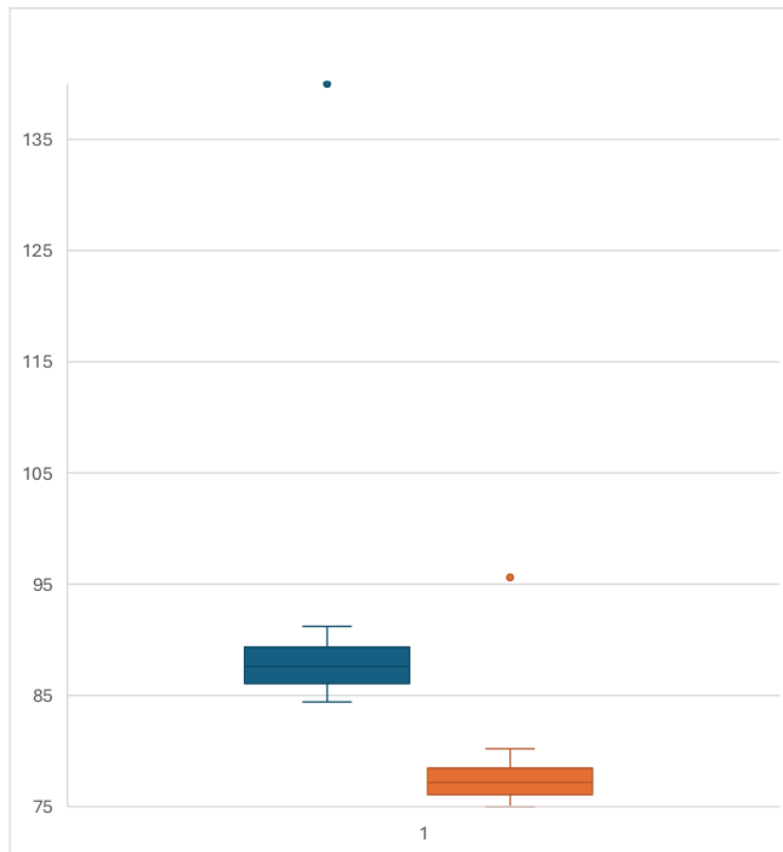
Descriptive Statistics

The table shown below highlights the average, minimum and maximum latency measurements. Latency is measured on a continuous scale and is therefore suitable for parametric statistical testing. This table however shows this containing a number of outliers which increases the maximum latency measures.

Server	Mean	Min	Max
1	88.87ms	84.4ms	140.0ms
2	77.62ms	75.0ms	95.6ms

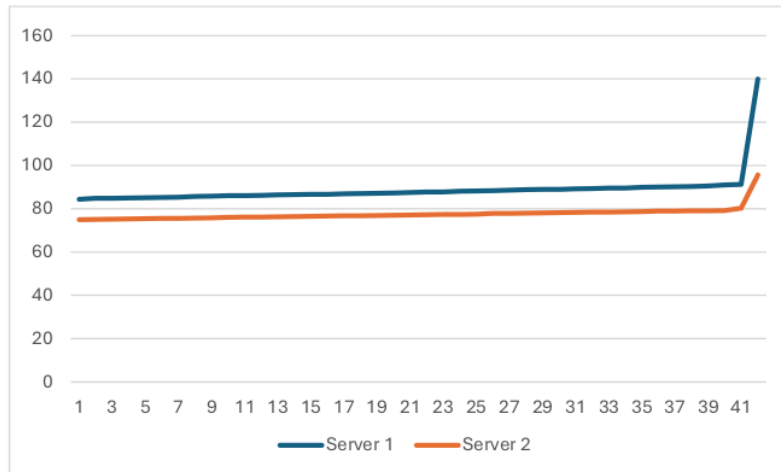
The table below demonstrates the same but having removed the outliers. These were 140.0ms from Server 1 and 95.6ms from Server 2. These may be caused by network spikes caused by network congestion or faulty hardware.

Server	Mean	Min	Max
1	87.62ms	84.4ms	91.2ms
2	77.18ms	75.0ms	80.2ms



The box and whisker chart displayed above demonstrates and highlights each of the outliers using the interquartile range (IQR) rule. This rule is when you multiply the IQR by 1.5 and using this value to determine the upper and lower boundaries of the data. If any of the values are over this, it is then considered an outlier. [3] As indicated on the chart by the small dots, 140.0ms in Server 1 and 95.6ms in Server 2 are identified as outliers in this experiment. These values sit noticeably outside the typical latency scores suggesting that they are unusually high compared to the rest of the data. This would indicate potential network spikes caused by network congestion or hardware faults. A box and whisker diagram was used as it effectively displays median values and outliers.

The graph shown below shows the latency scores of each server. It is clear that Server 2 consistently achieves much lower latency scores compared to Server 1. However, from this it is also easy to notice the variability and potential outliers. Both servers follow a similar pattern with occasional spikes in latency. This graph would suggest there is a positive skew in the data. Despite latency measurements being generally lower, there are spikes, potentially due to network congestion.



Development of hypothesis

To assess whether the new routing algorithm improves the network latency, we must consider the following hypothesis.

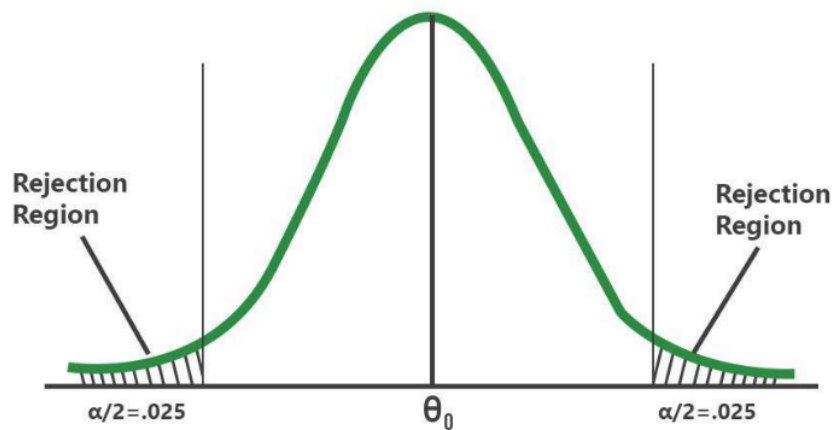
Null Hypothesis H_0

There is no difference in the mean latency of Server 1 and Server 2 when a new routing algorithm is used. Any observed differences in latency are due to random variation rather than the algorithm itself.

Alternative Hypothesis H_1

There is a significant difference in the mean latencies of Server 1 and Server 2 indicating that the new routing algorithm has an effect.

To measure this, a two-tailed test will be used. Although it is likely that the new routing algorithm will reduce latency, a two-tailed test will demonstrate whether there is a change at all.



On the two-tailed diagram shown above, the critical regions are shown at both ends of the graph. These tails represent the extreme values that would be unlikely to occur by chance. If the t-test results were to fall into either tail, it would indicate that there is a massive difference between the two servers. If the results were to fall in the middle zone, the difference wouldn't be considered significant enough to disprove the null hypothesis.

Null Hypothesis H_0

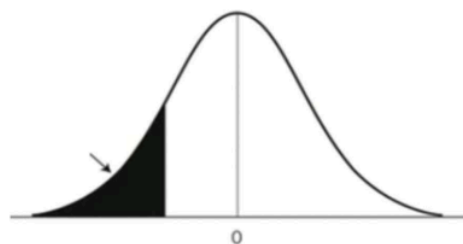
The mean latency of Server 1 will be better or the same as the Server 2 mean.

Alternative Hypothesis H_1

The mean latency will improve (reduce) with the new routing algorithm (Server 2).

To measure this hypothesis, a one tailed test will be used to check whether there is an improvement to prove the alternative hypothesis and disprove the null hypothesis.

Left-Tailed Test



As the hypothesis suggests that there should be a lower mean latency score on Server 2, a left tailed test is used. The shaded area is the critical value area which marks the

point beyond which the results are unlikely to occur by chance. If the value is to fall within this area, the null hypothesis can be rejected therefore proving the alternative hypothesis to be true.

Selection and justification of appropriate techniques

Firstly, in order to prove or disprove the hypotheses, the central tendency would need to be found. This is the mean, median and mode. By finding the mean and median it gives a basic average response time for each server. [2] Instead of comparing the 42 values, it is just comparing the single representative value. It is also required for further analysis. Tests such as the t-test requires the mean to determine whether differences between the servers are significant.

An independent t-test was selected to compare the latency values and means between Server 1 and Server 2. This test is appropriate because the samples are independent, the dependent variable is continuous and the sample size is equal. The t-test is robust to identify noticeable deviations especially when sample sizes exceed 30 observation groups. [1] The t-test takes into account the mean of each server, the variability of the results (standard deviation) and the sample size. By using a t-test, hypotheses can be supported with statistical evidence rather than relying on visual comparisons and averages.

Hypotheses are to be tested at significance levels of $p = 0.10$, $p=0.05$ and $p=0.01$. Testing at multiple levels of significance allows for evaluation of how strongly the evidence supports the alternate hypothesis and disproves the null hypothesis.

Results

Discussion of Results

The independent samples t-test was applied to compare the mean latency values of Server 1 and Server 2. The analysis indicated a statistically significant difference between the two servers with a p-value of less than 0.001. This provides very strong evidence against the null hypothesis. Due to the p-value being much smaller than all the significance levels, the null hypothesis is rejected at each level. This strongly supports the alternative hypothesis that there is a statistically significant difference in mean latency between the two servers. This result is inclusive of the two potential outliers (140.0ms from Server 1 and 95.6ms from Server 2) The t-test results shown below disprove the null hypothesis including the outlier. This is because the t Stat is far greater than the t Crit value.

This is tested to the significance level of 0.01.

t-Test: Two-Sample Assuming Unequal Variances

	<i>Variable 1</i>	<i>Variable 2</i>
Mean	88.87142857	77.54761905
Variance	68.88550523	9.906457607
Observations	42	42
Hypothesized Mean Difference	0	
df	53	
t Stat	8.267538785	
P(T<=t) one-tail	2.09648E-11	
t Critical one-tail	2.398789836	
P(T<=t) two-tail	4.19296E-11	
t Critical two-tail	2.671822636	

When removing both outliers, the p-value was still less than 0.001 which once again provides very strong evidence against the null hypothesis. The p-value is smaller than all significance levels again which rejects the null hypothesis at the highest level. This proves that despite outliers, the new routing algorithm is much more efficient and would be better for the organisation. Both sets of these results fall within the critical values area further disproving the null hypothesis and proving the alternative hypothesis. The t-test included below is the results of the t-test removing the outliers demonstrating that the outliers don't make a significant difference to the end result. This is because the t Stat is far greater than the t Crit value. This is tested to the significance level of 0.01.

t-Test: Two-Sample Assuming Unequal Variances

	<i>Variable 1</i>	<i>Variable 2</i>
Mean	87.62439024	77.10731707
Variance	3.660390244	1.808195122
Observations	41	41
Hypothesized Mean Difference	0	
df	72	
t Stat	28.79713788	
P(T<=t) one-tail	1.50456E-41	
t Critical one-tail	2.379262129	
P(T<=t) two-tail	3.00913E-41	
t Critical two-tail	2.645851913	

Regarding the second hypothesis, an independent samples t-test showed that Server 2 performed significantly better than Server 1. The mean difference between Server 1 and Server 2 is approximately 10.44ms. According to Cohen's d, a difference of over 0.8ms would've been considered a large difference. [4] Therefore, a difference of 10.44ms would be considered a substantial improvement proving the alternative hypothesis that the mean latency will improve (reduce) with the new routing algorithm (Server 2). It also disproves the null hypothesis that the latency will stay the same or get worse.

Assumptions and interpretations of the results

The result of this analysis clearly demonstrates that the new routing algorithm implemented on Server 2 massively outperforms the existing algorithm that is used in the configuration of Server 1 in terms of latency scores. It not only has a lower average latency score but also has less variability, suggesting that Server 2 was more consistent and stable. The presence of less extreme outliers in Server 2 suggests that the new improved algorithm handles traffic better under different conditions.

By having a reduced latency, it would benefit an organisation massively as it would help the efficiency of their operations. This would improve things such as video calls, real time data transmission and communication. These applications would all run smoothly and reliably leading to increased productivity and higher customer satisfaction.

Limitations, Additional Factors and Improvements

There are many potential factors that may have influenced the network latency scores that could not be controlled within this experiment. These factors include variations in network congestion, differences in time of day when the tests were conducted, potential hardware faults and presence of external network traffic. These factors can often cause network spikes, fluctuations in latency and not always give 100% accurate results.

In order for these to be controlled in future testing, it is important that the Servers are tested side by side using identical hardware configurations and under the same network conditions. By ensuring both servers are tested under the same conditions, any network spikes or irregularities would affect both systems in exactly the same way. This approach would improve the fairness of the experiment and therefore produce more valid results.

Recommendations

Based on the results of this experiment, it is recommended that the new routing algorithm be considered for broader implementation across the organisation as a way of improving overall network infrastructure and performance. The experiment suggests that the algorithm has the potential to reduce network latency which would lead to more efficient and reliable operations.

However, it should be noted that further testing should be conducted under more controlled conditions related to the organisations current usage to validate these results. Additional testing would help confirm the stability, consistency and scalability of the new routing algorithm. This should also include stress testing to see how the server handles extreme pressure with the new routing algorithm and the old and compare the two.

Conclusion

This assignment examined network latency data to determine whether a new routing algorithm is effective. Descriptive statistics, hypothesis testing and an analysis of outliers were used to gain a clear understanding of the data and identify any unusual results. Based on this analysis, it was found that the new routing algorithm significantly reduces network latency compared to the existing method.

Whilst the experiment did have some limitations such as constraints in sample size and due to things out of control such as network spikes, the results remained reliable and relevant to the aims. Both null hypotheses were rejected providing sufficient evidence to prove the alternative hypotheses. Overall, the findings suggest that the new routing algorithm offers a meaningful improvement in network performance.

References

- [1] "What is a T-test? How to Use and Interpret T-test Results." Accessed: Jan 10 2026. [Online]. Available: <https://amplitude.com/explore/experiment/t-test>
- [2] "Mean, Mode and Median - Measures of Central Tendency - When to use with Different Types of Variable and Skewed Distributions | Laerd Statistics," Accessed: Jan 9, 2026. Available at: <https://statistics.laerd.com/statistical-guides/measures-central-tendency-mean-mode-median.php>.
- [3] M. Lynch."How to calculate outliers with iqr" *The Tech Edvocate*. (-10-102023). Accessed: Jan 8, 20262026, [Blog]. Available at: <https://www.thetechedvocate.org/how-to-calculate-outliers-with-iqr/>
- [4] M. T. ISLAM."Cohens d: Definition, Calculation, and Interpretation of Effect Size" *Statistical Aid: A School of Statistics*. (-07-132025). Accessed: Jan 8, 20262026, [Blog]. Available at: <https://www.statisticalaid.com/cohens-d/>
- [5] "What is latency? | How to fix latency." Accessed: Jan 5 2026. [Online]. Available: <https://www.cloudflare.com/learning/performance/glossary/what-is-latency/>

Assignment 2

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

71 /100

Generic Assessment Criteria	Marks available	Marks awarded
1. Engagement with Literature Skills	10	
Bibliography and referencing present and good.		7
2. Knowledge and Understanding Skills	30	
Good knowledge demonstrated of the outliers and descriptive stats. Some good discussion around data types and variables as well as multiple hypotheses. Reasonable visualisations however more comparison may have been advantageous through discussion of correlation but		22

overall a good knowledge demonstrated through research.		
3. Cognitive and Intellectual Skills	30	
Well written interpretation of results and the discussion of outliers with consideration given to results with and without. More detail to explicit interpretation of results in the discussion would have been beneficial, not only discussing H0 but also H1 at all three significance levels. Some good justification to choices made, good consideration of one tailed and two tailed.		19
4. Practical Application Skills	20	
A well written H0 and H1, in both cases. Good use of evidence and tables although more detailed evidence of all significance levels would have been advantageous. It would have been good to see evidence of the consideration of results for both hypotheses at this stage. The acceptance or rejection of H1 as well at the significance levels could have been written more explicitly.		15

Reasonable use of visualisations and tables.		
5. Transferable Skills for Life and Professional Practice	10	
A well laid out and written report with good sectioning and use of figures and tables		8

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