

1 Average generations until equilibrium

There are lots of parameters that may affect the average generations until the equilibrium. We chose to look at the influence of the Happiness Rule(HR) on the average generations. For each HR ranging from 0 to 1 with increment 0.01, we ran 500 simulations and calculated the average, maximal and minimal generations it took to reach the equilibrium. The result is shown in figure 1.

In figure 1, we see that the average generations(blue graph) is increasing together with the Happiness Rule, which is expected since a higher HR requires more neighbours of the same type. We also see that at around a HR of 0.7, the average generations becomes more or less constant. That is also expected, because the requirement for the neighbours will be the same. For example, with a happiness of 0.8, a person with 3, 5 or 8 neighbours would require respectively 3, 5 or at least 7 of the same types. This requirement won't change much if a HR of 0.9 is applied. The same argument also explains why the average generations is constant at very low HR or for HR with little difference(Actually, it would be better to choose an increment of 0.1).

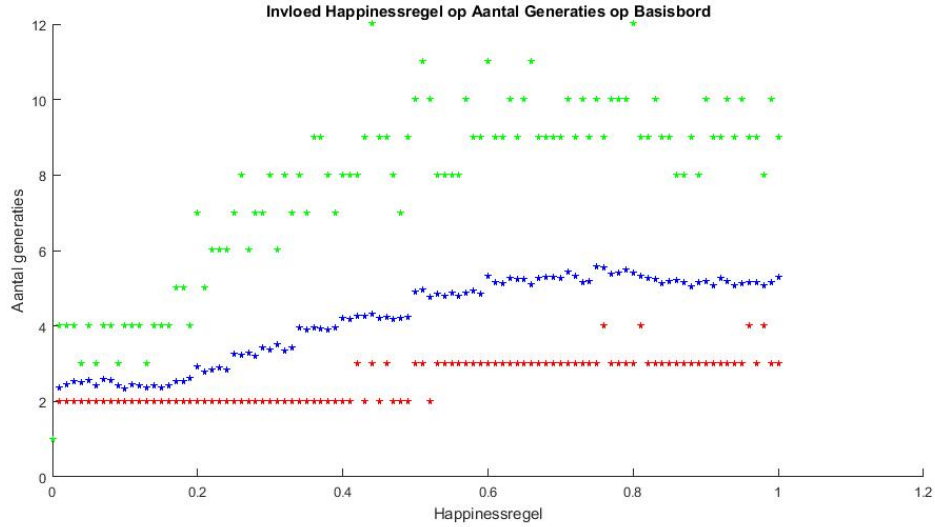
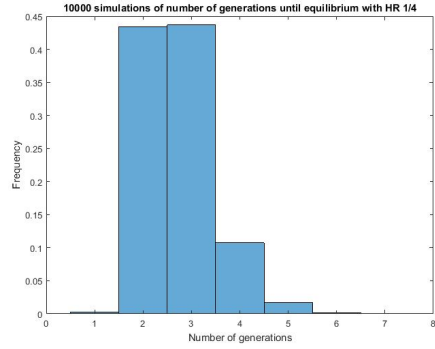


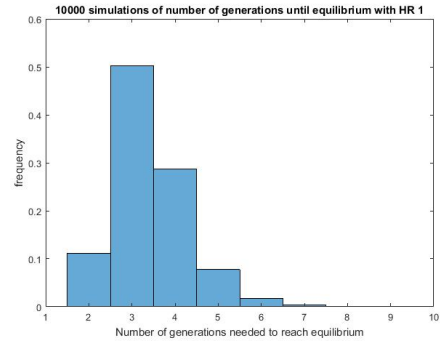
Figure 1: Influence of happiness rule on the number of generations until reaching the equilibrium. The green graph shows the maximal generations, the blue graph shows the average generations and the red graph shows the minimal generations

It is also interesting to know how the random variable Y , which we denote as the number of generations it takes to reach the equilibrium is distributed. Since Y depends on the position of each individual, whose position also depends on other individuals, the probability distribution of Y might be complicated. Therefore, we approximated the distribution of Y with a histogram (figure 2) of bin size 1, which is reasonable because Y only takes integer values. Also, to look at the influence of the HR on the distribution of Y , we made histograms for HR of $1/4$, $1/3$, $1/2$ and 1. We believe that the histograms are a good model for the distribution for Y , since according to the law of large number, the histogram will converge to the actual distribution and it is obtained after 10000 simulations.

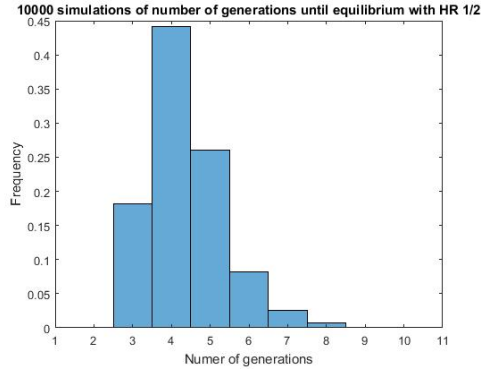
From figure 2, we see the distribution of Y is quite similar to the binomial distribution. But we don't think that it is binomially distributed because more simulation does not give a more symmetrical distribution. It is not clear for us yet how it is distributed.



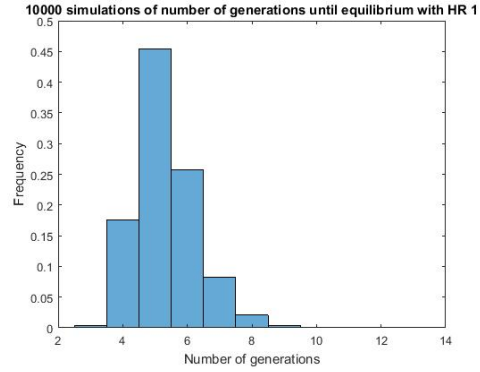
(a) 10000 simulations of number of generations until equilibrium with HR 1/4



(b) 10000 simulations of number of generations until equilibrium with HR 1/3



(c) 10000 simulations of number of generations until equilibrium with HR 1/2



(d) 10000 simulations of number of generations until equilibrium with HR 1

Figure 2: The probability distribution of Y (the number of generations until reaching the equilibrium) is approximated with a histogram of bin size 1. For each HR(1/4, 1/3, 1/2 and 1), 10000 simulations were ran