Lab 1: Traffic Characterization

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Exercise 1.1 Scaling Poisson traffic arrivals

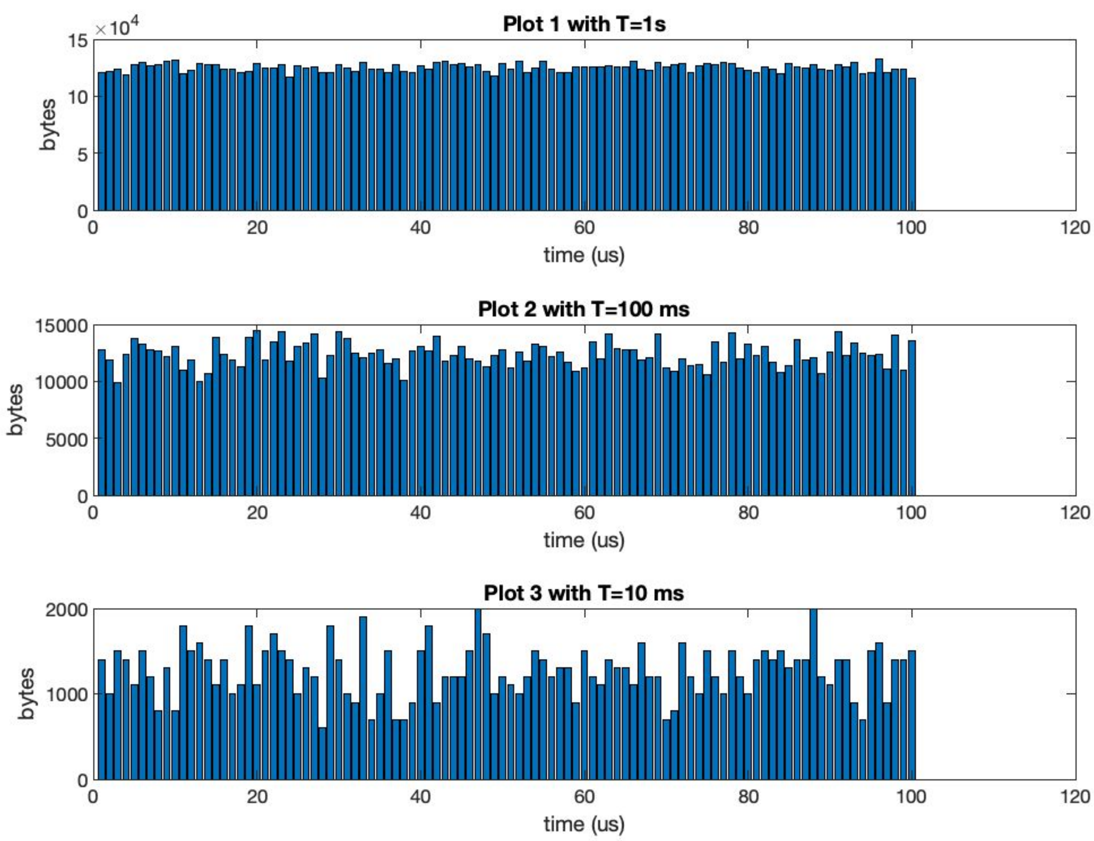
Mean and Variance of time between consecutive arrival events

Mean: 799.5051 μs Variance: 640,530 μs^2

Comparison of measured values with the theoretically expected values

The theoretically expected value is 1 Mbps whereas the measured value is 1.0006 Mbps. The two values are practically identical.

Plots of Poisson trace at 1 second, 100-millisecond and 10-millisecond intervals



Describe your observations of the graphs.

From the plots above we see that the Poisson distribution appears very smooth at granular time-scales (i.e. a period of 1 second) and bursty at finer time-scales (i.e. period of 10–milliseconds).

Exercise 1.3 Compound Poisson arrival process

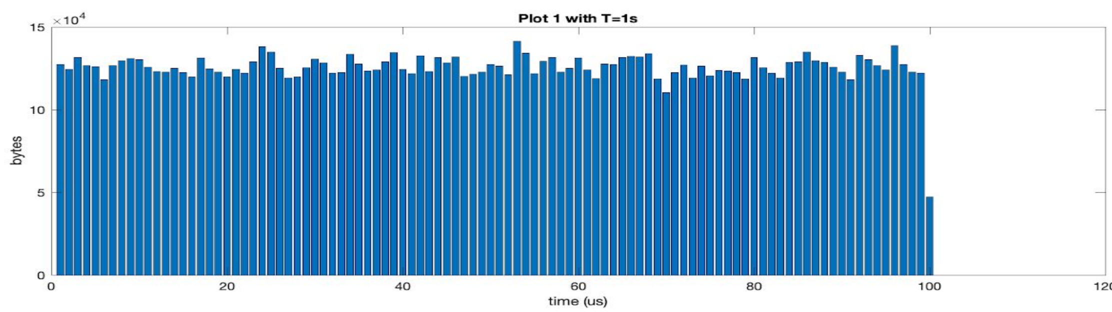
<u>Mean and Variance of time between consecutive arrival events</u>

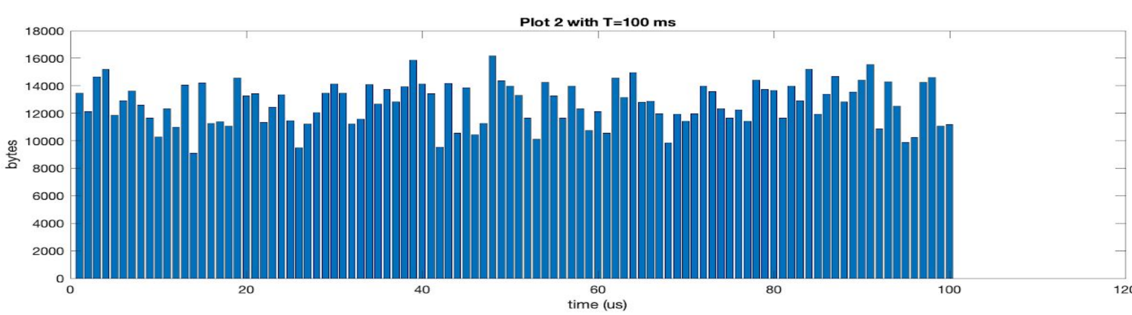
Mean: 795.1973 μs
Variance: 631,830 μs^2

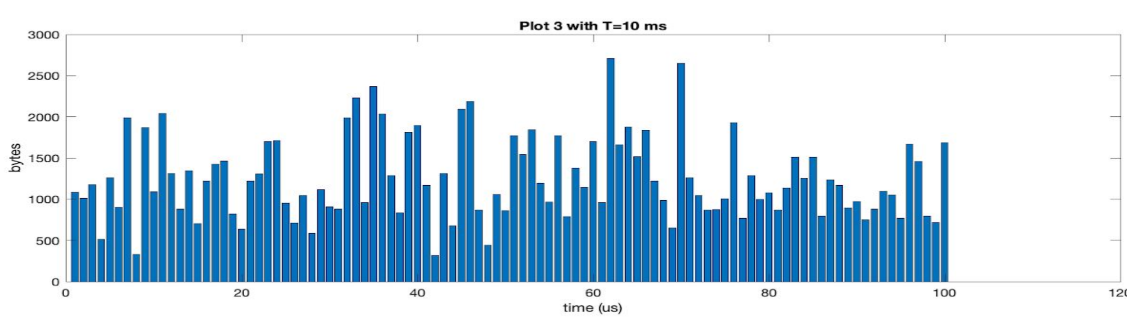
<u>Comparison of measured values with the theoretically expected values</u>

The theoretically expected value is 1 Mbps whereas the measured value is 1.0060 Mbps. As before, the two values are practically identical.

<u>Plots of Poisson trace 3 at 1 second, 100-millisecond and 10-millisecond intervals</u>







Provide a discussion where you compare the results, with those of the other exercises.

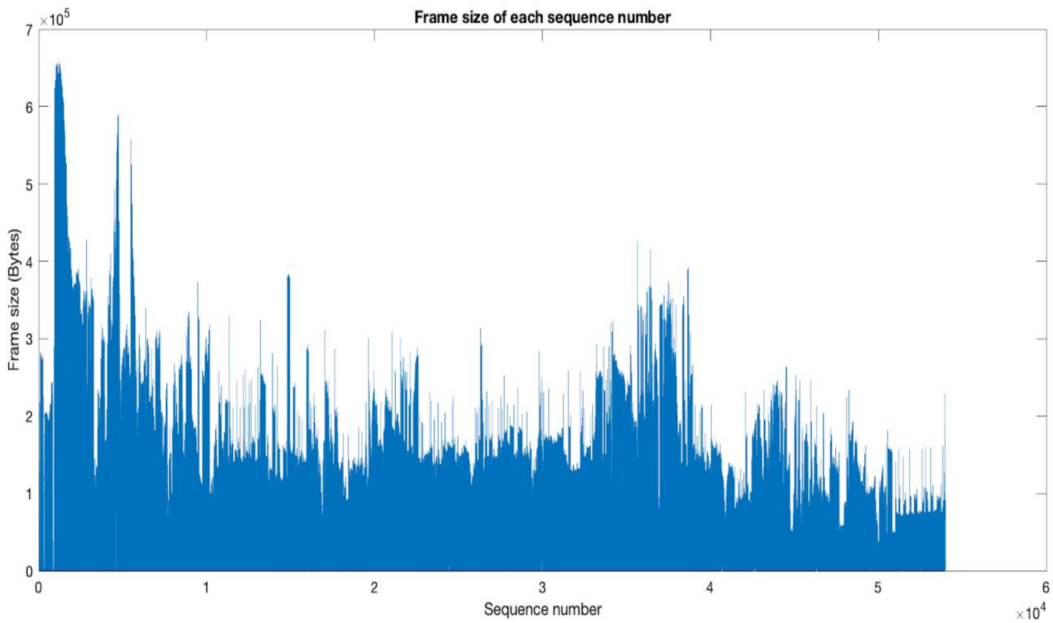
Similar to the observations seen in exercise 1.1, we observe that the Poisson distribution appears approximately smooth for granular time-scales and more bursty at finer time-scales. Though for this trace, there is more variability of the packet sizes compared to the trace for exercise 1.1, which is why the plot for the largest time-scale is comparatively less smooth for this trace versus that for exercise 1.1. Overall, as both are inherently Poisson processes they do exhibit the same behavior with a smooth appearance at large time-scales to a more bursty kind at a smaller time-scale.

Exercise 2.2 Determine statistical properties of the video trace

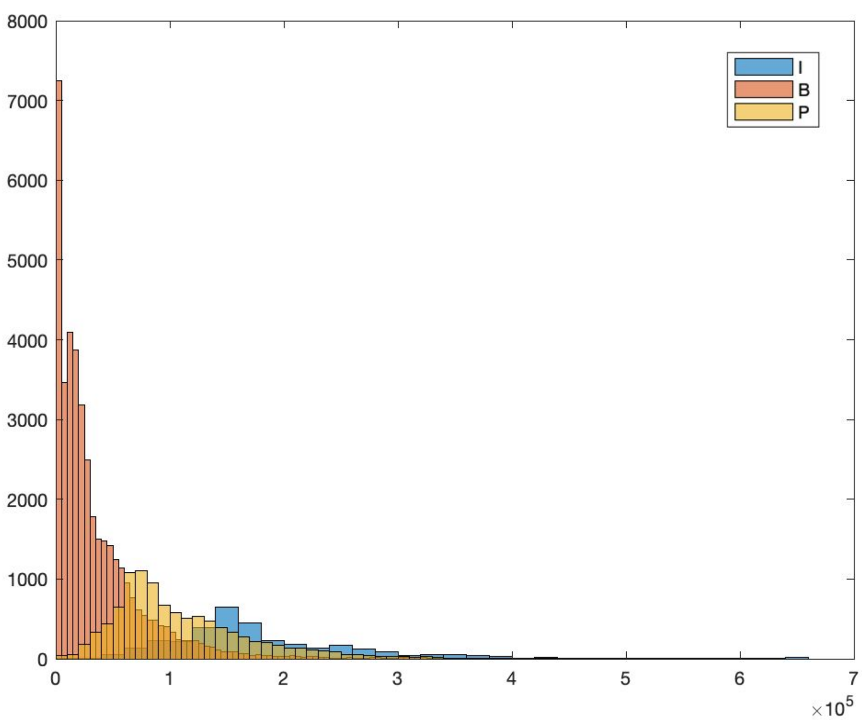
Properties of the Video Trace

Number of frames	53,997
Total number of bytes	3.21e+09 B
Size of the smallest, mean and largest frame	Small: 136 B Mean: 59,447 B Largest: 657,824 B
Size of the smallest, mean and largest I frame	Small: 528 B Mean: 183,780 B Largest: 657,824 B
Size of the smallest, mean and largest P frame	Small: 152 B Mean: 111,410 B Largest: 493,176 B
Size of the smallest, mean and largest B frame	Small: 136 B Mean: 36,093 B Largest: 368,976 B
Mean Bit Rate	1.4268e+07 bps or 14.268 Mbps
Peak Bit Rate	1.5788+08 or 157.88 Mbps
Ratio of peak rate and average rate	11.065

Generate a graph that shows the frame size as a function of the frame sequence number



Generate a graph that shows the distribution of I frames, P frames and B frames



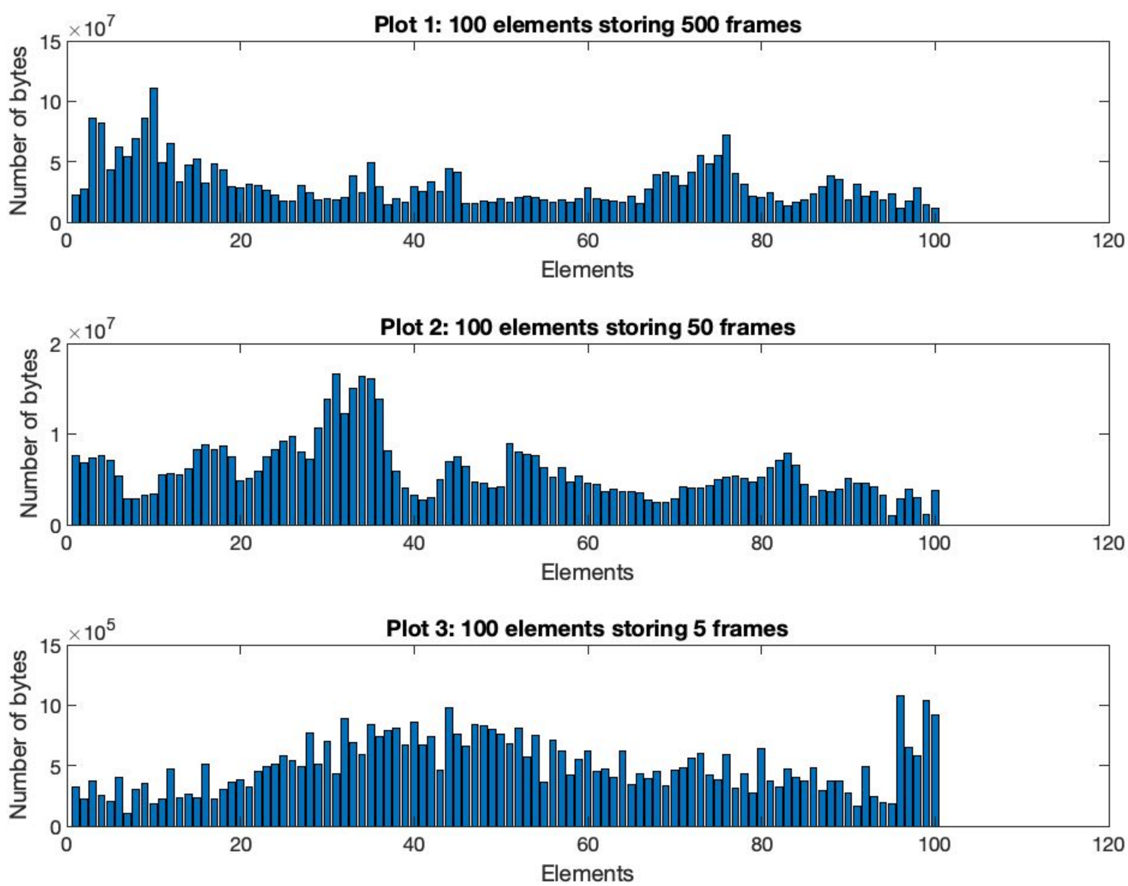
Observations for the above plots

For the first plot, although the plot appears very bursty there is somewhat of a pattern involving large to medium-sized frames followed by small ones. This behavior is expected since for every I or P frame the next I or P frame in the sequence is required before the corresponding B frame is transmitted. Since I frames are the largest followed by P frames then B frames, the bursty pattern (i.e. high to low) in the above plot is consistent with the aforementioned frame transmission sequence.

The second plot above depicts that B frames are the most frequent followed by P and I frames, this is consistent with the GOP pattern of IBBBPBBBPBBBPBBB, which is dominated by mostly B and P frames.

Exercise 2.3 Scaling Video traffic

Plot of Video Traffic for 500 frames, 100 frames and 10 frames per element (in bytes)



Describe your observations of the graphs, and compare them to the scaled versions of the Poisson plots from Part 1

Unlike the plots for the Poisson traces at varying time-scales, the plots for the video-traces appear similar regardless of whether the frames per element is large or small. This observation suggests that the video-traces are self-similar, in that the plots appear similar regardless of the scale. Unlike the video-trace, the Poisson traces as mentioned earlier, either appear smooth or bursty with respect to the time-scale and so were not a self-similar process.

Note: For exercises 3.1 – 3.3 we used the longer trace (i.e. Bel.data on the course website).

Exercise 3.2 Determine statistical properties of the Ethernet trace

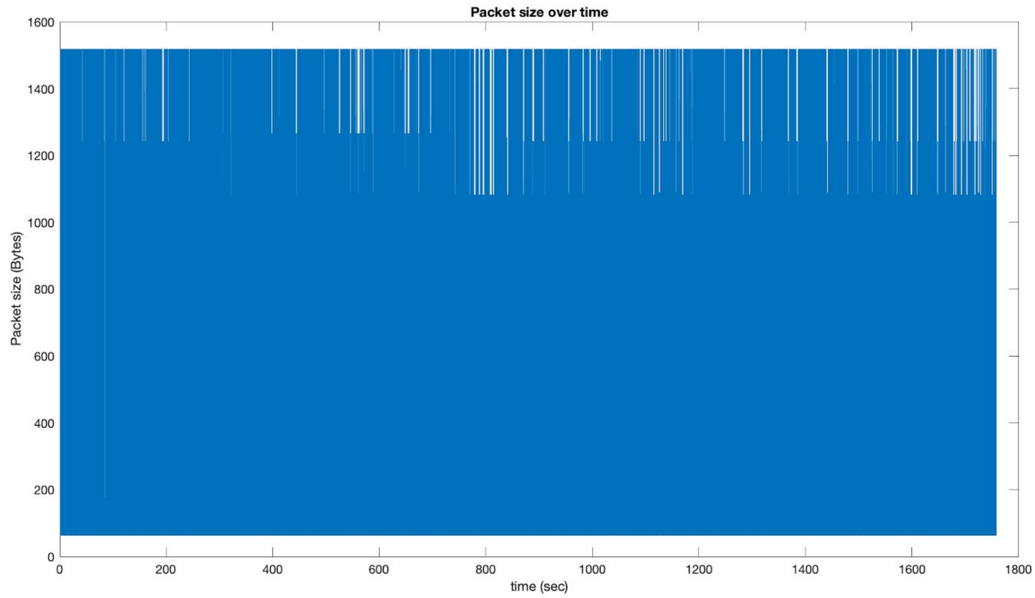
Analyze the trace of the Ethernet traffic

Number of captured packets	1,000,000
Total number of bytes	638,289,839 B
Mean bit rate of the entire trace	2.9019e+06 or 2.9019 Mbps
Peak bit rate of the trace	6.96e+07 bps or 69.6 Mbps
Compute the ratio of the peak rate and the average rate	23.9839

Compare this value to the peak-to-average rate ratio from the video trace in Part 2

The peak-to-average rate ratio of the video trace was 11.065 whereas for the Bellcore trace it is 23.9839. The discrepancy occurs from the fact that the two traces are markedly different. The Bellcore peak-to-average rate ratio is believed to be higher as the size of the packets vary between small and large extremes more frequently and at random. For instance, there are many instances where the packet sizes oscillate between ~66 B and ~1518 B. As for the video trace, though initially there are small frame sizes, the mean frame sizes for I, B and P frames all roughly, in a proportional manner, vary over time. For example, the B frames are initially ~136 B, I frames are ~ 528 B, and P frames are ~160 B but later on the B frames grow to ~54,992 B, the I frames to ~ 275,664 B and P frames to ~143,864 B. Accordingly, the video-trace's peak-to-average rate though representative of its bursty behavior is not as large due to the roughly proportional increase/decrease of frame sizes for each frame type.

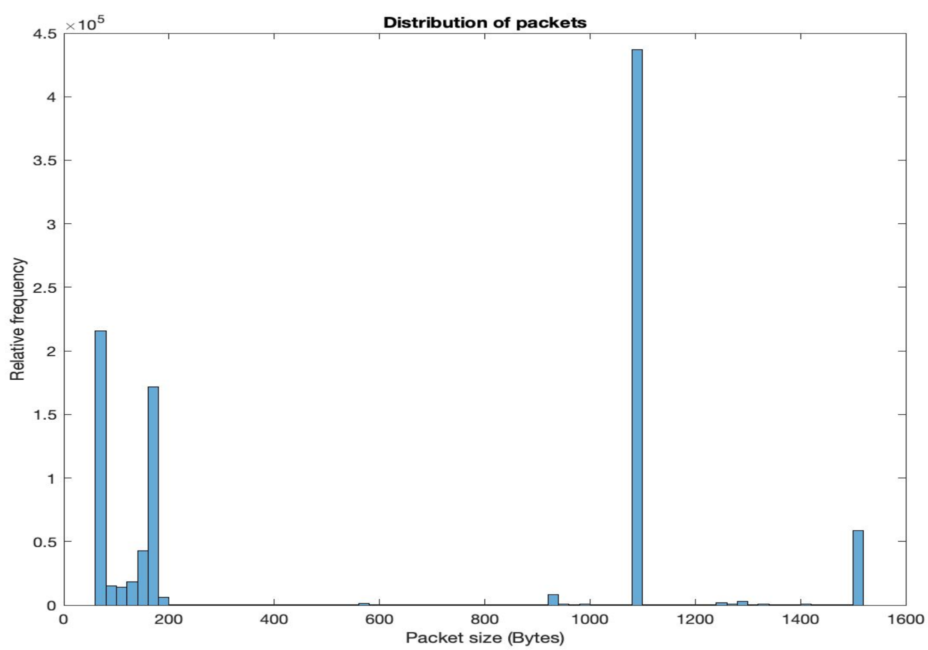
Generate a graph that depicts the packet size as a function of time



Observations

At the given time-scale (500 seconds) we observe that the packet sizes vary sporadically with respect to time.

Generate a graph that shows the distribution of packet sizes

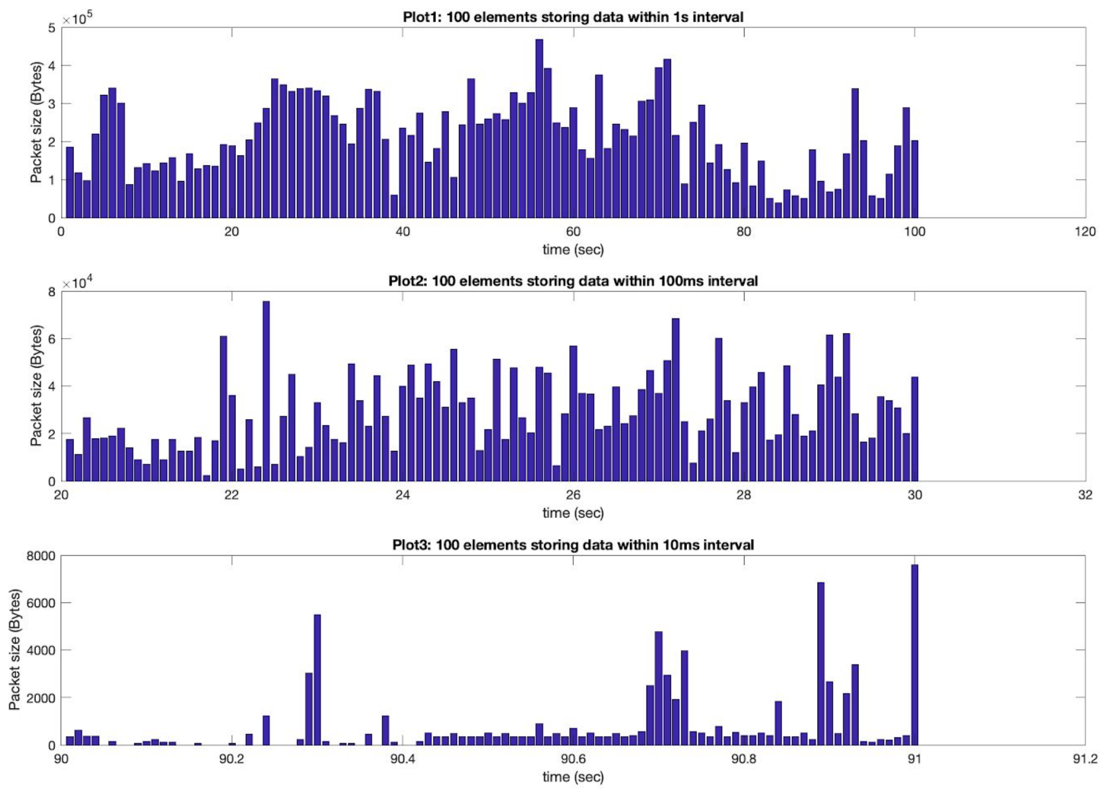


Observations

Observing the plot above, we see that there are many small packets and much fewer large packets. This makes sense for an internet trace as there are many control packets that are usually sent (i.e. for TCP communication). The larger packets can be attributed to potential data transfer.

Exercise 3.3 Scaled depiction of Ethernet traffic

Plot of Bell Trace for 1 second, 100 millisecond and 10 millisecond of traffic per element



Describe your observations of the graphs, and compare them to the plots from the Poisson traffic and the video trace.

For the plot above we observe that regardless of the time-scale, we observe bursty behavior, indicative of a self-similar process. For the smallest time-scale (i.e 10ms interval) we see much fewer packets being collected in each bin and of a comparatively much smaller size than the above two plots. This observation makes sense given the smaller time interval being considered.

In relation to the Poisson process from part 1, we see that it was not reflective of real-world internet traffic. Unlike the Bellcore trace, the Poisson trace is smooth for large time-scales and only bursty for small time-scales.

Comparing the video trace to the Bellcore trace, we see the two are markedly similar. Both appear to be self-similar processes that yield bursty behavior irrespective of the time-scale.