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> #Mudassir Lodi
#November 15, 2021
#Homework 21
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> read "C:/Users/mk1115/Documents/DMB.txt"
First Written: Nov. 2021
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This is DMB.txt, A Maple package to explore Dynamical models in Biology (both discrete and continuous)

accompanying the class Dynamical Models in Biology, Rutgers University. Taught by Dr. Z. (Doron Zeilbeger)

*The most current version is available on WWW at:
<http://sites.math.rutgers.edu/~zeilberg/tokhniot/DMB.txt> .
Please report all bugs to: DoronZeil at gmail dot com .*

*For general help, and a list of the MAIN functions,
type "Help()". For specific help type "Help(procedure_name);"*

*For a list of the supporting functions type: Help1();
For help with any of them type: Help(ProcedureName);*

*For a list of the functions that give examples of Discrete-time dynamical systems (some famous),
type: HelpDDM());*

For help with any of them type: Help(ProcedureName);

*For a list of the functions continuous-time dynamical systems (some famous) type: HelpCDM());
For help with any of them type: Help(ProcedureName);*

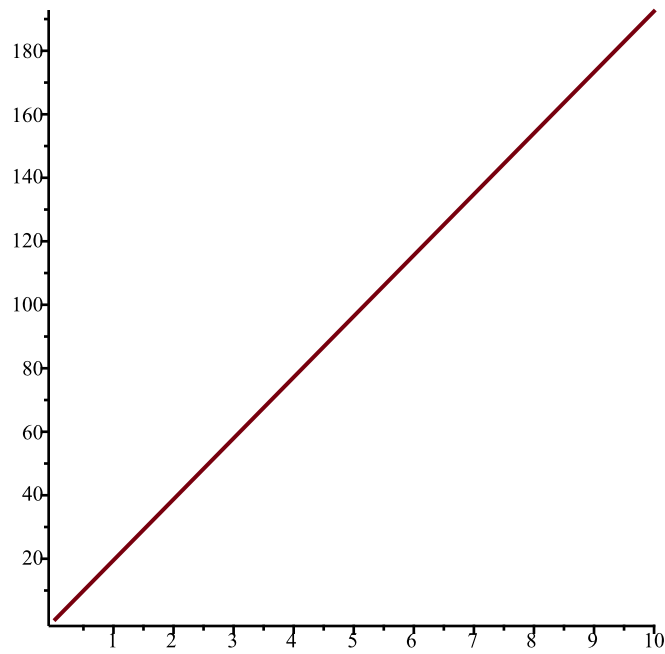
> Help(ChemoStat)
*ChemoStat(N,C,a1,a2): The Chemostat continuous-time dynamical system with N=Bacterial population density, and C=nutrient Concentration in growth chamber (see Table 4.1 of Edelstein-Keshet, p. 122)
with paramerts a1, a2, Equations (19a_, (19b) in Edelestein-Keshet p. 127 (section 4.5, where they are called alpha1, alpha2). a1 and a2 can be symbolic or numeric. Try:*

*ChemoStat(N,C,a1,a2);
ChemoStat(N,C,2,3);*

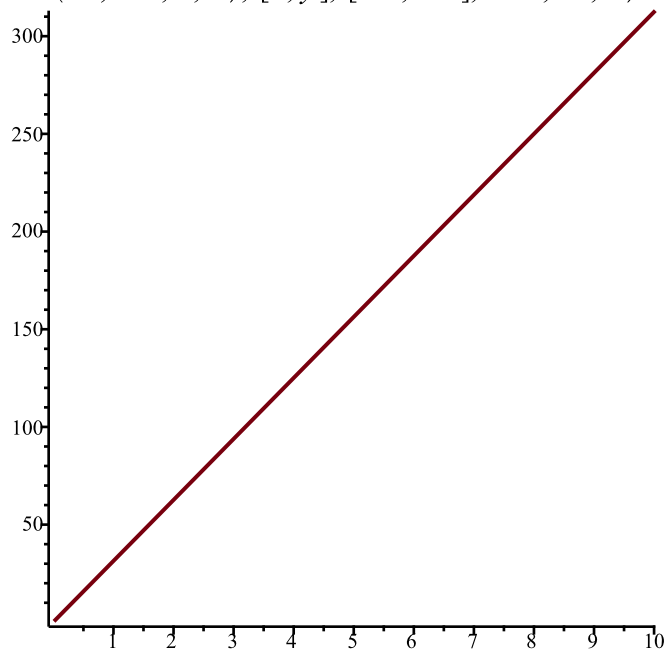
```
> TimeSeries(ChemoStat(20, 50, 2, 3), [x, y], [0.5, 0.5], 0.01, 10, 1)
```

(1)

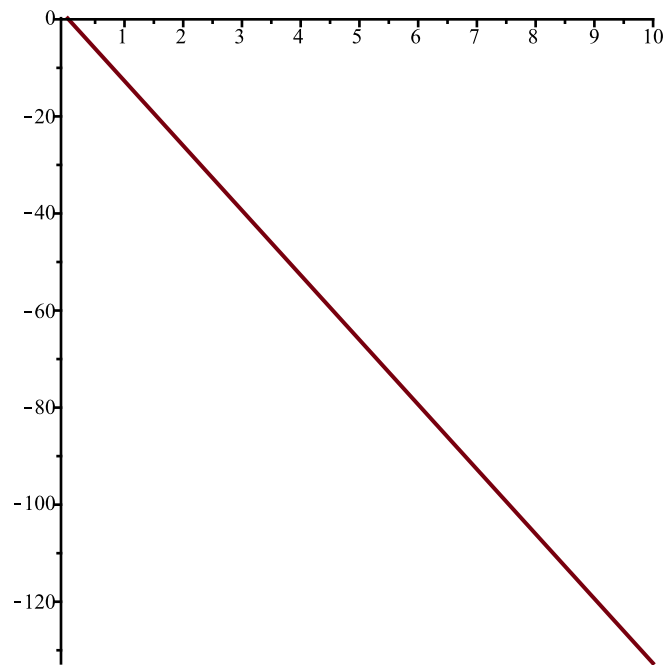
(2)



> *TimeSeries(ChemoStat(30,-50,2,3), [x,y], [0.5,0.5], 0.01, 10, 1)*



> *TimeSeries(ChemoStat(-20,5,2,3), [x,y], [0.5,0.5], 0.01, 10, 1)*



> *Help(GeneNet)*

GeneNet(a0,a,b,n,m1,m2,m3,p1,p2,p3): The continuous-time dynamical system, with quantities $m1,m2,m3,p1,p2,p3$, due to M. Elowitz and S. Leibler

described in the Ellner-Guckenheimer book, Eq. (4.1) (chapter 4, p. 112)

and parameters a_0 (called α_0 there), a (called α there), b (called β there) and n .

Try:

GeneNet(0,0.5,0.2,2,m1,m2,m3,p1,p2,p3);

(3)

> *TimeSeries(GeneNet(0, 0.5, 0.2, 2, 10, 2, 3, 10, 2, 3), [x, y, z], [0.5, 0.5, 0.5], 0.01, 10, 1)*
bad input

FAIL

(4)

> *Help(Lotka)*

Lotka(r1,k1,r2,k2,b12,b21,N1,N2): The Lotka-Volterra continuous-time dynamical system, Eqs. (9a),(9b) (p. 224, section 6.3) of Edelstein-Keshet

with populations $N1, N2$, and parameters $r1,r2,k1,k2, b12, b21$ (called there β_{12} and β_{21})

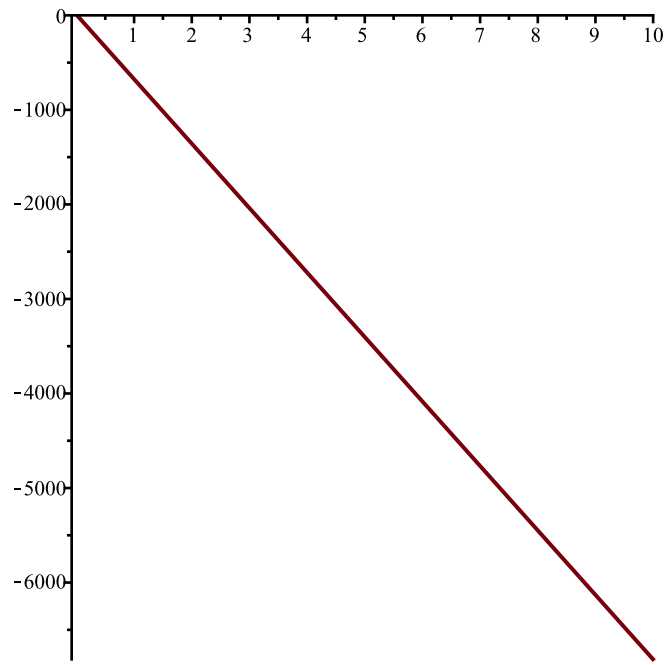
Try:

Lotka(r1,k1,r2,k2,b12,b21,N1,N2);

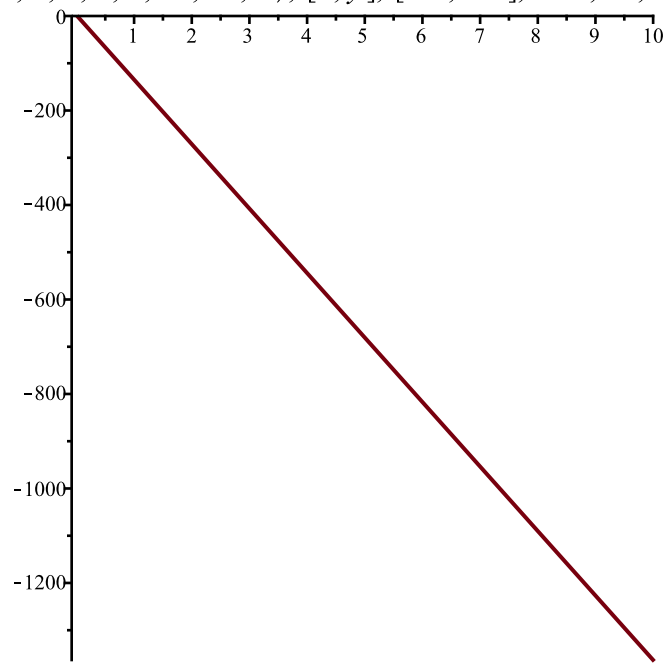
Lotka(1,2,2,3,1,2,N1,N2);

(5)

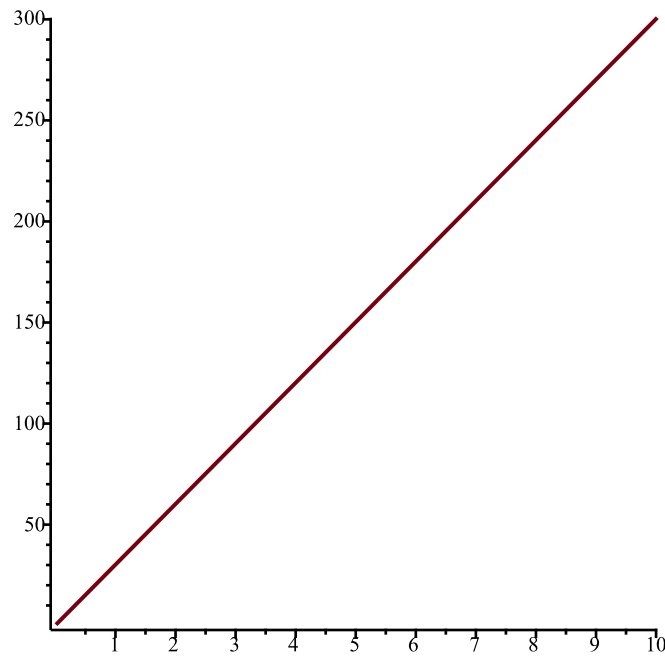
> *TimeSeries(Lotka(1, 2, 2, 3, 5, 20, 11, 23), [x, y], [0.5, 0.5], 0.01, 10, 1)*



> *TimeSeries*(Lotka(1, 2, 2, 3, 5, 20, 13, 2), [x, y], [0.5, 0.5], 0.01, 10, 1)



> *TimeSeries*(Lotka(1, 2, 2, 3, -5, -20, 5, 3), [x, y], [0.5, 0.5], 0.01, 10, 1)



> *Help(Volterra)*

Volterra(a,b,c,d,x,y): The (simple, original) Volterra predator-prey continuous-time dynamical system with parameters a,b,c,d

Given by Eqs. (7a) (7b) in Edelstein-Keshet p. 219 (section 6.2).

a,b,c,d may be symbolic or numeric

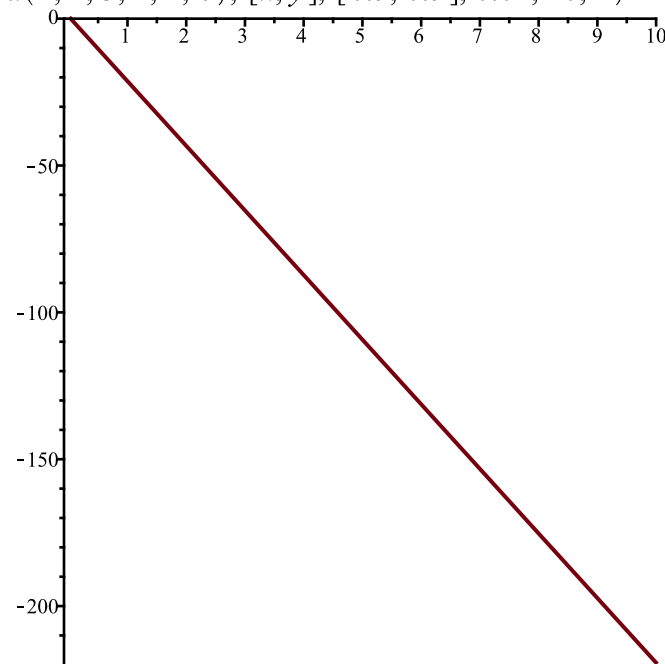
Try:

Volterra(a,b,c,d,x,y);

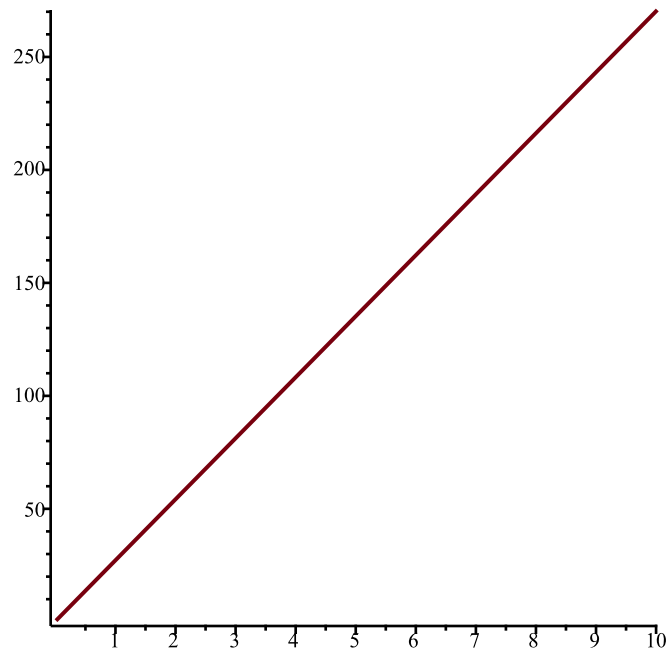
Volterra(1,2,3,4,x,y);

(6)

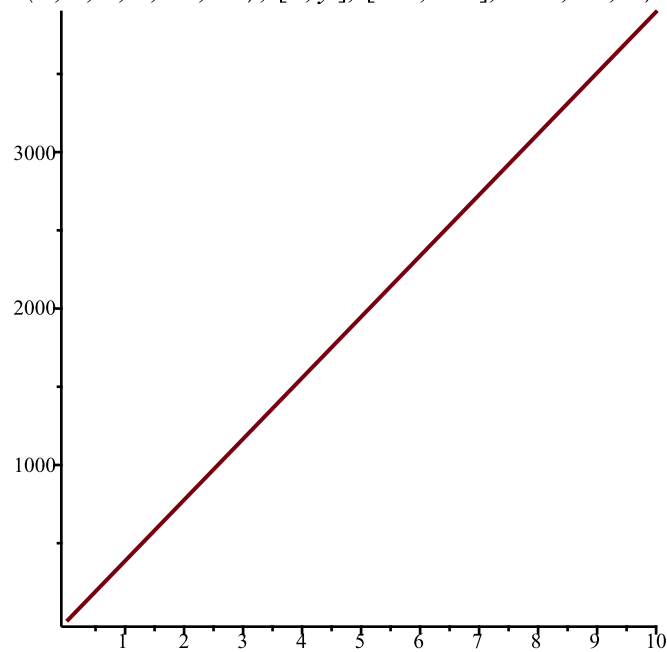
> *TimeSeries(Volterra(1, 2, 3, 4, 2, 6), [x, y], [0.5, 0.5], 0.01, 10, 1)*



> *TimeSeries(Volterra(1, 2, 3, 4, -3, 5), [x, y], [0.5, 0.5], 0.01, 10, 1)*



> `TimeSeries(Volterra(1, 2, 3, 4, 30, -6), [x, y], [0.5, 0.5], 0.01, 10, 1)`



> `Help(VolterraM)`

VolterraM(a,b,c,d,x,K,y): The MODIFIED Volterra predator-prey continuous-time dynamical system with parameters a,b,c,d,K

Given by Eqs. (8a) (8b) in Edelstein-Keshet p. 220 (section 6.2).

a,b,c,d ,K may be symbolic or numeric

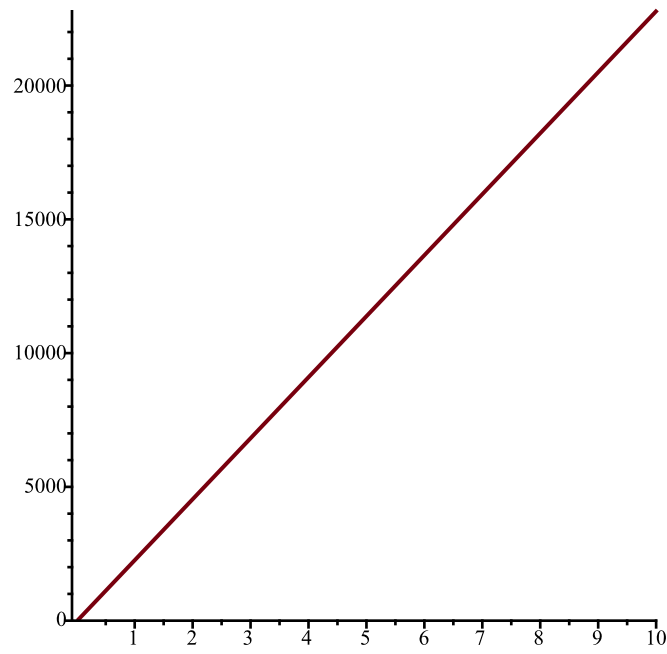
Try:

VolterraM(a,b,c,d,K,x,y);

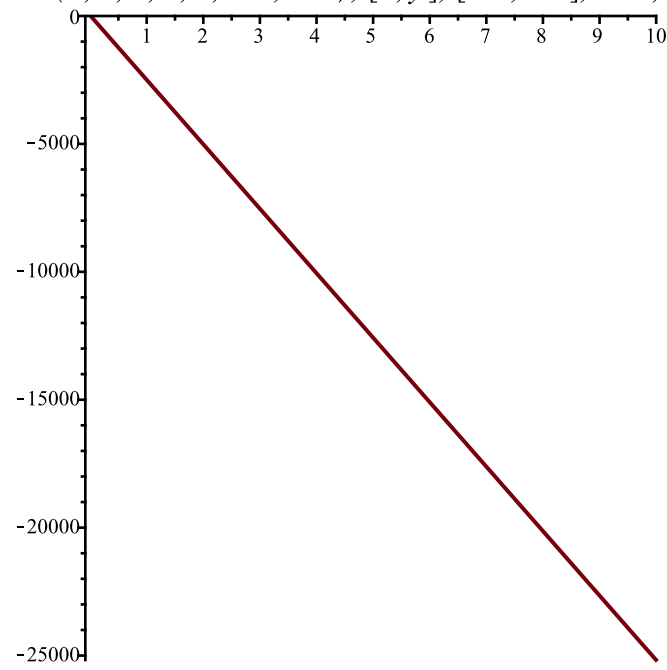
VolterraM(1,2,3,4,3,x,y);

> `TimeSeries(VolterraM(1, 2, 3, 4, 3, -20, 60), [x, y], [0.5, 0.5], 0.01, 10, 1)`

(7)



> *TimeSeries*(*VolterraM*(1, 2, 3, 4, 3, -20, -60), [x, y], [0.5, 0.5], 0.01, 10, 1)



> *TimeSeries*(*VolterraM*(1, 2, 3, 4, 3, -2, 5), [x, y], [0.5, 0.5], 0.01, 10, 1)

