Introduction to MATLAB

11: Solving DEs in MATLAB

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Solving ODEs with MATLAB

ode23

ode45

ode113

ode15s

ode23s

ode23t

ode23tb

doc ode23

ode45

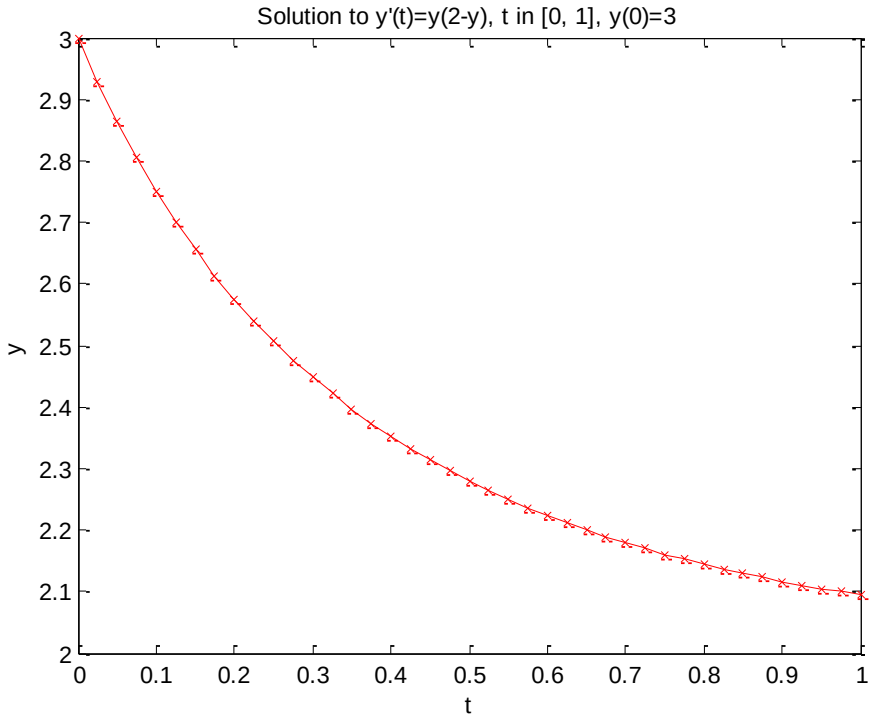
[t_out,y_out] = ode45(odefun, t_span, y0)

$$\begin{cases} y'(t) = f(t, y(t)) \\ y(t_0) = y_0 \end{cases}$$

Example 1

$$\begin{cases} y'(t) = y(2-y) \quad , \quad 0 \le t \le 1 \\ y(0) = 3 \end{cases}$$

```
>> f = @(t,y) y.*(2-y);
>> [t,y]=ode45(f,[0,1],3);
>> plot(t,y,'-rx')
>> xlabel('t')
>> ylabel('y')
```



ode45 works for systems of ODEs!

$$\begin{cases} x_1'(t) = -\frac{8}{3}x_1(t) + x_2(t)x_3(t) \\ x_2'(t) = -10x_2(t) + 10x_3(t) \\ x_3'(t) = -x_2(t)x_1(t) + 28x_2(t) - x_3(t) \\ x_1(0) = 20, x_2(0) = 5, x_3(0) = -5 \end{cases}$$

$$\begin{bmatrix} x_1'(t) \\ x_2'(t) \\ x_3'(t) \end{bmatrix} = \begin{bmatrix} -\frac{8}{3} & 0 & x_2(t) \\ 0 & -10 & 10 \\ -x_2(t) & 28 & -1 \end{bmatrix} \begin{bmatrix} x_1(t) \\ x_2(t) \\ x_3(t) \end{bmatrix} \Leftrightarrow \frac{d}{dt}\left(\vec{x}(t)\right) = \underbrace{\begin{bmatrix} -\frac{8}{3} & 0 & x_2(t) \\ 0 & -10 & 10 \\ -x_2(t) & 28 & -1 \end{bmatrix}}\vec{x}(t)$$

$$\vec{x}(0) = [20, 5, -5]$$

ode45 is used using matrices and vectors….

Solving PDEs with MATLAB: pdepe

```
>> help pdepe
 pdepe  Solve initial-boundary value problems for parabolic-elliptic PDEs in 1-D.
    SOL = pdepe(M,PDEFUN,ICFUN,BCFUN,XMESH,TSPAN) solves initial-boundary
    value problems for small systems of parabolic and elliptic PDEs in one
    space variable x and time t to modest accuracy. There are npde unknown
    solution components that satisfy a system of npde equations of the form

    c(x,t,u,Du/Dx) * Du/Dt = x^(-m) * D(x^m * f(x,t,u,Du/Dx))/Dx + s(x,t,u,Du/Dx)

    Here f(x,t,u,Du/Dx) is a flux and s(x,t,u,Du/Dx) is a source term. m must
    be 0, 1, or 2, corresponding to slab, cylindrical, or spherical symmetry,
```

pdepe can also be used to solve a system of PDEs!

Thank you!!