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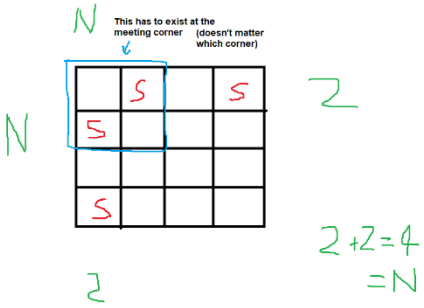
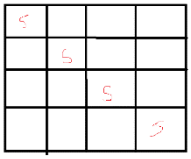
# Epidemic report

In our universes, the disease is able to spread by a vunerable person being located adjacent to at least 2 sick people. This is the only precondition required as any universe requires this to happen at least once in order for everyone to get sick.

Our universes can come in two primary shapes, an NxN which is a square or an MxN which is a rectangle. Because these are different shapes they require a different amount of minimum people in order for the disease to affect the entire vunerable population.

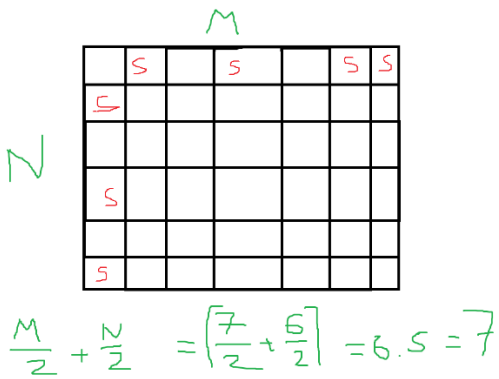
In an NxN (square) universe, the minimum number of sick people in order for the disease to spread throughout the universe is simply the value of N. This can be done generally by have a sick person every second column in both the rows and columns. The only requirement for this to work in all cases is that the first sick people where the sick row and column meet have to be diagonal to each other.



In the NxN universe the sick people initially have to be spread out like this or in a diagonal along the widest part of the square in order for the disease to spread. As long as this condition of the first two being diagonal is met, the disease will successfully spread throughout the universe.

In an M x N matrix the case is different. In order for everyone to get sick, the minimum initial sick people is roundedup(M/2) + roundedup(N/2). While the initial amount of sick people differs, the layout remains almost the same.



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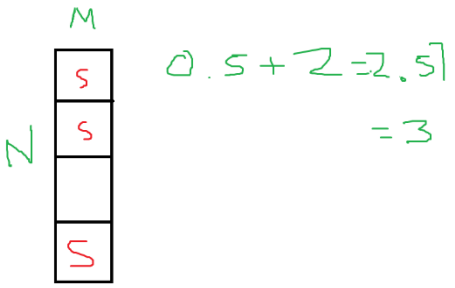
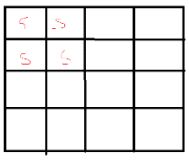
The only difference here is that the final column of the longest side, has to be sick in order for the disease to be able to spread to the final column. Once again the precondition for this to work is that the first two sick cells have to be diagonal to each other.

Even in special cases like 1xN work. The condition of course being that both ends of the matrix have to be sick.




The things that prevent an entire universe getting sick stems from where the intially infected are located. If they are not in the ideal starting positions as describe above, usually a row or column will remain uninfected at the end. This is particularly true of all the sick people are clumped together in either a square, row or column as then this acts as a separate universe and the vunerable won't be affected.



Once immune people are added to the universe finding a generalization for the minimum becomes more difficult because it now depends both on where the immune exists and where the sick people are located. Ultimately it means that the disease might not be as likely to spread and so our previous generalizations don't work. This is because an immune person could block the path for the infection to reach vunerable people. Occassionally it appears that the minimum required to make the disease spread is either min(immune free world) + 1. This of course does not work in all cases but does work in quite a few. For example this doesn't work if there are two immune people that are next to each other however and you could potentially need another person. Alternatively if all the immune people block a complete row you can treat the matrix on either side of the immune blockade as separate universes. For the min(immune free world) + 1 equation to work, the extra sick person has to be diagonal to a immune person and also not next to a sick person/s. This extra person being sick allows the disease to spread around the immune person.

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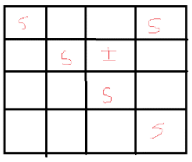

While sometimes adding another sick person to the universe does allow the disease to spread throughout the universe, it is important to note that there are many cases in which this equation does not work. This is because there are many various ways that the immune people could start the universe in. For example if the immune people create a box or circle around cells in the universe the strategy of just adding one more sick person wouldn't work, youd have to consider this universe as separate and fill it up with the min required amount of sick people. This makes it very hard to find a general solution for when immune people are located in the universe.