Problem 1:

> $i := 1$

> $SIRS(s, i, 0.01, 1.2, 1.2, 1000)$

> $i := 2$

> $SIRS(s, i, 0.01, 1.2, 1.2, 1000)$

> $i := 3$

> $SIRS(s, i, 0.01, 1.2, 1.2, 1000)$

> $i := 4$

> $SIRS(s, i, 0.01, 1.2, 1.2, 1000)$

> $i := 5$

> $SIRS(s, i, 0.01, 1.2, 1.2, 1000)$

> $i := 6$

> $SIRS(s, i, 0.01, 1.2, 1.2, 1000)$

> $i := 7$

> $SIRS(s, i, 0.01, 1.2, 1.2, 1000)$

> $i := 8$

> $SIRS(s, i, 0.01, 1.2, 1.2, 1000)$

$$i := 1$$
$$[-1.21\,s + 1198.8, 0.01\,s - 1.2]$$
$$i := 2$$
$$[-1.21\,s + 1198.8, 0.01\,s - 1.2]$$
$$i := 3$$
$$[-1.23\,s + 1196.4, 0.03\,s - 3.6]$$
$$i := 4$$
$$[-1.24\,s + 1195.2, 0.04\,s - 4.8]$$
$$i := 5$$
$$[-1.25\,s + 1194.0, 0.05\,s - 6.0]$$
$$i := 6$$
$$[-1.26\,s + 1192.8, 0.06\,s - 7.2]$$
$$i := 7$$
$$[-1.27\,s + 1191.6, 0.07\,s - 8.4]$$
$$i := 8$$
$$[-1.28\,s + 1190.4, 0.08\,s - 9.6]$$

the highlighted are removed

> $i := 9$

> $SIRS(s, i, 0.01, 1.2, 1.2, 1000)$

> $i := 10$

> $SIRS(s, i, 0.01, 1.2, 1.2, 1000)$

> $i := 11$

> $SIRS(s, i, 0.01, 1.2, 1.2, 1000)$

> $i := 12$

> $SIRS(s, i, 0.01, 1.2, 1.2, 1000)$

> $i := 13$

> $SIRS(s, i, 0.01, 1.2, 1.2, 1000)$

> $i := 14$

> $SIRS(s, i, 0.01, 1.2, 1.2, 1000)$

> $i := 15$

> $SIRS(s, i, 0.01, 1.2, 1.2, 1000)$

> $i := 16$

> $SIRS(s, i, 0.01, 1.2, 1.2, 1000)$

$$i := 9$$
$$[-1.29\,s + 1189.2, 0.09\,s - 10.8]$$
$$i := 10$$
$$[-1.30\,s + 1188.0, 0.10\,s - 12.0]$$
$$i := 11$$
$$[-1.31\,s + 1186.8, 0.11\,s - 13.2]$$
$$i := 12$$
$$[-1.32\,s + 1185.6, 0.12\,s - 14.4]$$
$$i := 13$$
$$[-1.33\,s + 1184.4, 0.13\,s - 15.6]$$
$$i := 14$$
$$[-1.34\,s + 1183.2, 0.14\,s - 16.8]$$
$$i := 15$$
$$[-1.35\,s + 1182.0, 0.15\,s - 18.0]$$
$$i := 16$$
$$[-1.36\,s + 1180.8, 0.16\,s - 19.2]$$

> $i := 17$

$$i := 17$$

> $SIRS(s, i, 0.01, 1.2, 1.2, 1000)$

$$[-1.37\,s + 1179.6, 0.17\,s - 20.4]$$

> $i := 18$

$$i := 18$$

> $SIRS(s, i, 0.01, 1.2, 1.2, 1000)$

$$[-1.38\,s + 1178.4, 0.18\,s - 21.6]$$

> $i := 19$

$$i := 19$$

> $SIRS(s, i, 0.01, 1.2, 1.2, 1000)$

$$[-1.39\,s + 1177.2, 0.19\,s - 22.8]$$

> $i := 20$

$$i := 20$$

> $SIRS(s, i, 0.01, 1.2, 1.2, 1000)$

$$[-1.40\,s + 1176.0, 0.20\,s - 24.0]$$

Problem 2:

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

$[93, 45]$

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

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

$[44, 100]$

$\{[4398.976744, 0.02325581395]\}$ (3)

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

$[38, 69]$

$\{[2620.972973, 0.02702702703]\}$ (4)

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

$[27, 96]$

$\{[2590.961538, 0.03846153846]\}$ (5)

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

$[17, 90]$

$\{[1528.937500, 0.06250000000]\}$ (6)

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

$[34, 18]$

$\{[610.9696970, 0.03030303030]\}$ (7)

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

$[52, 56]$

$\{[2910.980392, 0.01960784314]\}$ (8)

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

$[43, 83]$

$\{[3567.976190, 0.02380952381]\}$ (9)

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

$[25, 90]$

$\{[2248.958333, 0.04166666667]\}$ (10)

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

$[93, 60]$

$\{[5578.989130, 0.01086956522]\}$ (11)

all are stable

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

Page Break

[93, 14]

{[1300.989130, 0.01086956522]} (12)

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

[50, 47]

{[2348.979592, 0.02040816327]} (13)

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

[8, 46]

{[366.8571429, 0.1428571429]} (14)

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

[44, 9]

{[394.9767442, 0.02325581395]} (15)

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

[77, 59]

{[4541.986842, 0.01315789474]} (16)

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

[16, 1]

{[14.93333333, 0.06666666667]} (17)

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

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[70, 77]

{[5388.985507, 0.01449275362]} (18)

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

[39, 92]

{[3586.973684, 0.02631578947]} (19)

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

[71, 67]

{[4755.985714, 0.01428571429]} (20)

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

[78, 51]

{[3976.987013, 0.01298701299]} (21)

all are stable

>

Problem 3:

> 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]]]

beta is , $\frac{11}{10}$, *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]]] 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]]]

beta is , $\frac{13}{10}$, 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]]]

beta is , $\frac{3}{2}$, 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]]]

beta is , $\frac{17}{10}$, 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]]]

beta is , $\frac{19}{10}$, 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]]]

beta is , $\frac{21}{10}$, 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]]]

beta is , $\frac{23}{10}$, 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]]]

beta is , $\frac{39}{10}$, 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]]]

Problem 4:

> $HWgE(100, 1000);$

0.5500000000

> $HWgE(100, 1000);$

0.5280000000

> $HWgE(100, 1000);$

0.5710000000

> $HWgE(100, 1000);$

0.5480000000

> $HWgE(100, 1000);$

0.5510000000

> $HWgE(100, 1000);$

0.5810000000

> $HWgE(100, 1000);$

0.5640000000

>

> $HWgE(100, 1000);$

0.5430000000

> $HWgE(100, 1000);$

0.5510000000

>

> $HWgE(100, 1000);$

0.5410000000

answers are close together