INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR

COMPUTER COMMUNICATION LABORATORY
A REPORT ON

"Generation of Different Traffic Distributions"

October 11, 2020

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Contents

OBJECTIVE

The aim is to generate different traffic arrival patterns and plot the probability of packet arrival versus the number of arrivals for different distributions such as Poisson and Pareto.

DISCUSSION

- In a Poisson distribution, the inter-arrival times of the packets are exponentially distributed, whereas in Pareto distribution the inter-arrival times follow a power-law distribution.
- Only Uniform distributions can be generated by the pseudo-random number generator in binary machines. This uniform distribution is converted to exponential and power-law distributions using the inverse transform sampling with the appropriate inverse functions of the CDFs (more details in CODE EXPLANATION).
- A total of 10,000,000 packets were taken for each value of λ to get a smooth distribution.
- The values of λ used were 1, 4, and 10. Plotting the graphs with the value of k ranging from 0 to 20 was sufficient to observe the properties of the curves.
- The graphs were plotted using a wrapper for matplotlib from C++. This implies a working installation of Python with matplotlib is necessary to generate the plots.
- The Pareto distribution tends to a Delta function at $1/x_m$ as $\alpha \to \infty$.

CODE EXPLANATION

Poisson Distribution:

- The inter-arrival times of all the packets are stored in a vector `E`. Number of packets per interval are stored in another vector `arrivals`. These vectors are initialized to `0` in the beginning.
- The inter-arrival times of the packets are then computed by generating a uniform random variable and using the inverse transform given by

$$E = \frac{-log(U)}{\lambda}$$

The arrival time is computed by adding the new inter-arrival time to the previous arrival time. The size of the interval is taken to be 1 unit, so the new arrival can be placed in the appropriate bin by flooring its arrival time.

```
for (int i = 1; i < N; i++) {
  U = (rand() % RAND_MAX+1) / (1.0*(RAND_MAX));
  e = -log(U) / lambda;
  E[i] = E[i-1] + e;        // Arrival time of ith packet

  // Count number of packets per interval
  if ((int)(E[i]) < 2 * N) arrivals[(int)(E[i])]++;
}
```

- A histogram of the number of arrivals per interval is computed.

```
// Count number of intervals with given number of arrivals
for (int i = 0; i < int(E[N-1]); i++) {
  if(arrivals[i] < histSlots)
  P[arrivals[i]]++;
}
```

- The PDF is then computed by dividing the entire vector with the total number of arrivals. The resulting PDF is plotted.

Pareto Distribution:

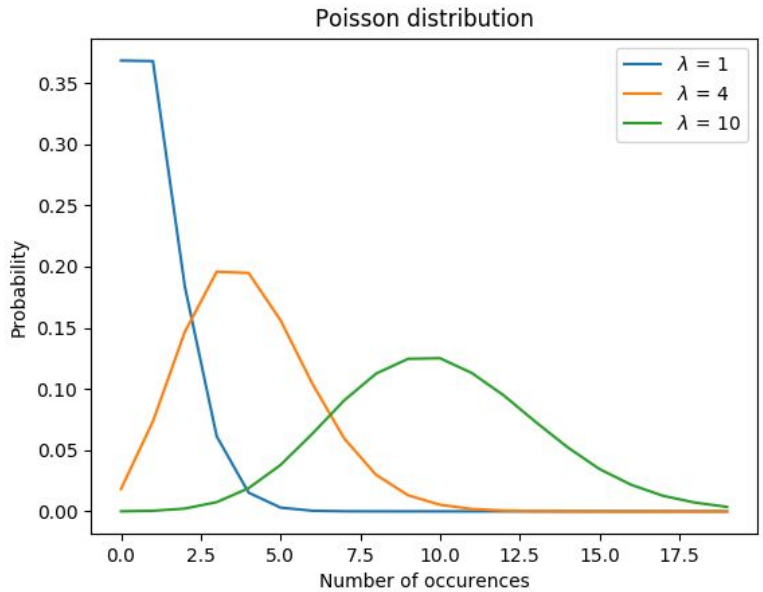
- The implementation of Pareto distribution is the same as that of Poisson with the only difference being the inverse transform function.

- For the Pareto distribution, the inverse transform function is given by

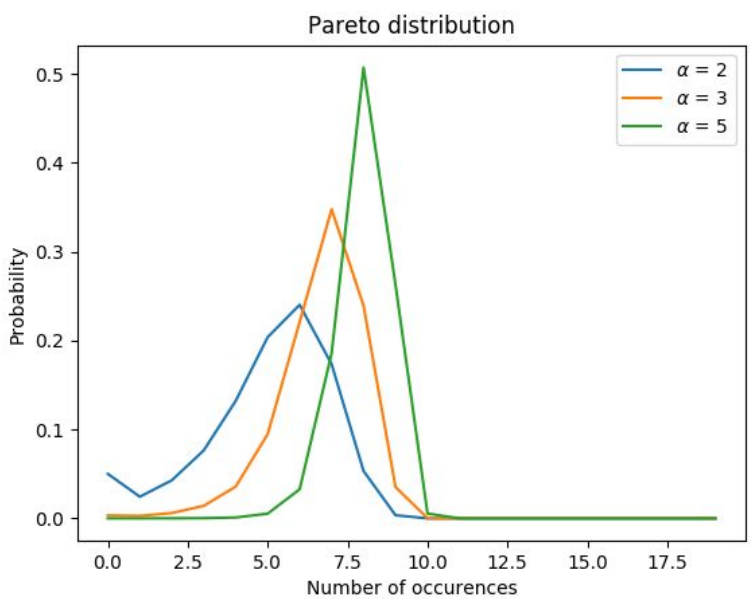
$$E = \frac{x_m}{U^{1/\alpha}}$$

RESULTS

The plot for Poisson distribution for various values of λ



The plot for Pareto distribution for $x_m = 0.1$ and various values of α



CONCLUSION

- Poisson and Pareto distributed traffic is generated, which can be used as the network traffic in further experiments.
- The plots obtained are close to the analytical functions of the two distributions.

REFERENCES

https://en.wikipedia.org/wiki/Poisson_distribution

https://en.wikipedia.org/wiki/Pareto_distribution