```
> #OK to post
>
>
> #Anne Somalwar, hw22, 11.22.2021
>
>
> read "C:/Users/aks238/OneDrive – Rutgers University/Documents/DMB.txt"
```

First Written: Nov. 2021

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);

--- **(1)**

```
>
>
>
> #2 (a)
```

```
> Orb([2·l + 3·h, 3·l + h], [l, h], [20., 10.], 0, 9)[10]
```

$$[1.3619620\ 10^{7},\ 1.1537890\ 10^{7}] \tag{2}$$

```
>
> #The value at the start of the tenth year is [1.3619620 10^7, 1.1537890 10^7].
>
>
>
> #(b)
> dsolve({diff(l(t), t) = 2·l(t) + 3 h(t), diff(h(t), t) = 3·l(t) + h(t), h(0) = 10, l(0) = 20},
      {l(t), h(t)})
```

$$\left\{ h(t) = \left(5 + \frac{55\sqrt{37}}{37}\right) e^{\frac{(3+\sqrt{37})\,t}{2}} + \left(5 - \frac{55\sqrt{37}}{37}\right) e^{-\frac{(-3+\sqrt{37})\,t}{2}},\ l(t) \right. \tag{3}$$

$$= \frac{\left(5 + \frac{55\sqrt{37}}{37}\right) e^{\frac{(3+\sqrt{37})\,t}{2}} \sqrt{37}}{6} - \frac{\left(5 - \frac{55\sqrt{37}}{37}\right) e^{-\frac{(-3+\sqrt{37})\,t}{2}} \sqrt{37}}{6}$$

$$\left. + \frac{\left(5 + \frac{55\sqrt{37}}{37}\right) e^{\frac{(3+\sqrt{37})\,t}{2}}}{6} + \frac{\left(5 - \frac{55\sqrt{37}}{37}\right) e^{-\frac{(-3+\sqrt{37})\,t}{2}}}{6} \right\}$$

```
>
>
> evalf(subs(t = 10, %[1]))
```

$$h(10) = 7.419856090\ 10^{20} \tag{4}$$

```
>
>
> dsolve({diff(l(t), t) = 2·l(t) + 3 h(t), diff(h(t), t) = 3·l(t) + h(t), h(0) = 10, l(0) = 20},
      {l(t), h(t)}) :
> evalf(subs(t = 10, %[2]))
```

$$l(10) = 8.758846450\ 10^{20} \tag{5}$$

```
>
>
>
>
>
> #3
>
> OrbF(AllenSIR(0.7, 0.1, 0.5, x, y), [x, y], [0.5, 0.5], 1000, 1010)
```

$$[[0.0226728810, 0.8639627141], [0.0226728810, 0.8639627141], [0.0226728810, 0.8639627141], [0.0226728810, 0.8639627141], [0.0226728810, 0.8639627141], \tag{6}$$

[0.0226728810, 0.8639627141], [0.0226728810, 0.8639627141], [0.0226728810, 0.8639627141], [0.0226728810, 0.8639627141], [0.0226728810, 0.8639627141], [0.0226728810, 0.8639627141], [0.0226728810, 0.8639627141]]

> $solve\left(\left\{(0.1+0.5)\cdot x = y\cdot(1-\exp(-0.7\cdot x)), y = 1 - x\cdot\left(1+\frac{0.5}{0.1}\right)\right\}, \{x, y\}\right)$

Warning, solutions may have been lost

$\{x = 0., y = 1.\}, \{x = 0.02267288109, y = 0.8639627135\}$ **(7)**

>

> *#Looks like the limit point and the second solution match up.*

>

>

>

> $OrbF(AllenSIR(2, 0.5, 0.5, x, y), [x, y], [0.5, 0.5], 1000, 1010)$

[[0.1974087114, 0.6051825771], [0.1974087114, 0.6051825771], [0.1974087114, 0.6051825771], [0.1974087114, 0.6051825771], [0.1974087114, 0.6051825771], [0.1974087114, 0.6051825771], [0.1974087114, 0.6051825771], [0.1974087114, 0.6051825771], [0.1974087114, 0.6051825771], [0.1974087114, 0.6051825771], [0.1974087114, 0.6051825771]] **(8)**

> $solve\left(\left\{(0.5+0.5)\cdot x = y\cdot(1-\exp(-2\cdot x)), y = 1 - x\cdot\left(1+\frac{0.5}{0.5}\right)\right\}, \{x, y\}\right)$

Warning, solutions may have been lost

$\{x = 0., y = 1.\}, \{x = 0.1974087114, y = 0.6051825771\}$ **(9)**

>

>

>

>

> *#4*

>

> $OrbkF(2, z, z[1]*(1-0.5)+(1-z[1])*(1-\exp(-0.7*z[2])), [0.3, 0.4], 1000, 1010);$

[0.2273657171, 0.2273657171, 0.2273657171, 0.2273657171, 0.2273657171, 0.2273657171, 0.2273657171, 0.2273657171, 0.2273657171, 0.2273657171, 0.2273657171] **(10)**

> $solve(0.5*y-(1-y)*(1-\exp(-0.7*y)), y);$

Warning, solutions may have been lost

$0.2273657169, 0.$ **(11)**

>

>

>

> $OrbkF(2, z, z[1]*(1-0.4)+(1-z[1])*(1-\exp(-0.8*z[2])), [0.3, 0.4], 1000, 1010)$

[0.4128852217, 0.4128852217, 0.4128852217, 0.4128852217, 0.4128852217, 0.4128852217, 0.4128852217, 0.4128852217, 0.4128852217, 0.4128852217, 0.4128852217] **(12)**

> $solve(0.4*y-(1-y)*(1-\exp(-0.8*y)), y)$

Warning, solutions may have been lost

0., 0.4128852218 **(13)**

>

>

>

>

> #5

>

>

> $FP\left(\left[\frac{x}{(10+x)}\right], [x]\right)$

$\{[-9], [0]\}$ **(14)**

>

> $SFP\left(\left[\frac{x}{(10+x)}\right], [x]\right)$

$\{[0.]\}$ **(15)**

>

>

>

> #6 (optional)

>

> #See written work