

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

Email the answers (as .pdf file) to

ShaloshBEkhad@gmail.com

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)

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?

> $T := RT([x], 10); SSSg(T, [x]); Ssg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1];$	$T := \frac{7 + 10x}{4 + 2x}$ $\{ \{3.121320343\} \}$ $[[-1.121320343], [3.121320343]]$ $[3.121320342]$	(5)
> $T := RT([x], 10); SSSg(T, [x]); Ssg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1];$	$T := \frac{4 + 6x}{5 + x}$ $\{ \{2.561552813\} \}$ $[[-1.561552813], [2.561552813]]$ $[2.561552813]$	(6)
> $T := RT([x], 10); SSSg(T, [x]); Ssg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1];$	$T := \frac{8 + 5x}{10 + 2x}$ $\{ \{1.108495283\} \}$ $[[-3.608495283], [1.108495283]]$ $[1.108495283]$	(7)
> $T := RT([x], 10); SSSg(T, [x]); Ssg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1];$	$T := \frac{2 + 4x}{8 + 3x}$ $\{ \{0.387425886\} \}$ $[[-1.720759220], [0.387425886]]$ $[0.387425886]$	(8)
> $T := RT([x], 10); SSSg(T, [x]); Ssg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1];$	$T := \frac{9 + 10x}{2 + 4x}$ $\{ \{1.672603940\} \}$ $[[-0.672603940], [1.672603940]]$ $[1.672603940]$	(9)
> $T := RT([x], 10); SSSg(T, [x]); Ssg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1];$	$T := \frac{10 + 9x}{2 + 6x}$ $\{ \{2.119632982\} \}$ $[[-0.786299648], [2.119632982]]$ $[2.119632981]$	(10)
> $T := RT([x], 10); SSSg(T, [x]); Ssg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1];$	$T := \frac{7 + 7x}{3 + 3x}$ $\{ \{2.333333333\} \}$ $\{ \{2.333333333\} \}$ $\{ \{2.333333333\} \}$	(11)
> $T := RT([x], 10); SSSg(T, [x]); Ssg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1];$	$T := \frac{5 + 3x}{8 + 10x}$ $\{ \{0.500000000\} \}$ $[[-1, 1], [0.500000000]]$ $[0.500000000]$	(12)
> $T := RT([x], 10); SSSg(T, [x]); Ssg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1];$	$T := \frac{3 + x}{1 + 3x}$ $\{ \{1\} \}$ $[[-1, 1], [1]]$ $[1.000000000]$	(13)
> $T := RT([x], 10); SSSg(T, [x]); Ssg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1];$	$T := \frac{5 + 5x}{10 + 10x}$ $\{ \{0.500000000\} \}$ $\{ \{0.500000000\} \}$ $\{ \{0.500000000\} \}$	(14)
> $T := RT([x], 10); SSSg(T, [x]); Ssg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1];$	$T := \frac{10 + 2x}{8 + 4x}$ $\{ \{1\} \}$ $[[-2.500000000], [1]]$ $[1.000000000]$	(15)
> $T := RT([x], 10); SSSg(T, [x]); Ssg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1];$	$T := \frac{2 + 9x}{5 + 9x}$ $\{ \{0.7433795288\} \}$ $[[-0.2989350844], [0.7433795288]]$ $[0.7433795290]$	(16)
> $T := RT([x], 10); SSSg(T, [x]); Ssg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1];$	$T := \frac{7 + 4x}{3 + 10x}$ $\{ \{0.8881527305\} \}$ $[[-0.7881527305], [0.8881527305]]$ $[0.8881527310]$	(17)
> $T := RT([x], 10); SSSg(T, [x]); Ssg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1];$	$T := \frac{9 + 10x}{4 + 9x}$ $\{ \{1.387425886\} \}$ $[[-0.7207592197], [1.387425886]]$ $[1.387425887]$	(18)
> $T := RT([x], 10); SSSg(T, [x]); Ssg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1];$	$T := \frac{7 + 8x}{9 + x}$ $\{ \{2.192582404\} \}$ $[[-3.192582404], [2.192582404]]$ $[2.192582404]$	(19)
> $T := RT([x], 10); SSSg(T, [x]); Ssg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1];$	$T := \frac{10 + 2x}{4 + 7x}$ $\{ \{1.060878539\} \}$ $[[-1.346592825], [1.060878539]]$ $[1.060878539]$	(20)
> $T := RT([x], 10); SSSg(T, [x]); Ssg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1];$	$T := \frac{8 + x}{6 + 4x}$ $\{ \{0.9211646100\} \}$ $[[-2.171164610], [0.9211646100]]$ $[0.9211646097]$	(21)
> $T := RT([x], 10); SSSg(T, [x]); Ssg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1];$	$T := \frac{1 + 7x}{2 + 9x}$ $\{ \{0.7116805376\} \}$ $[[-0.1561249820], [0.7116805376]]$ $[0.7116805376]$	(22)
> $T := RT([x], 10); SSSg(T, [x]); Ssg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1];$	$T := \frac{5 + 9x}{9 + 4x}$ $\{ \{1.118033988\} \}$ $[[-1.118033988], [1.118033988]]$ $[1.118033988]$	(23)
> $T := RT([x], 10); SSSg(T, [x]); Ssg(T, [x], z); ORB(T, [x], [6.], 1000, 1010)[-1];$	$T := \frac{3 + 4x}{6 + 4x}$ $\{ \{0.6513878188\} \}$ $[[-1.151387819], [0.6513878188]]$ $[0.6513878189]$	(24)

Agree 20/20 times

2. Copy-and-paste the following line into your worksheet (once you have donwloaded 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?

> T := RT([x,y],10);SSg(T,[x,y]);SSSg(T,[x,y]);ORB(T,[x,y],[6.,8.],1000,1010)[-1];	$T := \left[\begin{array}{c} \frac{4+10x+8y}{2+7x+2y} \cdot \frac{5+3x+5y}{7+5x+4y} \\ \{1.745632788, 0.7464565857\} \\ \{1.745632788, 0.7464565857\} \end{array} \right]$	(5)
> T := RT([x,y],10);SSg(T,[x,y]);SSSg(T,[x,y]);ORB(T,[x,y],[6.,8.],1000,1010)[-1];	$T := \left[\begin{array}{c} \frac{8+10x+2y}{6+8x+4y} \cdot \frac{8+7x+9y}{4+10x+3y} \\ \{1.051537188, 1.523154357\} \\ \{1.051537188, 1.523154357\} \end{array} \right]$	(6)
> T := RT([x,y],10);SSg(T,[x,y]);SSSg(T,[x,y]);ORB(T,[x,y],[6.,8.],1000,1010)[-1];	$T := \left[\begin{array}{c} \frac{2+9x+y}{1+5x+2y} \cdot \frac{4+4x+y}{6+3x+y} \\ [-0.309865067, 0.5920753815] \\ \emptyset \end{array} \right]$	(7)
> T := RT([x,y],10);SSg(T,[x,y]);SSSg(T,[x,y]);ORB(T,[x,y],[6.,8.],1000,1010)[-1];	$T := \left[\begin{array}{c} \frac{7+2x+y}{5+10x+3y} \cdot \frac{10+4x+6y}{8+8x+5y} \\ \{0.6472327339, 0.9230130065\} \\ \{0.6472327339, 0.9230130065\} \end{array} \right]$	(8)
> T := RT([x,y],10);SSg(T,[x,y]);SSSg(T,[x,y]);ORB(T,[x,y],[6.,8.],1000,1010)[-1];	$T := \left[\begin{array}{c} \frac{9+6x+y}{2+9x+5y} \cdot \frac{3+2x+5y}{3+9x+8y} \\ \{1.127014906, 0.4480178765\} \\ \{1.127014906, 0.4480178765\} \end{array} \right]$	(9)
> T := RT([x,y],10);SSg(T,[x,y]);SSSg(T,[x,y]);ORB(T,[x,y],[6.,8.],1000,1010)[-1];	$T := \left[\begin{array}{c} \frac{5+4x+3y}{3+9x+3y} \cdot \frac{8+7x+9y}{10+x+5y} \\ [-0.9035331901, 0.5692717868] \\ \emptyset \end{array} \right]$	(10)
> T := RT([x,y],10);SSg(T,[x,y]);SSSg(T,[x,y]);ORB(T,[x,y],[6.,8.],1000,1010)[-1];	$T := \left[\begin{array}{c} \frac{9+x+y}{3+9x+9y} \cdot \frac{9+4x+5y}{2+5x+5y} \\ \{3., -3., [0.4543504473, 2.017830805]\} \\ \{0.4543504473, 2.017830805\} \end{array} \right]$	(11)
> T := RT([x,y],10);SSg(T,[x,y]);SSSg(T,[x,y]);ORB(T,[x,y],[6.,8.],1000,1010)[-1];	$T := \left[\begin{array}{c} \frac{8+x+2y}{9+5x+8y} \cdot \frac{2+x+9y}{7+x+9y} \\ \{0.582171280, 0.6201667838\} \\ \{0.582171280, 0.6201667838\} \end{array} \right]$	(12)
> T := RT([x,y],10);SSg(T,[x,y]);SSSg(T,[x,y]);ORB(T,[x,y],[6.,8.],1000,1010)[-1];	$T := \left[\begin{array}{c} \frac{5+x+4y}{8+5x+y} \cdot \frac{5+10x+5y}{5+5x+10y} \\ [0.2021960617, -0.8900436637] \\ \emptyset \end{array} \right]$	(13)
> T := RT([x,y],10);SSg(T,[x,y]);SSSg(T,[x,y]);ORB(T,[x,y],[6.,8.],1000,1010)[-1];	$T := \left[\begin{array}{c} \frac{3+6x+6y}{7+x+4y} \cdot \frac{2+8x+2y}{2+4x+y} \\ \{1.432383688, 1.789903570\} \\ \{1.432383688, 1.789903570\} \end{array} \right]$	(14)
> T := RT([x,y],10);SSg(T,[x,y]);SSSg(T,[x,y]);ORB(T,[x,y],[6.,8.],1000,1010)[-1];	$T := \left[\begin{array}{c} \frac{2+5x+6y}{10+5x+5y} \cdot \frac{1+2x+8y}{10+2x+5y} \\ \{0.4687750581, 0.3945777786\} \\ \{0.4687750581, 0.3945777786\} \end{array} \right]$	(15)
> T := RT([x,y],10);SSg(T,[x,y]);SSSg(T,[x,y]);ORB(T,[x,y],[6.,8.],1000,1010)[-1];	$T := \left[\begin{array}{c} \frac{1+3x+9y}{2+2x+3y} \cdot \frac{5+4x+4y}{5+8x+7y} \\ \{1.615015944, 0.6261292450\} \\ \{1.615015944, 0.6261292450\} \end{array} \right]$	(16)
> T := RT([x,y],10);SSg(T,[x,y]);SSSg(T,[x,y]);ORB(T,[x,y],[6.,8.],1000,1010)[-1];	$T := \left[\begin{array}{c} \frac{1+2x+4y}{2+2x+3y} \cdot \frac{2+6x+4y}{10+4x+4y} \\ \{0.9340938070, 0.6220680673\} \\ \{0.9340938070, 0.6220680673\} \end{array} \right]$	(17)
> T := RT([x,y],10);SSg(T,[x,y]);SSSg(T,[x,y]);ORB(T,[x,y],[6.,8.],1000,1010)[-1];	$T := \left[\begin{array}{c} \frac{7+5x+y}{5+6x+3y} \cdot \frac{8+9x+9y}{5+3x+y} \\ [-1.218187898, 0.4090373769] \\ \emptyset \end{array} \right]$	(18)
> T := RT([x,y],10);SSg(T,[x,y]);SSSg(T,[x,y]);ORB(T,[x,y],[6.,8.],1000,1010)[-1];	$T := \left[\begin{array}{c} \frac{9+8x+10y}{7+3x+7y} \cdot \frac{3+8x+4y}{1+7x+y} \\ [-3.588859253, 0.9460901279] \\ \emptyset \end{array} \right]$	(19)
> T := RT([x,y],10);SSg(T,[x,y]);SSSg(T,[x,y]);ORB(T,[x,y],[6.,8.],1000,1010)[-1];	$T := \left[\begin{array}{c} \frac{6+8x+4y}{1+4x+10y} \cdot \frac{10+3x+2y}{6+10x+y} \\ [0.30715993482, -8.375921430] \\ \emptyset \end{array} \right]$	(20)
> T := RT([x,y],10);SSg(T,[x,y]);SSSg(T,[x,y]);ORB(T,[x,y],[6.,8.],1000,1010)[-1];	$T := \left[\begin{array}{c} \frac{6+7x+y}{2+9x+8y} \cdot \frac{10+x+10y}{7+7x+5y} \\ \{0.6455732285, 1.315132700\} \\ \{0.6455732285, 1.315132700\} \end{array} \right]$	(21)
> T := RT([x,y],10);SSg(T,[x,y]);SSSg(T,[x,y]);ORB(T,[x,y],[6.,8.],1000,1010)[-1];	$T := \left[\begin{array}{c} \frac{10+3x+5y}{5+3x+4y} \cdot \frac{9+5x+7y}{5+x+6y} \\ \{1.417902121, 1.686781071\} \\ \{1.417902121, 1.686781071\} \end{array} \right]$	(22)
> T := RT([x,y],10);SSg(T,[x,y]);SSSg(T,[x,y]);ORB(T,[x,y],[6.,8.],1000,1010)[-1];	$T := \left[\begin{array}{c} \frac{10+9x+y}{3+5x+10y} \cdot \frac{3+5x+9y}{5+x+3y} \\ \{0.6587766085, 2.108664959\} \\ \{0.6587766085, 2.108664959\} \end{array} \right]$	(23)
> T := RT([x,y],10);SSg(T,[x,y]);SSSg(T,[x,y]);ORB(T,[x,y],[6.,8.],1000,1010)[-1];	$T := \left[\begin{array}{c} \frac{2+8x+6y}{7+8x+5y} \cdot \frac{9+x+2y}{10+10x+9y} \\ \{1.035777768, 0.448195179\} \\ \{1.035777768, 0.448195179\} \end{array} \right]$	(24)

agree 13/20 times

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?

> 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];

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

$$[[0.6410287956, -0.965904358, 0.242567879]]$$

$$\emptyset$$

$$[1.317162504, 1.295733474, 0.9173181249]$$

agree 6/20 times

(5)

> 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];

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

$$[[0.9835233408, 0.6870012014, 0.8522912596]]$$

$$\{\{0.9835233408, 0.6870012014, 0.8522912596\}\}$$

$$\{0.9835233392, 0.6870012010, 0.8522912593\}$$

(6)

> 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];

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

$$[[0.3927438884, 0.12173545, -1.97889587]]$$

$$\emptyset$$

$$[1.253144062, 1.751511178, 1.477392012]$$

(7)

> 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];

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

$$[[0.3568517562, -0.82424832, 0.58235887]]$$

$$\emptyset$$

$$[0.7045134768, 0.9844002525, 0.9140619222]$$

(8)

> 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];

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

$$[[0.1669136937, 3.36995429, 0.48654787]]$$

$$\{\{0.1669136937, 3.36995429, 0.48654787\}\}$$

$$[0.1669136938, 3.369954285, 0.4865478672]$$

(9)

> 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];

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

$$[[1.269845917, 0.578281662, 1.901658766]]$$

$$\{\{1.269845917, 0.578281662, 1.901658766\}\}$$

$$[1.269845917, 0.5782816595, 1.901658773]$$

(10)

> 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];

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

$$[[1.111444348, 2.158621547, 0.7312695410]]$$

$$\{\{1.111444348, 2.158621547, 0.7312695410\}\}$$

$$[1.111444347, 2.158621541, 0.7312695401]$$

(11)

> 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];

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

$$[[0.9856701781, 8.90701596, -10.53709701]]$$

$$\emptyset$$

$$[1.863968442, 0.9721852327, 0.7009148972]$$

(12)

> 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];

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

$$[[-2.379671330, 3.650157528, 0.09352608318]]$$

$$\emptyset$$

$$[1.242135363, 1.116520001, 0.6927391257]$$

(13)

> 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];

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

$$[[0.2069369080, -7.932927744, 8.532334823]]$$

$$\emptyset$$

$$[1.576803812, 1.620080724, 1.508680891]$$

(14)

> $T := RT([x, y, z], 10); SSg(T, [x, y, z]); SSSg(T, [x, y, z]);$
 $ORB(T, [x, y, z], [6., 8., 11.], 1000, 1010)[-1];$

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

$$[[0.7721046707, -4.419290744, -0.045317532]]$$

$$\emptyset$$

$$[2.131292501, 0.6309131875, 0.8004643296]$$

(15)

> $T := RT([x, y, z], 10); SSg(T, [x, y, z]); SSSg(T, [x, y, z]);$
 $ORB(T, [x, y, z], [6., 8., 11.], 1000, 1010)[-1];$

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

$$[[0.239072995, 0.05905157107, -0.8086224432]]$$

$$\emptyset$$

$$[1.083838025, 1.124000405, 0.3186773417]$$

(16)

> $T := RT([x, y, z], 10); SSg(T, [x, y, z]); SSSg(T, [x, y, z]);$
 $ORB(T, [x, y, z], [6., 8., 11.], 1000, 1010)[-1];$

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

$$[[0.1426317665, 1.040372633, -2.291166327]]$$

$$\emptyset$$

$$[0.7627933799, 1.049232115, 1.273511329]$$

(17)

> $T := RT([x, y, z], 10); SSg(T, [x, y, z]); SSSg(T, [x, y, z]);$
 $ORB(T, [x, y, z], [6., 8., 11.], 1000, 1010)[-1];$

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

$$[[0.1839797317, -0.60361586, -0.71446680]]$$

$$\emptyset$$

$$[0.5953721697, 0.3736290865, 0.6400195255]$$

(18)

> $T := RT([x, y, z], 10); SSg(T, [x, y, z]); SSSg(T, [x, y, z]);$
 $ORB(T, [x, y, z], [6., 8., 11.], 1000, 1010)[-1];$

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

$$[[1.305341002, 0.6627518081, 0.766837864]]$$

$$\{[1.305341002, 0.6627518081, 0.766837864]\}$$

$$[1.305341000, 0.6627518084, 0.7668378649]$$

(19)

> $T := RT([x, y, z], 10); SSg(T, [x, y, z]); SSSg(T, [x, y, z]);$
 $ORB(T, [x, y, z], [6., 8., 11.], 1000, 1010)[-1];$

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

$$[[0.4741279627, 0.596203224, 0.57658189]]$$

$$\{[0.4741279627, 0.596203224, 0.57658189]\}$$

$$[0.4741279626, 0.5962032225, 0.5765818966]$$

(20)

> $T := RT([x, y, z], 10); SSg(T, [x, y, z]); SSSg(T, [x, y, z]);$
 $ORB(T, [x, y, z], [6., 8., 11.], 1000, 1010)[-1];$

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

$$[[0.02688631069, -1.283131530, 0.3756539739]]$$

$$\emptyset$$

$$[0.8462091852, 1.291816580, 1.015848272]$$

(21)

> $T := RT([x, y, z], 10); SSg(T, [x, y, z]); SSSg(T, [x, y, z]);$
 $ORB(T, [x, y, z], [6., 8., 11.], 1000, 1010)[-1];$

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

$$[[-2.536423176, 0.4651268569, 2.107870421]]$$

$$\emptyset$$

$$[0.7536548384, 0.7039120037, 1.913845881]$$

(22)

> $T := RT([x, y, z], 10); SSg(T, [x, y, z]); SSSg(T, [x, y, z]);$
 $ORB(T, [x, y, z], [6., 8., 11.], 1000, 1010)[-1];$

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

$$[[-1.824399896, 0.1705134395, 0.3370914600]]$$

$$\emptyset$$

$$[0.8731855907, 1.345913473, 1.333184810]$$

(23)

> $T := RT([x, y, z], 10); SSg(T, [x, y, z]); SSSg(T, [x, y, z]);$
 $ORB(T, [x, y, z], [6., 8., 11.], 1000, 1010)[-1];$

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

$$[[-0.1793924622, -1.015391689, 0.04027339613]]$$

$$\emptyset$$

$$[0.4987260840, 1.146821272, 0.6754259176]$$

(24)

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

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

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

> $f := \text{RR}([z[1], z[2]], 10); T := \text{RecToTs}(2, z, f); \text{SSg}(T, [z[1], z[2]]); \text{SSSg}(T, [z[1], z[2]]);$
 $\text{Orbk}(2, z, f, [5., 8.], 2000, 2010)[-1];$

$$f := \frac{6 + 8z_1 + 4z_2}{8 + 4z_1 + 5z_2}$$

$$T := \left[\frac{6 + 8z_1 + 4z_2}{8 + 4z_1 + 5z_2}, z_1 \right] \cdot [z_1, z_2]$$

$$[[1.068419234, 1.068419234]]$$

$$[[1.068419234, 1.068419234]]$$

$$1.068419234$$

agree 20/20 times

> $f := \text{RR}([z[1], z[2]], 10); T := \text{RecToTs}(2, z, f); \text{SSg}(T, [z[1], z[2]]); \text{SSSg}(T, [z[1], z[2]]);$
 $\text{Orbk}(2, z, f, [5., 8.], 2000, 2010)[-1];$

$$f := \frac{3 + 5z_1 + 3z_2}{10 + 9z_1 + 6z_2}$$

$$T := \left[\frac{3 + 5z_1 + 3z_2}{10 + 9z_1 + 6z_2}, z_1 \right] \cdot [z_1, z_2]$$

$$[[0.3854886655, 0.3854886655]]$$

$$[[0.3854886655, 0.3854886655]]$$

$$0.3854886657$$

> $f := \text{RR}([z[1], z[2]], 10); T := \text{RecToTs}(2, z, f); \text{SSg}(T, [z[1], z[2]]); \text{SSSg}(T, [z[1], z[2]]);$
 $\text{Orbk}(2, z, f, [5., 8.], 2000, 2010)[-1];$

$$f := \frac{1 + 9z_1 + 3z_2}{7 + 4z_1 + 3z_2}$$

$$T := \left[\frac{1 + 9z_1 + 3z_2}{7 + 4z_1 + 3z_2}, z_1 \right] \cdot [z_1, z_2]$$

$$[[0.8771507064, 0.8771507064]]$$

$$[[0.8771507064, 0.8771507064]]$$

$$0.8771507070$$

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

$$f := \frac{9 + 5z_1 + 7z_2}{6 + 2z_1 + 5z_2}$$

$$T := \left[\frac{9 + 5z_1 + 7z_2}{6 + 2z_1 + 5z_2}, z_1 \right] \cdot [z_1, z_2]$$

$$[[1.640754482, 1.640754482]]$$

$$[[1.640754482, 1.640754482]]$$

$$1.640754482$$

> $f := \text{RR}([z[1], z[2]], 10); T := \text{RecToTs}(2, z, f); \text{SSg}(T, [z[1], z[2]]); \text{SSSg}(T, [z[1], z[2]]);$
 $\text{Orbk}(2, z, f, [5., 8.], 2000, 2010)[-1];$

$$f := \frac{4 + z_1 + 4z_2}{1 + 3z_1 + 9z_2}$$

$$T := \left[\frac{4 + z_1 + 4z_2}{1 + 3z_1 + 9z_2}, z_1 \right] \cdot [z_1, z_2]$$

$$[[0.7675918792, 0.7675918792]]$$

$$[[0.7675918792, 0.7675918792]]$$

$$0.7675918794$$

> $f := \text{RR}([z[1], z[2]], 10); T := \text{RecToTs}(2, z, f); \text{SSg}(T, [z[1], z[2]]); \text{SSSg}(T, [z[1], z[2]]);$
 $\text{Orbk}(2, z, f, [5., 8.], 2000, 2010)[-1];$

$$f := \frac{1 + 4z_1 + 7z_2}{2 + 7z_1 + 5z_2}$$

$$T := \left[\frac{1 + 4z_1 + 7z_2}{2 + 7z_1 + 5z_2}, z_1 \right] \cdot [z_1, z_2]$$

$$[[0.8482423622, 0.8482423622]]$$

$$[[0.8482423622, 0.8482423622]]$$

$$0.8482423624$$

> $f := \text{RR}([z[1], z[2]], 10); T := \text{RecToTs}(2, z, f); \text{SSg}(T, [z[1], z[2]]); \text{SSSg}(T, [z[1], z[2]]);$
 $\text{Orbk}(2, z, f, [5., 8.], 2000, 2010)[-1];$

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

$$T := \left[\frac{8 + 2z_1 + 5z_2}{10 + 6z_1 + 6z_2}, z_1 \right] \cdot [z_1, z_2]$$

$$[[0.7010094834, 0.7010094834]]$$

$$[[0.7010094834, 0.7010094834]]$$

$$0.7010094832$$

> $f := \text{RR}([z[1], z[2]], 10); T := \text{RecToTs}(2, z, f); \text{SSg}(T, [z[1], z[2]]); \text{SSSg}(T, [z[1], z[2]]);$
 $\text{Orbk}(2, z, f, [5., 8.], 2000, 2010)[-1];$

$$f := \frac{1 + 4z_1 + 4z_2}{1 + z_1 + 6z_2}$$

$$T := \left[\frac{1 + 4z_1 + 4z_2}{1 + z_1 + 6z_2}, z_1 \right] \cdot [z_1, z_2]$$

$$[[1.126783171, 1.126783171]]$$

$$[[1.126783171, 1.126783171]]$$

$$1.126783170$$

> $f := \text{RR}([z[1], z[2]], 10); T := \text{RecToTs}(2, z, f); \text{SSg}(T, [z[1], z[2]]); \text{SSSg}(T, [z[1], z[2]]);$
 $\text{Orbk}(2, z, f, [5., 8.], 2000, 2010)[-1];$

$$f := \frac{6 + 2z_1 + 7z_2}{8 + 9z_1 + 10z_2}$$

$$T := \left[\frac{6 + 2z_1 + 7z_2}{8 + 9z_1 + 10z_2}, z_1 \right] \cdot [z_1, z_2]$$

$$[[0.5888831139, 0.5888831139]]$$

$$[[0.5888831139, 0.5888831139]]$$

$$0.5888831142$$

> $f := \text{RR}([z[1], z[2]], 10); T := \text{RecToTs}(2, z, f); \text{SSg}(T, [z[1], z[2]]); \text{SSSg}(T, [z[1], z[2]]);$
 $\text{Orbk}(2, z, f, [5., 8.], 2000, 2010)[-1];$

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

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

$$[[0.9351331652, 0.9351331652]]$$

$$[[0.9351331652, 0.9351331652]]$$

$$0.9351331656$$

> $f := \text{RR}([z[1], z[2]], 10); T := \text{RecToTs}(2, z, f); \text{SSg}(T, [z[1], z[2]]); \text{SSSg}(T, [z[1], z[2]]);$
 $\text{Orbk}(2, z, f, [5., 8.], 2000, 2010)[-1];$

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

$$T := \left[\frac{8 + 2z_1 + 5z_2}{4 + 6z_1 + 10z_2}, z_1 \right] \cdot [z_1, z_2]$$

$$[[0.8070445132, 0.8070445132]]$$

$$[[0.8070445132, 0.8070445132]]$$

$$0.8070445131$$

> $f = RR(\{z[1], z[2]\}, 10); T = RecToTs(2, z, f); SSg(T, \{z[1], z[2]\}); SSSg(T, \{z[1], z[2]\});$
 $Orbit(2, z, f, \{5, 8, \}, 2000, 2010)[-1];$

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

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

$$[[1.284159836, 1.284159836]]$$

$$((1.284159836, 1.284159836))$$

$$1.284159836$$

(16)

> $f = RR(\{z[1], z[2]\}, 10); T = RecToTs(2, z, f); SSg(T, \{z[1], z[2]\}); SSSg(T, \{z[1], z[2]\});$
 $Orbit(2, z, f, \{5, 8, \}, 2000, 2010)[-1];$

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

$$T = \left\lfloor \frac{8 + 6z_1 + 3z_2}{8 + 2z_1 + 8z_2}, z_1 \right\rfloor, [z_1, z_2]$$

$$[[0.9458236434, 0.9458236434]]$$

$$((0.9458236434, 0.9458236434))$$

$$0.9458236435$$

(17)

> $f = RR(\{z[1], z[2]\}, 10); T = RecToTs(2, z, f); SSg(T, \{z[1], z[2]\}); SSSg(T, \{z[1], z[2]\});$
 $Orbit(2, z, f, \{5, 8, \}, 2000, 2010)[-1];$

$$f = \frac{5 + 5z_1 + 6z_2}{5 + 9z_1 + 8z_2}$$

$$T = \left\lfloor \frac{5 + 5z_1 + 6z_2}{5 + 9z_1 + 8z_2}, z_1 \right\rfloor, [z_1, z_2]$$

$$[[0.7467858656, 0.7467858656]]$$

$$((0.7467858656, 0.7467858656))$$

$$0.7467858653$$

(18)

> $f = RR(\{z[1], z[2]\}, 10); T = RecToTs(2, z, f); SSg(T, \{z[1], z[2]\}); SSSg(T, \{z[1], z[2]\});$
 $Orbit(2, z, f, \{5, 8, \}, 2000, 2010)[-1];$

$$f = \frac{4 + 8z_1 + 3z_2}{3 + z_1 + 9z_2}$$

$$T = \left\lfloor \frac{4 + 8z_1 + 3z_2}{3 + z_1 + 9z_2}, z_1 \right\rfloor, [z_1, z_2]$$

$$[[1.148331477, 1.148331477]]$$

$$((1.148331477, 1.148331477))$$

$$1.148331478$$

$$1.148331478$$

(19)

(19)

> $f = RR(\{z[1], z[2]\}, 10); T = RecToTs(2, z, f); SSg(T, \{z[1], z[2]\}); SSSg(T, \{z[1], z[2]\});$
 $Orbit(2, z, f, \{5, 8, \}, 2000, 2010)[-1];$

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

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

$$[[1.057097577, 1.057097577]]$$

$$((1.057097577, 1.057097577))$$

$$1.057097577$$

(20)

> $f = RR(\{z[1], z[2]\}, 10); T = RecToTs(2, z, f); SSg(T, \{z[1], z[2]\}); SSSg(T, \{z[1], z[2]\});$
 $Orbit(2, z, f, \{5, 8, \}, 2000, 2010)[-1];$

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

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

$$[[0.4742718696, 0.4742718696]]$$

$$((0.4742718696, 0.4742718696))$$

$$0.4742718693$$

(21)

> $f = RR(\{z[1], z[2]\}, 10); T = RecToTs(2, z, f); SSg(T, \{z[1], z[2]\}); SSSg(T, \{z[1], z[2]\});$
 $Orbit(2, z, f, \{5, 8, \}, 2000, 2010)[-1];$

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

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

$$[[5.313657169, 5.313657169]]$$

$$([5.313657169, 5.313657169])$$

$$5.313657166$$

(22)

> $f = RR(\{z[1], z[2]\}, 10); T = RecToTs(2, z, f); SSg(T, \{z[1], z[2]\}); SSSg(T, \{z[1], z[2]\});$
 $Orbit(2, z, f, \{5, 8, \}, 2000, 2010)[-1];$

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

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

$$[[0.6030226892, 0.6030226892]]$$

$$([0.6030226892, 0.6030226892])$$

$$0.6030226892$$

(23)

0.6030226892

> $f = RR(\{z[1], z[2]\}, 10); T = RecToTs(2, z, f); SSg(T, \{z[1], z[2]\}); SSSg(T, \{z[1], z[2]\});$
 $Orbit(2, z, f, \{5, 8, \}, 2000, 2010)[-1];$

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

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

$$[[1.835781669, 1.835781669]]$$

$$([1.835781669, 1.835781669])$$

$$1.835781670$$

(24)

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

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

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

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?

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

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

$$T = \left[\frac{4 + z_1 + 5z_2 + 3z_3}{2 + z_1 + 5z_2 + z_3}, z_1, z_2 \right] \cdot [z_1, z_2, z_3]$$

[[1.406326967, 1.406326967, 1.406326967]]
 [[1.406326967, 1.406326967, 1.406326967]]
 1.406326967

agree 18/20
times

(5)

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

$$f = \frac{7 + 8z_1 + 3z_2 + 10z_3}{10 + 7z_1 + 6z_2 + 10z_3}$$

$$T = \left[\frac{7 + 8z_1 + 3z_2 + 10z_3}{10 + 7z_1 + 6z_2 + 10z_3}, z_1, z_2 \right] \cdot [z_1, z_2, z_3]$$

[[0.8404050733, 0.8404050733, 0.8404050733]]
 [[0.8404050733, 0.8404050733, 0.8404050733]]
 0.8404050733

(6)

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

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

$$T = \left[\frac{2 + 6z_1 + 10z_2 + 2z_3}{7 + 8z_1 + 2z_2 + z_3}, z_1, z_2 \right] \cdot [z_1, z_2, z_3]$$

[[1.157128741, 1.157128741, 1.157128741]]
 [[1.157128741, 1.157128741, 1.157128741]]
 1.157128741

(7)

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

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

$$T = \left[\frac{2 + 5z_1 + 5z_2 + 7z_3}{4 + 2z_1 + 8z_2 + 7z_3}, z_1, z_2 \right] \cdot [z_1, z_2, z_3]$$

[[0.8960073293, 0.8960073293, 0.8960073293]]
 [[0.8960073293, 0.8960073293, 0.8960073293]]
 0.8960073293

(8)

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

$$f = \frac{5 + 6z_1 + 6z_2 + 4z_3}{3 + 7z_1 + 10z_2 + 9z_3}$$

$$T = \left[\frac{5 + 6z_1 + 6z_2 + 4z_3}{3 + 7z_1 + 10z_2 + 9z_3}, z_1, z_2 \right] \cdot [z_1, z_2, z_3]$$

[[0.6984226500, 0.6984226500, 0.6984226500]]
 [[0.6984226500, 0.6984226500, 0.6984226500]]
 0.6984226500

(9)

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

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

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

[[1.040504561, 1.040504561, 1.040504561]]
 [[1.040504561, 1.040504561, 1.040504561]]
 1.040504561

(10)

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

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

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

[[0.7830951895, 0.7830951895, 0.7830951895]]
 [[0.7830951895, 0.7830951895, 0.7830951895]]
 0.7830951894

(11)

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

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

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

[[0.8818979205, 0.8818979205, 0.8818979205]]
 [[0.8818979205, 0.8818979205, 0.8818979205]]
 0.8818979201

(12)

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

$$f = \frac{1 + 2z_1 + 9z_2 + 7z_3}{7 + 7z_1 + 10z_2 + 2z_3}$$

$$T = \left[\frac{1 + 2z_1 + 9z_2 + 7z_3}{7 + 7z_1 + 10z_2 + 2z_3}, z_1, z_2 \right] \cdot [z_1, z_2, z_3]$$

[[0.6588333907, 0.6588333907, 0.6588333907]]
 [[0.6588333907, 0.6588333907, 0.6588333907]]
 0.6588333909

(13)

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

$$f = \frac{1 + 4z_1 + 9z_2 + 7z_3}{10 + z_1 + 2z_2 + 4z_3}$$

$$T = \left[\frac{1 + 4z_1 + 9z_2 + 7z_3}{10 + z_1 + 2z_2 + 4z_3}, z_1, z_2 \right] \cdot [z_1, z_2, z_3]$$

[[1.522407750, 1.522407750, 1.522407750]]
 [[1.522407750, 1.522407750, 1.522407750]]
 1.522407751

(14)

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

$$f = \frac{1 + z_1 + 9z_2 + 7z_3}{3 + 10z_1 + 3z_2 + 5z_3}$$

$$T = \left[\frac{1 + z_1 + 9z_2 + 7z_3}{3 + 10z_1 + 3z_2 + 5z_3}, z_1, z_2 \right] \cdot [z_1, z_2, z_3]$$

[[0.8436307095, 0.8436307095, 0.8436307095]]
 [[0.8436307095, 0.8436307095, 0.8436307095]]
 0.8436307100

(15)

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

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

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

[[1.252655075, 1.252655075, 1.252655075]]
 [[1.252655075, 1.252655075, 1.252655075]]
 1.252655075

(16)

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

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

$$T = \left[\frac{8 + 10z_1 + 7z_2 + 4z_3}{2 + 7z_1 + 2z_2 + 6z_3}, z_1, z_2 \right] [z_1, z_2, z_3]$$

$$[[-0.3333333333, -0.3333333333, -0.3333333333], [1.600000000, 1.600000000, 1.600000000]]$$

$$((1.600000000, 1.600000000, 1.600000000))$$

$$1.599999999$$

(17)

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

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

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

$$[[2.074570451, 2.074570451, 2.074570451],$$

$$[(2.074570451, 2.074570451, 2.074570451)]]$$

$$2.074570451$$

(18)

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

$$f = \frac{8 + 6z_1 + 9z_2 + z_3}{2 + 3z_1 + 8z_2 + 4z_3}$$

$$T = \left[\frac{8 + 6z_1 + 9z_2 + z_3}{2 + 3z_1 + 8z_2 + 4z_3}, z_1, z_2 \right] [z_1, z_2, z_3]$$

$$[[-0.4000000000, -0.4000000000, -0.4000000000], [1.333333333, 1.333333333, 1.333333333]]$$

$$((1.333333333, 1.333333333, 1.333333333))$$

$$1.333333333$$

(19)

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

$$f = \frac{6 + 8z_1 + z_2 + 10z_3}{9 + z_1 + 7z_2 + 3z_3}$$

$$T = \left[\frac{6 + 8z_1 + z_2 + 10z_3}{9 + z_1 + 7z_2 + 3z_3}, z_1, z_2 \right] [z_1, z_2, z_3]$$

$$[[1.321762910, 1.321762910, 1.321762910],$$

$$[(1.321762910, 1.321762910, 1.321762910)]]$$

$$1.321762910$$

(20)

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

$$f = \frac{10 + z_1 + 2z_2 + 2z_3}{1 + 7z_1 + 8z_2 + 5z_3}$$

$$T = \left[\frac{10 + z_1 + 2z_2 + 2z_3}{1 + 7z_1 + 8z_2 + 5z_3}, z_1, z_2 \right] [z_1, z_2, z_3]$$

$$[[0.8141428429, 0.8141428429, 0.8141428429],$$

$$[(0.8141428429, 0.8141428429, 0.8141428429)]]$$

$$0.8141428430$$

(21)

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

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

$$T = \left[\frac{1 + 3z_1 + 8z_2 + 10z_3}{4 + 10z_1 + 4z_2 + 6z_3}, z_1, z_2 \right] [z_1, z_2, z_3]$$

$$[[0.9052343178, 0.9052343178, 0.9052343178],$$

$$[(0.9052343178, 0.9052343178, 0.9052343178)]]$$

$$0.9052343179$$

(22)

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

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

$$T = \left[\frac{9 + 10z_1 + 4z_2 + 5z_3}{1 + 2z_1 + 10z_2 + 5z_3}, z_1, z_2 \right] [z_1, z_2, z_3]$$

$$[[1.429238738, 1.429238738, 1.429238738],$$

$$[(1.429238738, 1.429238738, 1.429238738)]]$$

$$1.429238738$$

(23)

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

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

$$T = \left[\frac{9 + 5z_1 + z_2 + 8z_3}{4 + 2z_1 + 3z_2 + 2z_3}, z_1, z_2 \right] [z_1, z_2, z_3]$$

$$[[2.054404503, 2.054404503, 2.054404503],$$

$$[(2.054404503, 2.054404503, 2.054404503)]]$$

$$2.054404503$$

(24)

```
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 := 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]);
```

0/20 were
non empty

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

```
Error, (in SSQ) cannot determine if this expression is true or false: max(1..1.697500000*abs(N)) < 1 [DMP14.txt:489]
> L:=rand(1..3); a:=rand(1..50){}/20; c:=rand(1..50){}/20; T:=NicholsonBailey(L,a,c,N,P)
> SSQ(Z[N,P]); SSQ(Z[N,P]);
```

```
Error, (in SSQ) cannot determine if this expression is true or false: max(1.,2.850000000*abs(W)) < 1 [DMR14.txt:489]
> L = rand(1..3); a = rand(1..50) / 10; c = rand(1..50) / 10; T = NicholsonBailey(L,a,c,N,P)
> SSq(T,[N,P]); SSqG(T,[N,P]);
```

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

```
Error, (in SSSg) cannot determine if this expression is true or false: max(1.,3.705000000*abs(N)) < 1 [DWB14.txt:489]
> L = rand(1..3)(); a = rand(1..50)()/20.; c = rand(1..50)()/20.; T = NicholsonBailey(L, a, c, N, P)
; SSSg(T, N, P); SSSg(T, N, P);
```

```
> 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 := 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 := 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 := 1.200000000
c := 1.650000000
T := [ 2.N.e-1.200000000.P, 1.650000000.N.(1 - e-1.200000000.P) ]
[[ 0., 0. ], [ 0.7001486672, 0.5776226505 ]]

```

(5)

(6)

(7)

(7)

(8)

(9)

(10)

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

$$L := 1$$

$$a := 1.100000000$$

$$c := 2.200000000$$

$$T := [N e^{-1.000000000 P}, 2.200000000 N (1 - e^{-1.000000000 P})]$$

$$[[N, 0]]$$

Error, (in SSSg) cannot determine if this expression is true or false: $\max(1..2.420000000 * \text{abs}(N)) < 1$ |DMB14.txt:489|

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

$$L := 2$$

$$a := 1.600000000$$

$$c := 0.800000000$$

$$T := [2 N e^{-1.600000000 P}, 0.800000000 N (1 - e^{-1.600000000 P})]$$

$$[[0., 0.], [1.083042470, 0.4332169878]]$$

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

$$L := 3$$

$$a := 2.250000000$$

$$c := 1.450000000$$

$$T := [3 N e^{-2.250000000 P}, 1.450000000 N (1 - e^{-2.250000000 P})]$$

$$[[0., 0.], [0.5051090982, 0.4882721283]]$$

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

$$L := 2$$

$$a := 2.300000000$$

$$c := 0.050000000$$

$$T := [2 N e^{-2.300000000 P}, 0.050000000 N (1 - e^{-2.300000000 P})]$$

$$[[0., 0.], [12.05473357, 0.3013683394]]$$

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

$$L := 2$$

$$a := 1.550000000$$

$$c := 1.850000000$$

$$T := [2 N e^{-1.550000000 P}, 1.850000000 N (1 - e^{-1.550000000 P})]$$

$$[[0., 0.], [0.4834505183, 0.4471917294]]$$

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

$$L := 1$$

$$a := 2.150000000$$

$$c := 0.050000000$$

$$T := [N e^{-2.150000000 P}, 0.050000000 N (1 - e^{-2.150000000 P})]$$

$$[[N, 0]]$$

Error, (in SSSg) cannot determine if this expression is true or false: $\max(1..1.075000000 * \text{abs}(N)) < 1$ |DMB14.txt:489|

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

$$L := 1$$

$$a := 1.900000000$$

$$c := 2.200000000$$

$$T := [N e^{-1.900000000 P}, 2.200000000 N (1 - e^{-1.900000000 P})]$$

$$[[N, 0]]$$

Error, (in SSSg) cannot determine if this expression is true or false: $\max(1..4.190000000 * \text{abs}(N)) < 1$ |DMB14.txt:489|

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

$$L := 2$$

$$a := 0.150000000$$

$$c := 1.250000000$$

$$T := [2 N e^{-0.150000000 P}, 1.250000000 N (1 - e^{-0.150000000 P})]$$

$$[[0., 0.], [7.393569926, 4.620981204]]$$

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

$$L := 3$$

$$a := 2.400000000$$

$$c := 0.800000000$$

$$T := [3 N e^{-2.400000000 P}, 0.800000000 N (1 - e^{-2.400000000 P})]$$

$$[[0., 0.], [0.8582908505, 0.4577551203]]$$

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

$$L := 2$$

$$a := 1.400000000$$

$$c := 1.300000000$$

$$T := [2 N e^{-1.400000000 P}, 1.300000000 N (1 - e^{-1.400000000 P})]$$

$$[[0., 0.], [0.7617001984, 0.4951051290]]$$

7. Copy-and-paste the following line into your worksheet (once you have donwloaded 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)

> 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]);	$T := [14 e^{-0.7000000000 - 0.7000000000 N}, 14 - 14 e^{-0.7000000000 N}]$	(5)
> 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]);	$T := [14 e^{-0.1000000000 - 0.1000000000 N}, 14 - 14 e^{-0.1000000000 N}]$ {(0.001563076979, 0.0021881368)}	(6)
> 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]);	$T := [14 e^{-2.566666667 - 0.4000000000 N}, 14 - 14 e^{-0.4000000000 N}]$ {(0.7852761752, 3.773863350)}	(7)
> 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]);	$T := [14 e^{-0.3200000000 - 0.4000000000 N}, 14 - 14 e^{-0.4000000000 N}]$	(8)
> 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]);	$T := [14 e^{-0.2000000000 - 0.6000000000 N}, 14 - 14 e^{-0.6000000000 N}]$	(9)
> 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]);	$T := [14 e^{-7.800000000 - 0.2000000000 N}, 14 - 14 e^{-0.2000000000 N}]$ {(0.005729720004, 0.0160340272)}	(10)
> 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]);	$T := [14 e^{-1.3000000000 - 0.3000000000 N}, 14 - 14 e^{-0.3000000000 N}]$ {(2.057901634, 6.448948392)}	(11)
> 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]);	$T := [14 e^{-1.8000000000 - 0.4000000000 N}, 14 - 14 e^{-0.4000000000 N}]$ {(1.349082148, 5.838528606)}	(12)
> 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]);	$T := [14 e^{-0.1200000000 - 0.8000000000 N}, 14 - 14 e^{-0.8000000000 N}]$	(13)
> 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]);	$T := [14 e^{-0.6000000000 - 0.7000000000 N}, 14 - 14 e^{-0.7000000000 N}]$	(14)
> 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]);	$T := [14 e^{-0.7000000000 - 0.7000000000 N}, 14 - 14 e^{-0.7000000000 N}]$	(15)
> 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]);	$T := [14 e^{-9.1000000000 - 0.1000000000 N}, 14 - 14 e^{-0.1000000000 N}]$ {(0.001563076979, 0.0021881368)}	(16)
> 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]);	$T := [14 e^{-2.566666667 - 0.4000000000 N}, 14 - 14 e^{-0.4000000000 N}]$ {(0.7852761752, 3.773863350)}	(17)
> 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]);	$T := [14 e^{-0.3200000000 - 0.4000000000 N}, 14 - 14 e^{-0.4000000000 N}]$	(18)
> 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]);	$T := [14 e^{-0.2000000000 - 0.6000000000 N}, 14 - 14 e^{-0.6000000000 N}]$	(19)
> 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]);	$T := [14 e^{-7.800000000 - 0.2000000000 N}, 14 - 14 e^{-0.2000000000 N}]$ {(0.005729720004, 0.0160340272)}	(20)
> 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]);	$T := [14 e^{-1.3000000000 - 0.3000000000 N}, 14 - 14 e^{-0.3000000000 N}]$ {(2.057901634, 6.448948392)}	(21)
> 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]);	$T := [14 e^{-1.8000000000 - 0.4000000000 N}, 14 - 14 e^{-0.4000000000 N}]$ {(1.349082148, 5.838528606)}	(22)
> 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]);	$T := [14 e^{-0.1200000000 - 0.8000000000 N}, 14 - 14 e^{-0.8000000000 N}]$	(23)
> 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]);	$T := [14 e^{-0.6000000000 - 0.7000000000 N}, 14 - 14 e^{-0.7000000000 N}]$	(24)
> 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]);	$T := [14 e^{-0.7000000000 - 0.7000000000 N}, 14 - 14 e^{-0.7000000000 N}]$	(25)
> 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]);	$T := [14 e^{-9.1000000000 - 0.1000000000 N}, 14 - 14 e^{-0.1000000000 N}]$ {(0.001563076979, 0.0021881368)}	(26)

non-empty
set 50/100 times


```
> 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]);
```

```
> 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]);
```

```
> 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]);
```

```
> 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]);
```

```
> 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]);
```

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

```
> 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]);
```

```
> a := rand(1..10)() / 10.; r := rand(1..10)() / 10.; K := rand(1..10)();  
T := NicholsonBaileyM(a, r, K, 14, N, P); SSG(T, {N, P});
```

```
> a := rand(1..10)(); r := rand(1..10)(); K := rand(1..10)();  
T := NicholsonBaileyM(a, r, K, 14, N, P);
```

```
> 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]);
```

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

$$T := [14 e^{-0.2000000000 - 0.6000000000 N}, 14 - 14 e^{-0.6000000000 N}] \quad (49)$$

$$T = [14 e^{-7.800000000 \times 10^{-20} \text{ s}}, 14 - 14 e^{-0.200000000 \text{ s}}] \\ ((0.005729720004, 0.0160340272)) \quad (50)$$

$$T = [14 e^{-1.3000000000000000 N}, 14 - 14 e^{-0.3000000000000000 N}]$$

$$\{2.057901634, 6.448948392\}$$
(51)

$$T := [14 e^{-1.8000000000 - 0.4000000000 N}, 14 - 14 e^{-0.4000000000 N}]$$

$$\{[1.349082148, 5.838528606]\}$$
 (52)

$$T := [14e^{-0.1200000000} - 0.8000000000 \, N, 14 - 14e^{-0.8000000000 \, N}]$$

$$\emptyset \tag{53}$$

$$T := [14 e^{-0.60000000000000000000 N}, 14 - 14 e^{-0.70000000000000000000 N}]$$
(54)

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

$$T = [14 e^{-0.100000000000000000 \lambda}, 14 - 14 e^{-0.100000000000000000 \lambda}]$$

$$\{0.001563076979, 0.0021881368\}$$
 (56)

$$T := [14 e^{-2.566666667 - 0.4000000000 \lambda}, 14 - 14 e^{-0.4000000000 \lambda}]$$

$$\{0.7852761752, 3.773863350\}$$
(57)

$$T = [14e^{-0.3200000000N}, 14 - 14e^{-0.4000000000N}] \quad (58)$$

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

(59)

$$T := [14 e^{-7.800000000 \times 0.200000000 N}, 14 - 14 e^{-0.200000000 N}]$$

$$\{(0.005729720004, 0.0160340272)\}$$
 (60)

$$T := [14e^{-1.3000000000000000 N}, 14 - 14e^{-0.3000000000 N}]$$

$$\{ \{2.057901634, 6.448948392\} \}$$
 (61)

$$T' = [14 e^{-1.8000000000000000 N}, 14 - 14 e^{-0.4000000000000000 N}]$$

$$(1.349082148, 5.838528606)$$
 (62)

$$T = [14 e^{-0.1200000000 - 0.8000000000 N}, 14 - 14 e^{-0.8000000000 N}] \quad (63)$$

$$T := [14 e^{-0.600000000000 - 0.7000000000 \wedge}, 14 - 14 e^{-0.7000000000 \wedge}]_{\sigma} \quad (64)$$

$$T := [14 e^{-0.7000000000} - 0.7000000000 \wedge, 14 - 14 e^{-0.7000000000 \wedge}]$$

$$T' = [14 e^{-9.100000000 \times 10^{00} s}, 14 - 14 e^{-0.1000000000 s}]$$

$$\{ (0.001563076979, 0.00218813681) \}$$
 (66)

$$T_m = [14 e^{-2.566666667 \times 10^{-04} 0000000000 N}, 14 - 14 e^{-0.4000000000 N}]$$

$$T_{\text{im}} = [14 \text{ e}^{-0.3200000000 - 0.4000000000 N}, 14 - 14 \text{ e}^{-0.4000000000 N}]$$

$$T = [14 e^{-0.2000000000 - 0.6000000000 N}, 14 - 14 e^{-0.6000000000 N}] \quad (40)$$

$$T := [14 e^{-7.800000000 \times 10^{26} i}, 14 - 14 e^{-0.2000000000 N}]$$

$$((0.005729720004, 0.01603402721)) \quad (70)$$


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

$$T := [14 e^{-0.1200000000 - 0.8000000000 N}, 14 - 14 e^{-0.8000000000 N}] \quad (93)$$

```
> 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]);
```

$$T := [14 e^{-0.6000000000 - 0.7000000000 N}, 14 - 14 e^{-0.7000000000 N}] \quad (94)$$

```
> 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]);
```

$$T := [14 e^{-0.7000000000 - 0.7000000000 N}, 14 - 14 e^{-0.7000000000 N}] \quad (95)$$

```
> 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]);
```

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

$$\{[0.001563076979, 0.0021881368]\}$$
 (96)

```
> 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]);
```

$$T_i = [14 e^{-2.566666667 \times 10^{-4000000000} h}, 14 - 14 e^{-2.566666667 \times 10^{-4000000000} h}]$$

$$\{ \{0.7852761752, 3.773863350\} \}$$
(97)

```
> 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]);
```

$$T := [14 e^{-0.3200000000 - 0.4000000000 N}, 14 - 14 e^{-0.4000000000 N}] \quad (98)$$

```
> 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]);
```

$$T := [14 e^{-0.2000000000 - 0.6000000000 N}, 14 - 14 e^{-0.6000000000 N}] \quad (99)$$

```
> 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]);
```

$$T := [14 e^{-0.8000000000 - 0.2000000000 N}, 14 - 14 e^{-0.2000000000 N}]$$

$$\{[0.005729720004, 0.0160340272]\} \quad (100)$$

```
> 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]);
```

$$T := \left[14 e^{-1.3000000000000000 N}, 14 - 14 e^{-0.3000000000000000 N} \right]_{\{2.057901634, 6.448948392\}} \quad (101)$$

```
> 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]);
```

$$T = [14 e^{-1.8000000000000000 \times 10^{-14} \text{ s}}, 14 - 14 e^{-1.8000000000000000 \times 10^{-14} \text{ s}}] \\ \{1.349082148, 5.838528606\} \quad (102)$$

```
> 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]);
```

$$\tilde{T} = [14 e^{-0.1200000000 - 0.8000000000 N}, 14 - 14 e^{-0.8000000000 N}] \quad (103)$$

```
> 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]);
```

$$T_1 = [14 e^{-0.6000000000000000 N}, 14 - 14 e^{-0.7000000000000000 N}]$$

```
> 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]);
```

$$T = [14 e^{-0.6000000000 - 0.7000000000 N}, 14 - 14 e^{-0.7000000000 N}] \quad (104)$$