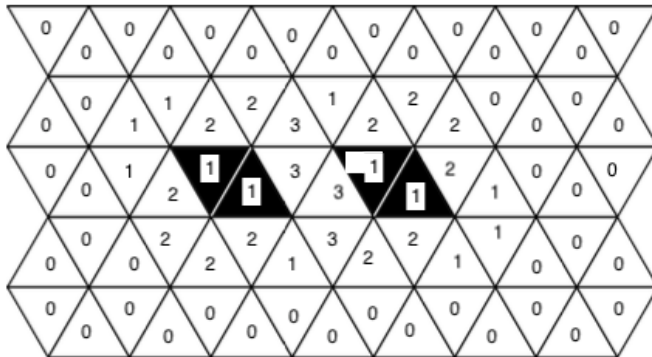
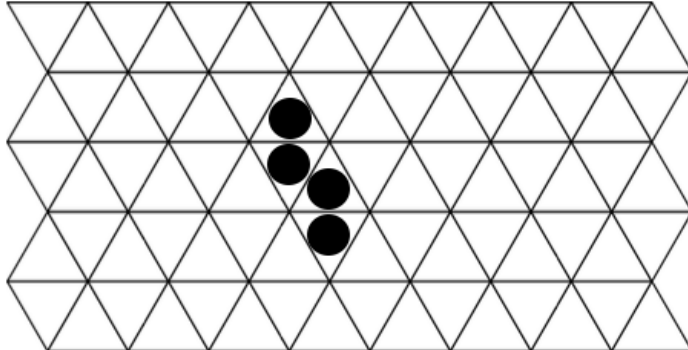


a.

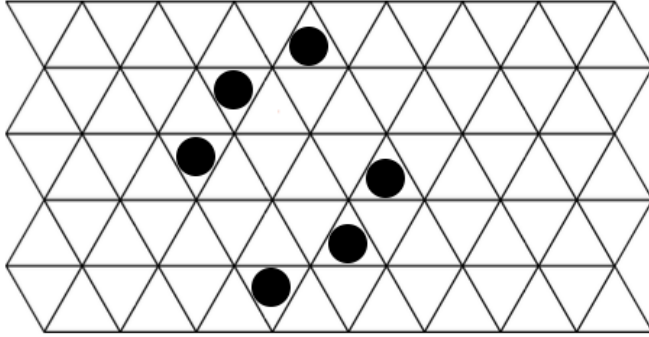


T=1:

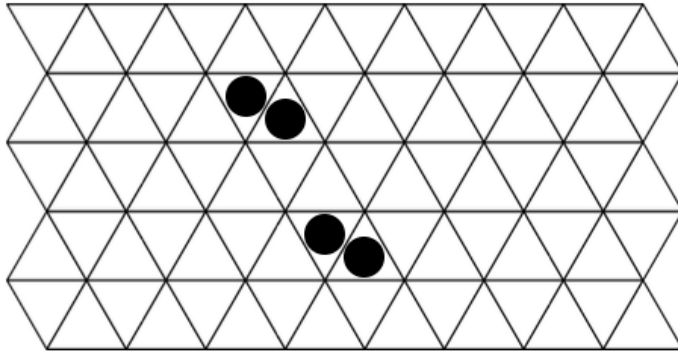


A triangular grid of 16 columns and 4 rows of triangles. In the center, there is a hexagonal arrangement of 7 black dots. The dots are located at the vertices of a central hexagon, with one additional dot at the center of that hexagon.

T=3:



T=4:



c.

If (i+j) even

$$N(i, j) = q_{(i-1, j-2)} + q_{(i-1, j-1)} + q_{(i-1, j)} + q_{(i-1, j+1)} + q_{(i, j+2)} + q_{(i, j-2)} + q_{(i, j-1)} + q_{(i, j+1)} + q_{(i, j+2)} + q_{(i+1, j-1)} + q_{(i+1, j)} + a_{(i+1, j+1)}$$

If (i+j) odd

$$N(i, j) = q_{(i-1, j-1)} + q_{(i-1, j)} + q_{(i-1, j+1)} + q_{(i, j-2)} + q_{(i, j-1)} + q_{(i, j+1)} + q_{(i, j+2)} + q_{(i+1, j-2)} + q_{(i+1, j-1)} + q_{(i+1, j)} + q_{(i+1, j+1)} + a_{(i+1, j+2)}$$

d.

$$\delta(q_{i, j}) = 1 \quad \text{if } N(i, j) = 3 \text{ or } (q_{i, j} = 1 \text{ and } N(i, j) = 2)$$

$$\delta(q_{i, j}) = 0 \quad \text{otherwise}$$

4.2 Simulating a JK Flip-Flop

a.

x(t)		q(t)	$\lambda(q)$	$\delta(q,x)$
j(t)	k(t)			
0	0	0	0	0
0	0	1	1	1
0	1	0	0	0
0	1	1	1	0
1	0	0	0	1
1	0	1	1	1
1	1	0	0	1
1	1	1	1	0

b.

t	0	1	2	3	4	5	6	7	8	9
j(t)	0	1	0	1	1	0	0	1	0	0
k(t)	1	0	1	1	1	0	1	0	1	0
q(t)	0	0	1	0	1	0	0	0	1	0
y(t)	0	0	1	0	1	0	0	0	1	0

4.3 Modeling Covid 19

a.

$$\delta(S, dS/dt, \Delta t) = S(t) + \Delta t * dS/dt$$

$$\delta(I, dI/dt, \Delta t) = I(t) + \Delta t * dI/dt$$

$$\delta(R, dR/dt, \Delta t) = R(t) + \Delta t * dR/dt$$

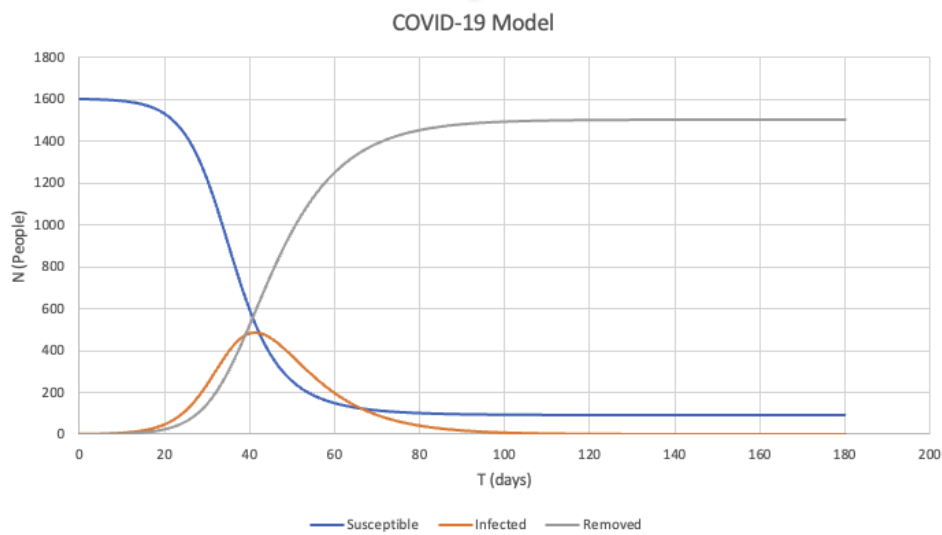
b.

$$\beta/\gamma = R_0 = 3$$

$$1/\gamma = 10 \rightarrow \gamma = 1/10$$

$$\beta/(1/10) = 3 \rightarrow \beta = 3/10$$

c.



d.

Peak infected: 484.78 at $t = 41.2$ days

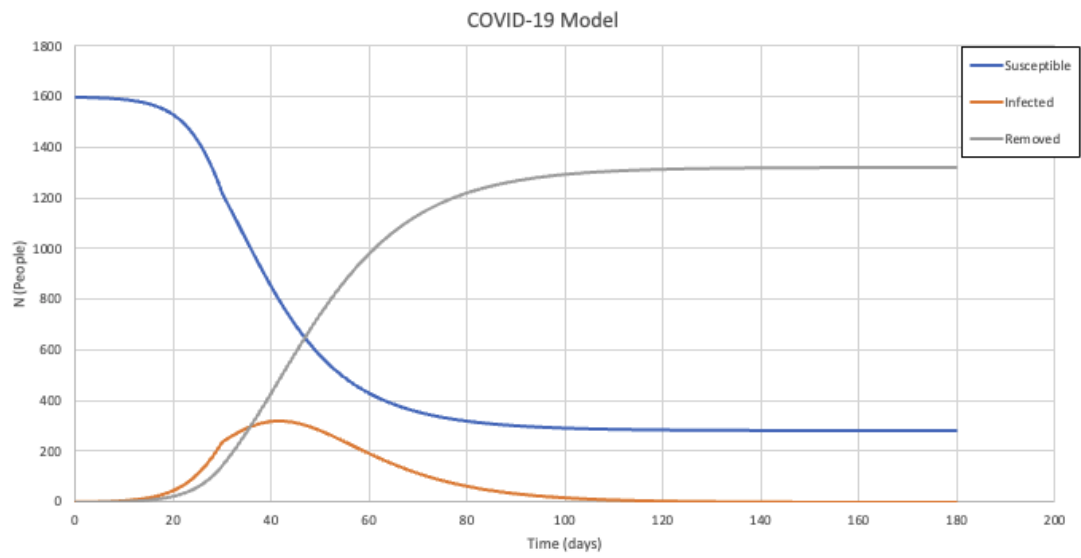
e.

$$0.2 * 1506.77 = 30.135 \text{ deaths}$$

f.

i. $R_0 = \beta/\gamma = 0.2/0.1 = 2$

ii.



iii.

Peak infections: 320.743 at $t = 41.6$ days

iv.

$$0.2 * 1321.49 = 26.43 \text{ deaths}$$