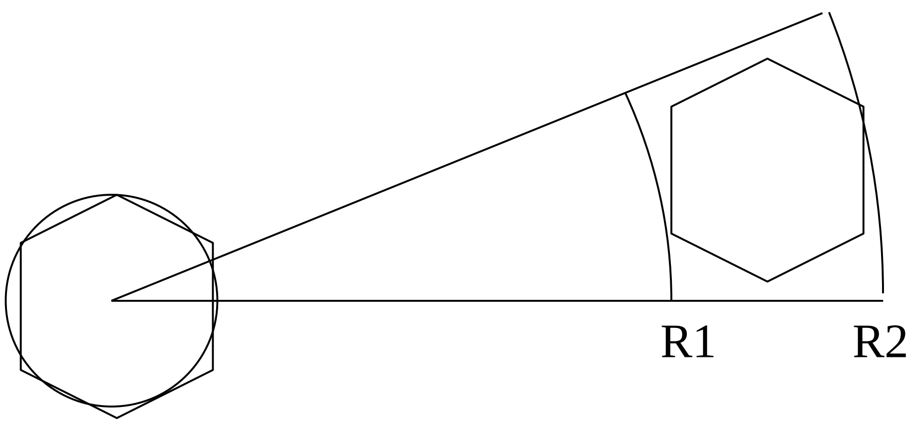
Homework 3 (due May 15)

1. Perform a simulation study of a single server queue writing a simple discrete-time program, for the following cases (assume that arrivals cannot leave in the same slot they arrive):
   a) P[1 arrival]=P[2 arrivals]=a, P[0 arrivals]=1-2a, with a in [0,0.5]. Service time for each arrival is one slot. (i) Plot delay vs. utilization factor rho by varying a from 0 to 1/3; (ii) plot a realization of queue size vs time for 10000 slots for a=1/4 ,1/3 and 1/2 and comment.
   b) P[1 arrival]=1-P[0 arrivals]=0.5, service time for each arrival is a geometric number of slots with mean 1/b. (i) Plot delay vs. rho by varying b from 0.5 to 1; (ii) plot a realization of queue size vs time for 10000 slots for b=1/3, 1/2, 2/3;
   c) For all cases in (ii) above, find the queue size for which P[overflow]=0.00001
   d) (optional) derive the analytical results from queueing theory and compare
2. Compute outage probabilities (plot vs. activity of interferers for six cells and reuse factor N=1, 3, 4, 7), capture probabilities (plot vs. collision size n), and throughput of slotted ALOHA vs. G. Compare results obtained using (i) Monte-Carlo simulation and (ii) Numerical computation via GQR. In all cases, use SIR threshold b=6 and 10 dB, sigma = 8 dB
3. Perform a simulation study of the multihop performance of GeRaF using (i) Monte-Carlo simulation and (ii) Numerical evaluation (bounds) via the recursive approach. Show same figures as Figs. 1-2-3, 8-9-10 in the paper

Homework 3 – Exercise 2

1. Approximate the intended user's cell with a circle
2. Approximate the interfering cells with a segment of circular ring: since for the uplink the only important parameter is the distance from the center of the intended cell, the angular coordinate is irrelevant so you just need to average between R1 and R2 over the pdf of r (which is h(r)=2r/(R2^2-R1^2))



$$P_s(r_0) = \int_{-\infty}^{\infty} \frac{d\xi_0}{\sqrt{2\pi}\sigma} e^{-\frac{\xi_0^2}{2\sigma^2}} [I(\xi_0, r_0)]^k$$

where

$$I(\xi_0, r_0) = \int_{-\infty}^{\infty} \frac{d\xi}{\sqrt{2\pi}\sigma} e^{-\frac{\xi^2}{2\sigma^2}} \int_{R1}^{R2} \frac{h(r)dr}{1 + be^{\xi-\xi_0}\left(\frac{r}{r_0}\right)^{-\eta}}.$$

3. Average P_s(r0) over the distribution of the the number of active interferers, which is Binomial with n=6 and p=α, you get in the integral (1-α+αI)^6
4. Average the result over the pdf of r0, i.e., 2r0/R^2, between 0 and R, where R is the radius of the approximating circle for the intended cell (~0.91)
5. Of course, P[outage] = 1-E[P_s(r0)]