```
> #I was confused by Q1 I'm not sure what to use for the number of
  succeptible and infected people
> for i from 1 to 20 do
    beta := i * 0.01;
    SIRS(s, i, beta, g, nu, 1000)
  end
```

$$\beta := 0.01$$
$$[-1.21\, s + 1198.8, 0.01\, s - 1.2]$$
$$\beta := 0.02$$
$$[-1.24\, s + 1197.6, 0.04\, s - 2.4]$$
$$\beta := 0.03$$
$$[-1.29\, s + 1196.4, 0.09\, s - 3.6]$$
$$\beta := 0.04$$
$$[-1.36\, s + 1195.2, 0.16\, s - 4.8]$$
$$\beta := 0.05$$
$$[-1.45\, s + 1194.0, 0.25\, s - 6.0]$$
$$\beta := 0.06$$
$$[-1.56\, s + 1192.8, 0.36\, s - 7.2]$$
$$\beta := 0.07$$
$$[-1.69\, s + 1191.6, 0.49\, s - 8.4]$$
$$\beta := 0.08$$
$$[-1.84\, s + 1190.4, 0.64\, s - 9.6]$$
$$\beta := 0.09$$
$$[-2.01\, s + 1189.2, 0.81\, s - 10.8]$$
$$\beta := 0.10$$
$$[-2.20\, s + 1188.0, 1.00\, s - 12.0]$$
$$\beta := 0.11$$
$$[-2.41\, s + 1186.8, 1.21\, s - 13.2]$$
$$\beta := 0.12$$
$$[-2.64\, s + 1185.6, 1.44\, s - 14.4]$$
$$\beta := 0.13$$
$$[-2.89\, s + 1184.4, 1.69\, s - 15.6]$$
$$\beta := 0.14$$
$$[-3.16\, s + 1183.2, 1.96\, s - 16.8]$$

$$\beta := 0.15$$

$$[-3.45\,s + 1182.0,\ 2.25\,s - 18.0]$$

$$\beta := 0.16$$

$$[-3.76\,s + 1180.8,\ 2.56\,s - 19.2]$$

$$\beta := 0.17$$

$$[-4.09\,s + 1179.6,\ 2.89\,s - 20.4]$$

$$\beta := 0.18$$

$$[-4.44\,s + 1178.4,\ 3.24\,s - 21.6]$$

$$\beta := 0.19$$

$$[-4.81\,s + 1177.2,\ 3.61\,s - 22.8]$$

$$\beta := 0.20$$

$$[-5.20\,s + 1176.0,\ 4.00\,s - 24.0] \quad \textbf{(1)}$$

```
> a1:=rand(1..100)(): a2:=rand(1..100)():[a1,a2];SEquP(ChemoStat(N,
  C,a1,a2),[N,C]);
```

$$[93, 45]$$

$$\{[4183.989130,\ 0.01086956522]\} \quad \textbf{(2)}$$

```
> #Q2
> for i from 1 to 20 do
    a1:=rand(1..100)(): a2:=rand(1..100)():[a1,a2];SEquP(ChemoStat
  (N,C,a1,a2),[N,C]);
  end;
```

$$a1 := 80$$

$$a2 := 96$$

$$[80, 96]$$

$$\{[7678.987342,\ 0.01265822785]\}$$

$$a1 := 11$$

$$a2 := 23$$

$$[11, 23]$$

$$\{[251.9000000,\ 0.1000000000]\}$$

$$a1 := 41$$

$$a2 := 52$$

$$[41, 52]$$

$$\{[2130.975000,\ 0.02500000000]\}$$

$$a1 := 58$$

$$a2 := 67$$
$$[58, 67]$$
$$\{[3884.982456, 0.01754385965]\}$$
$$a1 := 81$$
$$a2 := 65$$
$$[81, 65]$$
$$\{[5263.987500, 0.01250000000]\}$$
$$a1 := 69$$
$$a2 := 2$$
$$[69, 2]$$
$$\{[136.9852941, 0.01470588235]\}$$
$$a1 := 36$$
$$a2 := 61$$
$$[36, 61]$$
$$\{[2194.971429, 0.02857142857]\}$$
$$a1 := 84$$
$$a2 := 96$$
$$[84, 96]$$
$$\{[8062.987952, 0.01204819277]\}$$
$$a1 := 94$$
$$a2 := 31$$
$$[94, 31]$$
$$\{[2912.989247, 0.01075268817]\}$$
$$a1 := 81$$
$$a2 := 31$$
$$[81, 31]$$
$$\{[2509.987500, 0.01250000000]\}$$
$$a1 := 54$$
$$a2 := 67$$
$$[54, 67]$$
$$\{[3616.981132, 0.01886792453]\}$$
$$a1 := 59$$
$$a2 := 66$$
$$[59, 66]$$

$$\{[3892.982759, 0.01724137931]\}$$
$$a1 := 12$$
$$a2 := 49$$
$$[12, 49]$$
$$\{[586.9090909, 0.09090909091]\}$$
$$a1 := 90$$
$$a2 := 35$$
$$[90, 35]$$
$$\{[3148.988764, 0.01123595506]\}$$
$$a1 := 15$$
$$a2 := 26$$
$$[15, 26]$$
$$\{[388.9285714, 0.07142857143]\}$$
$$a1 := 100$$
$$a2 := 24$$
$$[100, 24]$$
$$\{[2398.989899, 0.01010101010]\}$$
$$a1 := 8$$
$$a2 := 63$$
$$[8, 63]$$
$$\{[502.8571429, 0.1428571429]\}$$
$$a1 := 78$$
$$a2 := 23$$
$$[78, 23]$$
$$\{[1792.987013, 0.01298701299]\}$$
$$a1 := 73$$
$$a2 := 22$$
$$[73, 22]$$
$$\{[1604.986111, 0.01388888889]\}$$
$$a1 := 32$$
$$a2 := 98$$
$$[32, 98]$$
$$\{[3134.967742, 0.03225806452]\}$$ **(3)**

```
> #it seems like they all find a stable state
```

```
#Q3:
> SIRSdemo(1000, 400, 1, 1, 0.01, 10)
```

This is a numerical demonstration of the R0 phenomenon in the SIRS model using discretization with mesh size=, 0.01, *and letting it run until time t=*, 10

with population size, 1000, *and fixed parameters nu=*, 1, *and gamma=*, 1

*where we change beta from 0.2*nu/N to 4*nu/N*

Recall that the epidemic will persist if beta exceeds nu/N, that in this case is, $\frac{1}{1000}$

We start with , 400, *infected individuals, 0 removed and hence*, 600, *susceptible*

We will show what happens once time is close to, 10

beta is , $\frac{1}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [999.6693512, 0.04464970605]], [9.99, [999.6721666, 0.04424784393]], [10.00, [999.6749582, 0.04384959883]], [10.01, [999.6777263, 0.04345493819]]]

beta is , $\frac{3}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [998.8686058, 0.2679278925]], [9.99, [998.8764375, 0.2660514879]], [10.00, [998.8842153, 0.2641882307]], [10.01, [998.8919395, 0.2623380288]]]

beta is , $\frac{1}{2}$, *times the threshold value*

the long-term behavior is

[[9.98, [995.5661036, 1.464972088]], [9.99, [995.5885005, 1.457614750]], [10.00, [995.6107835, 1.450294524]], [10.01, [995.6329532, 1.443011223]]]

beta is , $\frac{7}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [982.9907292, 6.871557578]], [9.99, [983.0448236, 6.850124744]], [10.00, [983.0987363, 6.828761355]], [10.01, [983.1524679, 6.807467168]]]

beta is , $\frac{9}{10}$, *times the threshold value*

the long-term behavior is

[[9.98, [944.9550913, 25.07830676]], [9.99, [945.0414764, 25.04080455]], [10.00, [945.1276722, 25.00337789]], [10.01, [945.2136792, 24.96602657]]]

$$\textit{beta is}\ ,\ \frac{11}{10},\ \textit{times the threshold value}$$

the long-term behavior is

$$[[9.98, [866.8575732, 64.57449614]], [9.99, [866.9275067, 64.54449698]], [10.00, [866.9972772, 64.51456141]], [10.01, [867.0668854, 64.48468924]]]$$

$$\textit{beta is}\ ,\ \frac{13}{10},\ \textit{times the threshold value}$$

the long-term behavior is

$$[[9.98, [764.2055840, 117.1693099]], [9.99, [764.2277964, 117.1616555]], [10.00, [764.2499053, 117.1540354]], [10.01, [764.2719113, 117.1464495]]]$$

$$\textit{beta is}\ ,\ \frac{3}{2},\ \textit{times the threshold value}$$

the long-term behavior is

$$[[9.98, [667.4467215, 166.2827762]], [9.99, [667.4446531, 166.2847218]], [10.00, [667.4425717, 166.2866623]], [10.01, [667.4404774, 166.2885977]]]$$

$$\textit{beta is}\ ,\ \frac{17}{10},\ \textit{times the threshold value}$$

the long-term behavior is

$$[[9.98, [588.7326192, 205.7837146]], [9.99, [588.7278789, 205.7854544]], [10.00, [588.7231678, 205.7871777]], [10.01, [588.7184858, 205.7888844]]]$$

$$\textit{beta is}\ ,\ \frac{19}{10},\ \textit{times the threshold value}$$

the long-term behavior is

$$[[9.98, [526.3391708, 236.9273141]], [9.99, [526.3371276, 236.9274194]], [10.00, [526.3351118, 236.9275155]], [10.01, [526.3331234, 236.9276024]]]$$

$$\textit{beta is}\ ,\ \frac{21}{10},\ \textit{times the threshold value}$$

the long-term behavior is

$$[[9.98, [476.0755911, 261.9954214]], [9.99, [476.0755589, 261.9947893]], [10.00, [476.0755398, 261.9941570]], [10.01, [476.0755336, 261.9935246]]]$$

$$\textit{beta is}\ ,\ \frac{23}{10},\ \textit{times the threshold value}$$

the long-term behavior is

$$[[9.98, [434.6820669, 282.6567829]], [9.99, [434.6827642, 282.6561293]], [10.00, [434.6834631, 282.6554802]], [10.01, [434.6841635, 282.6548356]]]$$

$$beta\ is\ ,\ \frac{5}{2},\ times\ the\ threshold\ value$$

the long-term behavior is

[[9.98, [399.9447066, 300.0130619]], [9.99, [399.9454130, 300.0126472]], [10.00, [399.9461153, 300.0122378]], [10.01, [399.9468135, 300.0118336]]]

$$beta\ is\ ,\ \frac{27}{10},\ times\ the\ threshold\ value$$

the long-term behavior is

[[9.98, [370.3498315, 314.8101124]], [9.99, [370.3503056, 314.8099378]], [10.00, [370.3507743, 314.8097672]], [10.01, [370.3512378, 314.8096006]]]

$$beta\ is\ ,\ \frac{29}{10},\ times\ the\ threshold\ value$$

the long-term behavior is

[[9.98, [344.8255549, 327.5761726]], [9.99, [344.8257953, 327.5761533]], [10.00, [344.8260313, 327.5761363]], [10.01, [344.8262630, 327.5761215]]]

$$beta\ is\ ,\ \frac{31}{10},\ times\ the\ threshold\ value$$

the long-term behavior is

[[9.98, [322.5856476, 338.7004341]], [9.99, [322.5857299, 338.7004867]], [10.00, [322.5858094, 338.7005401]], [10.01, [322.5858863, 338.7005943]]]

$$beta\ is\ ,\ \frac{33}{10},\ times\ the\ threshold\ value$$

the long-term behavior is

[[9.98, [303.0363872, 348.4783244]], [9.99, [303.0363869, 348.4783944]], [10.00, [303.0363852, 348.4784644]], [10.01, [303.0363821, 348.4785344]]]

$$beta\ is\ ,\ \frac{7}{2},\ times\ the\ threshold\ value$$

the long-term behavior is

[[9.98, [285.7191728, 357.1389626]], [9.99, [285.7191408, 357.1390237]], [10.00, [285.7191083, 357.1390844]], [10.01, [285.7190753, 357.1391447]]]

$$beta\ is\ ,\ \frac{37}{10},\ times\ the\ threshold\ value$$

the long-term behavior is

[[9.98, [270.2735369, 364.8628645]], [9.99, [270.2735002, 364.8629086]], [10.00, [270.2734634, 364.8629522]], [10.01, [270.2734267, 364.8629953]]]

$$\textit{beta is}, \frac{39}{10}, \textit{times the threshold value}$$

the long-term behavior is

[[9.98, [256.4121907, 371.7940209]], [9.99, [256.4121603, 371.7940490]], [10.00, [256.4121301, 371.7940766]], [10.01, [256.4121001, 371.7941037]]] **(4)**

```
> HWgE(100, 1000.0)
```

0.5630000000 **(5)**

```
> for i from 1 to 10 do
    HWgE(100., 1000.)
  end
```

0.5590000000

0.5590000000

0.5840000000

0.5670000000

Error, (in HWgE) cannot determine if this expression is true or false: abs(FAIL[1]-1) < .1e-2 or abs(FAIL[2]-1) < .1e-2 or abs(FAIL[1]-FAIL[2]) < .1e-2

```
> #Q4: this took a long time to run but it looks like ~0.57 is the
  probability given random matrices
```