Computational Epidemiology Assignment #2

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1. About the probability distribution of the random walk

Before the analysis of the experiment result, it is helpful to gain an insight into the problem of what kind of distribution the random walk follows. It is obvious that the sample space is {Infected, Not Infected}, so the the resulting distribution is simply a Bernoulli distribution. Suppose a random variable X:

$$X = \begin{cases} 1 & \text{infected} \\ 0 & \text{not infected} \end{cases}$$

Given X, we have E(X) = P(X=1), meaning that probability of being infected equals to the mathematical expectation of random variable X. In probability theory, according to the law of large numbers (LLN), the average of the results obtained from a large number of trials should be close to the expected value, and will tend to become closer as more trials are performed. Thus, if we perform enough trials with respect to X, we can estimate the probability of being infected as the average of infected result.

For both parts of the experiment, we perform 400 trials on each setting, which may be large enough to keep the randomness at a relatively lower level and make the result stable.

2. The experiment

2.1. Vary the number of contaminants in the grid

The experiment is done with the setting: 100×100 gird, each walker take 100 random moves, and the number of contaminants is in $\{1, 5, 10, 20, 50, 100\}$. The result is shown by Figure 1. The probability of being infected increases as the number of contaminants increases. It is very intuitive to explain the result in this way: suppose we have a grid with N contaminants in N cells. In case 1, the walker is not infected after the walk. If we keep the N contaminants in the same cells and put more contaminants in other cells, the walk will probably get infected. In case 2, the walker get infected. The walker is also infected if we put more contaminants in grid. This means the probability never decrease as the number of contaminants increases. In fact, when we increase the number of contaminants, the probability of being infected (P(X) = 1) increases as shown by Figure 1.

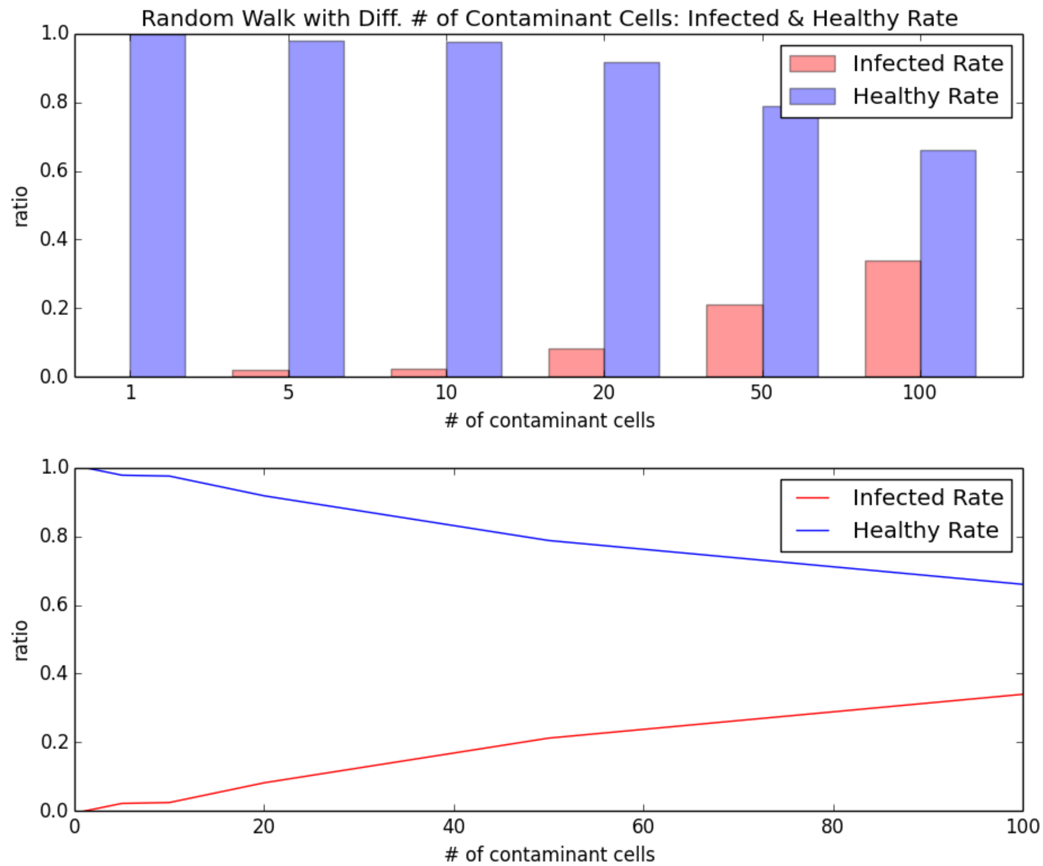

Figure 1: Resulting probability for different number of contaminants

2.2 Vary the number of moves to take

In this experiment, we must keep the number of contaminants fixed, and in order to make the result more evident, the number of contaminants is set to be 50, leading to the setting: 100×100 gird, the number of moves in {5, 20, 50, 100, 150, 200}, and the number of contaminants is 50. The result, as shown by Figure 2, indicates that the probability of being infected increases as the number of moves increases. This can also be explained intuitively in similar way as previous experiment: In case 1, after N moves, the walker is not infected. If the walker take more moves, he will probably get infected. In case 2, the walker is infected, and no matter how many moves he continues to take, he is already infected. As shown by Figure 2, when we increase the number of moves, the probability of being infected (P(X) = 1) increases.

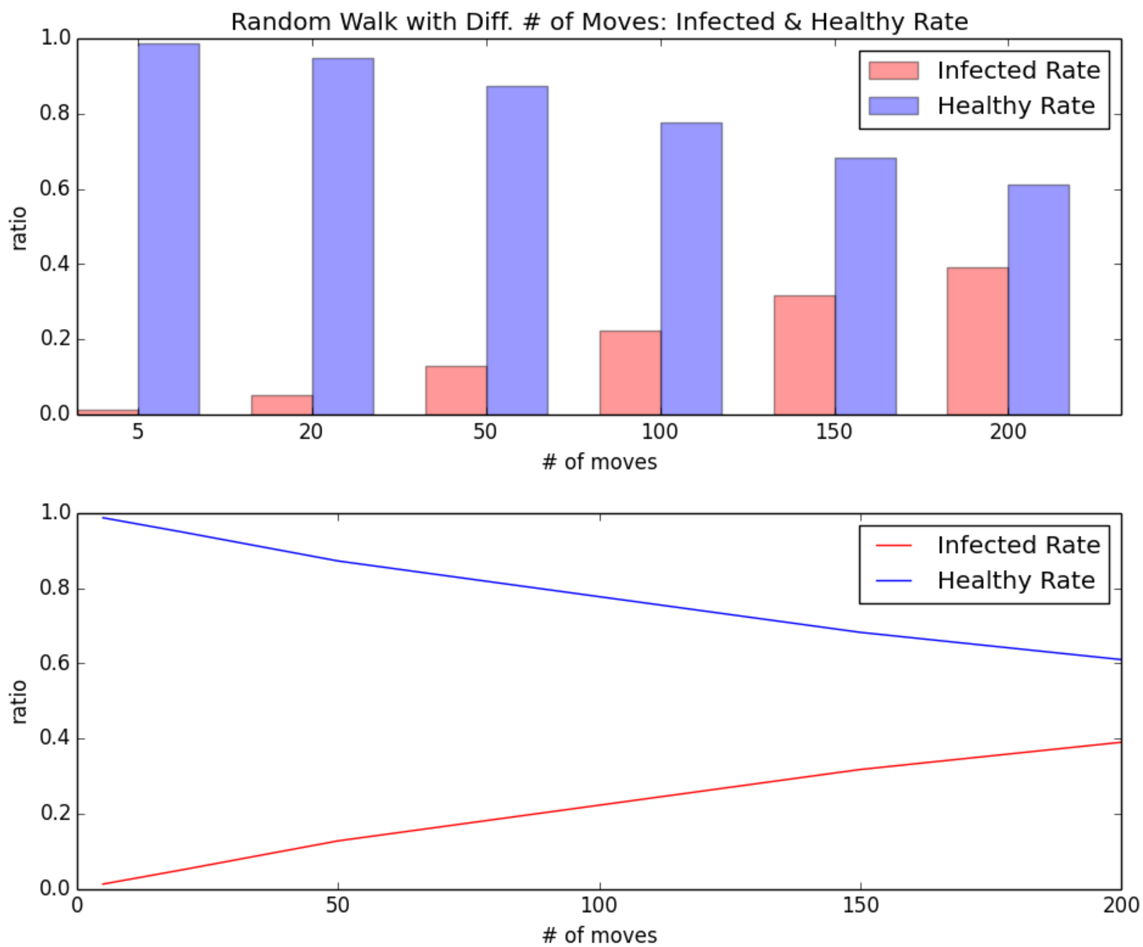

Figure 2: Resulting probability for different number of moves