
# Final Project

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## Simulation Parameters

| Parameter | Value |
|---|---|
| Burstiness Values | 1.1, 1.3, 2, 5, 10, 20, 30, 70, 100 |
| Simulation Time | $10^3$ seconds |
| Period Print (periodPrintLR) | $10^3$ samples |
| Block Size | $10^1$ packets |

Table 1: Simulation parameters.

## Project Structure

The main simulation entry point is `main.py`, which parses command-line arguments and invokes the `Simulation.run_simulation` method. The simulation logic is implemented in `Simulation.py`, which contains the `Simulation` class to run simulations, save results, and display a progress bar. Global variables, such as `periodPrintLR` and `blockSize`, are defined in `Globals.py`.

Traffic sources are defined in separate classes. `ConstantSource.py` implements a source with a constant transmission rate, `PoissonSource.py` models Poisson-distributed traffic, and `BurstySource.py` handles highly bursty traffic with ON/OFF patterns. The queueing behavior is managed by `QueueClass.py`, which simulates the infinite capacity queue.

For distributed simulations, `DistributedSimulation.py` enables deployment and execution of simulations across multiple machines using SSH and SCP. Results are stored as CSV files in the `results/` directory and analyzed using the `plotResults.ipynb` notebook, which generates visualizations of the data.

## Results

Figure 1 shows the average response times of the three traffic sources as the burstiness of the video traffic increases. The Poisson source (data traffic) and constant source (voice traffic) maintain nearly identical average response times throughout all burstiness values. However, as the burstiness increases, their response times rise slightly due to the increased competition for queue resources.

The bursty source (video traffic) is the most affected by burstiness. Its response time grows almost linearly with increasing burstiness, reaching approximately 0.07 time units when the burstiness value is 100. This behavior makes sense because increasing burstiness causes more data to be sent within shorter intervals, overloading the queue. Furthermore, the bursty source is most impacted as it inherently sends many packets simultaneously during ON periods, exacerbating the load on the queue.

The confidence intervals for the response times are shown in Table 2, as they are not very visible in Figure 1. As burstiness increases, the confidence intervals become wider, reflecting greater variability in the response times. This variability aligns with the increased intensity and

clustering of data arrivals in bursty traffic patterns, which can lead to fluctuations in queueing delays.

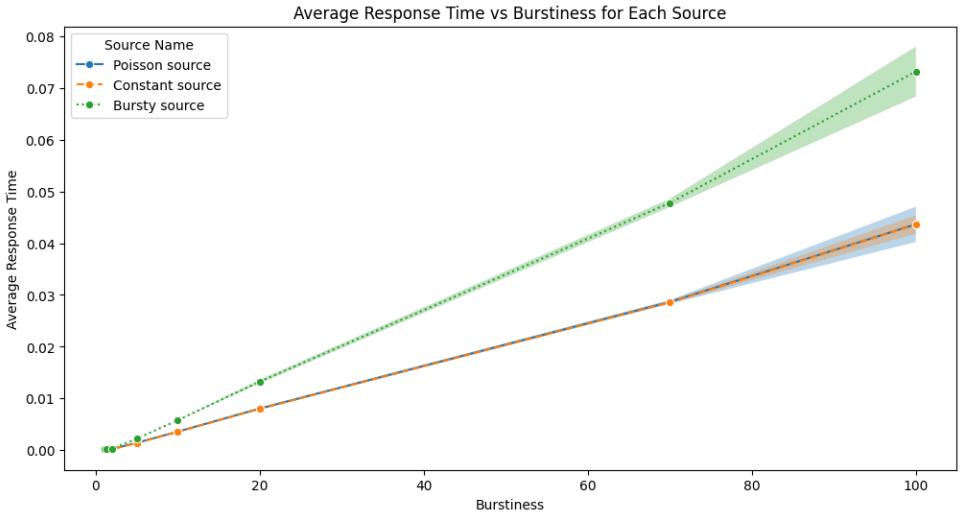


Figure 1: Average Response Time vs. Burstiness for each traffic source.

Figure 2 illustrates the variation in response times for each burstiness value using boxplots. This figure highlights the emergence of significant outliers, particularly for the bursty traffic, at higher burstiness values. These outliers seem to follow an exponential distribution, reflecting the ON/OFF behavior of the bursty source. Despite the presence of outliers, there is a noticeable concentration of response times around the mean, which increases linearly as burstiness grows.

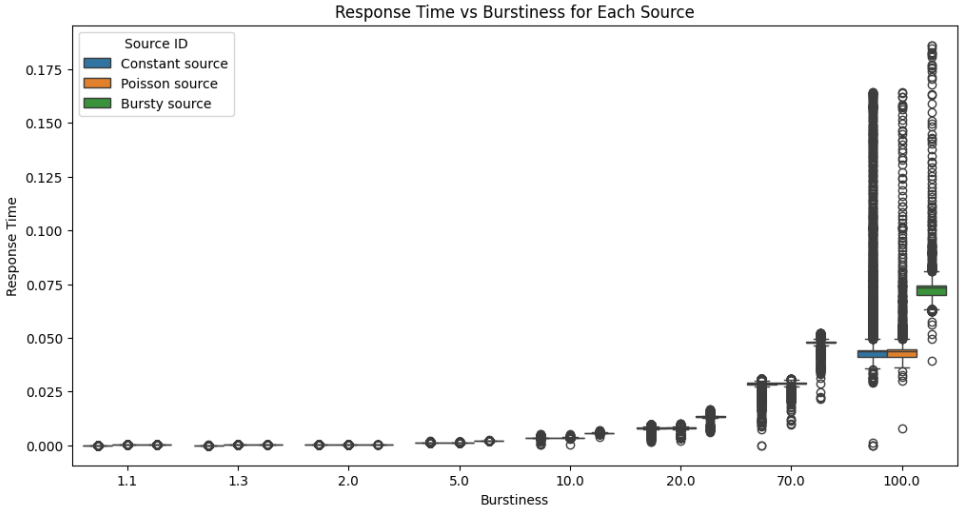


Figure 2: Response Time vs. Burstiness for each traffic source (boxplot).

# Appendix

| Source ID | Burstiness | Avg Resp Time | Source Name | CI Lower | CI Upper |
|---|---|---|---|---|---|
| 1 | 1.1 | 0.000143 | Poisson source | 0.000143 | 0.000143 |
| 1 | 1.3 | 0.000152 | Poisson source | 0.000152 | 0.000152 |
| 1 | 2.0 | 0.000247 | Poisson source | 0.000247 | 0.000248 |
| 1 | 5.0 | 0.001424 | Poisson source | 0.001417 | 0.001431 |
| 1 | 10.0 | 0.003595 | Poisson source | 0.003574 | 0.003616 |
| 1 | 20.0 | 0.008051 | Poisson source | 0.007856 | 0.008247 |
| 1 | 70.0 | 0.028655 | Poisson source | 0.028270 | 0.029041 |
| 1 | 100.0 | 0.043651 | Poisson source | 0.040244 | 0.047059 |
| 2 | 1.1 | 0.000098 | Constant source | 0.000098 | 0.000098 |
| 2 | 1.3 | 0.000107 | Constant source | 0.000107 | 0.000107 |
| 2 | 2.0 | 0.000202 | Constant source | 0.000202 | 0.000202 |
| 2 | 5.0 | 0.001380 | Constant source | 0.001377 | 0.001384 |
| 2 | 10.0 | 0.003547 | Constant source | 0.003528 | 0.003566 |
| 2 | 20.0 | 0.007998 | Constant source | 0.007900 | 0.008096 |
| 2 | 70.0 | 0.028586 | Constant source | 0.028376 | 0.028797 |
| 2 | 100.0 | 0.043616 | Constant source | 0.041877 | 0.045354 |
| 3 | 1.1 | 0.000145 | Bursty source | 0.000145 | 0.000145 |
| 3 | 1.3 | 0.000159 | Bursty source | 0.000159 | 0.000160 |
| 3 | 2.0 | 0.000310 | Bursty source | 0.000309 | 0.000311 |
| 3 | 5.0 | 0.002224 | Bursty source | 0.002216 | 0.002232 |
| 3 | 10.0 | 0.005803 | Bursty source | 0.005773 | 0.005832 |
| 3 | 20.0 | 0.013262 | Bursty source | 0.012904 | 0.013620 |
| 3 | 70.0 | 0.047796 | Bursty source | 0.046999 | 0.048593 |
| 3 | 100.0 | 0.073169 | Bursty source | 0.068348 | 0.077991 |

Table 2: Response times with confidence intervals for each source and burstiness value.