ECE466 Computer Networks II
Lab 1 Traffic Characterization
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Part 1. Poisson Traffic

Exercise 1.1 Scaling Poisson traffic arrivals

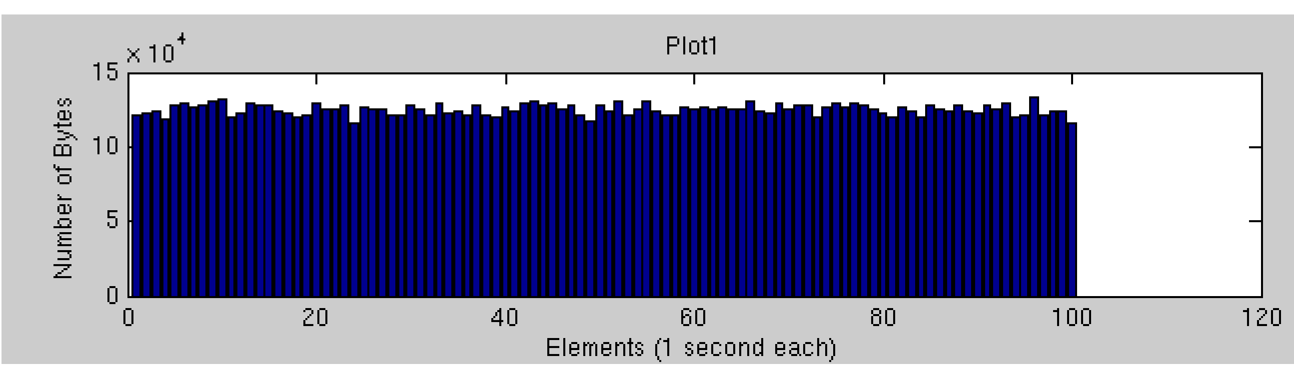
- Verify the measured mean bit rate of the flow with the target rate, by calculating the mean and the variance of the times between consecutive arrival events. Compare the values with the theoretically expected values.

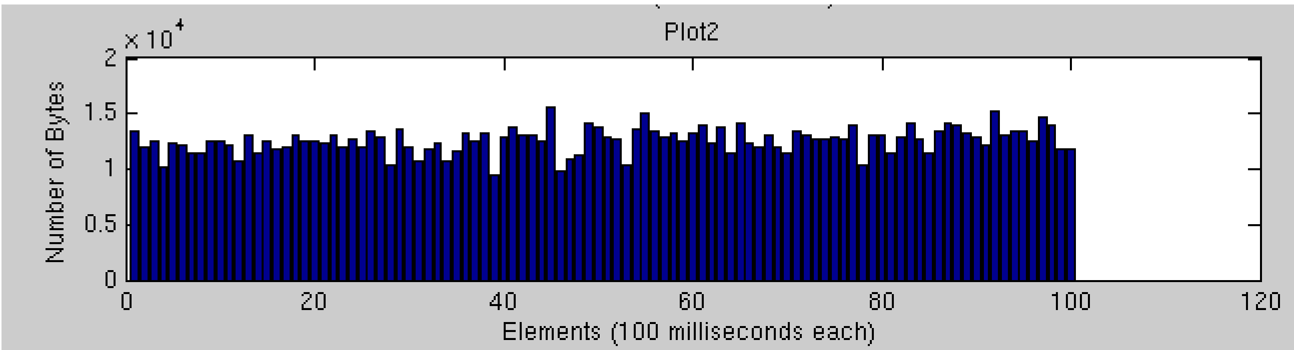
  Theoretically Expected Values
  bit rate = 1 Mbps
  packet size = 100 bytes = 800 bits
  arrival time of each packet = 800 bits/1Mbps = 800 µs

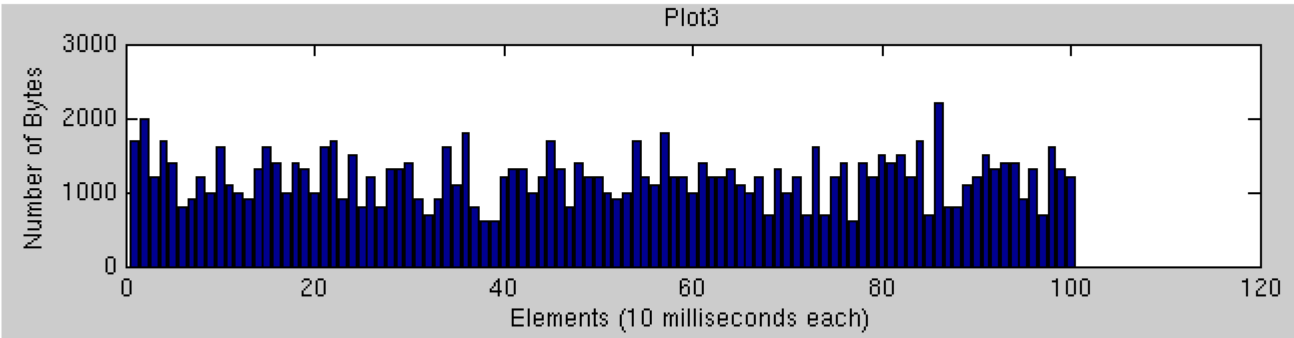
  Measured Values
  Calculate the times between two consecutive arrival events
  array of times starting at the second element to the last element
  time2 = time_p(2:size(time_p))
  array of times starting at the first element to the second last element
  time1 = time_p(1: (size(time_p)-1))
  time between two consecutive arrival events
  delta_t = time2-time1
  mean consecutive arrival time
  mean(delta_t) = 799.5115 µs
  variance of the consecutive arrival times
  var(delta_t) = 6.4054e+05
  standard deviation = sqrt(var(delta_t)) = 800.3374

  Our comparison shows that the measured and expected arrival time of two consecutive packets are very close. The high variance shows us that the data points are very spread out from the mean.

- Plot the content of the vectors in three separate graphs, with the time intervals on the x-axis, and the number of bytes on the y-axis. The data points should be depicted as vertical bars (e.g., using the MATLAB function `bar()’)







- Describe your observations of the graphs.

  The graphs show a non self-similar process like a poisson distribution. When observed on a fine time scale like 10 ms, it appears bursty and coarse time scale (1s) it appears to flatten.

Exercise 1.2 Traffic with exponentially sized packets

(You may skip Exercise 1.2)

Exercise 1.3 Compound Poisson arrival process

- Verify the measured mean bit rate of the flow with the target rate, by calculating the mean and the variance of the times between consecutive arrival events. Compare the values with the theoretically expected values.

  <u>Theoretically Expected Values</u>
  bit rate = 1 Mbps
  packet size = 100 bits = 800 bits
  arrival time of each packet = 800 bits/1Mbps = 800 µs

  <u>Measured Values</u>
  Calculate the times between two consecutive arrival events
  array of times starting at the second element to the last element
  time2 = time_p(2:size(time_p))
  array of times starting at the first element to the second last element
  time1 = time_p(1: (size(time_p)-1))
  time between two consecutive arrival events
  delta_t = time2-time1

mean consecutive arrival time

mean(delta_t) = 795.2037 µs

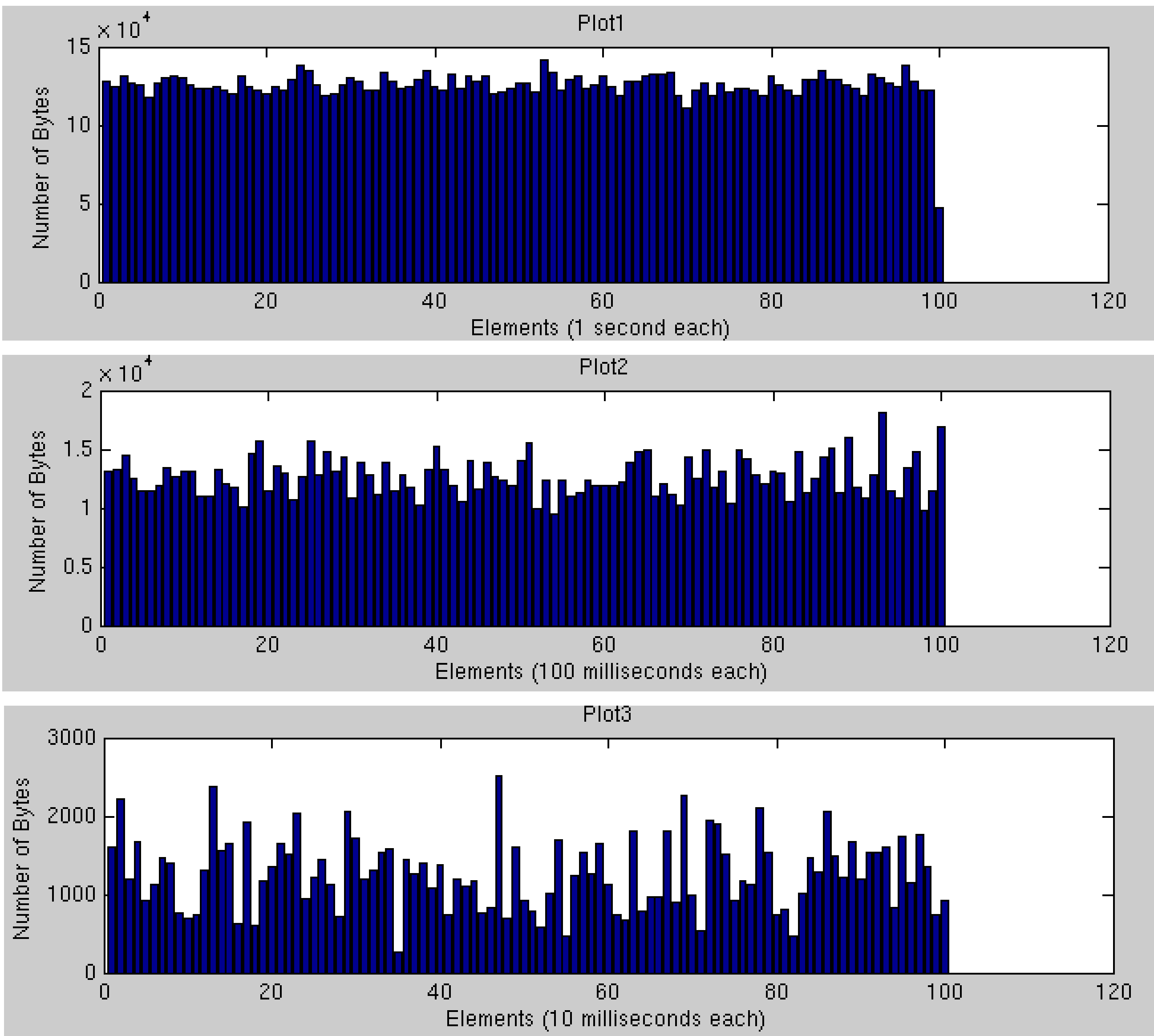
variance of the consecutive arrival times

var(delta_t) = 6.3184e+05

standard deviation = sqrt(var(delta_t)) = 794.8836

The comparison is similar to Exercise 1.1. We have a very close to expected mean arrival time and an high variance.

- Repeat the tasks in Exercise 1.1 with the above arrival flows.



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

Comparing our results to Exercise 1.1, the results are very similar such that they also follow the Poisson distribution as described in Exercise 1.1. The difference seen in these results is that these plots appear to be more bursty.

Part 2. Compressed Video Traffic

Exercise 2.1 Download a VBR video trace

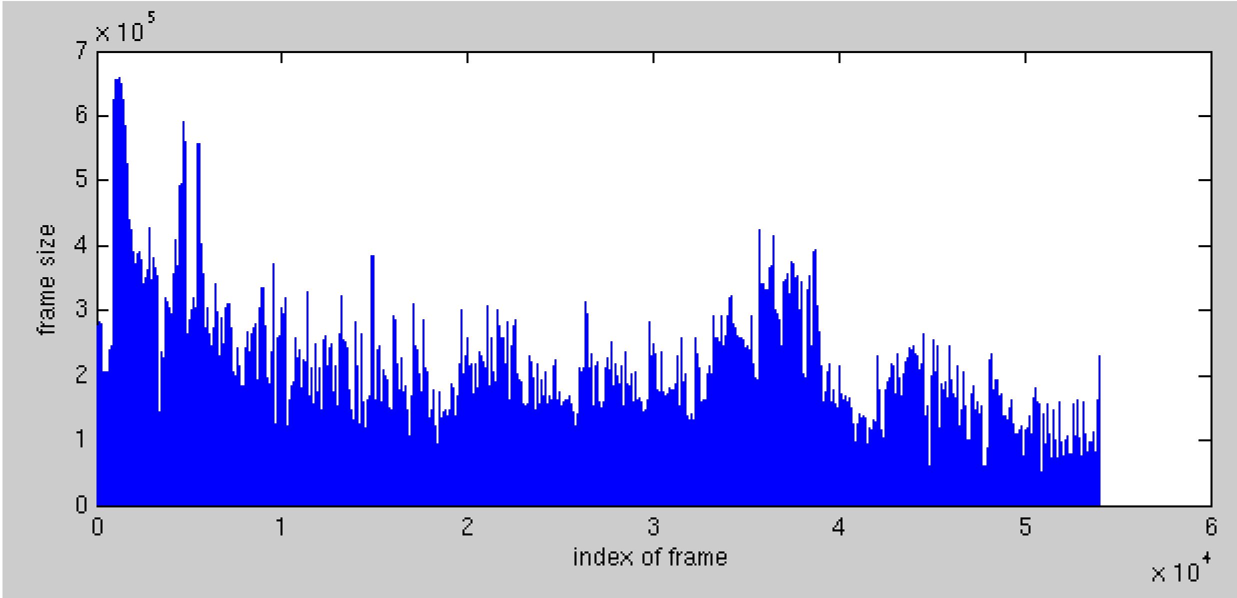
Nothing to report.

Exercise 2.2 Determine statistical properties of the video trace

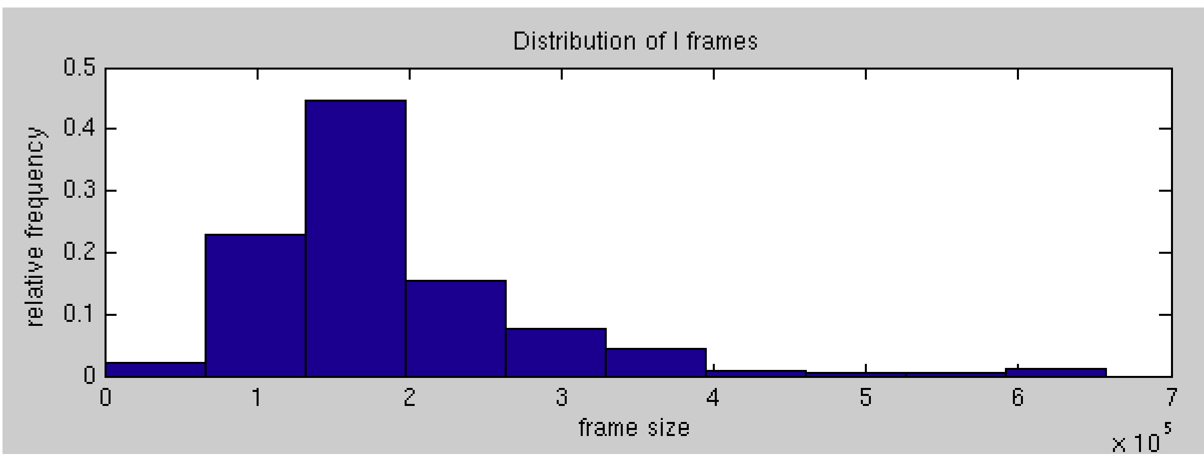
- Compute the following properties of the video trace

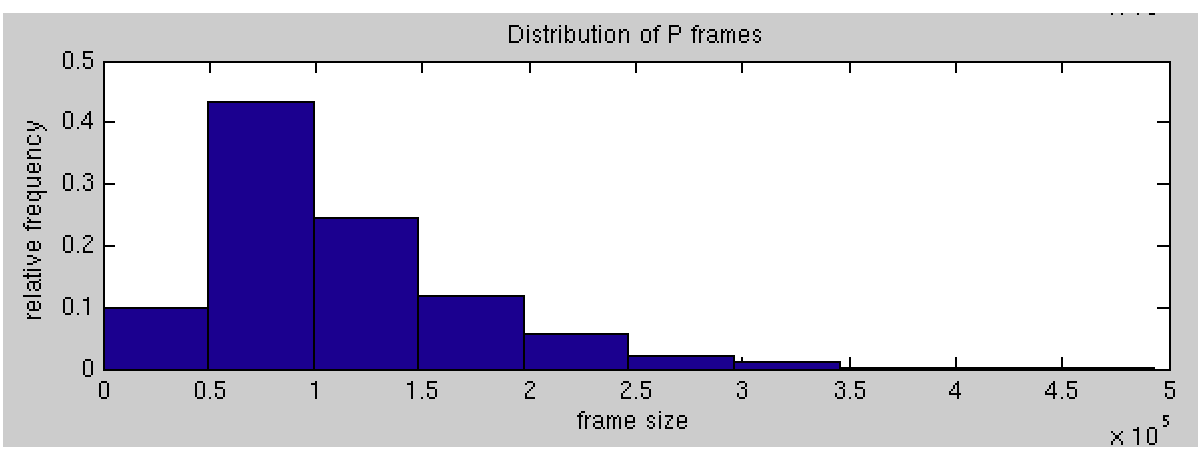
```
number of frames        = 53997 frames
total number of bytes   = 3209958344            = 3.209958344 GB
smallest frame size     = 136 bytes
largest frame size      = 657824 bytes          = 657.824 kB
mean frame size         = 5.944698e+04 bytes    = 59.44698 kB
smallest I frame        = 528 bytes
largest I frame         = 657824 bytes          = 657.824 kB
mean I frame            = 1.837761e+05 bytes    = 183.7761 kB
smallest P frame        = 152 bytes
largest P frame         = 493176 bytes          = 493.176 kB
mean P frame            = 1.114125e+05 bytes    = 111.4125 kB
smallest B frame        = 136 bytes
largest B frame         = 368976 bytes          = 368.976 kB
mean B frame            = 3.609310e+04 bytes    = 36.093 kB
mean bit rate           = 1.783409e+06 Bps      = 14.267272 Mbps
peak bit rate           = 19734720 Bps          = 157.87776 Mbps
peak/average rate       = 1.106573e+01          = 11.066
```

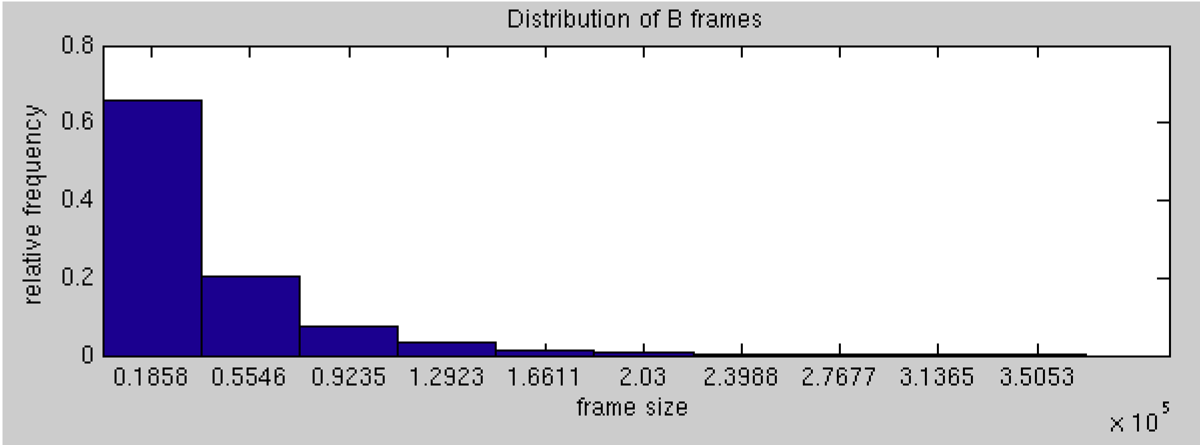
- Generate a set of graphs that show the properties of the video trace:
  - Generate a graph that shows the frame size as a function of the frame sequence number. (Use the sequence in which the frames are listed in the file, i.e., the transmit sequence.)



- Generate a graph that shows the distribution of I frames, P frames, and B frames. (x-axis is the frame size, y-axis is the relative frequency).



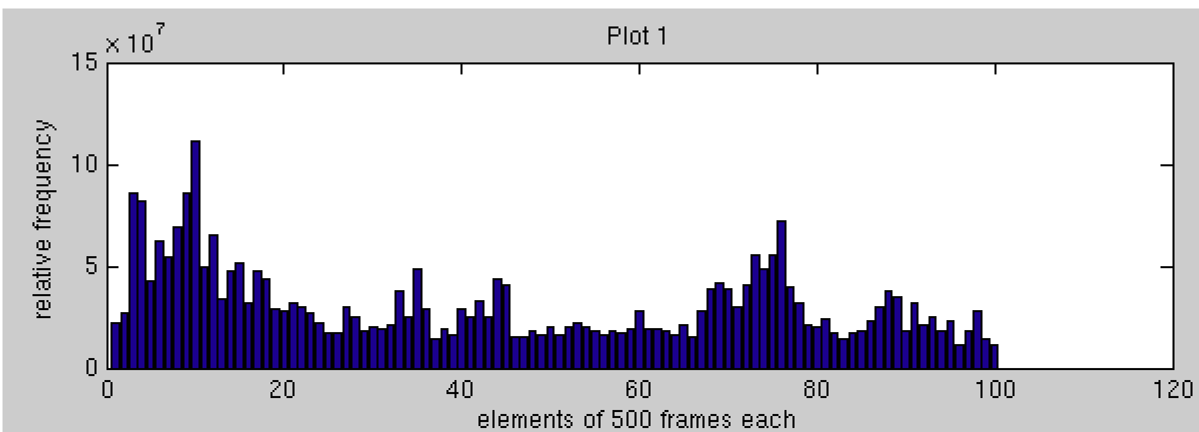


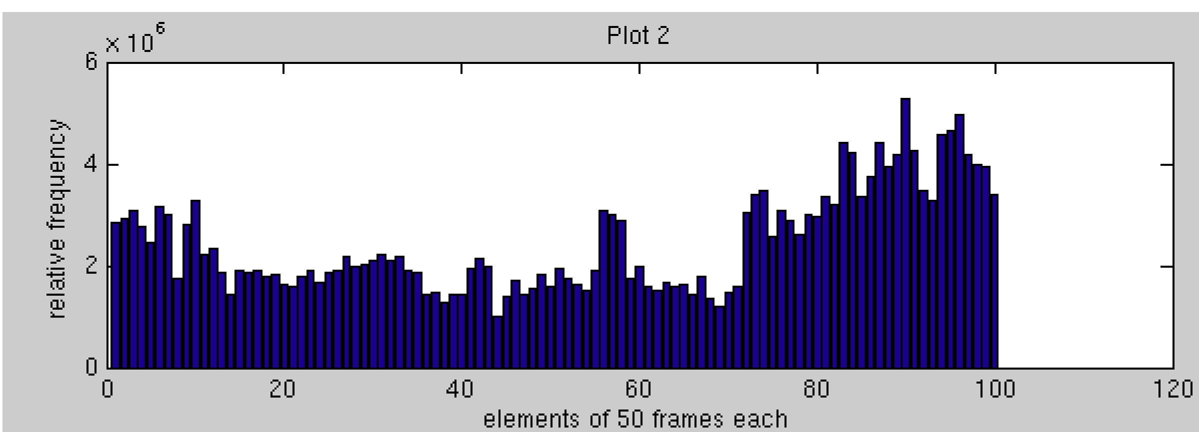


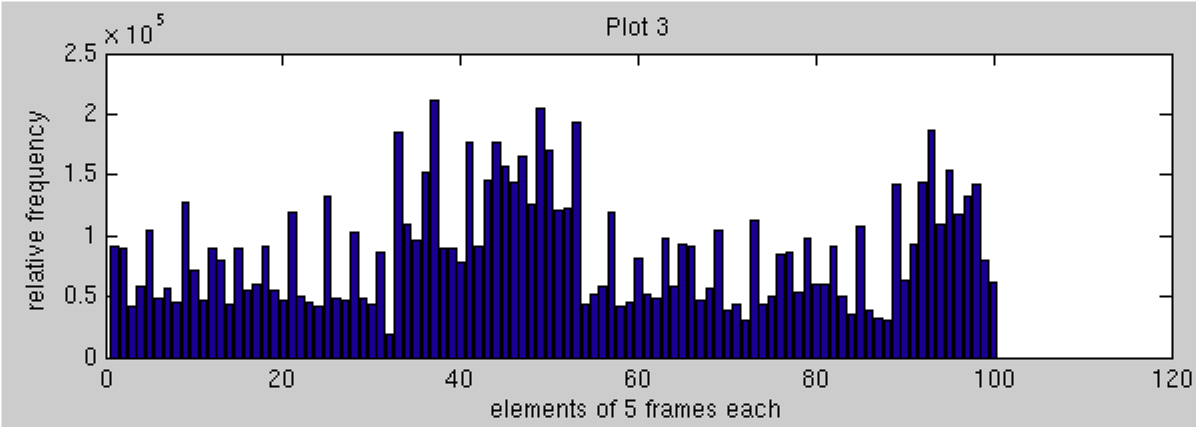
The frame sizes are in bytes.

Exercise 2.3 Scaling Video traffic

- Plot the content of the vectors in three separate graphs, with the frame number on the x-axis, and the number of bytes on the y-axis. The data points should be depicted as vertical bars (e.g., using the MATLAB function bar()).







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

  We can see that it looks very random since video data depends very much on what the video data is being displayed, ie. a very dark background, or flashy action data. Compared to the Poisson plots in part 1, the plots in part 1 becomes more bursty and random as we fine grain our time scale. A similar effect can be seen with these plots, except plot 1 does not look as smooth as Part 1's plot 1

Part 3. Aggregate traffic on an Ethernet network

Exercise 3.1 Download an Ethernet traffic trace

Nothing to report.

Exercise 3.2 Determine statistical properties of the Ethernet trace

- Analyze the trace of the Ethernet traffic:

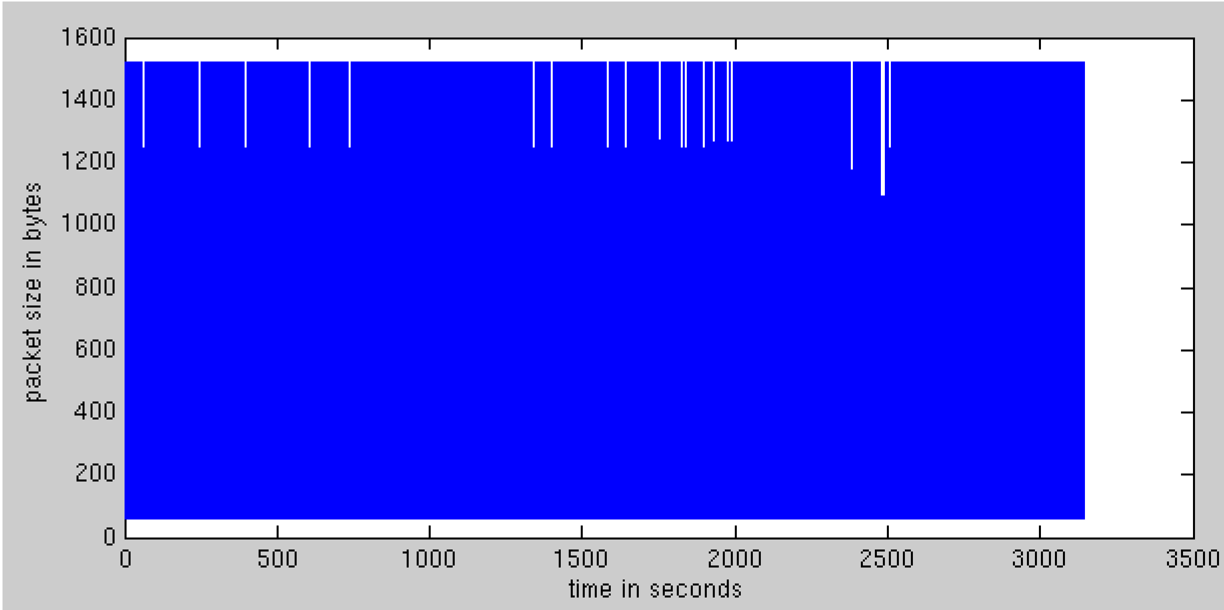
number of captured packets	= 1000000	
total number of bytes	= 434292031 bytes	= 434.292031 Mbytes
mean bit rate	= 1.105483e+06	= 1.105 Mbps
peak bit rate	= 4.350000e+07	= 43.50000 Mbps

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

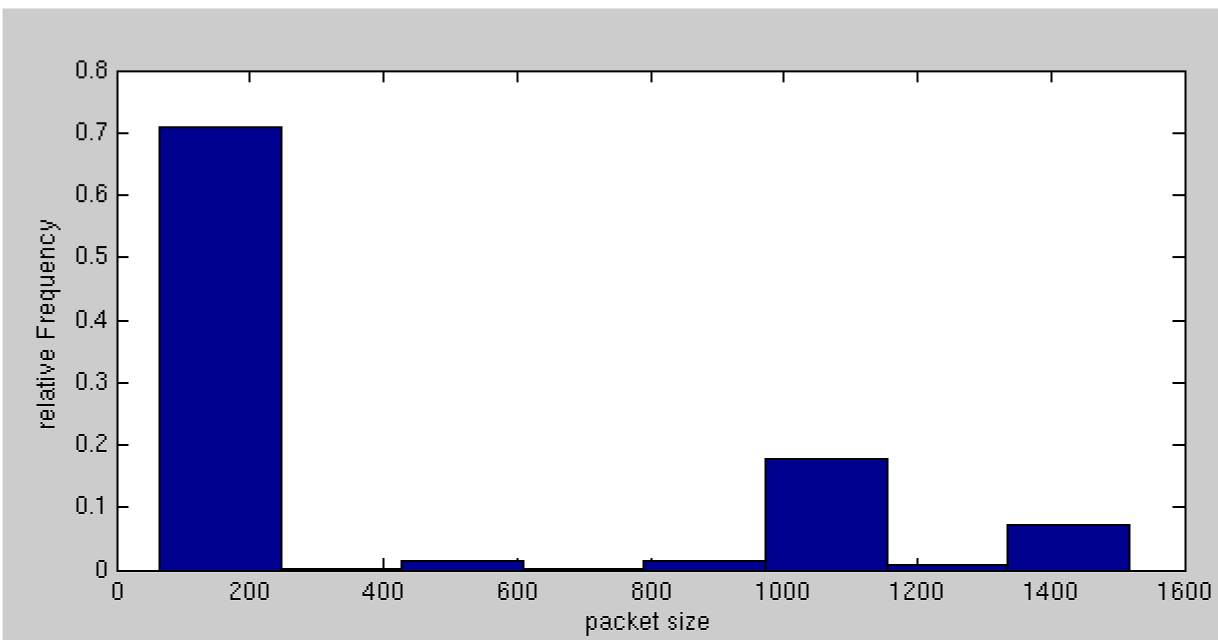
  peak rate / average rate = 39.3665

  Compared to Part 2's peak to average rate of 11, this value is much higher and shows that ethernet traffic can continue much higher variation than video traffic.

- Generate a set of graphs that show properties of the Ethernet traffic trace:
  - Generate a graph that depicts the packet size as a function of time.

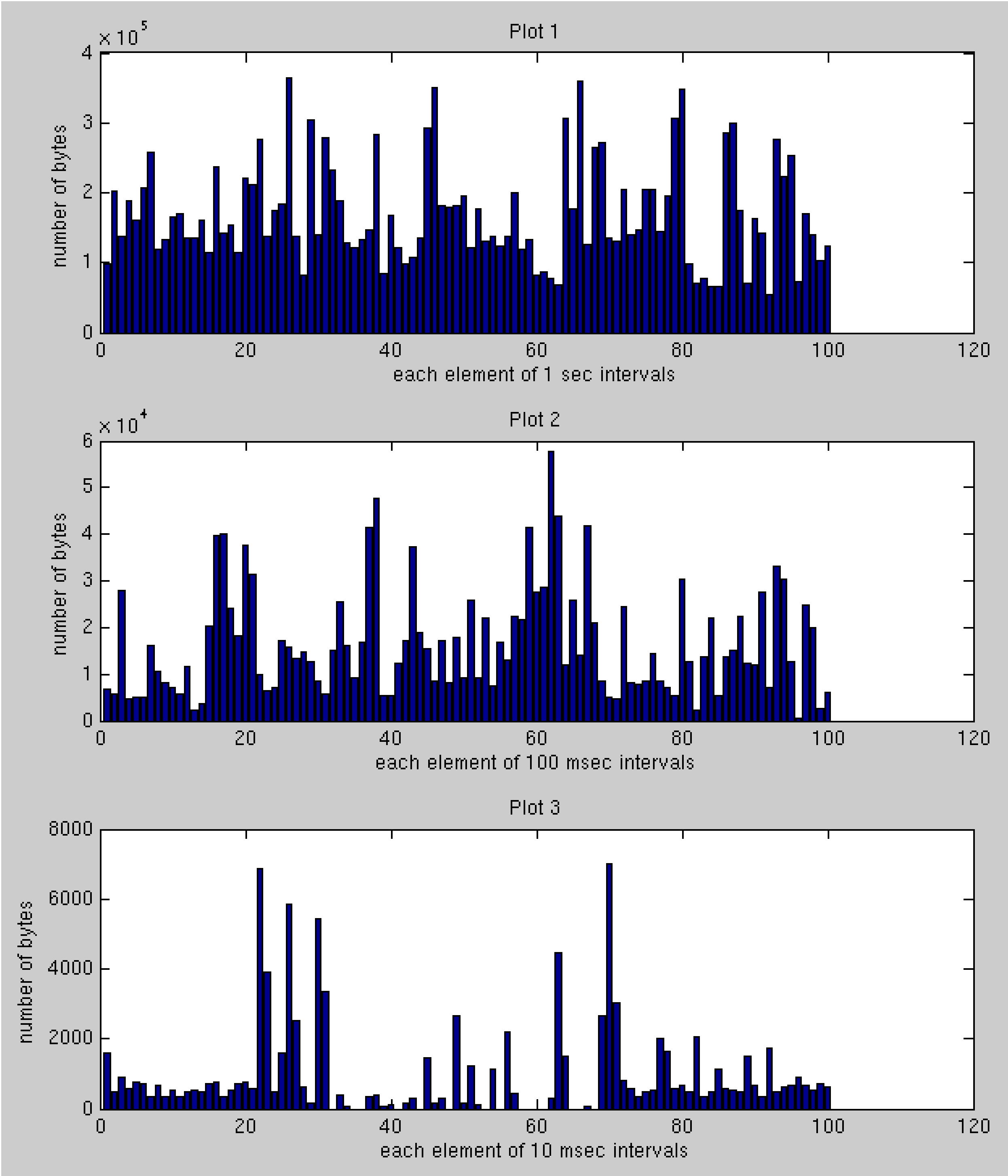


- Generate a graph that shows the distribution of packet sizes (x-axis shows the packet size, y-axis shows the relative frequency).



Exercise 3.3 Scaled depiction of Ethernet traffic

- Plot the content of the vectors in three separate graphs, with the packet number on the x-axis, and the number of bytes on the y-axis. The data points should be depicted as vertical bars (e.g., using the MATLAB function bar()).



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

  We can see that all three plots are self-similar, it does not smoothen out as we look at larger time intervals, unlike the Poisson traffic and the video trace. It looks random at any time interval.