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 donwloaded 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 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?

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

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

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

```
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 donwloaded 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 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)

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

60/100

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

They agree 20/20 times

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

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

$$\{[3.121320343]\}$$

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

$$[3.121320342] \quad (5)$$

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

$$T := \left\lfloor \frac{4 + 6x}{5 + x} \right\rfloor$$

$$\{[2.561552813]\}$$

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

$$[2.561552813] \quad (6)$$

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

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

$$\{[1.108495283]\}$$

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

$$[1.108495283] \quad (7)$$

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

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

$$\{[0.3874258863]\}$$

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

$$[0.3874258867] \quad (8)$$

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

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

$$\{[1.672603940]\}$$

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

$$[1.672603940] \quad (9)$$

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

$$T := \left\lfloor \frac{10 + 9x}{1 + 6x} \right\rfloor$$

$$\{[2.119632982]\}$$

$$[[-0.7862996483], [2.119632982]]$$

$$[2.119632981] \quad (10)$$

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

$$T := \left\lfloor \frac{7 + 7x}{3 + 3x} \right\rfloor$$

$$\{[2.333333333]\}$$

$$[[2.333333333]]$$

$$[2.333333333] \quad (11)$$

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

$$T := \left\lfloor \frac{5 + 3x}{8 + 10x} \right\rfloor$$

$$\{[0.5000000000]\}$$

$$[[-1.], [0.5000000000]]$$

$$[0.5000000000] \quad (12)$$

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

$$T := \left\lfloor \frac{3 + x}{1 + 3x} \right\rfloor$$

$$\{[1.]\}$$

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

$$[1.000000000] \quad (13)$$

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

$$T := \left\lfloor \frac{5 + 5x}{10 + 10x} \right\rfloor$$

$$\{[0.5000000000]\}$$

$$[[0.5000000000]]$$

$$[0.5000000000] \quad (14)$$

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

$$T := \left\lfloor \frac{10 + 2x}{8 + 4x} \right\rfloor$$

$$\{[1.]\}$$

$$[[-2.500000000], [1.]]$$

$$[1.000000000] \quad (15)$$

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

$$T := \left\lfloor \frac{2 + 9x}{5 + 9x} \right\rfloor$$

$$\{[0.7433795288]\}$$

$$[[-0.2989350844], [0.7433795288]]$$

$$[0.7433795290] \quad (16)$$

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

$$T := \left\lfloor \frac{7 + 4x}{3 + 10x} \right\rfloor$$

$$\{[0.8881527305]\}$$

$$[[-0.7881527305], [0.8881527305]]$$

$$[0.8881527310] \quad (17)$$

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

$$T := \left\lfloor \frac{9 + 10x}{4 + 9x} \right\rfloor$$

$$\{[1.387425886]\}$$

$$[[-0.7207592197], [1.387425886]]$$

$$[1.387425887] \quad (18)$$

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

$$T := \left\lfloor \frac{7 + 8x}{9 + x} \right\rfloor$$

$$\{[2.192582404]\}$$

$$[[-3.192582404], [2.192582404]]$$

$$[2.192582404] \quad (19)$$

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

$$T := \left\lfloor \frac{10 + 2x}{4 + 7x} \right\rfloor$$

$$\{[1.060878539]\}$$

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

$$[1.060878539] \quad (20)$$

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

$$T := \left\lfloor \frac{8 + x}{6 + 4x} \right\rfloor$$

$$\{[0.9211646100]\}$$

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

$$[0.9211646097] \quad (21)$$

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

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

$$\{[0.7116805376]\}$$

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

$$[0.7116805376] \quad (22)$$

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

$$T := \left\lfloor \frac{5 + 9x}{9 + 4x} \right\rfloor$$

$$\{[1.118033988]\}$$

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

$$[1.118033988] \quad (23)$$

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

$$T := \left\lfloor \frac{3 + 4x}{6 + 4x} \right\rfloor$$

$$\{[0.6513878188]\}$$

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

$$[0.6513878189] \quad (24)$$

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?

they agree 13/20 times.

```
> 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]                                   (5)

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

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

```
[1.051537188, 1.523154357]]
{[1.051537188, 1.523154357]}
[1.051537189, 1.523154359]                                    (6)

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

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

```
[[-0.309865067, 0.5920753815]]
∅
[1.587572199, 0.9648325670]                                   (7)

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

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

```
[[0.6472327339, 0.9230130065]]
{[0.6472327339, 0.9230130065]}
[0.6472327335, 0.9230130065]                                  (8)

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

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

```
[[1.127014906, 0.4480178765]]
{[1.127014906, 0.4480178765]}
[1.127014906, 0.4480178766]                                   (9)

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

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

```
[[-0.9035331901, 0.5692717868]]
∅
[0.8510988810, 1.495902933]                                   (10)

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

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

```
[[3., -3.], [0.4543504473, 2.017830805]]
{[0.4543504473, 2.017830805]}
[0.4543504470, 2.017830804]                                   (11)

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

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

```
[[0.582171280, 0.6201667838]]
{[0.582171280, 0.6201667838]}
[0.5821712805, 0.6201667838]                                  (12)

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

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

```
[[0.2021960617, -0.8900436637]]
∅
[0.7508491588, 0.9463446147]                                  (13)

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

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

```
[[1.432383688, 1.78990349]]
{[1.432383688, 1.78990349]}
[1.432383688, 1.789903570]                                    (14)

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

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

```
[[0.4687750581, 0.3945777786]]
{[0.4687750581, 0.3945777786]}
[0.4687750584, 0.3945777787]                                  (15)

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

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

```
[[1.615015944, 0.6261292450]]
{[1.615015944, 0.6261292450]}
[1.615015945, 0.6261292449]                                   (16)

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

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

```
[[0.9340938070, 0.6220680673]]
{[0.9340938070, 0.6220680673]}
[0.9340938073, 0.6220680677]                                  (17)

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

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

```
[[-1.218187898, 0.4090373769]]
∅
[0.6419052153, 4.891076637]                                   (18)

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

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

```
[[-3.588859253, 0.9460901279]]
∅
[1.650395683, 1.596487762]                                    (19)

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

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

```
[[0.3071993482, -8.375921430]]
∅
[1.440808853, 0.7476820875]                                   (20)

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

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

```
[[0.6455732285, 1.315132700]]
{[0.6455732285, 1.315132700]}
[0.6455732286, 1.315132699]                                   (21)

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

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

```
[[1.417902121, 1.686781071]]
{[1.417902121, 1.686781071]}
[1.417902121, 1.686781071]                                    (22)

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

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

```
[[0.6587766085, 2.108664959]]
{[0.6587766085, 2.108664959]}
[0.6587766093, 2.108664959]                                   (23)

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

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

```
[[1.035777768, 0.4481951791]]
{[1.035777768, 0.4481951791]}
[1.035777768, 0.4481951808]                                   (24)

>
```

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

they agree 6/20 times

```
> 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]]

∅

[1.317162504, 1.295733474, 0.9173181249] (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]]

∅

[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]]

∅

[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]]

∅

[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]]

∅

[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]]

∅

[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];
```

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

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

$$\varnothing$$

$$[2.131292501, 0.6309131875, 0.8004643296] \quad (15)$$

```
> 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];
```

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

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

$$\varnothing$$

$$[1.083838025, 1.124000405, 0.3186773417] \quad (16)$$

```
> 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];
```

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

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

$$\varnothing$$

$$[0.7627933799, 1.049232115, 1.273511329] \quad (17)$$

```
> 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];
```

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

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

$$\varnothing$$

$$[0.5953721697, 0.3736290865, 0.6400195255] \quad (18)$$

```
> 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];
```

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

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

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

$$[1.305341000, 0.6627518084, 0.7668378649] \quad (19)$$

```
> 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];
```

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

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

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

$$[0.4741279626, 0.5962032225, 0.5765818966] \quad (20)$$

```
> 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];
```

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

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

$$\varnothing$$

$$[0.8462091852, 1.291816580, 1.015848272] \quad (21)$$

```
> 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];
```

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

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

$$\varnothing$$

$$[0.7536548384, 0.7039120037, 1.913845881] \quad (22)$$

```
> 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];
```

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

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

$$\varnothing$$

$$[0.8731855907, 1.345913473, 1.333184810] \quad (23)$$

```
> 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];
```

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

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

$$\varnothing$$

$$[0.4987260840, 1.146821272, 0.6754259176] \quad (24)$$

```
>
```

4. Copy-and-paste the following line into your worksheet (once you have donwloaded 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];
```

they agree 20/20 times

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

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

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

[[1.068419234, 1.068419234]]

{[1.068419234, 1.068419234]}

1.068419234 (5)

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

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

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

[[0.3854886655, 0.3854886655]]

{[0.3854886655, 0.3854886655]}

0.3854886657 (6)

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

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

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

[[0.8771507064, 0.8771507064]]

{[0.8771507064, 0.8771507064]}

0.8771507070 (7)

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

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

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

[[1.640754482, 1.640754482]]

{[1.640754482, 1.640754482]}

1.640754482 (8)

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

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

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

[[0.7675918792, 0.7675918792]]

{[0.7675918792, 0.7675918792]}

0.7675918794 (9)

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

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

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

[[0.8482423622, 0.8482423622]]

{[0.8482423622, 0.8482423622]}

0.8482423624 (10)

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

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

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

[[0.7010094834, 0.7010094834]]

{[0.7010094834, 0.7010094834]}

0.7010094832 (11)

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

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

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

[[1.126783171, 1.126783171]]

{[1.126783171, 1.126783171]}

1.126783170 (12)

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

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

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

[[0.5888831139, 0.5888831139]]

{[0.5888831139, 0.5888831139]}

0.5888831142 (13)

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

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

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

[[0.9351331652, 0.9351331652]]

{[0.9351331652, 0.9351331652]}

0.9351331656 (14)

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

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

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

[[0.8070445132, 0.8070445132]]

{[0.8070445132, 0.8070445132]}

0.8070445131 (15)

```
> 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];
```

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

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

[[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];
```

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

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

[[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];
```

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

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

[[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];
```

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

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

[[1.148331477, 1.148331477]]

{{1.148331477, 1.148331477}}

1.148331478 (19)

1.1483314 / 8 (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];
```

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

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

[[1.057097577, 1.057097577]]

{{1.057097577, 1.057097577}}

1.057097577 (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];
```

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

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

[[0.4742718696, 0.4742718696]]

{{0.4742718696, 0.4742718696}}

0.4742718693 (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];
```

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

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

[[5.313657169, 5.313657169]]

{{5.313657169, 5.313657169}}

5.313657166 (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];
```

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

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

[[0.6030226892, 0.6030226892]]

{{0.6030226892, 0.6030226892}}

0.6030226892 (23)

0.6030226892 (23)

```
> 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];
```

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

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

[[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:=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?

they agree 18/20 times

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

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

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

[[1.406326967, 1.406326967, 1.406326967]]

{[1.406326967, 1.406326967, 1.406326967]}

1.406326967 (5)

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

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

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

[[0.8404050733, 0.8404050733, 0.8404050733]]

{[0.8404050733, 0.8404050733, 0.8404050733]}

0.8404050735 (6)

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

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

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

[[1.157128741, 1.157128741, 1.157128741]]

{[1.157128741, 1.157128741, 1.157128741]}

1.157128741 (7)

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

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

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

[[0.8960073293, 0.8960073293, 0.8960073293]]

{[0.8960073293, 0.8960073293, 0.8960073293]}

0.8960073293 (8)

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

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

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

[[0.6984226500, 0.6984226500, 0.6984226500]]

{[0.6984226500, 0.6984226500, 0.6984226500]}

0.6984226500 (9)

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

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

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

[[1.040504561, 1.040504561, 1.040504561]]

{[1.040504561, 1.040504561, 1.040504561]}

1.040504561 (10)

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

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

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

[[0.7830951895, 0.7830951895, 0.7830951895]]

{[0.7830951895, 0.7830951895, 0.7830951895]}

0.7830951894 (11)

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

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

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

[[0.8818979205, 0.8818979205, 0.8818979205]]

{[0.8818979205, 0.8818979205, 0.8818979205]}

0.8818979201 (12)

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

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

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

[[0.6588333907, 0.6588333907, 0.6588333907]]

{[0.6588333907, 0.6588333907, 0.6588333907]}

0.6588333909 (13)

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

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

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

[[1.522407750, 1.522407750, 1.522407750]]

{[1.522407750, 1.522407750, 1.522407750]}

1.522407751 (14)

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

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

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

[[0.8436307095, 0.8436307095, 0.8436307095]]

{[0.8436307095, 0.8436307095, 0.8436307095]}

0.8436307100 (15)

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

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

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

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

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

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

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

$$\{[1.600000000, 1.600000000, 1.600000000]\}$$

$$1.599999999 \tag{17}$$

```
> 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]]); Orbit(3, z, f, [5., 8., 11.], 2000, 2010)[-1];
```

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

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

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

$$\{[2.074570451, 2.074570451, 2.074570451]\}$$

$$2.074570451 \tag{18}$$

```
> 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]]); Orbit(3, z, f, [5., 8., 11.], 2000, 2010)[-1];
```

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

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

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

$$\{[1.333333333, 1.333333333, 1.333333333]\}$$

$$1.333333333 \tag{19}$$

```
> 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]]); Orbit(3, z, f, [5., 8., 11.], 2000, 2010)[-1];
```

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

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

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

$$\{[1.321762910, 1.321762910, 1.321762910]\}$$

$$1.321762910 \tag{20}$$

```
> 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]]); Orbit(3, z, f, [5., 8., 11.], 2000, 2010)[-1];
```

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

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

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

$$\{[0.8141428429, 0.8141428429, 0.8141428429]\}$$

$$0.8141428430 \tag{21}$$

```
> 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]]); Orbit(3, z, f, [5., 8., 11.], 2000, 2010)[-1];
```

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

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

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

$$\{[0.9052343178, 0.9052343178, 0.9052343178]\}$$

$$0.9052343179 \tag{22}$$

```
> 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]]); Orbit(3, z, f, [5., 8., 11.], 2000, 2010)[-1];
```

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

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

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

$$\{[1.429238738, 1.429238738, 1.429238738]\}$$

$$1.429238738 \tag{23}$$

```
> 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]]); Orbit(3, z, f, [5., 8., 11.], 2000, 2010)[-1];
```

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

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

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

$$\{[2.054404503, 2.054404503, 2.054404503]\}$$

$$2.054404503 \tag{24}$$

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

0/20 were nonempty

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

$$L := 3$$
$$a := 2.450000000$$
$$c := 1.100000000$$
$$T := [3\ N e^{-2.450000000\ P}, 1.100000000\ N\ (1 - e^{-2.450000000\ P})]$$
$$[[0., 0.], [0.6114725169, 0.4484131790]]$$
$$\varpi \quad (5)$$

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

$$L := 1$$
$$a := 0.7500000000$$
$$c := 2.250000000$$
$$T := [N e^{-0.7500000000\ P}, 2.250000000\ N\ (1 - e^{-0.7500000000\ P})]$$
$$[[N, 0.]]$$

Error, (in SSSg) cannot determine if this expression is true or false: max(1..,1.687500000*abs(N)) < 1 |DMB14.txt:489|

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

$$L := 1$$
$$a := 1.900000000$$
$$c := 1.500000000$$
$$T := [N e^{-1.900000000\ P}, 1.500000000\ N\ (1 - e^{-1.900000000\ P})]$$
$$[[N, 0.]]$$

Error, (in SSSg) cannot determine if this expression is true or false: max(1..,2.850000000*abs(N)) < 1 |DMB14.txt:489|

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

$$L := 3$$
$$a := 2.400000000$$
$$c := 2.100000000$$
$$T := [3\ N e^{-2.400000000\ P}, 2.100000000\ N\ (1 - e^{-2.400000000\ P})]$$
$$[[0., 0.], [0.3269679431, 0.4577551203]]$$
$$\varpi \quad (6)$$

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

$$L := 2$$
$$a := 2.200000000$$
$$c := 0.5500000000$$
$$T := [2\ N e^{-2.200000000\ P}, 0.5500000000\ N\ (1 - e^{-2.200000000\ P})]$$
$$[[0., 0.], [1.145697819, 0.3150669003]]$$
$$\varpi \quad (7)$$

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

$$L := 1$$
$$a := 1.900000000$$
$$c := 1.950000000$$
$$T := [N e^{-1.900000000\ P}, 1.950000000\ N\ (1 - e^{-1.900000000\ P})]$$
$$[[N, 0.]]$$

Error, (in SSSg) cannot determine if this expression is true or false: max(1..,3.705000000*abs(N)) < 1 |DMB14.txt:489|

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

$$L := 2$$
$$a := 1.750000000$$
$$c := 0.1500000000$$
$$T := [2\ N e^{-1.750000000\ P}, 0.1500000000\ N\ (1 - e^{-1.750000000\ P})]$$
$$[[0., 0.], [5.281121376, 0.3960841032]]$$
$$\varpi \quad (8)$$

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

$$L := 3$$
$$a := 2.050000000$$
$$c := 1.950000000$$
$$T := [3\ N e^{-2.050000000\ P}, 1.950000000\ N\ (1 - e^{-2.050000000\ P})]$$
$$[[0., 0.], [0.4122372565, 0.5359084335]]$$
$$\varpi \quad (9)$$

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

$$L := 3$$
$$a := 2.350000000$$
$$c := 0.3500000000$$
$$T := [3\ N e^{-2.350000000\ P}, 0.3500000000\ N\ (1 - e^{-2.350000000\ P})]$$
$$[[0., 0.], [2.003548247, 0.4674945909]]$$
$$\varpi \quad (10)$$

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

$$L := 2$$
$$a := 1.200000000$$
$$c := 1.650000000$$
$$T := [2\ N e^{-1.200000000\ P}, 1.650000000\ N\ (1 - e^{-1.200000000\ P})]$$
$$[[0., 0.], [0.7001486672, 0.5776226505]]$$
$$\varpi \quad (11)$$

```
> 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]);
```

$$L := 1$$
$$a := 1.100000000$$
$$c := 2.200000000$$
$$T := [N e^{-1.100000000\,P}, 2.200000000\,N\,(1 - e^{-1.100000000\,P})]$$
$$[[N, 0.]]$$

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

```
> 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]);
```

$$L := 2$$
$$a := 1.600000000$$
$$c := 0.8000000000$$
$$T := [2\,N e^{-1.600000000\,P}, 0.8000000000\,N\,(1 - e^{-1.600000000\,P})]$$
$$[[0., 0.], [1.083042470, 0.4332169878]]$$
$$\varpi \tag{12}$$

```
> 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]);
```

$$L := 3$$
$$a := 2.250000000$$
$$c := 1.450000000$$
$$T := [3\,N e^{-2.250000000\,P}, 1.450000000\,N\,(1 - e^{-2.250000000\,P})]$$
$$[[0., 0.], [0.5051090982, 0.4882721283]]$$
$$\varpi \tag{13}$$

```
> 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]);
```

$$L := 2$$
$$a := 2.300000000$$
$$c := 0.05000000000$$
$$T := [2\,N e^{-2.300000000\,P}, 0.05000000000\,N\,(1 - e^{-2.300000000\,P})]$$
$$[[0., 0.], [12.05473357, 0.3013683394]]$$
$$\varpi \tag{14}$$

```
> 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]);
```

$$L := 2$$
$$a := 1.550000000$$
$$c := 1.850000000$$
$$T := [2\,N e^{-1.550000000\,P}, 1.850000000\,N\,(1 - e^{-1.550000000\,P})]$$
$$[[0., 0.], [0.4834505183, 0.4471917294]]$$
$$\varpi \tag{15}$$

```
> 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]);
```

$$L := 1$$
$$a := 2.150000000$$
$$c := 0.05000000000$$
$$T := [N e^{-2.150000000\,P}, 0.05000000000\,N\,(1 - e^{-2.150000000\,P})]$$
$$[[N, 0.]]$$

```
Error, (in SSSg) cannot determine if this expression is true or false: max(1..1075000000*abs(N)) < 1 |DMB14.txt:489|
```

```
> 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]);
```

$$L := 1$$
$$a := 1.900000000$$
$$c := 2.200000000$$
$$T := [N e^{-1.900000000\,P}, 2.200000000\,N\,(1 - e^{-1.900000000\,P})]$$
$$[[N, 0.]]$$

```
Error, (in SSSg) cannot determine if this expression is true or false: max(1..4.180000000*abs(N)) < 1 |DMB14.txt:489|
```

```
> 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]);
```

$$L := 2$$
$$a := 0.1500000000$$
$$c := 1.250000000$$
$$T := [2\,N e^{-0.1500000000\,P}, 1.250000000\,N\,(1 - e^{-0.1500000000\,P})]$$
$$[[0., 0.], [7.393569926, 4.620981204]]$$
$$\varpi \tag{16}$$

```
> 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]);
```

$$L := 3$$
$$a := 2.400000000$$
$$c := 0.8000000000$$
$$T := [3\,N e^{-2.400000000\,P}, 0.8000000000\,N\,(1 - e^{-2.400000000\,P})]$$
$$[[0., 0.], [0.8582908505, 0.4577551203]]$$
$$\varpi \tag{17}$$

```
> 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]);
```

$$L := 2$$
$$a := 1.400000000$$
$$c := 1.300000000$$
$$T := [2\,N e^{-1.400000000\,P}, 1.300000000\,N\,(1 - e^{-1.400000000\,P})]$$
$$[[0., 0.], [0.7617001984, 0.4951051290]]$$
$$\varpi \tag{18}$$

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)

it got a 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]);
```

$$T := \left[14\, e^{-2.566666667 - 0.4000000000\, N},\ 14 - 14\, e^{-0.4000000000\, N}\right] \tag{27}$$

{{0.7852761752, 3.773863350}}

```
> 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]);
```

$$T := \left[14\, e^{-0.3200000000 - 0.4000000000\, N},\ 14 - 14\, e^{-0.4000000000\, N}\right] \tag{28}$$

or

```
> 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]);
```

$$T := \left[14\, e^{-0.2000000000 - 0.6000000000\, N},\ 14 - 14\, e^{-0.6000000000\, N}\right] \tag{29}$$

or

```
>
> 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]);
```

$$T := \left[14\, e^{-7.800000000 - 0.2000000000\, N},\ 14 - 14\, e^{-0.2000000000\, N}\right] \tag{30}$$

{{0.005729720004, 0.0160340272}}

```
> 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]);
```

$$T := \left[14\, e^{-1.300000000 - 0.3000000000\, N},\ 14 - 14\, e^{-0.3000000000\, N}\right] \tag{31}$$

{{2.057901634, 6.448948392}}

```
> 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]);
```

$$T := \left[14\, e^{-1.800000000 - 0.4000000000\, N},\ 14 - 14\, e^{-0.4000000000\, N}\right] \tag{32}$$

{{1.349082148, 5.838528606}}

```
> 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]);
```

$$T := \left[14\, e^{-0.1200000000 - 0.8000000000\, N},\ 14 - 14\, e^{-0.8000000000\, N}\right] \tag{33}$$

or

```
> 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]);
```

$$T := \left[14\, e^{-0.6000000000 - 0.7000000000\, N},\ 14 - 14\, e^{-0.7000000000\, N}\right] \tag{34}$$

or

```
>
> 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]);
```

$$T := \left[14\, e^{-0.7000000000 - 0.7000000000\, N},\ 14 - 14\, e^{-0.7000000000\, N}\right] \tag{35}$$

or

```
> 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]);
```

$$T := \left[14\, e^{-9.100000000 - 0.1000000000\, N},\ 14 - 14\, e^{-0.1000000000\, N}\right] \tag{36}$$

{{0.001563076979, 0.0021881368}}

```
> 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]);
```

$$T := \left[14\, e^{-2.566666667 - 0.4000000000\, N},\ 14 - 14\, e^{-0.4000000000\, N}\right] \tag{37}$$

{{0.7852761752, 3.773863350}}

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

$$T := \left[14\, e^{-0.3200000000 - 0.4000000000\, N},\ 14 - 14\, e^{-0.4000000000\, N}\right] \tag{38}$$

or

```
> 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]);
```

$$T := \left[14\, e^{-0.2000000000 - 0.6000000000\, N},\ 14 - 14\, e^{-0.6000000000\, N}\right] \tag{39}$$

or

```
>
> 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]);
```

$$T := \left[14\, e^{-7.800000000 - 0.2000000000\, N},\ 14 - 14\, e^{-0.2000000000\, N}\right] \tag{40}$$

{{0.005729720004, 0.0160340272}}

```
> 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]);
```

$$T := \left[14\, e^{-1.300000000 - 0.3000000000\, N},\ 14 - 14\, e^{-0.3000000000\, N}\right] \tag{41}$$

{{2.057901634, 6.448948392}}

```
> 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]);
```

$$T := \left[14\, e^{-1.800000000 - 0.4000000000\, N},\ 14 - 14\, e^{-0.4000000000\, N}\right] \tag{42}$$

{{1.349082148, 5.838528606}}

```
> 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]);
```

$$T := \left[14\, e^{-0.1200000000 - 0.8000000000\, N},\ 14 - 14\, e^{-0.8000000000\, N}\right] \tag{43}$$

or

```
> 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]);
```

$$T := \left[14\, e^{-0.6000000000 - 0.7000000000\, N},\ 14 - 14\, e^{-0.7000000000\, N}\right] \tag{44}$$

or

```
>
> 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]);
```

$$T := \left[14\, e^{-0.7000000000 - 0.7000000000\, N},\ 14 - 14\, e^{-0.7000000000\, N}\right] \tag{45}$$

or

```
> 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]);
```

$$T := \left[14\, e^{-9.100000000 - 0.1000000000\, N},\ 14 - 14\, e^{-0.1000000000\, N}\right] \tag{46}$$

{{0.001563076979, 0.0021881368}}

```
> 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]);
```

$$T := \left[14\, e^{-2.566666667 - 0.4000000000\, N},\ 14 - 14\, e^{-0.4000000000\, N}\right] \tag{47}$$

{{0.7852761752, 3.773863350}}

```
> 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]);
```

$$T := \left[14\, e^{-0.3200000000 - 0.4000000000\, N},\ 14 - 14\, e^{-0.4000000000\, N}\right] \tag{48}$$

or

```
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]);
```

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

$$\varpi \tag{49}$$

```
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]);
```

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

$$\{[0.005729720004,\ 0.0160340272]\} \tag{50}$$

```
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]);
```

$$T := [14\,e^{-1.300000000 - 0.3000000000\,N},\ 14 - 14\,e^{-0.3000000000\,N}]$$

$$\{[2.057901634,\ 6.448948392]\} \tag{51}$$

```
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]);
```

$$T := [14\,e^{-1.800000000 - 0.4000000000\,N},\ 14 - 14\,e^{-0.4000000000\,N}]$$

$$\{[1.349082148,\ 5.838528606]\} \tag{52}$$

```
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]);
```

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

$$\varpi \tag{53}$$

```
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]);
```

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

$$\varpi \tag{54}$$

```
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]);
```

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

$$\varpi \tag{55}$$

```
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]);
```

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

$$\{[0.001563076979,\ 0.0021881368]\} \tag{56}$$

```
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]);
```

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

$$\{[0.7852761752,\ 3.773863350]\} \tag{57}$$

```
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]);
```

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

$$\varpi \tag{58}$$

```
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]);
```

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

$$\varpi \tag{59}$$

```
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]);
```

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

$$\{[0.005729720004,\ 0.0160340272]\} \tag{60}$$

```
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]);
```

$$T := [14\,e^{-1.300000000 - 0.3000000000\,N},\ 14 - 14\,e^{-0.3000000000\,N}]$$

$$\{[2.057901634,\ 6.448948392]\} \tag{61}$$

```
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]);
```

$$T := [14\,e^{-1.800000000 - 0.4000000000\,N},\ 14 - 14\,e^{-0.4000000000\,N}]$$

$$\{[1.349082148,\ 5.838528606]\} \tag{62}$$

```
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]);
```

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

$$\varpi \tag{63}$$

```
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]);
```

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

$$\varpi \tag{64}$$

```
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]);
```

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

$$\varpi \tag{65}$$

```
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]);
```

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

$$\{[0.001563076979,\ 0.0021881368]\} \tag{66}$$

```
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]);
```

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

$$\{[0.7852761752,\ 3.773863350]\} \tag{67}$$

```
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]);
```

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

$$\varpi \tag{68}$$

```
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]);
```

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

$$\varpi \tag{69}$$

```
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]);
```

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

$$\{[0.005729720004,\ 0.0160340272]\} \tag{70}$$

```
a := rand(1..10)() / 10. : r := rand(1..10)() / 10. : K := rand(1..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]);
```

$$T := [14\,e^{-1.300000000 - 0.3000000000\,N},\ 14 - 14\,e^{-0.3000000000\,N}]$$

$$\{[2.057901634,\ 6.448948392]\} \tag{71}$$

```
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]);
```

$$T := [14\,e^{-1.800000000 - 0.4000000000\,N},\ 14 - 14\,e^{-0.4000000000\,N}]$$

$$\{[1.349082148,\ 5.838528606]\} \tag{72}$$

```
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]);
```

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

$$\varnothing \tag{73}$$

```
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]);
```

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

$$\varnothing \tag{74}$$

```
>
>
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]);
```

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

$$\varnothing \tag{75}$$

```
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]);
```

$$T := [14\,e^{-9.100000000 - 0.1000000000\,N},\ 14 - 14\,e^{-0.1000000000\,N}]$$

$$\{[0.001563076979,\ 0.0021881368]\} \tag{76}$$

```
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]);
```

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

$$\{[0.7852761752,\ 3.773863350]\} \tag{77}$$

```
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]);
```

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

$$\varnothing \tag{78}$$

```
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]);
```

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

$$\varnothing \tag{79}$$

```
>
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]);
```

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

$$\{[0.005729720004,\ 0.0160340272]\} \tag{80}$$

```
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]);
```

$$T := [14\,e^{-1.300000000 - 0.3000000000\,N},\ 14 - 14\,e^{-0.3000000000\,N}]$$

$$\{[2.057901634,\ 6.448948392]\} \tag{81}$$

```
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]);
```

$$T := [14\,e^{-1.800000000 - 0.4000000000\,N},\ 14 - 14\,e^{-0.4000000000\,N}]$$

$$\{[1.349082148,\ 5.838528606]\} \tag{82}$$

```
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]);
```

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

$$\varnothing \tag{83}$$

```
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]);
```

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

$$\varnothing \tag{84}$$

```
>
>
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]);
```

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

$$\varnothing \tag{85}$$

```
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]);
```

$$T := [14\,e^{-9.100000000 - 0.1000000000\,N},\ 14 - 14\,e^{-0.1000000000\,N}]$$

$$\{[0.001563076979,\ 0.0021881368]\} \tag{86}$$

```
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]);
```

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

$$\{[0.7852761752,\ 3.773863350]\} \tag{87}$$

```
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]);
```

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

$$\varnothing \tag{88}$$

```
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]);
```

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

$$\varnothing \tag{89}$$

```
>
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]);
```

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

$$\{[0.005729720004,\ 0.0160340272]\} \tag{90}$$

```
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]);
```

$$T := [14\,e^{-1.300000000 - 0.3000000000\,N},\ 14 - 14\,e^{-0.3000000000\,N}]$$

$$\{[2.057901634,\ 6.448948392]\} \tag{91}$$

```
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]);
```

$$T := [14\,e^{-1.800000000 - 0.4000000000\,N},\ 14 - 14\,e^{-0.4000000000\,N}]$$

$$\{[1.349082148,\ 5.838528606]\} \tag{92}$$

```
> 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]);
```

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

(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]);
```

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

(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]);
```

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

(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]);
```

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

$$\{[0.7852761752,\ 3.773863350]\}$$

(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]);
```

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

(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]);
```

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

(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]);
```

$$T := [14\,e^{-1.800000000 - 0.2000000000\,N},\ 14 - 14\,e^{-0.2000000000\,N}]$$

$$\{[0.005729720004,\ 0.0160340272]\}$$

(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]);
```

$$T := [14\,e^{-1.300000000 - 0.3000000000\,N},\ 14 - 14\,e^{-0.3000000000\,N}]$$

$$\{[2.057901634,\ 6.448948392]\}$$

(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]);
```

$$T := [14\,e^{-1.800000000 - 0.4000000000\,N},\ 14 - 14\,e^{-0.4000000000\,N}]$$

$$\{[1.349082148,\ 5.838528606]\}$$

(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]);
```

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

(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]);
```

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

(104)