Homework 2
Simulation and Performance Evaluation
University of Trento

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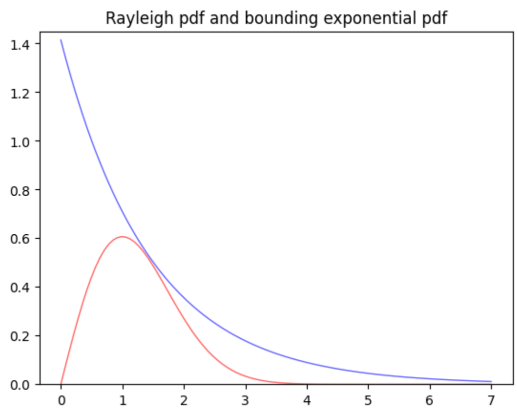
Exercise 1

We used rejection sampling to get samples from the Rayleigh and the Rice function, using an exponential bounding pdf. The results of the process can be seen in figures 1 and 2. In figures 1a and 2a it's possible to see the plot of the function being sampled (either Rayleigh or Rice) and the bounding exponential pdf. in figures 1b and 2b it's highlighted the similarity between the distribution of the accepted samples and the function themselves.

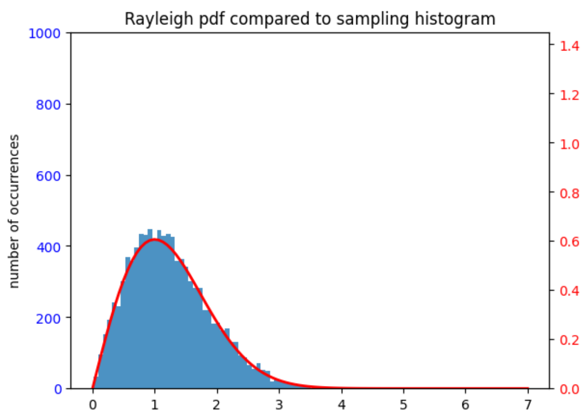
To minimize the number of attempts before a random variate is accepted both the mean and the scaling factor were adjusted, as modifying only one of them lead to sub-optimal results. We didn't use mathematical calculation to find the ideal values for those parameters, but rather manually modifies the values until a good enough solution was found. These are the results:

Function	**lambda**	**scaling factor**	**draws per accept**
Rayleigh	0.6897	2.05	2.035
Rice	0.25	2.15	2.15

Although those values are not the ideal ones they can significantly reduce the number of attempts required with respect to a non-tuned exponential. Ideally, for any value of lambda, the optimal scaling factor would be the one that makes the exponential pdf tangent to the function to be sampled.

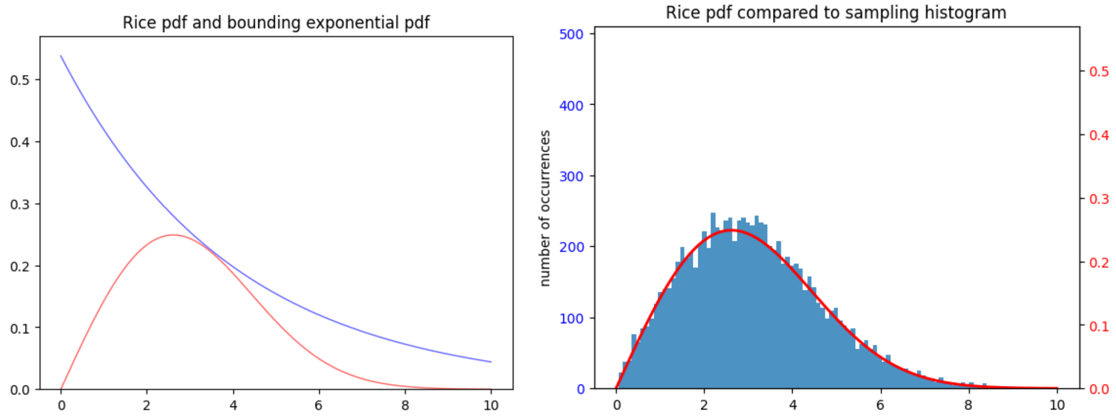


(a)



(b)

Figure 1: Rejection sampling of the Rayleigh function



(a) (b)

Figure 2: Rejection sampling of the Rice function

Exercise 2

2.1

We draw two number X1 and X2 that will be our coordinate in the space of [10m x 10m] representing the wireless terminal. As per request the density on the diagonals of the square is minimum and progressively increasing towards the four sides.

The first step is choosing the X1 and X2; we have obtained them from a random function which gives us a uniformly distributed number between 0 and 10. Then we increasingly remove points the more they are near the diagonals of the created square. The number of samples used are 10000 and for repeatability of the randomness of the data used the seed used is equal to 876567.

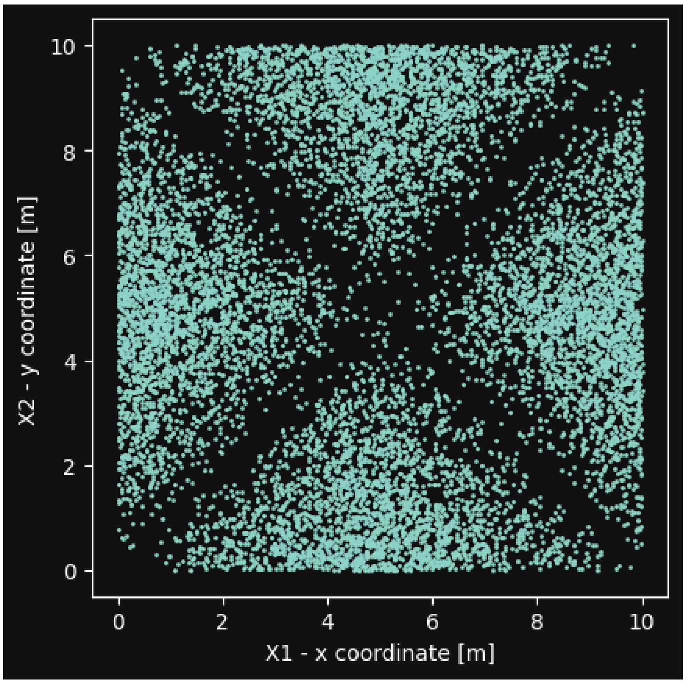


Figure 3: Distribution of wireless terminal

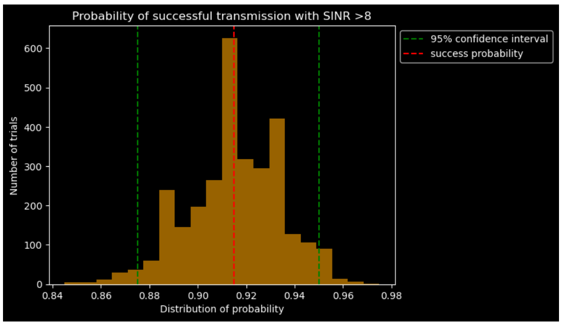
2.2/3

To establish the probability that two distinct terminal taken at random have to communicate given the condition that γ result greater than 8 we simulate 3000 trials in which we take 200 pairs of terminal and evaluate the possibility of communication. Then we take the mean of the probabilities obtained in each trial and the resulting probability is of 0.9150 as can be seen in 4a

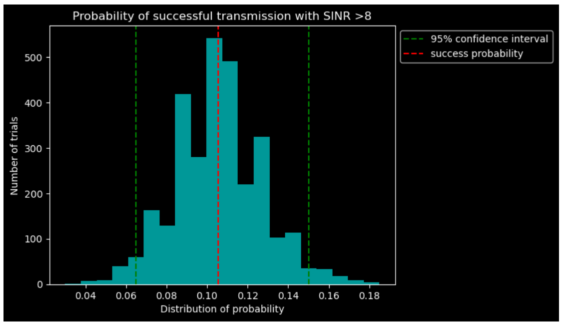
Our 95%-confidence interval, calculated using the Bootstrap Percentile Method, as depicted in the plot is [0.8750, 0.9500].

We also compute the same probability if there is a terminal that cause interference in the communication which resulted in a much smaller one than the previous of 0.1056 with 95%confidence interval equal to [0.0650, 0.1500] that can be seen in 4b

In the second case we can observe that for each successful communication the distance between the source terminal and the interference terminal is always bigger than the one between the source and the receiver. The same can't be said for the inverse.



(a) SNR



(b) SINR

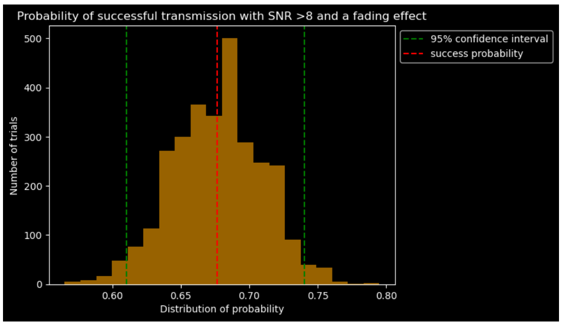
Figure 4: Graph to represent the probability of successful transmission

2.4

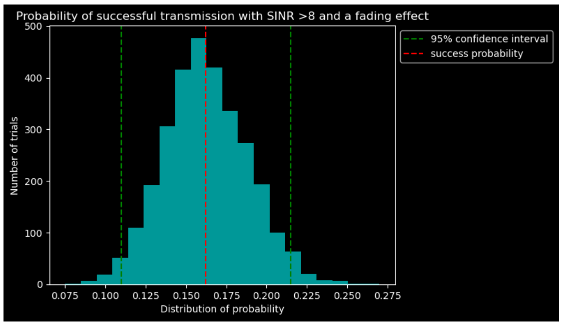
With the introduction of a fading factor the results are substantially different. The fading factor is randomly drawn from an exponential distribution with lambda equals to 1 for each transmission.

In the first case visible in 5a the probability of the values previously taken into consideration has become 0.6764 with 95% confidence interval of [0.6100, 0.7400]; it is a major worsening from the previous data.

In the second case in 5b we have the opposite: the probability of a successful transmission increase to 0.1621 because even the terminal creating the interference is subject to the fading factor himself so the impact it has is reduced. The new 95% confidence interval is [0.1100, 0.2150].



(a) SNR with fading effect



(b) SINR with fading effect

Figure 5: Graph to represent the probability of successful transmission

	Prob.	**Prob. with fading effect**
SNR	0.9120	0.6764
SINR	0.1055	0.1617

Table 1: Comparison