

Homework for Lecture 14 of Dr. Z.'s Dynamical Models in Biology class

Email the answers (as .pdf file) to

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by 8:00pm Monday, Oct. 27, 2025.

Subject: hw14

with an attachment hw14FirstLast.pdf and/or hw14FirstLast.txt (preferred)

Using

<http://sites.math.rutgers.edu/~zeilberg/Bio25/DMB14.txt>

1. Copy-and-paste the following line into your worksheet (once you have downloaded and read DMB14.txt):

```
T:=RT([x],10);SSSg(T,[x]); SSg(T,[x],z);ORB(T,[x],[6.],1000,1010)[-1];
```

Run it **twenty** times. Out of these twenty times, how many times did the first and third numbers agree?

2. Copy-and-paste the following line into your worksheet (once you have downloaded and read DMB14.txt):

```
T:=RT([x,y],10);SSg(T,[x,y]); SSSg(T,[x,y]);ORB(T,[x,y],[6.,8.],1000,1010)[-1];
```

Run it **twenty** times. Out of these twenty times, how many times did the first and third numbers agree?

3. Copy-and-paste the following line into your worksheet (once you have downloaded and read DMB14.txt):

```
T:=RT([x,y,z],10);SSg(T,[x,y,z]); SSSg(T,[x,y,z]);
```

```
ORB(T,[x,y,z],[6.,8.,11.],1000,1010)[-1];
```

Run it **twenty** times. Out of these twenty times, how many times did the first and third numbers agree?

4. Copy-and-paste the following line into your worksheet (once you have downloaded and read DMB14.txt):

```
f:=RR([z[1],z[2]],10); T:=RecToTs(2,z,f);SSg(T,[z[1],z[2]]); SSSg(T,[z[1],z[2]]);
```

```
Orbk(2,z,f,[5.,8.],2000,2010)[-1];
```

5. Copy-and-paste the following line into your worksheet (once you have downloaded and read DMB14.txt):

```
f:=RR([z[1],z[2],z[3]],10); T:=RecToTs(3,z,f);SSg(T,[z[1],z[2],z[3]]);  
SSSg(T,[z[1],z[2],z[3]]); Orbk(3,z,f,[5.,8.,11.],2000,2010)[-1];
```

Run it **twenty** times. Out of these twenty times, how many times did the last coordinate of the first point and the third numbers agree?

6. Copy-and-paste the following line into your worksheet (once you have downloaded and read DMB14.txt):

```
L:=rand(1..3)(); a:=rand(1..50)()/20.;c:=rand(1..50)()/20.; T:=NicholsonBailey(L,a,c,N,P)  
;SSg(T,[N,P]);SSSg(T,[N,P]);
```

Run it **twenty** times. Out of these twenty times, how many times did you get a non-empty set of stable steady-states? (ignore those that have an error message)

7. Copy-and-paste the following line into your worksheet (once you have downloaded and read DMB14.txt):

```
a:=rand(1..10)()/10.; r:=rand(1..10)()/10.; K:=rand(1..10)():  
T:=NicholsonBaileyM(a,r,K,14,N,P); SSSg(T,[N,P]);
```

Run it **100** times. Out of these fifty times, how many times did you get a non-empty set of stable steady-states? (ignore those that have an error message)

read`DMB.txt`

*For a list of the Main procedures type: Help(); for help with a specific procedure type: Help
(ProcedureName); for example Help(Feig);* **(1)**

#Question 1

$T := RT([x], 10); SSSg(T, [x]); SSg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1];$

$$T := \left[\frac{7 + 10x}{6 + 2x} \right]$$

$$\{[3.121320343]\}$$

$$[[-1.121320343], [3.121320343]]$$

$$[3.121320342]$$

(2)

$T := RT([x], 10); SSSg(T, [x]); SSg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1];$

$$T := \left[\frac{4 + 6x}{5 + x} \right]$$

$$\{[2.561552813]\}$$

$$[[-1.561552813], [2.561552813]]$$

$$[2.561552813]$$

(3)

$T := RT([x], 10); SSSg(T, [x]); SSg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1];$

$$T := \left[\frac{8 + 5x}{10 + 2x} \right]$$

$$\{[1.108495283]\}$$

$$[[-3.608495283], [1.108495283]]$$

$$[1.108495283]$$

(4)

$T := RT([x], 10); SSSg(T, [x]); SSg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1];$

$$T := \left[\frac{2 + 4x}{8 + 3x} \right]$$

$$\{[0.3874258863]\}$$

$$[[-1.720759220], [0.3874258863]]$$

$$[0.3874258867]$$

(5)

$T := RT([x], 10); SSSg(T, [x]); SSg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1];$

$$T := \left[\frac{9 + 10x}{2 + 8x} \right]$$

$$\{[1.672603940]\}$$

$$[[-0.6726039400], [1.672603940]]$$

$$\begin{aligned}
& [1.672603940] \\
T &:= RT([x], 10); SSSg(T, [x]); SSg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1]; \\
& T := \left[\frac{10 + 9x}{1 + 6x} \right] \\
& \{[2.119632982]\} \\
& [[-0.7862996483], [2.119632982]] \\
& [2.119632981] \\
T &:= RT([x], 10); SSSg(T, [x]); SSg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1]; \\
& T := \left[\frac{7 + 7x}{3 + 3x} \right] \\
& \{[2.333333333]\} \\
& [[2.333333333]] \\
& [2.333333333] \\
T &:= RT([x], 10); SSSg(T, [x]); SSg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1]; \\
& T := \left[\frac{5 + 3x}{8 + 10x} \right] \\
& \{[0.5000000000]\} \\
& [[-1.], [0.5000000000]] \\
& [0.5000000000] \\
T &:= RT([x], 10); SSSg(T, [x]); SSg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1]; \\
& T := \left[\frac{3 + x}{1 + 3x} \right] \\
& \{[1.]\} \\
& [[-1.], [1.]] \\
& [1.000000000] \\
T &:= RT([x], 10); SSSg(T, [x]); SSg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1]; \\
& T := \left[\frac{5 + 5x}{10 + 10x} \right] \\
& \{[0.5000000000]\} \\
& [[0.5000000000]] \\
& [0.5000000000]
\end{aligned}$$

$$T := RT([x], 10); SSSg(T, [x]); SSg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1];$$

$$\begin{aligned}
T &:= \left\lfloor \frac{10 + 2x}{8 + 4x} \right\rfloor \\
&\quad \{[1.]\} \\
&\quad [[-2.500000000], [1.]] \\
&\quad [1.000000000]
\end{aligned} \tag{12}$$

$$\begin{aligned}
T &:= RT([x], 10); SSSg(T, [x]); SSg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1]; \\
T &:= \left\lfloor \frac{2 + 9x}{5 + 9x} \right\rfloor \\
&\quad \{[0.7433795288]\} \\
&\quad [[-0.2989350844], [0.7433795288]] \\
&\quad [0.7433795290]
\end{aligned} \tag{13}$$

$$\begin{aligned}
T &:= RT([x], 10); SSSg(T, [x]); SSg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1]; \\
T &:= \left\lfloor \frac{7 + 4x}{3 + 10x} \right\rfloor \\
&\quad \{[0.8881527305]\} \\
&\quad [[-0.7881527305], [0.8881527305]] \\
&\quad [0.8881527310]
\end{aligned} \tag{14}$$

$$\begin{aligned}
T &:= RT([x], 10); SSSg(T, [x]); SSg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1]; \\
T &:= \left\lfloor \frac{9 + 10x}{4 + 9x} \right\rfloor \\
&\quad \{[1.387425886]\} \\
&\quad [[-0.7207592197], [1.387425886]] \\
&\quad [1.387425887]
\end{aligned} \tag{15}$$

$$\begin{aligned}
T &:= RT([x], 10); SSSg(T, [x]); SSg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1]; \\
T &:= \left\lfloor \frac{7 + 8x}{9 + x} \right\rfloor \\
&\quad \{[2.192582404]\} \\
&\quad [[-3.192582404], [2.192582404]] \\
&\quad [2.192582404]
\end{aligned} \tag{16}$$

$$\begin{aligned}
T &:= RT([x], 10); SSSg(T, [x]); SSg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1]; \\
T &:= \left\lfloor \frac{10 + 2x}{4 + 7x} \right\rfloor \\
&\quad \{[1.060878539]\}
\end{aligned}$$

$$[[-1.346592825], [1.060878539]]$$

$$[1.060878539]$$

(17)

$$T := RT([x], 10); SSSg(T, [x]); SSg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1];$$

$$T := \left[\frac{8+x}{6+4x} \right]$$

$$\{[0.9211646100]\}$$

$$[[-2.171164610], [0.9211646100]]$$

$$[0.9211646097]$$

(18)

$$T := RT([x], 10); SSSg(T, [x]); SSg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1];$$

$$T := \left[\frac{1+7x}{2+9x} \right]$$

$$\{[0.7116805376]\}$$

$$[[-0.1561249820], [0.7116805376]]$$

$$[0.7116805376]$$

(19)

$$T := RT([x], 10); SSSg(T, [x]); SSg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1];$$

$$T := \left[\frac{5+9x}{9+4x} \right]$$

$$\{[1.118033988]\}$$

$$[[-1.118033988], [1.118033988]]$$

$$[1.118033988]$$

(20)

$$T := RT([x], 10); SSSg(T, [x]); SSg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1];$$

$$T := \left[\frac{3+4x}{6+4x} \right]$$

$$\{[0.6513878188]\}$$

$$[[-1.151387819], [0.6513878188]]$$

$$[0.6513878189]$$

(21)

#The times that the first and the third agreed were all them if there was a little rounding.

#Question 2

$$T := RT([x, y], 10); SSg(T, [x, y]); SSSg(T, [x, y]); ORB(T, [x, y], [6., 8.], 1000, 1010)[-1];$$

$$T := \left[\frac{4+10x+8y}{2+7x+2y}, \frac{5+3x+5y}{7+5x+4y} \right]$$

$$[[1.745632788, 0.7464565858]]$$

$$\{[1.745632788, 0.7464565858]\}$$

$$[1.745632788, 0.7464565857] \quad (22)$$

$$T := RT([x, y], 10); SSg(T, [x, y]); SSSg(T, [x, y]); ORB(T, [x, y], [6., 8.], 1000, 1010)[-1];$$

$$T := \left[\frac{8 + 10x + 2y}{6 + 8x + 4y}, \frac{8 + 7x + 9y}{4 + 10x + 3y} \right]$$

$$[[1.051537188, 1.523154357]]$$

$$\{[1.051537188, 1.523154357]\}$$

$$[1.051537189, 1.523154359] \quad (23)$$

$$T := RT([x, y], 10); SSg(T, [x, y]); SSSg(T, [x, y]); ORB(T, [x, y], [6., 8.], 1000, 1010)[-1];$$

$$T := \left[\frac{2 + 9x + y}{1 + 5x + 2y}, \frac{4 + 4x + y}{6 + 3x + y} \right]$$

$$[[-0.309865067, 0.5920753815]]$$

$$\emptyset$$

$$[1.587572199, 0.9648325670] \quad (24)$$

$$T := RT([x, y], 10); SSg(T, [x, y]); SSSg(T, [x, y]); ORB(T, [x, y], [6., 8.], 1000, 1010)[-1];$$

$$T := \left[\frac{7 + 2x + y}{5 + 10x + 3y}, \frac{10 + 4x + 6y}{8 + 8x + 7y} \right]$$

$$[[0.6472327339, 0.9230130065]]$$

$$\{[0.6472327339, 0.9230130065]\}$$

$$[0.6472327335, 0.9230130065] \quad (25)$$

$$T := RT([x, y], 10); SSg(T, [x, y]); SSSg(T, [x, y]); ORB(T, [x, y], [6., 8.], 1000, 1010)[-1];$$

$$T := \left[\frac{9 + 6x + y}{2 + 9x + 5y}, \frac{3 + 2x + 5y}{3 + 9x + 8y} \right]$$

$$[[1.127014906, 0.4480178765]]$$

$$\{[1.127014906, 0.4480178765]\}$$

$$[1.127014906, 0.4480178766] \quad (26)$$

$$T := RT([x, y], 10); SSg(T, [x, y]); SSSg(T, [x, y]); ORB(T, [x, y], [6., 8.], 1000, 1010)[-1];$$

$$T := \left[\frac{5 + 4x + 3y}{3 + 9x + 3y}, \frac{8 + 7x + 9y}{10 + x + 5y} \right]$$

$$[[-0.9035331901, 0.5692717868]]$$

$$\emptyset$$

$$\begin{aligned}
& [0.8510988810, 1.495902933] \quad (27) \\
T := RT([x, y], 10); SSg(T, [x, y]); SSSg(T, [x, y]); ORB(T, [x, y], [6., 8.], 1000, 1010)[-1];
\end{aligned}$$

$$\begin{aligned}
& T := \left[\frac{9 + x + y}{3 + 9x + 9y}, \frac{9 + 4x + 9y}{2 + 5x + 5y} \right] \\
& [[3., -3.], [0.4543504473, 2.017830805]] \\
& \{[0.4543504473, 2.017830805]\} \\
& [0.4543504470, 2.017830804] \quad (28) \\
T := RT([x, y], 10); SSg(T, [x, y]); SSSg(T, [x, y]); ORB(T, [x, y], [6., 8.], 1000, 1010)[-1];
\end{aligned}$$

$$\begin{aligned}
& T := \left[\frac{8 + x + 2y}{9 + 5x + 8y}, \frac{2 + x + 9y}{7 + x + 9y} \right] \\
& [[0.582171280, 0.6201667838]] \\
& \{[0.582171280, 0.6201667838]\} \\
& [0.5821712805, 0.6201667838] \quad (29) \\
T := RT([x, y], 10); SSg(T, [x, y]); SSSg(T, [x, y]); ORB(T, [x, y], [6., 8.], 1000, 1010)[-1];
\end{aligned}$$

$$\begin{aligned}
& T := \left[\frac{5 + x + 4y}{8 + 5x + y}, \frac{5 + 10x + 5y}{5 + 5x + 10y} \right] \\
& [[0.2021960617, -0.8900436637]] \\
& \emptyset \\
& [0.7508491588, 0.9463446147] \quad (30) \\
T := RT([x, y], 10); SSg(T, [x, y]); SSSg(T, [x, y]); ORB(T, [x, y], [6., 8.], 1000, 1010)[-1];
\end{aligned}$$

$$\begin{aligned}
& T := \left[\frac{3 + 6x + 6y}{7 + x + 4y}, \frac{2 + 8x + 2y}{2 + 4x + y} \right] \\
& [[1.432383688, 1.78990349]] \\
& \{[1.432383688, 1.78990349]\} \\
& [1.432383688, 1.789903570] \quad (31) \\
T := RT([x, y], 10); SSg(T, [x, y]); SSSg(T, [x, y]); ORB(T, [x, y], [6., 8.], 1000, 1010)[-1];
\end{aligned}$$

$$\begin{aligned}
& T := \left[\frac{2 + 5x + 6y}{10 + 5x + 5y}, \frac{1 + 2x + 8y}{10 + 2x + 5y} \right] \\
& [[0.4687750581, 0.3945777786]] \\
& \{[0.4687750581, 0.3945777786]\}
\end{aligned}$$

$$[0.4687750584, 0.3945777787] \quad (32)$$

$$T := RT([x, y], 10); SSg(T, [x, y]); SSSg(T, [x, y]); ORB(T, [x, y], [6., 8.], 1000, 1010)[-1];$$

$$T := \left[\frac{1 + 3x + 9y}{2 + 2x + 3y}, \frac{5 + 4x + 4y}{5 + 8x + 7y} \right]$$

$$[[1.615015944, 0.6261292450]]$$

$$\{[1.615015944, 0.6261292450]\}$$

$$[1.615015945, 0.6261292449] \quad (33)$$

$$T := RT([x, y], 10); SSg(T, [x, y]); SSSg(T, [x, y]); ORB(T, [x, y], [6., 8.], 1000, 1010)[-1];$$

$$T := \left[\frac{1 + 2x + 4y}{2 + 2x + 3y}, \frac{2 + 6x + 4y}{10 + 4x + 4y} \right]$$

$$[[0.9340938070, 0.6220680673]]$$

$$\{[0.9340938070, 0.6220680673]\}$$

$$[0.9340938073, 0.6220680677] \quad (34)$$

$$T := RT([x, y], 10); SSg(T, [x, y]); SSSg(T, [x, y]); ORB(T, [x, y], [6., 8.], 1000, 1010)[-1];$$

$$T := \left[\frac{7 + 5x + y}{5 + 6x + 3y}, \frac{8 + 9x + 9y}{5 + 3x + y} \right]$$

$$[[-1.218187898, 0.4090373769]]$$

$$\emptyset$$

$$[0.6419052153, 4.891076637] \quad (35)$$

$$T := RT([x, y], 10); SSg(T, [x, y]); SSSg(T, [x, y]); ORB(T, [x, y], [6., 8.], 1000, 1010)[-1];$$

$$T := \left[\frac{9 + 8x + 10y}{7 + 3x + 7y}, \frac{3 + 8x + 4y}{1 + 7x + y} \right]$$

$$[[-3.588859253, 0.9460901279]]$$

$$\emptyset$$

$$[1.650395683, 1.596487762] \quad (36)$$

$$T := RT([x, y], 10); SSg(T, [x, y]); SSSg(T, [x, y]); ORB(T, [x, y], [6., 8.], 1000, 1010)[-1];$$

$$T := \left[\frac{6 + 8x + 4y}{1 + 4x + 10y}, \frac{10 + 3x + 2y}{6 + 10x + y} \right]$$

$$[[0.3071993482, -8.375921430]]$$

$$\emptyset$$

$$[1.440808853, 0.7476820875] \quad (37)$$

$$T := RT([x, y], 10); SSg(T, [x, y]); SSSg(T, [x, y]); ORB(T, [x, y], [6., 8.], 1000, 1010)[-1];$$

$$T := \left[\frac{6 + 7x + y}{2 + 9x + 8y}, \frac{10 + x + 10y}{7 + 7x + 5y} \right]$$

$$[[0.6455732285, 1.315132700]]$$

$$\{[0.6455732285, 1.315132700]\}$$

$$[0.6455732286, 1.315132699] \quad (38)$$

$$T := RT([x, y], 10); SSg(T, [x, y]); SSSg(T, [x, y]); ORB(T, [x, y], [6., 8.], 1000, 1010)[-1];$$

$$T := \left[\frac{10 + 3x + 5y}{5 + 3x + 4y}, \frac{9 + 5x + 7y}{5 + x + 6y} \right]$$

$$[[1.417902121, 1.686781071]]$$

$$\{[1.417902121, 1.686781071]\}$$

$$[1.417902121, 1.686781071] \quad (39)$$

$$T := RT([x, y], 10); SSg(T, [x, y]); SSSg(T, [x, y]); ORB(T, [x, y], [6., 8.], 1000, 1010)[-1];$$

$$T := \left[\frac{10 + 9x + y}{3 + 5x + 10y}, \frac{3 + 5x + 9y}{5 + x + 3y} \right]$$

$$[[0.6587766085, 2.108664959]]$$

$$\{[0.6587766085, 2.108664959]\}$$

$$[0.6587766093, 2.108664959] \quad (40)$$

$$T := RT([x, y], 10); SSg(T, [x, y]); SSSg(T, [x, y]); ORB(T, [x, y], [6., 8.], 1000, 1010)[-1];$$

$$T := \left[\frac{8 + x + 4y}{8 + x + 6y}, \frac{3 + 10x + 9y}{4 + 2x + 8y} \right]$$

$$[[0.8364993868, 1.417839337]]$$

$$\{[0.8364993868, 1.417839337]\}$$

$$[0.8364993871, 1.417839337] \quad (41)$$

#out of 20 runs, there was only 3 trials that didnt match the thrid and the first values. Trial 1,4,19.

#Question 3

$$T := RT([x, y, z], 10); SSg(T, [x, y, z]); SSSg(T, [x, y, z]);$$

$$ORB(T, [x, y, z], [6., 8., 11.], 1000, 1010)[-1];$$

$$T := \left[\frac{2 + 2x + 7y + 9z}{6 + 7x + 7y + 2z}, \frac{2 + 7x + 8y + 3z}{1 + x + 4y + 10z}, \frac{9 + 6x + 9y + 9z}{3 + 8x + 4y + 3z} \right]$$

$$[[1.150104464, 0.928193444, 1.915713456]]$$

$$\begin{aligned} & \{[1.150104464, 0.928193444, 1.915713456]\} \\ & [1.150104395, 0.9281937770, 1.915713456] \end{aligned} \quad (42)$$

$$\begin{aligned} T &:= RT([x, y, z], 10); SSg(T, [x, y, z]); SSSg(T, [x, y, z]); \\ ORB(T, [x, y, z], [6., 8., 11.], 1000, 1010)[-1]; \\ T &:= \left[\frac{2+9x+4y+2z}{8+4x+3y+9z}, \frac{4+9x+5y+z}{2+9x+9y+4z}, \frac{2+6x+7y+4z}{4+4x+9y+2z} \right] \\ & [[0.06304080045, -0.7319449255, 0.518072944]] \\ & \emptyset \end{aligned}$$

$$[0.5711919383, 0.7770749271, 0.9688436779] \quad (43)$$

$$\begin{aligned} T &:= RT([x, y, z], 10); SSg(T, [x, y, z]); SSSg(T, [x, y, z]); \\ ORB(T, [x, y, z], [6., 8., 11.], 1000, 1010)[-1]; \\ T &:= \left[\frac{9+5x+10y+7z}{9+2x+7y+z}, \frac{4+4x+6y+z}{8+8x+5y+6z}, \frac{3+3x+6y+5z}{7+9x+y+9z} \right] \\ & [[-5.19796385, 0.4615142867, 0.232671297]] \\ & \emptyset \end{aligned}$$

$$[1.573103544, 0.5317990203, 0.5122187195] \quad (44)$$

$$\begin{aligned} T &:= RT([x, y, z], 10); SSg(T, [x, y, z]); SSSg(T, [x, y, z]); \\ ORB(T, [x, y, z], [6., 8., 11.], 1000, 1010)[-1]; \\ T &:= \left[\frac{3+8x+5y+2z}{5+10x+y+9z}, \frac{10+8x+8y+2z}{4+3x+10y+4z}, \frac{6+9x+4y+2z}{10+2x+3y+3z} \right] \\ & [[0.1532874042, -0.258840762, -3.175890885]] \\ & \emptyset \end{aligned}$$

$$[0.7384075948, 1.224212727, 1.071936329] \quad (45)$$

$$\begin{aligned} T &:= RT([x, y, z], 10); SSg(T, [x, y, z]); SSSg(T, [x, y, z]); \\ ORB(T, [x, y, z], [6., 8., 11.], 1000, 1010)[-1]; \\ T &:= \left[\frac{4+4x+6y+7z}{5+2x+10y+5z}, \frac{2+10x+3y+6z}{5+9x+y+4z}, \frac{10+3x+4y+7z}{7+x+7y+z} \right] \\ & [[0.5527469037, -9.62524991, 0.404137512]] \\ & \emptyset \end{aligned}$$

$$[0.9839854930, 1.166269743, 1.633956011] \quad (46)$$

$$\begin{aligned} T &:= RT([x, y, z], 10); SSg(T, [x, y, z]); SSSg(T, [x, y, z]); \\ ORB(T, [x, y, z], [6., 8., 11.], 1000, 1010)[-1]; \\ T &:= \left[\frac{2+x+4y+7z}{9+8x+9y+6z}, \frac{7+8x+3y+3z}{2+2x+y+3z}, \frac{5+4x+3y+10z}{1+8x+3y+8z} \right] \\ & [[0.4912124382, 2.4186132, 1.2036441]] \end{aligned}$$

$$\{[0.4912124382, 2.4186132, 1.2036441]\}$$

$$[0.4912124379, 2.418613185, 1.203644341]$$

(47)

$$T := RT([x, y, z], 10); SSg(T, [x, y, z]); SSSg(T, [x, y, z]);$$

$$ORB(T, [x, y, z], [6., 8., 11.], 1000, 1010)[-1];$$

$$T := \left[\frac{8 + 7x + 5y + 6z}{7 + x + 5y + 6z}, \frac{6 + 6x + 4y + 10z}{10 + 5x + 9y + 9z}, \frac{5 + 10x + 9y + 5z}{5 + 2x + 4y + 9z} \right]$$

$$[[1.457842860, 0.857131344, 1.424264799]]$$

$$\{[1.457842860, 0.857131344, 1.424264799]\}$$

$$[1.457842860, 0.8571312933, 1.424264863]$$

(48)

$$T := RT([x, y, z], 10); SSg(T, [x, y, z]); SSSg(T, [x, y, z]);$$

$$ORB(T, [x, y, z], [6., 8., 11.], 1000, 1010)[-1];$$

$$T := \left[\frac{10 + 3x + 7y + z}{4 + 9x + 5y + 9z}, \frac{10 + 7x + 9y + 6z}{1 + 5x + 2y + z}, \frac{3 + 3x + 10y + 9z}{9 + 2x + 2y + 3z} \right]$$

$$[[5.415226477, 0.8726538048, -5.799623308]]$$

$$\emptyset$$

$$[0.7980729998, 4.323902821, 2.666007780]$$

(49)

$$T := RT([x, y, z], 10); SSg(T, [x, y, z]); SSSg(T, [x, y, z]);$$

$$ORB(T, [x, y, z], [6., 8., 11.], 1000, 1010)[-1];$$

$$T := \left[\frac{10 + 5x + 3y + 8z}{2 + 3x + y + 10z}, \frac{7 + 6x + 6y + 8z}{10 + 4x + 5y + 3z}, \frac{8 + x + 10y + 6z}{8 + 10x + 9y + 7z} \right]$$

$$[[1.865411368, 1.197200236, 0.61152769]]$$

$$\{[1.865411368, 1.197200236, 0.61152769]\}$$

$$[1.865411367, 1.197200220, 0.6115276541]$$

(50)

$$T := RT([x, y, z], 10); SSg(T, [x, y, z]); SSSg(T, [x, y, z]);$$

$$ORB(T, [x, y, z], [6., 8., 11.], 1000, 1010)[-1];$$

$$T := \left[\frac{8 + 2x + 10y + 3z}{7 + 4x + 7y + 7z}, \frac{5 + 2x + 5y + 6z}{4 + x + 7y + 10z}, \frac{5 + x + 4y + 10z}{7 + 8x + 2y + 2z} \right]$$

$$[[-2.425604177, 0.2445746702, -0.1597776592]]$$

$$\emptyset$$

$$[0.8786195250, 0.8035847034, 1.146716759]$$

(51)

$$T := RT([x, y, z], 10); SSg(T, [x, y, z]); SSSg(T, [x, y, z]);$$

$$ORB(T, [x, y, z], [6., 8., 11.], 1000, 1010)[-1];$$

$$T := \left[\frac{7 + 9x + 9y + 6z}{1 + 4x + 8y + 10z}, \frac{8 + 5x + 6y + z}{2 + 7x + 6y + 10z}, \frac{7 + 5x + 4y + 6z}{4 + 4x + 3y + 7z} \right]$$

$$[[-2.562041, 0.368017, 0.9138845178]]$$

$\emptyset$

$$[1.361208233, 0.7317230040, 1.194863913]$$

(52)

$$T := RT([x, y, z], 10); SSg(T, [x, y, z]); SSSg(T, [x, y, z]);$$

$$ORB(T, [x, y, z], [6., 8., 11.], 1000, 1010)[-1];$$

$$T := \left[\frac{6 + 6x + 7y + 2z}{1 + 5x + 8y + 7z}, \frac{4 + 3x + 2y + 8z}{8 + 3x + 4y + 9z}, \frac{2 + 2x + 2y + 3z}{2 + 9x + 9y + z} \right]$$

$$[[0.08459129938, 0.9566867033, -8.833661034]]$$

 $\emptyset$

$$[1.252765182, 0.6762949144, 0.3505322265]$$

(53)

$$T := RT([x, y, z], 10); SSg(T, [x, y, z]); SSSg(T, [x, y, z]);$$

$$ORB(T, [x, y, z], [6., 8., 11.], 1000, 1010)[-1];$$

$$T := \left[\frac{3 + 10x + 2y + 9z}{1 + 2x + 8y + 7z}, \frac{1 + x + 9y + 2z}{2 + 5x + 3y + z}, \frac{4 + x + 6y + 4z}{9 + 10x + 4y + 8z} \right]$$

$$[[2.710549811, 0.508906890, 0.2690297892]]$$

$$\{[2.710549811, 0.508906890, 0.2690297892]\}$$

$$[2.710549813, 0.5089069183, 0.2690296650]$$

(54)

$$T := RT([x, y, z], 10); SSg(T, [x, y, z]); SSSg(T, [x, y, z]);$$

$$ORB(T, [x, y, z], [6., 8., 11.], 1000, 1010)[-1];$$

$$T := \left[\frac{5 + 4x + 6y + 4z}{8 + 9x + 9y + 7z}, \frac{3 + 5x + 3y + 9z}{2 + 3x + 3y + 4z}, \frac{9 + 6x + 7y + 6z}{1 + 7x + 5y + 4z} \right]$$

$$[[0.6007401067, 1.6828825, 1.6939284]]$$

$$\{[0.6007401067, 1.6828825, 1.6939284]\}$$

$$[0.6007401070, 1.682882675, 1.693928342]$$

(55)

$$T := RT([x, y, z], 10); SSg(T, [x, y, z]); SSSg(T, [x, y, z]);$$

$$ORB(T, [x, y, z], [6., 8., 11.], 1000, 1010)[-1];$$

$$T := \left[\frac{3 + 8x + y + 4z}{10 + 3x + 10y + 7z}, \frac{9 + x + 5y + 8z}{9 + 6x + 10y + 3z}, \frac{1 + 4x + 3y + 3z}{9 + x + y + 6z} \right]$$

$$[[-0.86333786, 0.6096773471, -0.83277584]]$$

 $\emptyset$

$$[0.3893199028, 0.8287349908, 0.4950302027]$$

(56)

$$T := RT([x, y, z], 10); SSg(T, [x, y, z]); SSSg(T, [x, y, z]);$$

$$ORB(T, [x, y, z], [6., 8., 11.], 1000, 1010)[-1];$$

$$T := \left[\frac{4 + 5x + 4y + 3z}{9 + 7x + 4y + 5z}, \frac{9 + 3x + 2y + 2z}{10 + 7x + 9y + 6z}, \frac{7 + 3x + 6y + 2z}{7 + 3x + 4y + 8z} \right]$$

$$[[0.5989328481, 0.5625941273, 0.791488313]]$$

$$\begin{aligned} & \{[0.5989328481, 0.5625941273, 0.791488313]\} \\ & [0.5989328482, 0.5625941272, 0.7914883131] \end{aligned} \quad (57)$$

$$\begin{aligned} T &:= RT([x, y, z], 10); SSg(T, [x, y, z]); SSSg(T, [x, y, z]); \\ ORB(T, [x, y, z], [6., 8., 11.], 1000, 1010)[-1]; \end{aligned}$$

$$\begin{aligned} T &:= \left[\frac{1 + 10x + 6y + 10z}{1 + 10x + 2y + 9z}, \frac{1 + 9x + 4y + 6z}{2 + 8x + 6y + 3z}, \frac{5 + 8x + 10y + z}{1 + 7x + 7y + 8z} \right] \\ & [[0.02856554780, -0.5669864969, 0.2176553392]] \\ & \emptyset \end{aligned}$$

$$[1.214040545, 1.057921814, 1.043035387] \quad (58)$$

$$\begin{aligned} T &:= RT([x, y, z], 10); SSg(T, [x, y, z]); SSSg(T, [x, y, z]); \\ ORB(T, [x, y, z], [6., 8., 11.], 1000, 1010)[-1]; \end{aligned}$$

$$\begin{aligned} T &:= \left[\frac{5 + 4x + 8y + z}{5 + 6x + 7y + 4z}, \frac{5 + 4x + 9y + 9z}{1 + 2x + 9y + 4z}, \frac{8 + 4x + 6y + 6z}{8 + 7x + 10y + 3z} \right] \\ & [[0.888530379, 1.501848923, 0.801948849]] \\ & \{[0.888530379, 1.501848923, 0.801948849]\} \\ & [0.8885303803, 1.501848923, 0.8019488463] \end{aligned} \quad (59)$$

$$\begin{aligned} T &:= RT([x, y, z], 10); SSg(T, [x, y, z]); SSSg(T, [x, y, z]); \\ ORB(T, [x, y, z], [6., 8., 11.], 1000, 1010)[-1]; \end{aligned}$$

$$\begin{aligned} T &:= \left[\frac{10 + 6x + y + 3z}{1 + x + 7y + 3z}, \frac{8 + 5x + 9y + 5z}{10 + 3x + 6y + 2z}, \frac{4 + 5x + 3y + 2z}{6 + 6x + 6y + 10z} \right] \\ & [[1.728197322, 1.294584699, 0.5895017152]] \\ & \{[1.728197322, 1.294584699, 0.5895017152]\} \\ & [1.728197316, 1.294584699, 0.5895017153] \end{aligned} \quad (60)$$

$$\begin{aligned} T &:= RT([x, y, z], 10); SSg(T, [x, y, z]); SSSg(T, [x, y, z]); \\ ORB(T, [x, y, z], [6., 8., 11.], 1000, 1010)[-1]; \end{aligned}$$

$$\begin{aligned} T &:= \left[\frac{7 + 8x + 9y + 4z}{3 + 5x + 3y + 10z}, \frac{9 + 6x + 3y + 5z}{4 + 6x + y + 9z}, \frac{3 + 7x + 4y + 3z}{1 + x + 10y + 3z} \right] \\ & [[1.299655531, 1.104171980, 1.187696065]] \\ & \{[1.299655531, 1.104171980, 1.187696065]\} \\ & [1.299655529, 1.104171980, 1.187696066] \end{aligned} \quad (61)$$

#out of the 20 times run there were only 11 non-matches (9 matches). As the dimensions increase, the random transformation and orbit operations get more numerically unstable or there is rounding error. So the chance that the fixed point remains constant between SSg and Orb decreases.

#Question 4

$$f := RR([z[1], z[2]], 10); T := RecToTs(2, z, f); SSg(T, [z[1], z[2]]); SSSg(T, [z[1], z[2]]);$$

$$Orbk(2, z, f, [5., 8.], 2000, 2010) [-1];$$

$$f := \frac{4 + 10 z_1 + 8 z_2}{4 + z_1 + 4 z_2}$$

$$T := \left[\frac{4 + 10 z_1 + 8 z_2}{4 + z_1 + 4 z_2}, z_1 \right], [z_1, z_2]$$

$$[[3.061324772, 3.061324772]]$$

$$\{[3.061324772, 3.061324772]\}$$

$$3.061324773$$

(62)

$$f := RR([z[1], z[2]], 10); T := RecToTs(2, z, f); SSg(T, [z[1], z[2]]); SSSg(T, [z[1], z[2]]);$$

$$Orbk(2, z, f, [5., 8.], 2000, 2010) [-1];$$

$$f := \frac{8 + 10 z_1 + 3 z_2}{3 + 10 z_1 + z_2}$$

$$T := \left[\frac{8 + 10 z_1 + 3 z_2}{3 + 10 z_1 + z_2}, z_1 \right], [z_1, z_2]$$

$$[[1.420922347, 1.420922347]]$$

$$\{[1.420922347, 1.420922347]\}$$

$$1.420922346$$

(63)

$$f := RR([z[1], z[2]], 10); T := RecToTs(2, z, f); SSg(T, [z[1], z[2]]); SSSg(T, [z[1], z[2]]);$$

$$Orbk(2, z, f, [5., 8.], 2000, 2010) [-1];$$

$$f := \frac{8 + 10 z_1 + 6 z_2}{7 + 4 z_1 + 2 z_2}$$

$$T := \left[\frac{8 + 10 z_1 + 6 z_2}{7 + 4 z_1 + 2 z_2}, z_1 \right], [z_1, z_2]$$

$$[[2.126892637, 2.126892637]]$$

$$\{[2.126892637, 2.126892637]\}$$

$$2.126892636$$

(64)

$$f := RR([z[1], z[2]], 10); T := RecToTs(2, z, f); SSg(T, [z[1], z[2]]); SSSg(T, [z[1], z[2]]);$$

$$Orbk(2, z, f, [5., 8.], 2000, 2010) [-1];$$

$$f := \frac{6 + z_1 + 5 z_2}{10 + 2 z_1 + 10 z_2}$$

$$T := \left[\frac{6 + z_1 + 5 z_2}{10 + 2 z_1 + 10 z_2}, z_1 \right], [z_1, z_2]$$

$$[[0.5598164906, 0.5598164906]]$$

$$\{[0.5598164906, 0.5598164906]\}$$

$$0.5598164905$$

(65)

$$f := RR([z[1], z[2]], 10); T := RecToTs(2, z, f); SSg(T, [z[1], z[2]]); SSSg(T, [z[1], z[2]]);$$

$$Orbk(2, z, f, [5., 8.], 2000, 2010)[-1];$$

$$f := \frac{4 + z_1 + z_2}{6 + 3 z_1 + 3 z_2}$$

$$T := \left[\frac{4 + z_1 + z_2}{6 + 3 z_1 + 3 z_2}, z_1 \right], [z_1, z_2]$$

$$[[0.5485837704, 0.5485837704]]$$

$$\{[0.5485837704, 0.5485837704]\}$$

$$0.5485837703$$

(66)

$$f := RR([z[1], z[2]], 10); T := RecToTs(2, z, f); SSg(T, [z[1], z[2]]); SSSg(T, [z[1], z[2]]);$$

$$Orbk(2, z, f, [5., 8.], 2000, 2010)[-1];$$

$$f := \frac{9 + 10 z_1 + 5 z_2}{8 + z_1 + z_2}$$

$$T := \left[\frac{9 + 10 z_1 + 5 z_2}{8 + z_1 + z_2}, z_1 \right], [z_1, z_2]$$

$$[[-1., -1.], [4.500000000, 4.500000000]]$$

$$\{[4.500000000, 4.500000000]\}$$

$$4.499999999$$

(67)

$$f := RR([z[1], z[2]], 10); T := RecToTs(2, z, f); SSg(T, [z[1], z[2]]); SSSg(T, [z[1], z[2]]);$$

$$Orbk(2, z, f, [5., 8.], 2000, 2010)[-1];$$

$$f := \frac{3 + 7 z_1 + 6 z_2}{8 + 2 z_1 + 5 z_2}$$

$$T := \left[\frac{3 + 7 z_1 + 6 z_2}{8 + 2 z_1 + 5 z_2}, z_1 \right], [z_1, z_2]$$

$$[[1.102879036, 1.102879036]]$$

$$\{[1.102879036, 1.102879036]\}$$

1.102879036

(68)

$$f := RR([z[1], z[2]], 10); T := RecToTs(2, z, f); SSg(T, [z[1], z[2]]); SSSg(T, [z[1], z[2]]);$$

$$Orbk(2, z, f, [5., 8.], 2000, 2010)[-1];$$

$$f := \frac{3 + 7z_1 + 4z_2}{2 + 8z_1 + 8z_2}$$

$$T := \left[\frac{3 + 7z_1 + 4z_2}{2 + 8z_1 + 8z_2}, z_1 \right], [z_1, z_2]$$

$$[[0.7975847388, 0.7975847388]]$$

$$\{[0.7975847388, 0.7975847388]\}$$

0.7975847385

(69)

$$f := RR([z[1], z[2]], 10); T := RecToTs(2, z, f); SSg(T, [z[1], z[2]]); SSSg(T, [z[1], z[2]]);$$

$$Orbk(2, z, f, [5., 8.], 2000, 2010)[-1];$$

$$f := \frac{2 + 5z_1 + 6z_2}{4 + 2z_1 + 5z_2}$$

$$T := \left[\frac{2 + 5z_1 + 6z_2}{4 + 2z_1 + 5z_2}, z_1 \right], [z_1, z_2]$$

$$[[1.231925055, 1.231925055]]$$

$$\{[1.231925055, 1.231925055]\}$$

1.231925055

(70)

$$f := RR([z[1], z[2]], 10); T := RecToTs(2, z, f); SSg(T, [z[1], z[2]]); SSSg(T, [z[1], z[2]]);$$

$$Orbk(2, z, f, [5., 8.], 2000, 2010)[-1];$$

$$f := \frac{3 + 3z_1 + 7z_2}{10 + 8z_1 + 5z_2}$$

$$T := \left[\frac{3 + 3z_1 + 7z_2}{10 + 8z_1 + 5z_2}, z_1 \right], [z_1, z_2]$$

$$[[0.4803844614, 0.4803844614]]$$

$$\{[0.4803844614, 0.4803844614]\}$$

0.4803844614

(71)

$$f := RR([z[1], z[2]], 10); T := RecToTs(2, z, f); SSg(T, [z[1], z[2]]); SSSg(T, [z[1], z[2]]);$$

$$Orbk(2, z, f, [5., 8.], 2000, 2010)[-1];$$

$$f := \frac{7 + z_1 + 7z_2}{2 + 4z_1 + 8z_2}$$

$$T := \left[\frac{7 + z_1 + 7 z_2}{2 + 4 z_1 + 8 z_2}, z_1 \right], [z_1, z_2]$$

$$[[1.053637564, 1.053637564]]$$

$$\{[1.053637564, 1.053637564]\}$$

$$1.053637564$$

(72)

$$f := RR([z[1], z[2]], 10); T := RecToTs(2, z, f); SSg(T, [z[1], z[2]]); SSSg(T, [z[1], z[2]]);$$

$$Orbk(2, z, f, [5., 8.], 2000, 2010)[-1];$$

$$f := \frac{9 + z_1 + 8 z_2}{8 + 3 z_1 + 6 z_2}$$

$$T := \left[\frac{9 + z_1 + 8 z_2}{8 + 3 z_1 + 6 z_2}, z_1 \right], [z_1, z_2]$$

$$[[1.057097577, 1.057097577]]$$

$$\{[1.057097577, 1.057097577]\}$$

$$1.057097577$$

(73)

$$f := RR([z[1], z[2]], 10); T := RecToTs(2, z, f); SSg(T, [z[1], z[2]]); SSSg(T, [z[1], z[2]]);$$

$$Orbk(2, z, f, [5., 8.], 2000, 2010)[-1];$$

$$f := \frac{2 + 5 z_1 + 6 z_2}{10 + 5 z_1 + 6 z_2}$$

$$T := \left[\frac{2 + 5 z_1 + 6 z_2}{10 + 5 z_1 + 6 z_2}, z_1 \right], [z_1, z_2]$$

$$[[0.4742718696, 0.4742718696]]$$

$$\{[0.4742718696, 0.4742718696]\}$$

$$0.4742718693$$

(74)

$$f := RR([z[1], z[2]], 10); T := RecToTs(2, z, f); SSg(T, [z[1], z[2]]); SSSg(T, [z[1], z[2]]);$$

$$Orbk(2, z, f, [5., 8.], 2000, 2010)[-1];$$

$$f := \frac{5 + 8 z_1 + 10 z_2}{3 + 2 z_1 + z_2}$$

$$T := \left[\frac{5 + 8 z_1 + 10 z_2}{3 + 2 z_1 + z_2}, z_1 \right], [z_1, z_2]$$

$$[[5.313657169, 5.313657169]]$$

$$\{[5.313657169, 5.313657169]\}$$

5.313657166

(75)

$$f := RR([z[1], z[2]], 10); T := RecToTs(2, z, f); SSg(T, [z[1], z[2]]); SSSg(T, [z[1], z[2]]);$$

$$Orbk(2, z, f, [5., 8.], 2000, 2010)[-1];$$

$$f := \frac{4 + 4z_1 + 4z_2}{8 + 7z_1 + 4z_2}$$

$$T := \left[\frac{4 + 4z_1 + 4z_2}{8 + 7z_1 + 4z_2}, z_1 \right], [z_1, z_2]$$

$$[[0.6030226892, 0.6030226892]]$$

$$\{[0.6030226892, 0.6030226892]\}$$

0.6030226892

(76)

$$f := RR([z[1], z[2]], 10); T := RecToTs(2, z, f); SSg(T, [z[1], z[2]]); SSSg(T, [z[1], z[2]]);$$

$$Orbk(2, z, f, [5., 8.], 2000, 2010)[-1];$$

$$f := \frac{8 + 8z_1 + 9z_2}{3 + 8z_1 + 2z_2}$$

$$T := \left[\frac{8 + 8z_1 + 9z_2}{3 + 8z_1 + 2z_2}, z_1 \right], [z_1, z_2]$$

$$[[1.835781669, 1.835781669]]$$

$$\{[1.835781669, 1.835781669]\}$$

1.835781670

(77)

$$f := RR([z[1], z[2]], 10); T := RecToTs(2, z, f); SSg(T, [z[1], z[2]]); SSSg(T, [z[1], z[2]]);$$

$$Orbk(2, z, f, [5., 8.], 2000, 2010)[-1];$$

$$f := \frac{4 + z_1 + 5z_2}{3 + 2z_1 + z_2}$$

$$T := \left[\frac{4 + z_1 + 5z_2}{3 + 2z_1 + z_2}, z_1 \right], [z_1, z_2]$$

$$[[1.758305739, 1.758305739]]$$

$$\{[1.758305739, 1.758305739]\}$$

1.758305740

(78)

$$f := RR([z[1], z[2]], 10); T := RecToTs(2, z, f); SSg(T, [z[1], z[2]]); SSSg(T, [z[1], z[2]]);$$

$$Orbk(2, z, f, [5., 8.], 2000, 2010)[-1];$$

$$f := \frac{6 + 3z_1 + 9z_2}{3 + 6z_1 + 5z_2}$$

$$T := \left[\frac{6 + 3 z_1 + 9 z_2}{3 + 6 z_1 + 5 z_2}, z_1 \right], [z_1, z_2]$$

$$[[1.253371619, 1.253371619]]$$

$$\{[1.253371619, 1.253371619]\}$$

$$1.253371619$$

(79)

$$f := RR([z[1], z[2]], 10); T := RecToTs(2, z, f); SSg(T, [z[1], z[2]]); SSSg(T, [z[1], z[2]]);$$

$$Orbk(2, z, f, [5., 8.], 2000, 2010)[-1];$$

$$f := \frac{10 + 7 z_1 + 6 z_2}{10 + 8 z_1 + 2 z_2}$$

$$T := \left[\frac{10 + 7 z_1 + 6 z_2}{10 + 8 z_1 + 2 z_2}, z_1 \right], [z_1, z_2]$$

$$[[1.161187421, 1.161187421]]$$

$$\{[1.161187421, 1.161187421]\}$$

$$1.161187421$$

(80)

$$f := RR([z[1], z[2]], 10); T := RecToTs(2, z, f); SSg(T, [z[1], z[2]]); SSSg(T, [z[1], z[2]]);$$

$$Orbk(2, z, f, [5., 8.], 2000, 2010)[-1];$$

$$f := \frac{2 + 2 z_1 + 6 z_2}{10 + 2 z_1 + 7 z_2}$$

$$T := \left[\frac{2 + 2 z_1 + 6 z_2}{10 + 2 z_1 + 7 z_2}, z_1 \right], [z_1, z_2]$$

$$[[0.3732109937, 0.3732109937]]$$

$$\{[0.3732109937, 0.3732109937]\}$$

$$0.3732109936$$

(81)

$$f := RR([z[1], z[2]], 10); T := RecToTs(2, z, f); SSg(T, [z[1], z[2]]); SSSg(T, [z[1], z[2]]);$$

$$Orbk(2, z, f, [5., 8.], 2000, 2010)[-1];$$

$$f := \frac{1 + 2 z_1 + 2 z_2}{2 + 2 z_1 + 2 z_2}$$

$$T := \left[\frac{1 + 2 z_1 + 2 z_2}{2 + 2 z_1 + 2 z_2}, z_1 \right], [z_1, z_2]$$

$$[[0.8090169945, 0.8090169945]]$$

$$\{[0.8090169945, 0.8090169945]\}$$

$$0.8090169944$$

(82)

$$f := RR([z[1], z[2]], 10); T := RecToTs(2, z, f); SSg(T, [z[1], z[2]]); SSSg(T, [z[1], z[2]]);$$

$$Orbk(2, z, f, [5., 8.], 2000, 2010)[-1];$$

$$f := \frac{3 + 5z_1 + 8z_2}{6 + 7z_1 + z_2}$$

$$T := \left[\frac{3 + 5z_1 + 8z_2}{6 + 7z_1 + z_2}, z_1 \right], [z_1, z_2]$$

$$[[1.190099661, 1.190099661]]$$

$$\{[1.190099661, 1.190099661]\}$$

$$1.190099664$$

(83)

#They all match.

#Question 5

$$f := RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]);$$

$$SSSg(T, [z[1], z[2], z[3]]); Orbk(3, z, f, [5., 8., 11.], 2000, 2010)[-1];$$

$$f := \frac{6 + 4z_1 + 5z_2 + 7z_3}{10 + 9z_1 + z_2 + 9z_3}$$

$$T := \left[\frac{6 + 4z_1 + 5z_2 + 7z_3}{10 + 9z_1 + z_2 + 9z_3}, z_1, z_2 \right], [z_1, z_2, z_3]$$

$$[[0.7416071845, 0.7416071845, 0.7416071845]]$$

$$\{[0.7416071845, 0.7416071845, 0.7416071845]\}$$

$$0.7416071850$$

(84)

$$f := RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]);$$

$$SSSg(T, [z[1], z[2], z[3]]); Orbk(3, z, f, [5., 8., 11.], 2000, 2010)[-1];$$

$$f := \frac{9 + 8z_1 + 3z_2 + 10z_3}{8 + 3z_1 + 6z_2 + 2z_3}$$

$$T := \left[\frac{9 + 8z_1 + 3z_2 + 10z_3}{8 + 3z_1 + 6z_2 + 2z_3}, z_1, z_2 \right], [z_1, z_2, z_3]$$

$$[[1.671351302, 1.671351302, 1.671351302]]$$

$$\{[1.671351302, 1.671351302, 1.671351302]\}$$

$$1.671351302$$

(85)

$$f := RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]);$$

$$SSSg(T, [z[1], z[2], z[3]]); Orbk(3, z, f, [5., 8., 11.], 2000, 2010)[-1];$$

$$\begin{aligned}
f &:= \frac{1 + 2 z_1 + 5 z_2 + 2 z_3}{3 + 5 z_1 + 8 z_2 + 7 z_3} \\
T &:= \left[\frac{1 + 2 z_1 + 5 z_2 + 2 z_3}{3 + 5 z_1 + 8 z_2 + 7 z_3}, z_1, z_2 \right], [z_1, z_2, z_3] \\
&[[0.4192582404, 0.4192582404, 0.4192582404]] \\
&\{[0.4192582404, 0.4192582404, 0.4192582404]\} \\
&0.4192582402
\end{aligned} \tag{86}$$

$$\begin{aligned}
f &:= RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]); \\
&SSSg(T, [z[1], z[2], z[3]]); Orbk(3, z, f, [5., 8., 11.], 2000, 2010)[-1];
\end{aligned}$$

$$\begin{aligned}
f &:= \frac{10 + 3 z_1 + 7 z_2 + 7 z_3}{5 + 10 z_1 + 9 z_2 + 2 z_3} \\
T &:= \left[\frac{10 + 3 z_1 + 7 z_2 + 7 z_3}{5 + 10 z_1 + 9 z_2 + 2 z_3}, z_1, z_2 \right], [z_1, z_2, z_3] \\
&[[1.032589864, 1.032589864, 1.032589864]] \\
&\{[1.032589864, 1.032589864, 1.032589864]\} \\
&1.032589863
\end{aligned} \tag{87}$$

$$\begin{aligned}
f &:= RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]); \\
&SSSg(T, [z[1], z[2], z[3]]); Orbk(3, z, f, [5., 8., 11.], 2000, 2010)[-1];
\end{aligned}$$

$$\begin{aligned}
f &:= \frac{2 + 5 z_1 + 10 z_2 + 7 z_3}{8 + 7 z_1 + 4 z_2 + 6 z_3} \\
T &:= \left[\frac{2 + 5 z_1 + 10 z_2 + 7 z_3}{8 + 7 z_1 + 4 z_2 + 6 z_3}, z_1, z_2 \right], [z_1, z_2, z_3] \\
&[[0.9476725635, 0.9476725635, 0.9476725635]] \\
&\{[0.9476725635, 0.9476725635, 0.9476725635]\} \\
&0.9476725640
\end{aligned} \tag{88}$$

$$\begin{aligned}
f &:= RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]); \\
&SSSg(T, [z[1], z[2], z[3]]); Orbk(3, z, f, [5., 8., 11.], 2000, 2010)[-1];
\end{aligned}$$

$$\begin{aligned}
f &:= \frac{2 + 4 z_1 + 8 z_2 + 10 z_3}{7 + 2 z_1 + 5 z_2 + 6 z_3} \\
T &:= \left[\frac{2 + 4 z_1 + 8 z_2 + 10 z_3}{7 + 2 z_1 + 5 z_2 + 6 z_3}, z_1, z_2 \right], [z_1, z_2, z_3]
\end{aligned}$$

$$[[1.274552198, 1.274552198, 1.274552198]]$$

$$\{[1.274552198, 1.274552198, 1.274552198]\}$$

$$1.274552198$$

(89)

$$f := RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]);$$

$$SSSg(T, [z[1], z[2], z[3]]); Orbk(3, z, f, [5., 8., 11.], 2000, 2010)[-1];$$

$$f := \frac{7 + 3z_1 + 10z_2 + 3z_3}{5 + z_1 + 8z_2 + 4z_3}$$

$$T := \left[\frac{7 + 3z_1 + 10z_2 + 3z_3}{5 + z_1 + 8z_2 + 4z_3}, z_1, z_2 \right], [z_1, z_2, z_3]$$

$$[[1.270104444, 1.270104444, 1.270104444]]$$

$$\{[1.270104444, 1.270104444, 1.270104444]\}$$

$$1.270104444$$

(90)

$$f := RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]);$$

$$SSSg(T, [z[1], z[2], z[3]]); Orbk(3, z, f, [5., 8., 11.], 2000, 2010)[-1];$$

$$f := \frac{6 + 2z_1 + 4z_2 + 5z_3}{9 + z_1 + 10z_2 + 9z_3}$$

$$T := \left[\frac{6 + 2z_1 + 4z_2 + 5z_3}{9 + z_1 + 10z_2 + 9z_3}, z_1, z_2 \right], [z_1, z_2, z_3]$$

$$[[-0.5000000000, -0.5000000000, -0.5000000000], [0.6000000000, 0.6000000000,$$

$$0.6000000000]]$$

$$\{[0.6000000000, 0.6000000000, 0.6000000000]\}$$

$$0.6000000000$$

(91)

$$f := RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]);$$

$$SSSg(T, [z[1], z[2], z[3]]); Orbk(3, z, f, [5., 8., 11.], 2000, 2010)[-1];$$

$$f := \frac{10 + 7z_1 + 4z_2 + 2z_3}{7 + 2z_1 + 6z_2 + z_3}$$

$$T := \left[\frac{10 + 7z_1 + 4z_2 + 2z_3}{7 + 2z_1 + 6z_2 + z_3}, z_1, z_2 \right], [z_1, z_2, z_3]$$

$$[[1.438874930, 1.438874930, 1.438874930]]$$

$$\{[1.438874930, 1.438874930, 1.438874930]\}$$

$$1.438874929$$

(92)

$$f := RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]);$$

$$\begin{aligned}
&SSSg(T, [z[1], z[2], z[3]]); Orbk(3, z, f, [5., 8., 11.], 2000, 2010)[-1]; \\
&f := \frac{8 + 10z_1 + 10z_2 + 10z_3}{3 + 6z_1 + 2z_2 + 6z_3} \\
&T := \left[\frac{8 + 10z_1 + 10z_2 + 10z_3}{3 + 6z_1 + 2z_2 + 6z_3}, z_1, z_2 \right], [z_1, z_2, z_3] \\
&[[2.189551200, 2.189551200, 2.189551200]] \\
&\{[2.189551200, 2.189551200, 2.189551200]\} \\
&2.189551199 \tag{93}
\end{aligned}$$

$$\begin{aligned}
&f := RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]); \\
&SSSg(T, [z[1], z[2], z[3]]); Orbk(3, z, f, [5., 8., 11.], 2000, 2010)[-1]; \\
&f := \frac{8 + 6z_1 + 9z_2 + z_3}{2 + 3z_1 + 8z_2 + 4z_3} \\
&T := \left[\frac{8 + 6z_1 + 9z_2 + z_3}{2 + 3z_1 + 8z_2 + 4z_3}, z_1, z_2 \right], [z_1, z_2, z_3] \\
&[[-0.4000000000, -0.4000000000, -0.4000000000], [1.333333333, 1.333333333, \\
&1.333333333]] \\
&\{[1.333333333, 1.333333333, 1.333333333]\} \\
&1.333333333 \tag{94}
\end{aligned}$$

$$\begin{aligned}
&f := RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]); \\
&SSSg(T, [z[1], z[2], z[3]]); Orbk(3, z, f, [5., 8., 11.], 2000, 2010)[-1]; \\
&f := \frac{6 + 8z_1 + z_2 + 10z_3}{9 + z_1 + 7z_2 + 3z_3} \\
&T := \left[\frac{6 + 8z_1 + z_2 + 10z_3}{9 + z_1 + 7z_2 + 3z_3}, z_1, z_2 \right], [z_1, z_2, z_3] \\
&[[1.321762910, 1.321762910, 1.321762910]] \\
&\{[1.321762910, 1.321762910, 1.321762910]\} \\
&1.321762910 \tag{95}
\end{aligned}$$

$$\begin{aligned}
&f := RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]); \\
&SSSg(T, [z[1], z[2], z[3]]); Orbk(3, z, f, [5., 8., 11.], 2000, 2010)[-1]; \\
&f := \frac{10 + z_1 + 2z_2 + 2z_3}{1 + 7z_1 + 8z_2 + 5z_3}
\end{aligned}$$

$$\begin{aligned}
T &:= \left[\frac{10 + z_1 + 2z_2 + 2z_3}{1 + 7z_1 + 8z_2 + 5z_3}, z_1, z_2 \right], [z_1, z_2, z_3] \\
&[[0.8141428429, 0.8141428429, 0.8141428429]] \\
&\{[0.8141428429, 0.8141428429, 0.8141428429]\} \\
&0.8141428430 \tag{96}
\end{aligned}$$

$$\begin{aligned}
f &:= RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]); \\
&SSSg(T, [z[1], z[2], z[3]]); OrbK(3, z, f, [5., 8., 11.], 2000, 2010)[-1];
\end{aligned}$$

$$f := \frac{1 + 3z_1 + 8z_2 + 10z_3}{4 + 10z_1 + 4z_2 + 6z_3}$$

$$\begin{aligned}
T &:= \left[\frac{1 + 3z_1 + 8z_2 + 10z_3}{4 + 10z_1 + 4z_2 + 6z_3}, z_1, z_2 \right], [z_1, z_2, z_3] \\
&[[0.9052343178, 0.9052343178, 0.9052343178]] \\
&\{[0.9052343178, 0.9052343178, 0.9052343178]\} \\
&0.9052343179 \tag{97}
\end{aligned}$$

$$\begin{aligned}
f &:= RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]); \\
&SSSg(T, [z[1], z[2], z[3]]); OrbK(3, z, f, [5., 8., 11.], 2000, 2010)[-1];
\end{aligned}$$

$$f := \frac{9 + 10z_1 + 4z_2 + 5z_3}{1 + 2z_1 + 10z_2 + 5z_3}$$

$$\begin{aligned}
T &:= \left[\frac{9 + 10z_1 + 4z_2 + 5z_3}{1 + 2z_1 + 10z_2 + 5z_3}, z_1, z_2 \right], [z_1, z_2, z_3] \\
&[[1.429238738, 1.429238738, 1.429238738]] \\
&\{[1.429238738, 1.429238738, 1.429238738]\} \\
&1.429238738 \tag{98}
\end{aligned}$$

$$\begin{aligned}
f &:= RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]); \\
&SSSg(T, [z[1], z[2], z[3]]); OrbK(3, z, f, [5., 8., 11.], 2000, 2010)[-1];
\end{aligned}$$

$$f := \frac{9 + 5z_1 + z_2 + 8z_3}{4 + 2z_1 + 3z_2 + 2z_3}$$

$$\begin{aligned}
T &:= \left[\frac{9 + 5z_1 + z_2 + 8z_3}{4 + 2z_1 + 3z_2 + 2z_3}, z_1, z_2 \right], [z_1, z_2, z_3] \\
&[[2.054404503, 2.054404503, 2.054404503]] \\
&\{[2.054404503, 2.054404503, 2.054404503]\}
\end{aligned}$$

2.054404503

(99)

$f := RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]);$
 $SSSg(T, [z[1], z[2], z[3]]); Orbk(3, z, f, [5., 8., 11.], 2000, 2010)[-1];$

$$f := \frac{3 + z_1 + 6z_2 + 5z_3}{8 + 2z_1 + 2z_2 + 5z_3}$$

$$T := \left[\frac{3 + z_1 + 6z_2 + 5z_3}{8 + 2z_1 + 2z_2 + 5z_3}, z_1, z_2 \right], [z_1, z_2, z_3]$$

$$[[0.8408627070, 0.8408627070, 0.8408627070]]$$

$$\{[0.8408627070, 0.8408627070, 0.8408627070]\}$$

0.8408627069

(100)

$f := RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]);$
 $SSSg(T, [z[1], z[2], z[3]]); Orbk(3, z, f, [5., 8., 11.], 2000, 2010)[-1];$

$$f := \frac{5 + 6z_1 + 7z_2 + 3z_3}{3 + 7z_1 + 9z_2 + 7z_3}$$

$$T := \left[\frac{5 + 6z_1 + 7z_2 + 3z_3}{3 + 7z_1 + 9z_2 + 7z_3}, z_1, z_2 \right], [z_1, z_2, z_3]$$

$$[[0.8278233132, 0.8278233132, 0.8278233132]]$$

$$\{[0.8278233132, 0.8278233132, 0.8278233132]\}$$

0.8278233133

(101)

$f := RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]);$
 $SSSg(T, [z[1], z[2], z[3]]); Orbk(3, z, f, [5., 8., 11.], 2000, 2010)[-1];$

$$f := \frac{2 + 7z_1 + 6z_2 + z_3}{10 + 5z_1 + 10z_2 + z_3}$$

$$T := \left[\frac{2 + 7z_1 + 6z_2 + z_3}{10 + 5z_1 + 10z_2 + z_3}, z_1, z_2 \right], [z_1, z_2, z_3]$$

$$[[-0.2500000000, -0.2500000000, -0.2500000000], [0.5000000000, 0.5000000000, 0.5000000000]]$$

$$\{[0.5000000000, 0.5000000000, 0.5000000000]\}$$

0.5000000001

(102)

$f := RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]);$
 $SSSg(T, [z[1], z[2], z[3]]); Orbk(3, z, f, [5., 8., 11.], 2000, 2010)[-1];$

$$\begin{aligned}
f &:= \frac{4 + 10 z_1 + 10 z_2 + 2 z_3}{6 + 3 z_1 + 5 z_2 + 6 z_3} \\
T &:= \left[\frac{4 + 10 z_1 + 10 z_2 + 2 z_3}{6 + 3 z_1 + 5 z_2 + 6 z_3}, z_1, z_2 \right], [z_1, z_2, z_3] \\
&[[1.353889368, 1.353889368, 1.353889368]] \\
&\{[1.353889368, 1.353889368, 1.353889368]\} \\
&1.353889368
\end{aligned} \tag{103}$$

#they all match again. 3

$f := RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]);$
 $SSSg(T, [z[1], z[2], z[3]]); Orbk(3, z, f, [5., 8., 11.], 2000, 2010)[-1];$

$$\begin{aligned}
f &:= \frac{6 + 4 z_1 + 5 z_2 + 7 z_3}{10 + 9 z_1 + z_2 + 9 z_3} \\
T &:= \left[\frac{6 + 4 z_1 + 5 z_2 + 7 z_3}{10 + 9 z_1 + z_2 + 9 z_3}, z_1, z_2 \right], [z_1, z_2, z_3] \\
&[[0.7416071845, 0.7416071845, 0.7416071845]] \\
&\{[0.7416071845, 0.7416071845, 0.7416071845]\} \\
&0.7416071850
\end{aligned} \tag{104}$$

$f := RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]);$
 $SSSg(T, [z[1], z[2], z[3]]); Orbk(3, z, f, [5., 8., 11.], 2000, 2010)[-1];$

$$\begin{aligned}
f &:= \frac{9 + 8 z_1 + 3 z_2 + 10 z_3}{8 + 3 z_1 + 6 z_2 + 2 z_3} \\
T &:= \left[\frac{9 + 8 z_1 + 3 z_2 + 10 z_3}{8 + 3 z_1 + 6 z_2 + 2 z_3}, z_1, z_2 \right], [z_1, z_2, z_3] \\
&[[1.671351302, 1.671351302, 1.671351302]] \\
&\{[1.671351302, 1.671351302, 1.671351302]\} \\
&1.671351302
\end{aligned} \tag{105}$$

$f := RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]);$
 $SSSg(T, [z[1], z[2], z[3]]); Orbk(3, z, f, [5., 8., 11.], 2000, 2010)[-1];$

$$f := \frac{1 + 2 z_1 + 5 z_2 + 2 z_3}{3 + 5 z_1 + 8 z_2 + 7 z_3}$$

$$\begin{aligned}
T &:= \left[\frac{1 + 2 z_1 + 5 z_2 + 2 z_3}{3 + 5 z_1 + 8 z_2 + 7 z_3}, z_1, z_2 \right], [z_1, z_2, z_3] \\
&[[0.4192582404, 0.4192582404, 0.4192582404]] \\
&\{[0.4192582404, 0.4192582404, 0.4192582404]\} \\
&0.4192582402
\end{aligned} \tag{106}$$

$$\begin{aligned}
f &:= RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]); \\
&SSSg(T, [z[1], z[2], z[3]]); Orbk(3, z, f, [5., 8., 11.], 2000, 2010)[-1];
\end{aligned}$$

$$f := \frac{10 + 3 z_1 + 7 z_2 + 7 z_3}{5 + 10 z_1 + 9 z_2 + 2 z_3}$$

$$\begin{aligned}
T &:= \left[\frac{10 + 3 z_1 + 7 z_2 + 7 z_3}{5 + 10 z_1 + 9 z_2 + 2 z_3}, z_1, z_2 \right], [z_1, z_2, z_3] \\
&[[1.032589864, 1.032589864, 1.032589864]] \\
&\{[1.032589864, 1.032589864, 1.032589864]\}
\end{aligned}$$

$$1.032589863 \tag{107}$$

$$\begin{aligned}
f &:= RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]); \\
&SSSg(T, [z[1], z[2], z[3]]); Orbk(3, z, f, [5., 8., 11.], 2000, 2010)[-1];
\end{aligned}$$

$$f := \frac{2 + 5 z_1 + 10 z_2 + 7 z_3}{8 + 7 z_1 + 4 z_2 + 6 z_3}$$

$$\begin{aligned}
T &:= \left[\frac{2 + 5 z_1 + 10 z_2 + 7 z_3}{8 + 7 z_1 + 4 z_2 + 6 z_3}, z_1, z_2 \right], [z_1, z_2, z_3] \\
&[[0.9476725635, 0.9476725635, 0.9476725635]] \\
&\{[0.9476725635, 0.9476725635, 0.9476725635]\}
\end{aligned}$$

$$0.9476725640 \tag{108}$$

$$\begin{aligned}
f &:= RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]); \\
&SSSg(T, [z[1], z[2], z[3]]); Orbk(3, z, f, [5., 8., 11.], 2000, 2010)[-1];
\end{aligned}$$

$$f := \frac{2 + 4 z_1 + 8 z_2 + 10 z_3}{7 + 2 z_1 + 5 z_2 + 6 z_3}$$

$$\begin{aligned}
T &:= \left[\frac{2 + 4 z_1 + 8 z_2 + 10 z_3}{7 + 2 z_1 + 5 z_2 + 6 z_3}, z_1, z_2 \right], [z_1, z_2, z_3] \\
&[[1.274552198, 1.274552198, 1.274552198]] \\
&\{[1.274552198, 1.274552198, 1.274552198]\}
\end{aligned}$$

1.274552198

(109)

$$f := RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]);$$

$$SSSg(T, [z[1], z[2], z[3]]); Orbk(3, z, f, [5., 8., 11.], 2000, 2010)[-1];$$

$$f := \frac{7 + 3z_1 + 10z_2 + 3z_3}{5 + z_1 + 8z_2 + 4z_3}$$

$$T := \left[\frac{7 + 3z_1 + 10z_2 + 3z_3}{5 + z_1 + 8z_2 + 4z_3}, z_1, z_2 \right], [z_1, z_2, z_3]$$

$$[[1.270104444, 1.270104444, 1.270104444]]$$

$$\{[1.270104444, 1.270104444, 1.270104444]\}$$

1.270104444

(110)

$$f := RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]);$$

$$SSSg(T, [z[1], z[2], z[3]]); Orbk(3, z, f, [5., 8., 11.], 2000, 2010)[-1];$$

$$f := \frac{6 + 2z_1 + 4z_2 + 5z_3}{9 + z_1 + 10z_2 + 9z_3}$$

$$T := \left[\frac{6 + 2z_1 + 4z_2 + 5z_3}{9 + z_1 + 10z_2 + 9z_3}, z_1, z_2 \right], [z_1, z_2, z_3]$$

$$[[-0.5000000000, -0.5000000000, -0.5000000000], [0.6000000000, 0.6000000000, 0.6000000000]]$$

$$\{[0.6000000000, 0.6000000000, 0.6000000000]\}$$

0.6000000000

(111)

$$f := RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]);$$

$$SSSg(T, [z[1], z[2], z[3]]); Orbk(3, z, f, [5., 8., 11.], 2000, 2010)[-1];$$

$$f := \frac{10 + 7z_1 + 4z_2 + 2z_3}{7 + 2z_1 + 6z_2 + z_3}$$

$$T := \left[\frac{10 + 7z_1 + 4z_2 + 2z_3}{7 + 2z_1 + 6z_2 + z_3}, z_1, z_2 \right], [z_1, z_2, z_3]$$

$$[[1.438874930, 1.438874930, 1.438874930]]$$

$$\{[1.438874930, 1.438874930, 1.438874930]\}$$

1.438874929

(112)

$$f := RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]);$$

$$SSSg(T, [z[1], z[2], z[3]]); Orbk(3, z, f, [5., 8., 11.], 2000, 2010)[-1];$$

$$\begin{aligned}
f &:= \frac{8 + 10 z_1 + 10 z_2 + 10 z_3}{3 + 6 z_1 + 2 z_2 + 6 z_3} \\
T &:= \left[\frac{8 + 10 z_1 + 10 z_2 + 10 z_3}{3 + 6 z_1 + 2 z_2 + 6 z_3}, z_1, z_2 \right], [z_1, z_2, z_3] \\
&[[2.189551200, 2.189551200, 2.189551200]] \\
&\{[2.189551200, 2.189551200, 2.189551200]\} \\
&2.189551199
\end{aligned} \tag{113}$$

$$\begin{aligned}
f &:= RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]); \\
&SSSg(T, [z[1], z[2], z[3]]); Orbk(3, z, f, [5., 8., 11.], 2000, 2010)[-1]; \\
f &:= \frac{8 + 6 z_1 + 9 z_2 + z_3}{2 + 3 z_1 + 8 z_2 + 4 z_3} \\
T &:= \left[\frac{8 + 6 z_1 + 9 z_2 + z_3}{2 + 3 z_1 + 8 z_2 + 4 z_3}, z_1, z_2 \right], [z_1, z_2, z_3] \\
&[[-0.4000000000, -0.4000000000, -0.4000000000], [1.333333333, 1.333333333, \\
&1.333333333]] \\
&\{[1.333333333, 1.333333333, 1.333333333]\} \\
&1.333333333
\end{aligned} \tag{114}$$

$$\begin{aligned}
f &:= RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]); \\
&SSSg(T, [z[1], z[2], z[3]]); Orbk(3, z, f, [5., 8., 11.], 2000, 2010)[-1]; \\
f &:= \frac{6 + 8 z_1 + z_2 + 10 z_3}{9 + z_1 + 7 z_2 + 3 z_3} \\
T &:= \left[\frac{6 + 8 z_1 + z_2 + 10 z_3}{9 + z_1 + 7 z_2 + 3 z_3}, z_1, z_2 \right], [z_1, z_2, z_3] \\
&[[1.321762910, 1.321762910, 1.321762910]] \\
&\{[1.321762910, 1.321762910, 1.321762910]\} \\
&1.321762910
\end{aligned} \tag{115}$$

$$\begin{aligned}
f &:= RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]); \\
&SSSg(T, [z[1], z[2], z[3]]); Orbk(3, z, f, [5., 8., 11.], 2000, 2010)[-1]; \\
f &:= \frac{10 + z_1 + 2 z_2 + 2 z_3}{1 + 7 z_1 + 8 z_2 + 5 z_3}
\end{aligned}$$

$$\begin{aligned}
T &:= \left[\frac{10 + z_1 + 2z_2 + 2z_3}{1 + 7z_1 + 8z_2 + 5z_3}, z_1, z_2 \right], [z_1, z_2, z_3] \\
&[[0.8141428429, 0.8141428429, 0.8141428429]] \\
&\{[0.8141428429, 0.8141428429, 0.8141428429]\} \\
&0.8141428430
\end{aligned} \tag{116}$$

$$\begin{aligned}
f &:= RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]); \\
&SSSg(T, [z[1], z[2], z[3]]); Orbk(3, z, f, [5., 8., 11.], 2000, 2010)[-1];
\end{aligned}$$

$$f := \frac{1 + 3z_1 + 8z_2 + 10z_3}{4 + 10z_1 + 4z_2 + 6z_3}$$

$$\begin{aligned}
T &:= \left[\frac{1 + 3z_1 + 8z_2 + 10z_3}{4 + 10z_1 + 4z_2 + 6z_3}, z_1, z_2 \right], [z_1, z_2, z_3] \\
&[[0.9052343178, 0.9052343178, 0.9052343178]] \\
&\{[0.9052343178, 0.9052343178, 0.9052343178]\}
\end{aligned}$$

$$0.9052343179 \tag{117}$$

$$\begin{aligned}
f &:= RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]); \\
&SSSg(T, [z[1], z[2], z[3]]); Orbk(3, z, f, [5., 8., 11.], 2000, 2010)[-1];
\end{aligned}$$

$$f := \frac{9 + 10z_1 + 4z_2 + 5z_3}{1 + 2z_1 + 10z_2 + 5z_3}$$

$$\begin{aligned}
T &:= \left[\frac{9 + 10z_1 + 4z_2 + 5z_3}{1 + 2z_1 + 10z_2 + 5z_3}, z_1, z_2 \right], [z_1, z_2, z_3] \\
&[[1.429238738, 1.429238738, 1.429238738]] \\
&\{[1.429238738, 1.429238738, 1.429238738]\}
\end{aligned}$$

$$1.429238738 \tag{118}$$

$$\begin{aligned}
f &:= RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]); \\
&SSSg(T, [z[1], z[2], z[3]]); Orbk(3, z, f, [5., 8., 11.], 2000, 2010)[-1];
\end{aligned}$$

$$f := \frac{9 + 5z_1 + z_2 + 8z_3}{4 + 2z_1 + 3z_2 + 2z_3}$$

$$\begin{aligned}
T &:= \left[\frac{9 + 5z_1 + z_2 + 8z_3}{4 + 2z_1 + 3z_2 + 2z_3}, z_1, z_2 \right], [z_1, z_2, z_3] \\
&[[2.054404503, 2.054404503, 2.054404503]] \\
&\{[2.054404503, 2.054404503, 2.054404503]\}
\end{aligned}$$

2.054404503

(119)

$f := RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]);$
 $SSSg(T, [z[1], z[2], z[3]]); Orbk(3, z, f, [5., 8., 11.], 2000, 2010)[-1];$

$$f := \frac{3 + z_1 + 6z_2 + 5z_3}{8 + 2z_1 + 2z_2 + 5z_3}$$

$$T := \left[\frac{3 + z_1 + 6z_2 + 5z_3}{8 + 2z_1 + 2z_2 + 5z_3}, z_1, z_2 \right], [z_1, z_2, z_3]$$

$$[[0.8408627070, 0.8408627070, 0.8408627070]]$$

$$\{[0.8408627070, 0.8408627070, 0.8408627070]\}$$

0.8408627069

(120)

$f := RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]);$
 $SSSg(T, [z[1], z[2], z[3]]); Orbk(3, z, f, [5., 8., 11.], 2000, 2010)[-1];$

$$f := \frac{5 + 6z_1 + 7z_2 + 3z_3}{3 + 7z_1 + 9z_2 + 7z_3}$$

$$T := \left[\frac{5 + 6z_1 + 7z_2 + 3z_3}{3 + 7z_1 + 9z_2 + 7z_3}, z_1, z_2 \right], [z_1, z_2, z_3]$$

$$[[0.8278233132, 0.8278233132, 0.8278233132]]$$

$$\{[0.8278233132, 0.8278233132, 0.8278233132]\}$$

0.8278233133

(121)

$f := RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]);$
 $SSSg(T, [z[1], z[2], z[3]]); Orbk(3, z, f, [5., 8., 11.], 2000, 2010)[-1];$

$$f := \frac{2 + 7z_1 + 6z_2 + z_3}{10 + 5z_1 + 10z_2 + z_3}$$

$$T := \left[\frac{2 + 7z_1 + 6z_2 + z_3}{10 + 5z_1 + 10z_2 + z_3}, z_1, z_2 \right], [z_1, z_2, z_3]$$

$$[[-0.2500000000, -0.2500000000, -0.2500000000], [0.5000000000, 0.5000000000, 0.5000000000]]$$

$$\{[0.5000000000, 0.5000000000, 0.5000000000]\}$$

0.5000000001

(122)

$f := RR([z[1], z[2], z[3]], 10); T := RecToTs(3, z, f); SSg(T, [z[1], z[2], z[3]]);$
 $SSSg(T, [z[1], z[2], z[3]]); Orbk(3, z, f, [5., 8., 11.], 2000, 2010)[-1];$

$$\begin{aligned}
f &:= \frac{4 + 10 z_1 + 10 z_2 + 2 z_3}{6 + 3 z_1 + 5 z_2 + 6 z_3} \\
T &:= \left[\frac{4 + 10 z_1 + 10 z_2 + 2 z_3}{6 + 3 z_1 + 5 z_2 + 6 z_3}, z_1, z_2 \right], [z_1, z_2, z_3] \\
&[[1.353889368, 1.353889368, 1.353889368]] \\
&\{[1.353889368, 1.353889368, 1.353889368]\} \\
&1.353889368
\end{aligned} \tag{123}$$

#they all match again. the 3-variable rational recurrence system remains numerically and dynamically stable under these random parameter sets.

#question 6

$L := \text{rand}(1..3)()$; $a := \text{rand}(1..50)() / 20.$; $c := \text{rand}(1..50)() / 20.$; $T := \text{NicholsonBailey}(L, a, c, N, P)$
 $; \text{SSg}(T, [N, P]); \text{SSSg}(T, [N, P]);$

$$\begin{aligned}
L &:= 2 \\
a &:= 0.1000000000 \\
c &:= 0.3000000000 \\
T &:= [2 N e^{-0.1000000000 P}, 0.3000000000 N (1 - e^{-0.1000000000 P})] \\
&[[0., 0.], [46.20981204, 6.931471806]] \\
&\emptyset
\end{aligned} \tag{124}$$

$L := \text{rand}(1..3)()$; $a := \text{rand}(1..50)() / 20.$; $c := \text{rand}(1..50)() / 20.$; $T := \text{NicholsonBailey}(L, a, c, N, P)$
 $; \text{SSg}(T, [N, P]); \text{SSSg}(T, [N, P]);$

$$\begin{aligned}
L &:= 3 \\
a &:= 0.6500000000 \\
c &:= 2.2500000000 \\
T &:= [3 N e^{-0.6500000000 P}, 2.2500000000 N (1 - e^{-0.6500000000 P})] \\
&[[0., 0.], [1.126781835, 1.690172752]] \\
&\emptyset
\end{aligned} \tag{125}$$

$L := \text{rand}(1..3)()$; $a := \text{rand}(1..50)() / 20.$; $c := \text{rand}(1..50)() / 20.$; $T := \text{NicholsonBailey}(L, a, c, N, P)$
 $; \text{SSg}(T, [N, P]); \text{SSSg}(T, [N, P]);$

$$\begin{aligned}
L &:= 3 \\
a &:= 1.9500000000 \\
c &:= 2.5000000000
\end{aligned}$$

$$T := \left[3 N e^{-1.950000000 P}, 2.500000000 N \left(1 - e^{-1.950000000 P} \right) \right] \\ \left[[0., 0.], [0.3380345504, 0.5633909173] \right] \\ \emptyset \quad (126)$$

$L := rand(1..3) ()$; $a := rand(1..50) () / 20.$; $c := rand(1..50) () / 20.$; $T := NicholsonBailey(L, a, c, N, P)$
; $SSg(T, [N, P])$; $SSSg(T, [N, P])$;

$$L := 2$$

$$a := 1.750000000$$

$$c := 1.600000000$$

$$T := \left[2 N e^{-1.750000000 P}, 1.600000000 N \left(1 - e^{-1.750000000 P} \right) \right] \\ \left[[0., 0.], [0.4951051290, 0.3960841032] \right] \\ \emptyset \quad (127)$$

$L := rand(1..3) ()$; $a := rand(1..50) () / 20.$; $c := rand(1..50) () / 20.$; $T := NicholsonBailey(L, a, c, N, P)$
; $SSg(T, [N, P])$; $SSSg(T, [N, P])$;

$$L := 3$$

$$a := 2.450000000$$

$$c := 1.550000000$$

$$T := \left[3 N e^{-2.450000000 P}, 1.550000000 N \left(1 - e^{-2.450000000 P} \right) \right] \\ \left[[0., 0.], [0.4339482378, 0.4484131790] \right] \\ \emptyset \quad (128)$$

$L := rand(1..3) ()$; $a := rand(1..50) () / 20.$; $c := rand(1..50) () / 20.$; $T := NicholsonBailey(L, a, c, N, P)$
; $SSg(T, [N, P])$; $SSSg(T, [N, P])$;

$$L := 1$$

$$a := 0.6500000000$$

$$c := 1.150000000$$

$$T := \left[N e^{-0.6500000000 P}, 1.150000000 N \left(1 - e^{-0.6500000000 P} \right) \right] \\ \left[[N, 0.] \right]$$

Error, (in SSSg) cannot determine if this expression is true or false: $\max(1., .7475000000 * \text{abs}(N)) < 1$ |DMB.txt:556|

$L := rand(1..3) ()$; $a := rand(1..50) () / 20.$; $c := rand(1..50) () / 20.$; $T := NicholsonBailey(L, a, c, N, P)$
; $SSg(T, [N, P])$; $SSSg(T, [N, P])$;

$$\begin{aligned}
& L := 1 \\
& a := 1.800000000 \\
& c := 2.200000000 \\
& T := \left[N e^{-1.800000000 P}, 2.200000000 N \left(1 - e^{-1.800000000 P} \right) \right] \\
& \quad \left[[N, 0.] \right] \\
& \text{Error, (in SSSg) cannot determine if this expression is true or} \\
& \text{false: max(1.,3.960000000*abs(N)) < 1 |DMB.txt:556|} \\
& L := \text{rand}(1..3)(); a := \text{rand}(1..50)() / 20.; c := \text{rand}(1..50)() / 20.; T := \text{NicholsonBailey}(L, a, \\
& \quad c, N, P) \\
& ; \text{SSg}(T, [N, P]); \text{SSSg}(T, [N, P]); \\
& L := 3 \\
& a := 1.000000000 \\
& c := 0.550000000 \\
& T := \left[3 N e^{-1.000000000 P}, 0.550000000 N \left(1 - e^{-1.000000000 P} \right) \right] \\
& \quad \left[[0., 0.], [2.996215333, 1.098612289] \right] \\
& \quad \emptyset \tag{129}
\end{aligned}$$

$$\begin{aligned}
& L := \text{rand}(1..3)(); a := \text{rand}(1..50)() / 20.; c := \text{rand}(1..50)() / 20.; T := \text{NicholsonBailey}(L, a, \\
& \quad c, N, P) \\
& ; \text{SSg}(T, [N, P]); \text{SSSg}(T, [N, P]); \\
& L := 2 \\
& a := 1.900000000 \\
& c := 1.900000000 \\
& T := \left[2 N e^{-1.900000000 P}, 1.900000000 N \left(1 - e^{-1.900000000 P} \right) \right] \\
& \quad \left[[0., 0.], [0.3840150585, 0.3648143056] \right] \\
& \quad \emptyset \tag{130}
\end{aligned}$$

$$\begin{aligned}
& L := \text{rand}(1..3)(); a := \text{rand}(1..50)() / 20.; c := \text{rand}(1..50)() / 20.; T := \text{NicholsonBailey}(L, a, \\
& \quad c, N, P) \\
& ; \text{SSg}(T, [N, P]); \text{SSSg}(T, [N, P]); \\
& L := 2 \\
& a := 1.600000000 \\
& c := 2.450000000 \\
& T := \left[2 N e^{-1.600000000 P}, 2.450000000 N \left(1 - e^{-1.600000000 P} \right) \right] \\
& \quad \left[[0., 0.], [0.3536465207, 0.4332169878] \right] \\
& \quad \emptyset \tag{131}
\end{aligned}$$

$L := \text{rand}(1..3)(); a := \text{rand}(1..50)() / 20.; c := \text{rand}(1..50)() / 20.; T := \text{NicholsonBailey}(L, a, c, N, P)$
 $; \text{SSg}(T, [N, P]); \text{SSSg}(T, [N, P]);$

$L := 1$

$a := 1.750000000$

$c := 2.450000000$

$T := [N e^{-1.750000000 P}, 2.450000000 N (1 - e^{-1.750000000 P})]$

$[[N, 0.]]$

Error, (in SSSg) cannot determine if this expression is true or false: $\max(1., 4.287500000 * \text{abs}(N)) < 1$ |DMB.txt:556|

$L := \text{rand}(1..3)(); a := \text{rand}(1..50)() / 20.; c := \text{rand}(1..50)() / 20.; T := \text{NicholsonBailey}(L, a, c, N, P)$
 $; \text{SSg}(T, [N, P]); \text{SSSg}(T, [N, P]);$

$L := 2$

$a := 1.800000000$

$c := 1.600000000$

$T := [2 N e^{-1.800000000 P}, 1.600000000 N (1 - e^{-1.800000000 P})]$

$[[0., 0.], [0.4813522087, 0.3850817670]]$

$\emptyset$

(132)

$L := \text{rand}(1..3)(); a := \text{rand}(1..50)() / 20.; c := \text{rand}(1..50)() / 20.; T := \text{NicholsonBailey}(L, a, c, N, P)$
 $; \text{SSg}(T, [N, P]); \text{SSSg}(T, [N, P]);$

$L := 1$

$a := 0.9500000000$

$c := 1.600000000$

$T := [N e^{-0.9500000000 P}, 1.600000000 N (1 - e^{-0.9500000000 P})]$

$[[N, 0.]]$

Error, (in SSSg) cannot determine if this expression is true or false: $\max(1., 1.520000000 * \text{abs}(N)) < 1$ |DMB.txt:556|

$L := \text{rand}(1..3)(); a := \text{rand}(1..50)() / 20.; c := \text{rand}(1..50)() / 20.; T := \text{NicholsonBailey}(L, a, c, N, P)$
 $; \text{SSg}(T, [N, P]); \text{SSSg}(T, [N, P]);$

$L := 2$

$a := 0.4000000000$

$$\begin{aligned}
c &:= 1.9500000000 \\
T &:= \left[2 N e^{-0.4000000000 P}, 1.9500000000 N \left(1 - e^{-0.4000000000 P} \right) \right] \\
&[[0., 0.], [1.777300463, 1.732867951]] \\
&\emptyset
\end{aligned} \tag{133}$$

$$\begin{aligned}
L &:= \text{rand}(1..3)(); a := \text{rand}(1..50)() / 20.; c := \text{rand}(1..50)() / 20.; T := \text{NicholsonBailey}(L, a, \\
&c, N, P) \\
&; \text{SSg}(T, [N, P]); \text{SSSg}(T, [N, P]);
\end{aligned}$$

$$\begin{aligned}
L &:= 2 \\
a &:= 1.6000000000 \\
c &:= 2.1000000000 \\
T &:= \left[2 N e^{-1.6000000000 P}, 2.1000000000 N \left(1 - e^{-1.6000000000 P} \right) \right] \\
&[[0., 0.], [0.4125876075, 0.4332169878]] \\
&\emptyset
\end{aligned} \tag{134}$$

$$\begin{aligned}
L &:= \text{rand}(1..3)(); a := \text{rand}(1..50)() / 20.; c := \text{rand}(1..50)() / 20.; T := \text{NicholsonBailey}(L, a, \\
&c, N, P) \\
&; \text{SSg}(T, [N, P]); \text{SSSg}(T, [N, P]);
\end{aligned}$$

$$\begin{aligned}
L &:= 3 \\
a &:= 2.1000000000 \\
c &:= 2.4000000000 \\
T &:= \left[3 N e^{-2.1000000000 P}, 2.4000000000 N \left(1 - e^{-2.1000000000 P} \right) \right] \\
&[[0., 0.], [0.3269679431, 0.5231487089]] \\
&\emptyset
\end{aligned} \tag{135}$$

$$\begin{aligned}
L &:= \text{rand}(1..3)(); a := \text{rand}(1..50)() / 20.; c := \text{rand}(1..50)() / 20.; T := \text{NicholsonBailey}(L, a, \\
&c, N, P) \\
&; \text{SSg}(T, [N, P]); \text{SSSg}(T, [N, P]);
\end{aligned}$$

$$\begin{aligned}
L &:= 2 \\
a &:= 0.2000000000 \\
c &:= 2.2500000000 \\
T &:= \left[2 N e^{-0.2000000000 P}, 2.2500000000 N \left(1 - e^{-0.2000000000 P} \right) \right] \\
&[[0., 0.], [3.080654136, 3.465735903]] \\
&\emptyset
\end{aligned} \tag{136}$$

$$\begin{aligned}
L &:= \text{rand}(1..3)(); a := \text{rand}(1..50)() / 20.; c := \text{rand}(1..50)() / 20.; T := \text{NicholsonBailey}(L, a, \\
&c, N, P) \\
&; \text{SSg}(T, [N, P]); \text{SSSg}(T, [N, P]);
\end{aligned}$$

$$\begin{aligned}
& L := 1 \\
& a := 2.500000000 \\
& c := 1.150000000 \\
& T := \left[N e^{-2.500000000 P}, 1.150000000 N (1 - e^{-2.500000000 P}) \right] \\
& \quad [[N, 0.]] \\
& \text{Error, (in SSSg) cannot determine if this expression is true or} \\
& \text{false: max(1.,2.875000000*abs(N)) < 1 |DMB.txt:556|} \\
& L := \text{rand}(1..3)(); a := \text{rand}(1..50)() / 20.; c := \text{rand}(1..50)() / 20.; T := \text{NicholsonBailey}(L, a, \\
& \quad c, N, P) \\
& ; \text{SSg}(T, [N, P]); \text{SSSg}(T, [N, P]); \\
& L := 3 \\
& a := 2.300000000 \\
& c := 0.100000000 \\
& T := \left[3 N e^{-2.300000000 P}, 0.100000000 N (1 - e^{-2.300000000 P}) \right] \\
& \quad [[0., 0.], [7.164862752, 0.4776575168]] \\
& \quad \emptyset \tag{137}
\end{aligned}$$

$$\begin{aligned}
& L := \text{rand}(1..3)(); a := \text{rand}(1..50)() / 20.; c := \text{rand}(1..50)() / 20.; T := \text{NicholsonBailey}(L, a, \\
& \quad c, N, P) \\
& ; \text{SSg}(T, [N, P]); \text{SSSg}(T, [N, P]); \\
& L := 2 \\
& a := 2.150000000 \\
& c := 0.950000000 \\
& T := \left[2 N e^{-2.150000000 P}, 0.950000000 N (1 - e^{-2.150000000 P}) \right] \\
& \quad [[0., 0.], [0.6787242894, 0.3223940375]] \\
& \quad \emptyset \tag{138}
\end{aligned}$$

$$\begin{aligned}
& L := \text{rand}(1..3)(); a := \text{rand}(1..50)() / 20.; c := \text{rand}(1..50)() / 20.; T := \text{NicholsonBailey}(L, a, \\
& \quad c, N, P) \\
& ; \text{SSg}(T, [N, P]); \text{SSSg}(T, [N, P]); \\
& L := 3 \\
& a := 1.350000000 \\
& c := 0.550000000 \\
& T := \left[3 N e^{-1.350000000 P}, 0.550000000 N (1 - e^{-1.350000000 P}) \right] \\
& \quad [[0., 0.], [2.219418765, 0.8137868805]] \\
& \quad \emptyset \tag{139}
\end{aligned}$$

$$\begin{aligned}
&L := \text{rand}(1..3)(); a := \text{rand}(1..50)() / 20.; c := \text{rand}(1..50)() / 20.; T := \text{NicholsonBailey}(L, a, \\
&\quad c, N, P) \\
&; \text{SSg}(T, [N, P]); \text{SSSg}(T, [N, P]); \\
&\quad L := 2 \\
&\quad a := 1.350000000 \\
&\quad c := 0.4500000000 \\
&\quad T := [2 N e^{-1.350000000 P}, 0.4500000000 N (1 - e^{-1.350000000 P})] \\
&\quad \quad [[0., 0.], [2.281966027, 0.5134423560]] \\
&\quad \quad \emptyset
\end{aligned} \tag{140}$$

$$\begin{aligned}
&L := \text{rand}(1..3)(); a := \text{rand}(1..50)() / 20.; c := \text{rand}(1..50)() / 20.; T := \text{NicholsonBailey}(L, a, \\
&\quad c, N, P) \\
&; \text{SSg}(T, [N, P]); \text{SSSg}(T, [N, P]); \\
&\quad L := 1 \\
&\quad a := 1.550000000 \\
&\quad c := 1.900000000 \\
&\quad T := [N e^{-1.550000000 P}, 1.900000000 N (1 - e^{-1.550000000 P})] \\
&\quad \quad [[N, 0.]]
\end{aligned}$$

Error, (in SSSg) cannot determine if this expression is true or false: max(1., 2.945000000*abs(N)) < 1 |DMB.txt:556|

#None of them were non-empty SSSg (stable steady states found. is expected for the Nicholson–Bailey model: the positive equilibrium exists but is always unstable for biologically reasonable parameter values.

#Question 7

$$\begin{aligned}
&a := \text{rand}(1..10)() / 10.; r := \text{rand}(1..10)() / 10.; K := \text{rand}(1..10)() : \\
&T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);
\end{aligned}$$

$$\begin{aligned}
&T := [14 e^{-2.200000000 - 0.2000000000 N}, 14 - 14 e^{-0.2000000000 N}] \\
&\quad \{[1.216284216, 3.023018532]\}
\end{aligned} \tag{141}$$

$$\begin{aligned}
&a := \text{rand}(1..10)() / 10.; r := \text{rand}(1..10)() / 10.; K := \text{rand}(1..10)() : \\
&T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);
\end{aligned}$$

$$\begin{aligned}
&T := [14 e^{-0.3200000000 - 0.9000000000 N}, 14 - 14 e^{-0.9000000000 N}] \\
&\quad \emptyset
\end{aligned} \tag{142}$$

$$\begin{aligned}
&a := \text{rand}(1..10)() / 10.; r := \text{rand}(1..10)() / 10.; K := \text{rand}(1..10)() : \\
&T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);
\end{aligned}$$

$$T := \left[14 e^{-0.4444444444 - 0.6000000000 N}, 14 - 14 e^{-0.6000000000 N} \right]$$

$$\emptyset \quad (143)$$

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() :$$

$$T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := \left[14 e^{-1.0000000000 - 0.5000000000 N}, 14 - 14 e^{-0.5000000000 N} \right]$$

$$\{[1.946277506, 8.709469223]\} \quad (144)$$

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() :$$

$$T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := \left[14 e^{-0.5250000000 - 0.5000000000 N}, 14 - 14 e^{-0.5000000000 N} \right]$$

$$\emptyset \quad (145)$$

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() :$$

$$T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := \left[14 e^{-0.08000000000 - 0.7000000000 N}, 14 - 14 e^{-0.7000000000 N} \right]$$

$$\emptyset \quad (146)$$

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() :$$

$$T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := \left[14 e^{-0.5333333333 - 0.1000000000 N}, 14 - 14 e^{-0.1000000000 N} \right]$$

$$\{[4.987630497, 5.498060789]\} \quad (147)$$

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() :$$

$$T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := \left[14 e^{-0.3333333333 - 0.3000000000 N}, 14 - 14 e^{-0.3000000000 N} \right]$$

$$\emptyset \quad (148)$$

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() :$$

$$T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := \left[14 e^{-2.566666667 - 0.3000000000 N}, 14 - 14 e^{-0.3000000000 N} \right]$$

$$\{[0.8364795524, 3.107075349]\} \quad (149)$$

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() :$$

$$T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := \left[14 e^{-0.3200000000 - 0.5000000000 N}, 14 - 14 e^{-0.5000000000 N} \right]$$

$$\emptyset \quad (150)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := [14 e^{-1.260000000 - 0.8000000000 N}, 14 - 14 e^{-0.8000000000 N}]$$

$$\emptyset \quad (151)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := [14 e^{-0.6666666666 - 0.7000000000 N}, 14 - 14 e^{-0.7000000000 N}]$$

$$\emptyset \quad (152)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := [14 e^{-1.440000000 - 1.000000000 N}, 14 - 14 e^{-1.000000000 N}]$$

$$\emptyset \quad (153)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := [14 e^{-0.2666666667 - 0.7000000000 N}, 14 - 14 e^{-0.7000000000 N}]$$

$$\emptyset \quad (154)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := [14 e^{-0.2250000000 - 0.7000000000 N}, 14 - 14 e^{-0.7000000000 N}]$$

$$\emptyset \quad (155)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := [14 e^{-4.200000000 - 0.1000000000 N}, 14 - 14 e^{-0.1000000000 N}]$$

$$\{[0.2056644916, 0.2849896305]\} \quad (156)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := [14 e^{-1.000000000 - 0.7000000000 N}, 14 - 14 e^{-0.7000000000 N}]$$

$$\emptyset \quad (157)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-0.6000000000 - 0.9000000000 N}, 14 - 14 e^{-0.9000000000 N} \right] \\ \emptyset \quad (158)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-0.3000000000 - 0.2000000000 N}, 14 - 14 e^{-0.2000000000 N} \right] \\ \{[4.347398522, 8.131625815]\} \quad (159)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-3.9000000000 - 0.9000000000 N}, 14 - 14 e^{-0.9000000000 N} \right] \\ \{[0.2303304856, 2.621109907]\} \quad (160)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-2.6000000000 - 0.4000000000 N}, 14 - 14 e^{-0.4000000000 N} \right] \\ \{[0.7655488740, 3.692850507]\} \quad (161)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-1.6200000000 - 0.7000000000 N}, 14 - 14 e^{-0.7000000000 N} \right] \\ \{[1.197872183, 7.947043673]\} \quad (162)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-1.2000000000 - 0.8000000000 N}, 14 - 14 e^{-0.8000000000 N} \right] \\ \emptyset \quad (163)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-1.6200000000 - 0.9000000000 N}, 14 - 14 e^{-0.9000000000 N} \right] \\ \{[1.063685834, 8.625099411]\} \quad (164)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-1.250000000 - 0.5000000000 N}, 14 - 14 e^{-0.5000000000 N} \right] \\ \{ [1.707755172, 8.039348761] \} \quad (165)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-0.8000000000 - 0.1000000000 N}, 14 - 14 e^{-0.1000000000 N} \right] \\ \{ [4.152783932, 4.757809392] \} \quad (166)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-1.333333333 - 0.3000000000 N}, 14 - 14 e^{-0.3000000000 N} \right] \\ \{ [2.015759625, 6.352877431] \} \quad (167)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-0.6000000000 - 0.5000000000 N}, 14 - 14 e^{-0.5000000000 N} \right] \\ \emptyset \quad (168)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-0.08000000000 - 0.1000000000 N}, 14 - 14 e^{-0.1000000000 N} \right] \\ \{ [6.647765486, 6.798561620] \} \quad (169)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-0.2222222222 - 0.1000000000 N}, 14 - 14 e^{-0.1000000000 N} \right] \\ \{ [6.094493874, 6.388898218] \} \quad (170)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-0.04000000000 - 0.7000000000 N}, 14 - 14 e^{-0.7000000000 N} \right] \\ \emptyset \quad (171)$$

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() : \\ T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := [14 e^{-0.1666666667 - 0.7000000000 N}, 14 - 14 e^{-0.7000000000 N}]$$

$\emptyset$

(172)

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() : \\ T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := [14 e^{-0.7333333333 - 0.9000000000 N}, 14 - 14 e^{-0.9000000000 N}]$$

$\emptyset$

(173)

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() : \\ T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := [14 e^{-0.3333333333 - 0.1000000000 N}, 14 - 14 e^{-0.1000000000 N}]$$

$$\{[5.682799737, 6.069014079]\}$$

(174)

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() : \\ T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := [14 e^{-0.4000000000 - 0.5000000000 N}, 14 - 14 e^{-0.5000000000 N}]$$

$\emptyset$

(175)

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() : \\ T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := [14 e^{-0.9000000000 - 0.9000000000 N}, 14 - 14 e^{-0.9000000000 N}]$$

$\emptyset$

(176)

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() : \\ T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := [14 e^{-1.1000000000 - 0.7000000000 N}, 14 - 14 e^{-0.7000000000 N}]$$

$\emptyset$

(177)

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() : \\ T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := [14 e^{-1.0000000000 - 1.0000000000 N}, 14 - 14 e^{-1.0000000000 N}]$$

$\emptyset$

(178)

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() : \\ T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := \left[14 e^{-0.6000000000 - 0.8000000000 N}, 14 - 14 e^{-0.8000000000 N} \right]$$

$$\emptyset$$
(179)

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() :$$

$$T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-0.3000000000 - 0.1000000000 N}, 14 - 14 e^{-0.1000000000 N} \right]$$

$$\{[5.804403963, 6.164874188]\}$$
(180)

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() :$$

$$T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-0.4444444444 - 0.7000000000 N}, 14 - 14 e^{-0.7000000000 N} \right]$$

$$\emptyset$$
(181)

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() :$$

$$T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-1.5000000000 - 0.2000000000 N}, 14 - 14 e^{-0.2000000000 N} \right]$$

$$\{[2.066355211, 4.739238437]\}$$
(182)

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() :$$

$$T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-2.6000000000 - 1.0000000000 N}, 14 - 14 e^{-1.0000000000 N} \right]$$

$$\{[0.5813903016, 6.172313283]\}$$
(183)

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() :$$

$$T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-0.2000000000 - 0.1000000000 N}, 14 - 14 e^{-0.1000000000 N} \right]$$

$$\{[6.179003374, 6.452948236]\}$$
(184)

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() :$$

$$T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-2.5000000000 - 0.7000000000 N}, 14 - 14 e^{-0.7000000000 N} \right]$$

$$\{[0.7026964911, 5.439404240]\}$$
(185)

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() :$$

$$T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-0.1000000000 - 0.2000000000 N}, 14 - 14 e^{-0.2000000000 N} \right]$$

$$\{[4.825605526, 8.666881111]\} \quad (186)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := [14 e^{-1.066666667 - 0.4000000000 N}, 14 - 14 e^{-0.4000000000 N}] \\ \{[2.089119702, 7.929691370]\} \quad (187)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := [14 e^{-0.3333333333 - 0.4000000000 N}, 14 - 14 e^{-0.4000000000 N}] \\ \emptyset \quad (188)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := [14 e^{-7.800000000 - 0.9000000000 N}, 14 - 14 e^{-0.9000000000 N}] \\ \{[0.005706902439, 0.0717226218]\} \quad (189)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := [14 e^{-0.7200000000 - 0.1000000000 N}, 14 - 14 e^{-0.1000000000 N}] \\ \{[4.392221635, 4.976474006]\} \quad (190)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := [14 e^{-0.3666666667 - 0.4000000000 N}, 14 - 14 e^{-0.4000000000 N}] \\ \emptyset \quad (191)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := [14 e^{-0.4000000000 - 0.1000000000 N}, 14 - 14 e^{-0.1000000000 N}] \\ \{[5.444504952, 5.877753046]\} \quad (192)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := [14 e^{-0.2800000000 - 0.6000000000 N}, 14 - 14 e^{-0.6000000000 N}]$$

$$\emptyset \quad (193)$$

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() : \\ T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := \left[14 e^{-0.07500000000 - 0.3000000000 N}, 14 - 14 e^{-0.3000000000 N} \right]$$

$$\emptyset \quad (194)$$

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() : \\ T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := \left[14 e^{-0.9000000000 - 1.000000000 N}, 14 - 14 e^{-1.000000000 N} \right]$$

$$\emptyset \quad (195)$$

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() : \\ T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := \left[14 e^{-4.800000000 - 1.000000000 N}, 14 - 14 e^{-1.000000000 N} \right]$$

$$\{[0.1038514167, 1.380970998]\} \quad (196)$$

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() : \\ T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := \left[14 e^{-0.4000000000 - 0.8000000000 N}, 14 - 14 e^{-0.8000000000 N} \right]$$

$$\emptyset \quad (197)$$

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() : \\ T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := \left[14 e^{-3.666666667 - 0.8000000000 N}, 14 - 14 e^{-0.8000000000 N} \right]$$

$$\{[0.2849203486, 2.853550121]\} \quad (198)$$

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() : \\ T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := \left[14 e^{-0.05555555556 - 0.3000000000 N}, 14 - 14 e^{-0.3000000000 N} \right]$$

$$\emptyset \quad (199)$$

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() : \\ T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := \left[14 e^{-1.333333333 - 0.8000000000 N}, 14 - 14 e^{-0.8000000000 N} \right]$$

$$\emptyset \quad (200)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-0.9000000000 - 0.6000000000 N}, 14 - 14 e^{-0.6000000000 N} \right]$$

$\emptyset$

(201)

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-0.6000000000 - 0.2000000000 N}, 14 - 14 e^{-0.2000000000 N} \right]$$

$$\{[3.680306485, 7.294044363]\}$$

(202)

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-1.5000000000 - 1.0000000000 N}, 14 - 14 e^{-1.0000000000 N} \right]$$

$\emptyset$

(203)

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-0.1000000000 - 0.9000000000 N}, 14 - 14 e^{-0.9000000000 N} \right]$$

$\emptyset$

(204)

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-0.1666666667 - 0.2000000000 N}, 14 - 14 e^{-0.2000000000 N} \right]$$

$$\{[4.663317640, 8.490941147]\}$$

(205)

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-0.1500000000 - 0.3000000000 N}, 14 - 14 e^{-0.3000000000 N} \right]$$

$\emptyset$

(206)

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-4.8000000000 - 0.7000000000 N}, 14 - 14 e^{-0.7000000000 N} \right]$$

$$\{[0.1069088312, 1.009463280]\}$$

(207)

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-0.6000000000 - 0.2000000000 N}, 14 - 14 e^{-0.2000000000 N} \right] \\ \{ [3.680306485, 7.294044363] \} \quad (208)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-0.9333333333 - 0.7000000000 N}, 14 - 14 e^{-0.7000000000 N} \right] \\ \emptyset \quad (209)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-0.1000000000 - 0.7000000000 N}, 14 - 14 e^{-0.7000000000 N} \right] \\ \emptyset \quad (210)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-0.2222222222 - 0.4000000000 N}, 14 - 14 e^{-0.4000000000 N} \right] \\ \emptyset \quad (211)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-0.3000000000 - 1.0000000000 N}, 14 - 14 e^{-1.0000000000 N} \right] \\ \emptyset \quad (212)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-1.3333333333 - 0.7000000000 N}, 14 - 14 e^{-0.7000000000 N} \right] \\ \{ [1.392410661, 8.717656380] \} \quad (213)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-0.0750000000 - 0.8000000000 N}, 14 - 14 e^{-0.8000000000 N} \right] \\ \emptyset \quad (214)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-0.6000000000 - 0.5000000000 N}, 14 - 14 e^{-0.5000000000 N} \right]$$

$$\emptyset \quad (215)$$

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() : \\ T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := \left[14 e^{-2.400000000 - 0.2000000000 N}, 14 - 14 e^{-0.2000000000 N} \right] \\ \{[1.032991558, 2.613151854]\} \quad (216)$$

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() : \\ T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := \left[14 e^{-1.100000000 - 0.4000000000 N}, 14 - 14 e^{-0.4000000000 N} \right] \\ \{[2.051371653, 7.837338978]\} \quad (217)$$

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() : \\ T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := \left[14 e^{-0.4000000000 - 0.2000000000 N}, 14 - 14 e^{-0.2000000000 N} \right] \\ \{[4.118202608, 7.856363639]\} \quad (218)$$

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() : \\ T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := \left[14 e^{-0.3750000000 - 0.5000000000 N}, 14 - 14 e^{-0.5000000000 N} \right] \\ \emptyset \quad (219)$$

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() : \\ T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := \left[14 e^{-1.500000000 - 0.1000000000 N}, 14 - 14 e^{-0.1000000000 N} \right] \\ \{[2.446006470, 3.037759536]\} \quad (220)$$

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() : \\ T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := \left[14 e^{-0.9000000000 - 0.6000000000 N}, 14 - 14 e^{-0.6000000000 N} \right] \\ \emptyset \quad (221)$$

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() : \\ T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := \left[14 e^{-0.7500000000 - 0.1000000000 N}, 14 - 14 e^{-0.1000000000 N} \right]$$

$$\{[4.301330158, 4.894083985]\} \quad (222)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := [14 e^{-5.400000000 - 0.1000000000 N}, 14 - 14 e^{-0.1000000000 N}] \\ \{[0.06283605314, 0.0876946665]\} \quad (223)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := [14 e^{-1.333333333 - 0.5000000000 N}, 14 - 14 e^{-0.5000000000 N}] \\ \{[1.631926076, 7.809014442]\} \quad (224)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := [14 e^{-0.1200000000 - 0.4000000000 N}, 14 - 14 e^{-0.4000000000 N}] \\ \emptyset \quad (225)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := [14 e^{-9.100000000 - 0.2000000000 N}, 14 - 14 e^{-0.2000000000 N}] \\ \{[0.001562832753, 0.0043752480]\} \quad (226)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := [14 e^{-0.9000000000 - 0.3000000000 N}, 14 - 14 e^{-0.3000000000 N}] \\ \{[2.605182280, 7.592285560]\} \quad (227)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := [14 e^{-0.3666666667 - 1.000000000 N}, 14 - 14 e^{-1.000000000 N}] \\ \emptyset \quad (228)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := [14 e^{-0.1200000000 - 0.3000000000 N}, 14 - 14 e^{-0.3000000000 N}] \\ \emptyset \quad (229)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-6.000000000 - 0.4000000000 N}, 14 - 14 e^{-0.4000000000 N} \right] \\ \{ [0.03423061309, 0.1903850595] \} \quad (230)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-0.4500000000 - 0.7000000000 N}, 14 - 14 e^{-0.7000000000 N} \right] \\ \emptyset \quad (231)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-1.800000000 - 0.4000000000 N}, 14 - 14 e^{-0.4000000000 N} \right] \\ \{ [1.349082148, 5.838528606] \} \quad (232)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-1.000000000 - 0.5000000000 N}, 14 - 14 e^{-0.5000000000 N} \right] \\ \{ [1.946277506, 8.709469223] \} \quad (233)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-0.1111111111 - 0.9000000000 N}, 14 - 14 e^{-0.9000000000 N} \right] \\ \emptyset \quad (234)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-0.4444444444 - 0.5000000000 N}, 14 - 14 e^{-0.5000000000 N} \right] \\ \emptyset \quad (235)$$

$$a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..10)() : \\ T := NicholsonBaileyM(a, r, K, 14, N, P); SSSg(T, [N, P]);$$

$$T := \left[14 e^{-1.200000000 - 0.6000000000 N}, 14 - 14 e^{-0.6000000000 N} \right] \\ \{ [1.607399479, 8.663245789] \} \quad (236)$$

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() : \\ T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := [14 e^{-5.400000000 - 1.000000000 N}, 14 - 14 e^{-1.000000000 N}] \\ \{[0.05957508915, 0.8096930159]\} \quad (237)$$

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() : \\ T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := [14 e^{-0.6000000000 - 0.9000000000 N}, 14 - 14 e^{-0.9000000000 N}] \\ \emptyset \quad (238)$$

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() : \\ T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := [14 e^{-0.1200000000 - 0.3000000000 N}, 14 - 14 e^{-0.3000000000 N}] \\ \emptyset \quad (239)$$

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() : \\ T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := [14 e^{-2.566666667 - 0.5000000000 N}, 14 - 14 e^{-0.5000000000 N}] \\ \{[0.7418899769, 4.338853358]\} \quad (240)$$

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() : \\ T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := [14 e^{-2.500000000 - 0.5000000000 N}, 14 - 14 e^{-0.5000000000 N}] \\ \{[0.7786085036, 4.514606607]\} \quad (241)$$

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() : \\ T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := [14 e^{-11.70000000 - 0.9000000000 N}, 14 - 14 e^{-0.9000000000 N}] \\ \{[0.0001161013360, 0.00146280040]\} \quad (242)$$

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() : \\ T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := [14 e^{-0.3600000000 - 0.3000000000 N}, 14 - 14 e^{-0.3000000000 N}] \\ \emptyset \quad (243)$$

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() : \\ T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := [14 e^{-13.000000000 - 0.4000000000 N}, 14 - 14 e^{-0.4000000000 N}] \\ \{[0.00003164421115, 0.0001772065]\} \quad (244)$$

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() : \\ T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := [14 e^{-5.200000000 - 0.4000000000 N}, 14 - 14 e^{-0.4000000000 N}] \\ \{[0.07495082840, 0.4134953049]\} \quad (245)$$

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() : \\ T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := [14 e^{-0.1800000000 - 0.6000000000 N}, 14 - 14 e^{-0.6000000000 N}] \\ \emptyset \quad (246)$$

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() : \\ T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := [14 e^{-1.750000000 - 0.7000000000 N}, 14 - 14 e^{-0.7000000000 N}] \\ \{[1.114813972, 7.584688535]\} \quad (247)$$

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() : \\ T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := [14 e^{-11.700000000 - 1.0000000000 N}, 14 - 14 e^{-1.0000000000 N}] \\ \{[0.0001160999883, 0.00162530548]\} \quad (248)$$

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() : \\ T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := [14 e^{-9.100000000 - 0.5000000000 N}, 14 - 14 e^{-0.5000000000 N}] \\ \{[0.001562100763, 0.0109304362]\} \quad (249)$$

$$a := \text{rand}(1..10)() / 10. : r := \text{rand}(1..10)() / 10. : K := \text{rand}(1..10)() : \\ T := \text{NicholsonBaileyM}(a, r, K, 14, N, P); \text{SSSg}(T, [N, P]);$$

$$T := [14 e^{-2.600000000 - 0.8000000000 N}, 14 - 14 e^{-0.8000000000 N}] \\ \{[0.6287830015, 5.534230388]\} \quad (250)$$

#out of 100 runs, there was 28 non-empty steady state sets.