Network analysis and simulation
Homework 1

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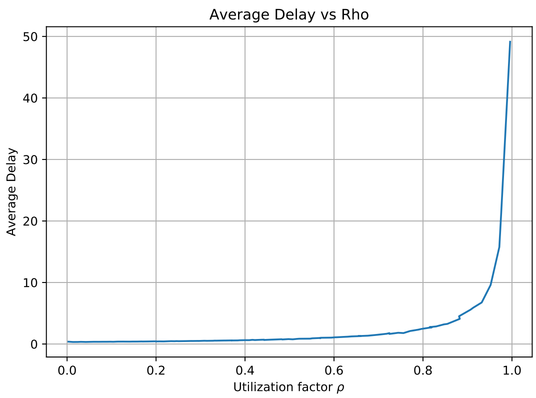
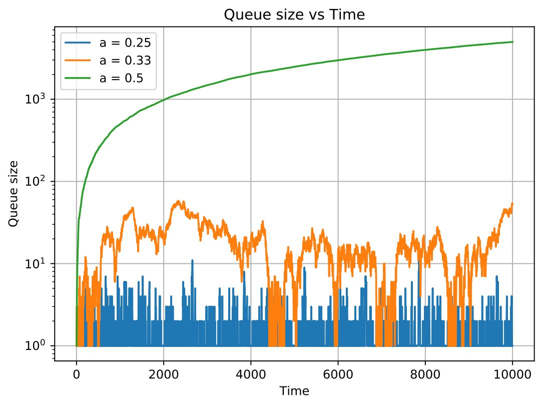
Exercise 1

In the first exercise the implementation of a slotted queue is required. The three different case follows:

Exercise 1.1



(a) Average delay vs Utilization factor



(b) Queue size vs time by varying a

Figure 1: Plots required in Exercise 1.1

In this first case is required to plot:

- the average delay in function of the utilization factor ρ by varying a, that is the probability the 1 or 2 packets arrive to the queue, from 0 to 1/3, the result is in Figure 1a
- a realization of the queue size in function of the time for 10000 slots for a = 1/4, 1/3 and 1/2, the result is in Figure 1b

From the second plot can be seen that for a = 1/2 the queue is unstable and its size diverges. Indeed from queueing theory we know that the arrival rate for this queue is:

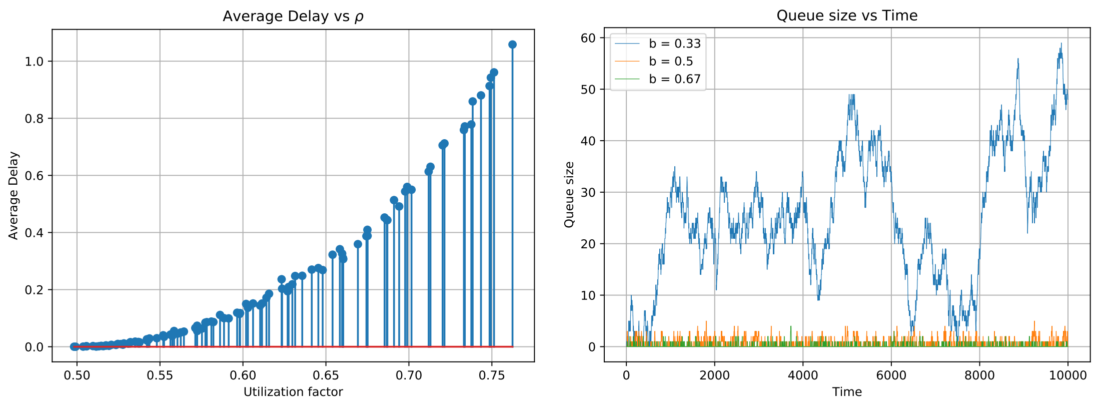
$$\lambda = 1 \cdot a + 2 \cdot a \tag{1}$$

while the service time μ is one slot. To be stable, the queue has to satisfy Equation 2, so, as simulated, in the first two cases the queue is stable.

$$\lambda \leq \mu \Rightarrow 3a \leq 1 \Rightarrow a \leq 1/3 \tag{2}$$

Exercise 1.2

In the second case the same plots are required with the difference that this time the parameter to vary is b, i.e. the parameter of the geometric service time.



(a) Average delay vs Utilization factor

(b) Queue size vs time by varying b

Figure 2: Plots required in Exercise 1.2

Exercise 1.3

In Exercise 1.1 the queue size for which $P[overflow] = 0.00001$ is respectively 12 for $a = 0.25$, 58 for $a = 0.33$ and 61 for $a = 0.5$ even if in the latter the queue is unstable, so eventually the queue will become full.

In Exercise 1.2 the queue size for which $P[overflow] = 0.00001$ is respectively 81 for $b = 0.33$, 9 for $b = 0.5$ and 5 for $b = 0.66$.

Exercise 2

The second exercise is required to implement a raw simulator of a basic cellular network. In the follows the required plots are showed.

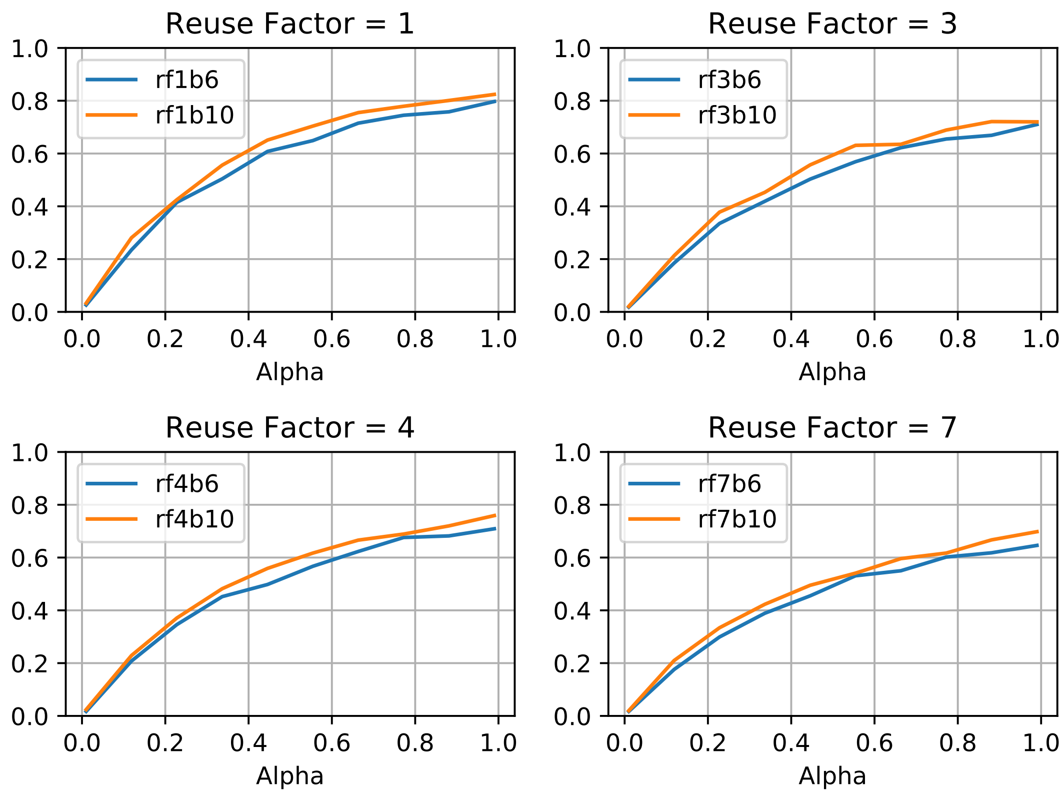
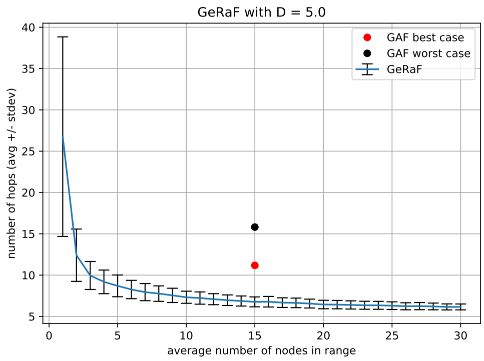


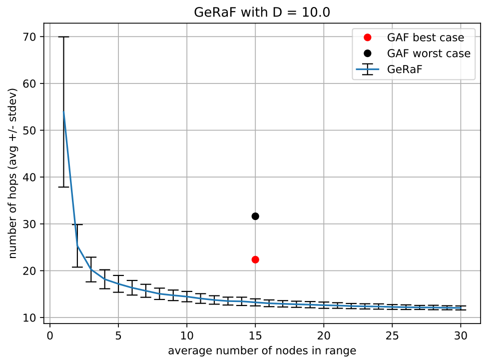
Figure 3: Outage probabilities vs activity of interferers for six cells and reuse factor 1,3,4,7

Exercise 3

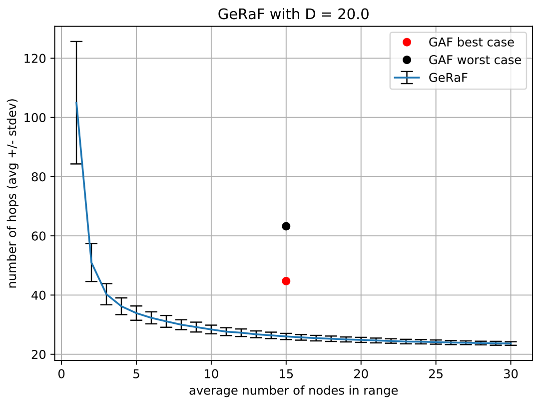
The third exercise requires to perform a simulation study of the multihop performance of GeRaF using both Montecarlo simulations and numerical evaluation and to ripropose the figures showed in the paper. The figures follows:



(a) Average number of hops ± standard deviation versus average number of active neighbors. Distance D = 5

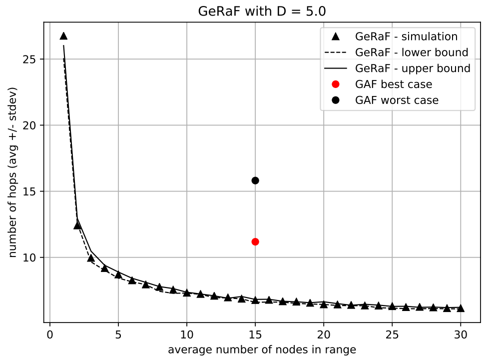


(b) Average number of hops ± standard deviation versus average number of active neighbors. Distance D = 10

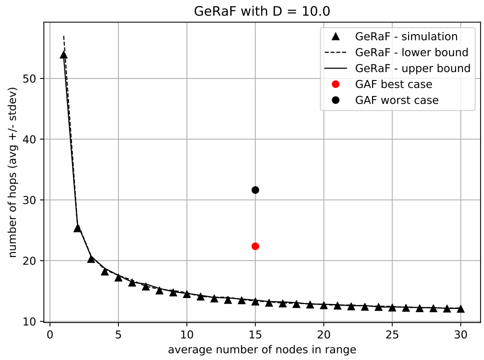


(c) Average number of hops ± standard deviation versus average number of active neighbors. Distance D = 20

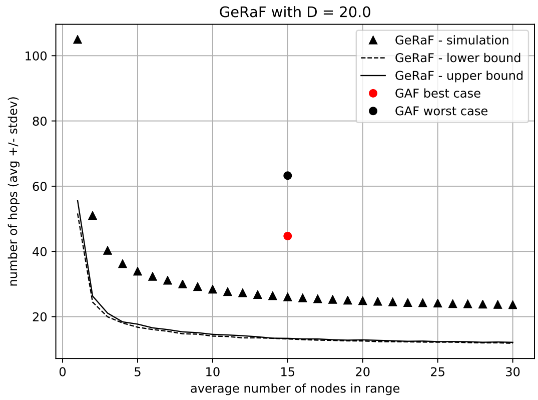
Figure 4: Plots required in third exercise using Montecarlo simulations



(a) Average number of hops ± standard deviation versus average number of active neighbors. Distance D = 5



(b) Average number of hops ± standard deviation versus average number of active neighbors. Distance D = 10



(c) Average number of hops ± standard deviation versus average number of active neighbors. Distance D = 20

Figure 5: Plots required in third exercise using numerical evaluation