```
> #hw24 - Alan Ho
> #OK to post

> #3ii)
> read("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);

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(1)

```
> ode := diff(x(t), t, t) = -10 - 2·diff(x(t), t)
```

$$ode := \frac{d^2}{dt^2} x(t) = -10 - 2 \frac{d}{dt} x(t) \quad \textbf{(2)}$$

```
> ics := x(0) = 0, D(x)(0) = 0
```

$$ics := x(0) = 0, D(x)(0) = 0 \quad \textbf{(3)}$$

```
> dsolve({ics, ode})
```

$$x(t) = -\frac{5\,e^{-2t}}{2} - 5\,t + \frac{5}{2} \tag{4}$$

```
> evalf(solve(100 = -5*exp(-2*t)/2 + 5*t - 5/2, t))
```

$$20.50000000 \tag{5}$$

```
> #it takes 20.5 seconds for the ball to hit the ground with air resistance
```

```
> #5i)
> Help(Orb)
```

Orb(F,x,x0,K1,K2): Inputs a transformation F in the list of variables x with initial point pt, outputs the trajectory of of the discrete dynamical system (i.e. solutions of the difference equation): x(n)=F(x(n-1)) with x(0)=x0 from n=K1 to n=K2.

For the full trajectory (from n=0 to n=K2), use K1=0. Try:

*Orb([5/2*x*(1-x)],[x], [0.5], 1000,1010);*

*Orb([(1+x+y)/(2+x+y),(6+x+y)/(2+4*x+5*y),[x,y], [2.,3.], 1000,1010);* **(6)**

```
> F := (x+1)/(x+2)
```

$$F := \frac{x+1}{x+2} \tag{7}$$

```
> Orb([(x+1)/(x+2)], [x], [0.5], 1000, 1010)
```

$$[[0.6180339888], [0.6180339888], [0.6180339888], [0.6180339888], [0.6180339888], [0.6180339888], [0.6180339888], [0.6180339888], [0.6180339888], [0.6180339888]] \tag{8}$$

```
> evalf(solve(x = F, x))
```

$$0.6180339880,\ -1.618033988 \tag{9}$$

```
> diff(F, x)
```

$$\frac{1}{x+2} - \frac{x+1}{(x+2)^2} \tag{10}$$

```
> subs(x = 0.618, %)
```

$$0.1459018221 \tag{11}$$

```
> #5ii)
> F := 5/2·x·(1 - x)
```

$$F := \frac{5\,x\,(1-x)}{2} \tag{12}$$

```
> Orb([F], [x], [0.5], 1000, 1010)
```

$$[[0.6000000000], [0.6000000000], [0.6000000000], [0.6000000000], [0.6000000000], [0.6000000000], [0.6000000000], [0.6000000000], [0.6000000000], [0.6000000000]] \quad (13)$$

> $evalf(solve(x = F, x))$

$$0., 0.6000000000 \quad (14)$$

> $diff(F, x)$

$$\frac{5}{2} - 5x \quad (15)$$

> $subs(x = 0.6, \%)$

$$-0.500000000 \quad (16)$$

> *#5iii)*

> $F := \frac{7}{2} \cdot x \cdot (1 - x)$

$$F := \frac{7x(1-x)}{2} \quad (17)$$

> $Orb([F], [x], [0.5], 1000, 1010)$

$$[[0.5008842111], [0.8749972637], [0.3828196827], [0.8269407062], [0.5008842111], [0.8749972637], [0.3828196827], [0.8269407062], [0.5008842111], [0.8749972637], [0.3828196827]] \quad (18)$$

> $evalf(solve(x = F, x))$

$$0., 0.7142857143 \quad (19)$$

> $diff(F, x)$

$$\frac{7}{2} - 7x \quad (20)$$

> $subs(x = 0.7142857143, \%)$

$$-1.500000000 \quad (21)$$

>