How to solve a differential equation, when dsolve doesn't work.

Predator-prey model

```
> dsolve( {diff(x(t),t) = x(t) -0.4*x(t)*y(t),
           diff(y(t),t) = 0.5*x(t)*y(t)-0.1*y(t) }, {x(t),y(t)});
```

$$\left[\{y(t)=0\},\ \{x(t)=\_C1\,e^{t}\}\right],\left[\left\{y(t)=RootOf\left(-\left(\int^{\_Z}\frac{10}{\_a\left(\ln\left(-\text{LambertW}\left(-\frac{e^{-1}\left(e^{-\_a}\right)^{4}\left(e^{-\_C1}\right)^{2}}{\_a^{10}}\right)\right)-4\,\_a+10\ln(\_a)-2\,\_C1\right)}\,d\_a\right)+t+\_C2\right)\right\},\left\{x(t)=\frac{1}{5}\,\frac{10\left(\frac{d}{dt}y(t)\right)+y(t)}{y(t)}\right\}\right] \quad (1)$$

```
> # Now, find an approximate solution instead
  restart:
  read("d:/475/RungeKutta.mpl"):

> # To apply the program, prepare input
  f := Vector(2):  # the RHS functions
  f[1] := (t,x,y) -> x - 0.1*x*y:
  f[2] := (t,x,y) -> 0.02*x*y-0.5*y:
> f;
```

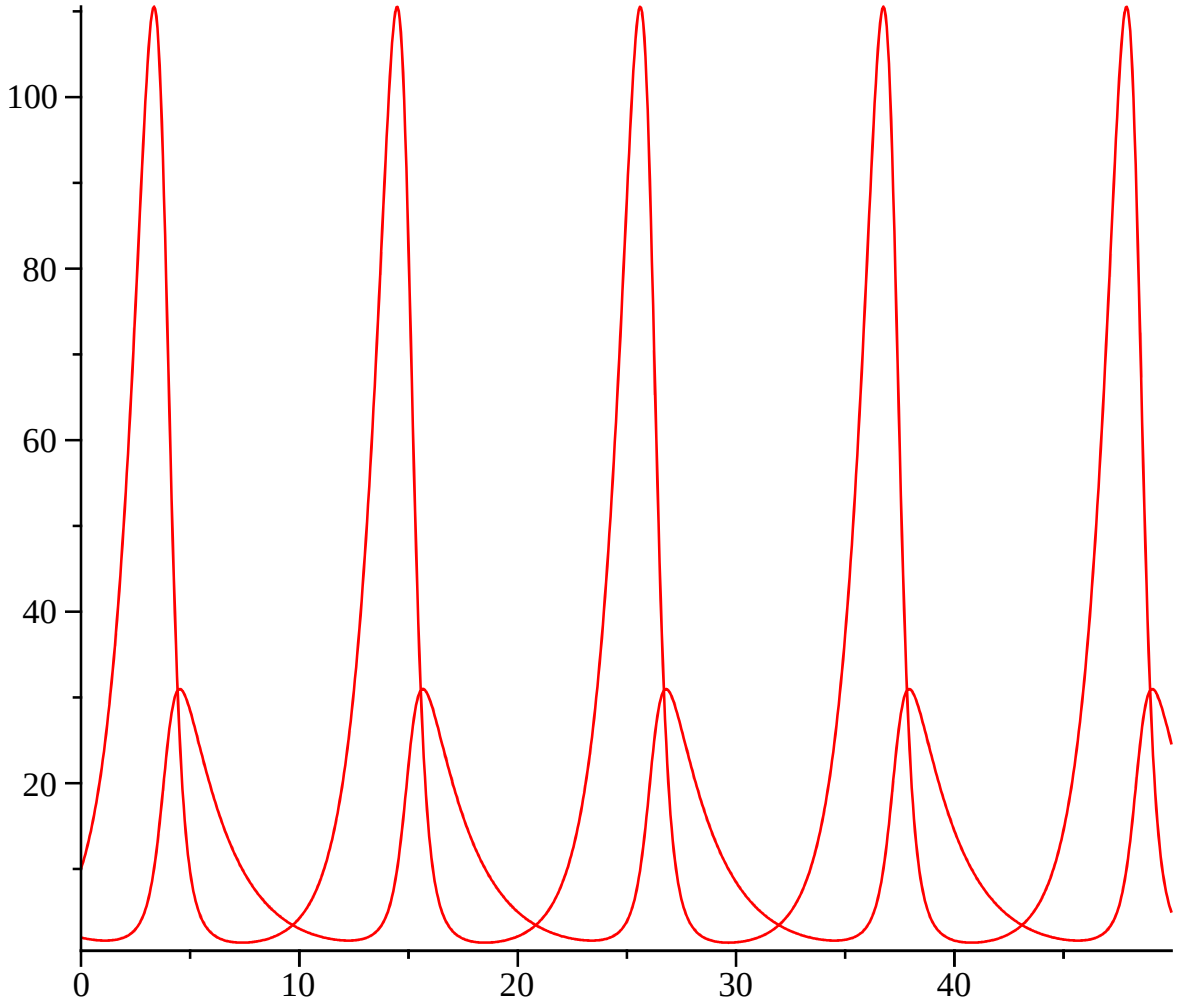
$$\begin{bmatrix}(t,x,y)\rightarrow x-0.1\,x\,y\\(t,x,y)\rightarrow 0.02\,x\,y-0.5\,y\end{bmatrix} \quad (2)$$

```
> a, b := 0, 50:    # the time interval
> c := Vector([10,2]):  # initial values
> m := 1000:
> t, y := RungeKutta(f,a,b,c,m);
```

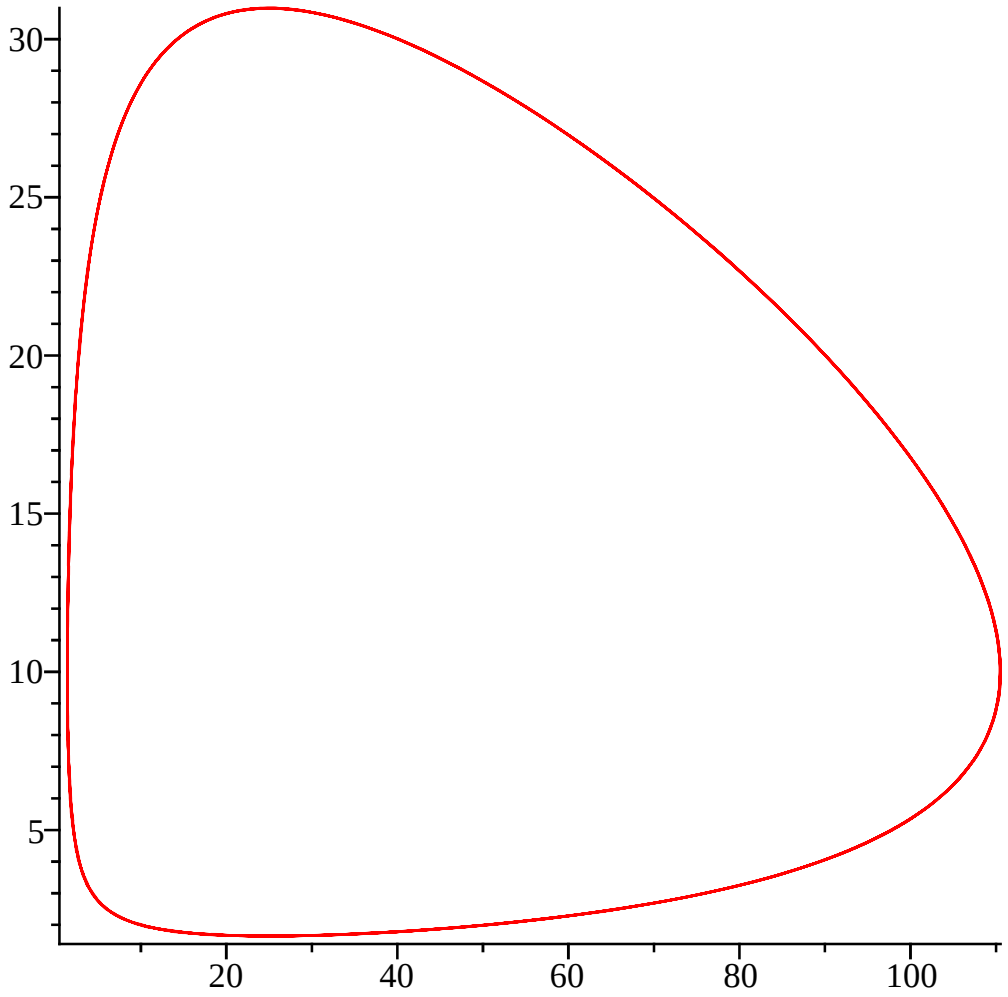
(3)

$$t, y := \begin{bmatrix} 1 .. 1001\ Vector_{column} \\ Data\ Type: anything \\ Storage: rectangular \\ Order: Fortran\_order \end{bmatrix}, x \qquad \textbf{(3)}$$

```
> plot1 := plot( [seq([t[k],y[1][k]],k=1..m)]  ):
> plot2 := plot( [seq([t[k],y[2][k]],k=1..m)]  ):
> plots[display]({plot1,plot2});
```



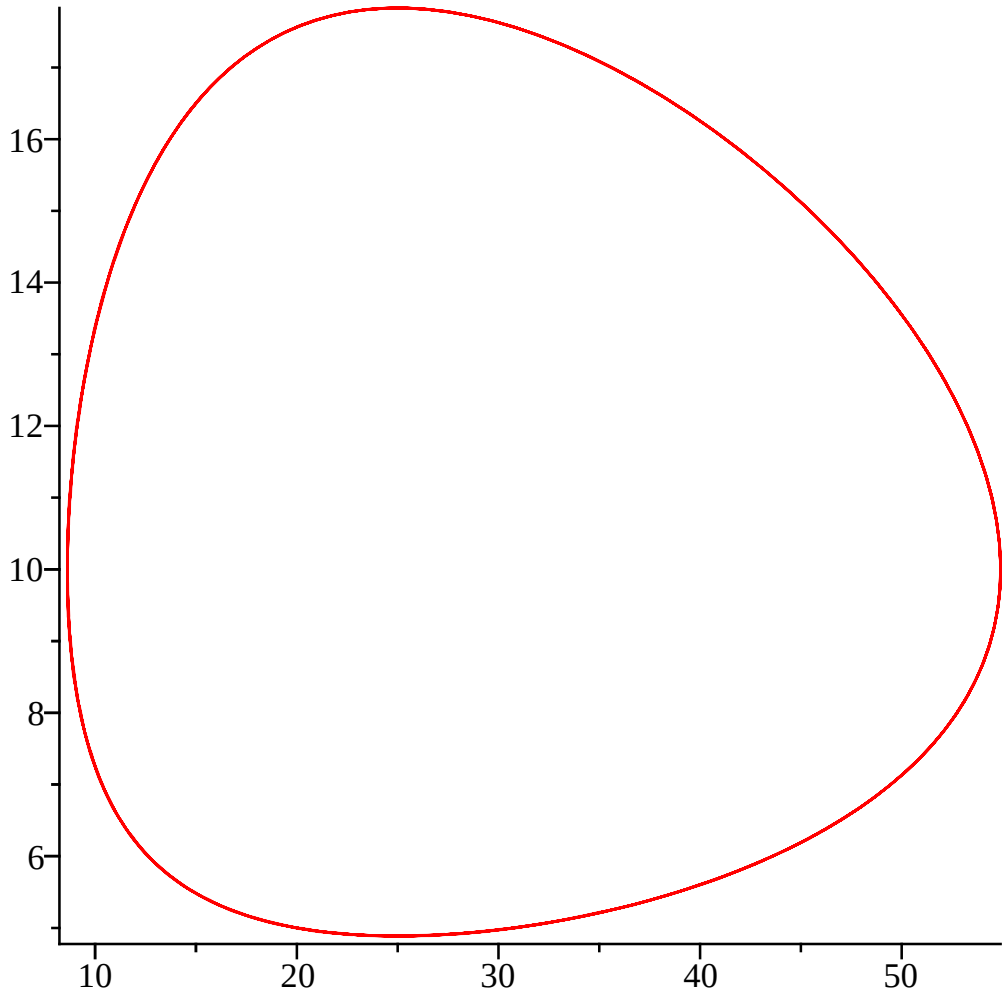

```
> plot( [seq([y[1][k],y[2][k]],k=1..m)]  );
```



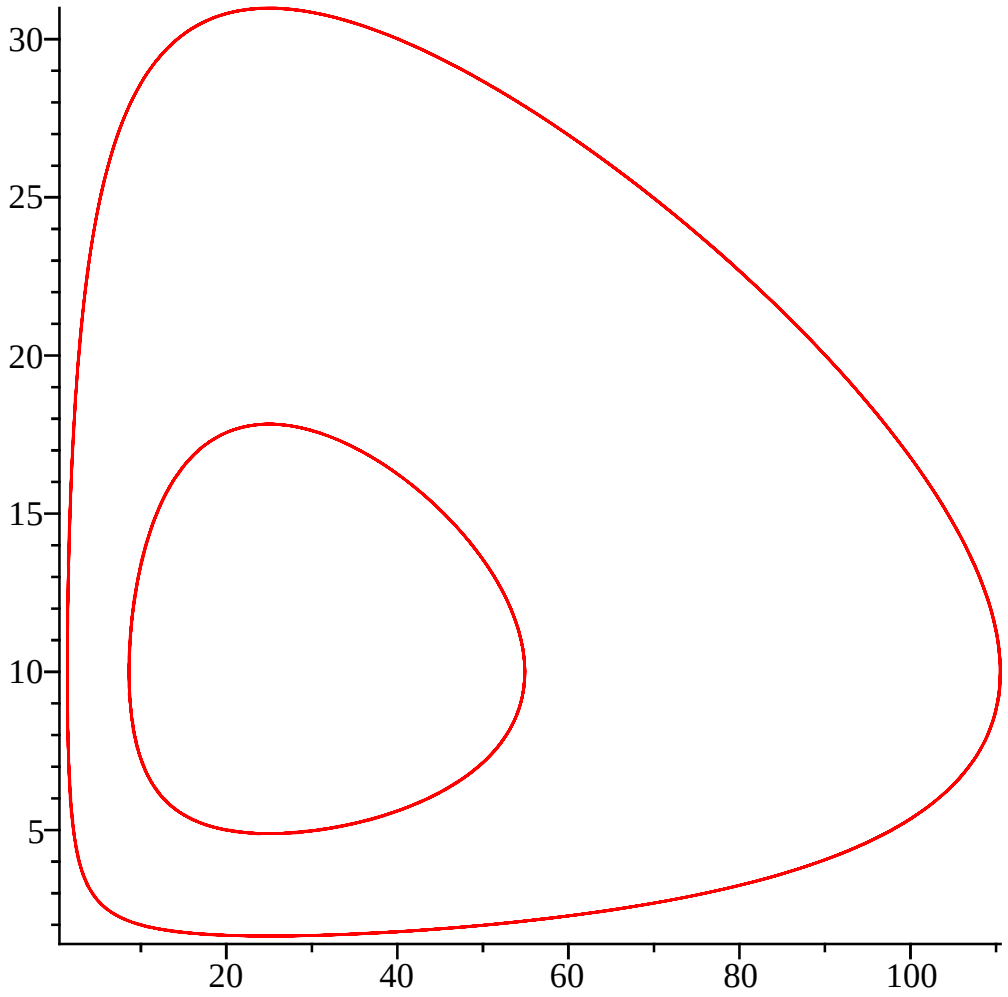

```
> c1 := Vector([20,5]):
> t, z := RungeKutta(f,a,b,c1,m);
```

$$t, z := \left[\begin{array}{c} 1 \,..\, 1001\ Vector_{column} \\ Data\ Type: anything \\ Storage: rectangular \\ Order: Fortran\_order \end{array} \right], x \qquad \textbf{(4)}$$

```
> plot( [seq([z[1][k],z[2][k]],k=1..m)]  );
```




```
> p1 := plot( [seq([y[1][k],y[2][k]],k=1..m)]  ):
  p2 := plot( [seq([z[1][k],z[2][k]],k=1..m)]  ):
  plots[display]({p1,p2});
```




```
> # To find the fixed point
  solve( {f[1](s,u,v)=0, f[2](s,u,v)=0}, {u,v});
```

$$\{u = 0., v = 0.\}, \{u = 25., v = 10.\} \quad \textbf{(5)}$$

```
>
```

Project:

Project 5.8, part 1
Project 5.9, part 1