

XPP Tutorial

XPP (XPPAUT) is a tool for solving

- differential equations,
- difference equations,
- delay equations,
- functional equations,
- boundary value problems,
- stochastic equations,

and provides a user-friendly front-end for the popular bifurcation program, AUTO¹.

The (free) XPP software and an online tutorial may be found at

<http://www.math.pitt.edu/~bard/xpp/xpp.html>

Pendulum example

$$\ddot{x} + g\dot{x} + x = 0$$

```
par g=0
```

```
x'=v
```

```
v'=-g*v-x
```

```
aux E=0.5*(x^2+v^2)
```

```
@ meth=rungekutta,dt=0.01,total=10,maxstore=100000
```

```
@ xp=x,xlo=-1,xhi=1,yp=v,ylo=-1,yhi=1
```

```
done
```

¹<http://indy.cs.concordia.ca/auto/>

FitzHugh Nagumo example

$$\mu \dot{v} = f(v) - w + J, \quad \dot{w} = v - bw, \quad f(v) = v(v - a)(1 - v)$$

```
par J=0.5,mu=0.01,b=0.5,a=0.1
```

```
v(0)=0
```

```
w(0)=0
```

```
f(x)=x*(x-a)*(1-x)
```

```
v'=1.0/mu*(f(v) - w + J)
```

```
w'=v-b*w
```

```
@ meth=cvode,dt=0.001,total=5,maxstore=10000000,bounds=1000
```

```
@ xp=v,xlo=-.75,xhi=1.5,yp=w,ylo=0,yhi=1,nmesh=100
```

```
done
```

Bliss-Painter-Marr oscillator model

$$\dot{y}_1 = \frac{a}{1 + y_3} - by_1, \quad \dot{y}_2 = b(y_1 - y_2), \quad \dot{y}_3 = by_2 - \frac{cy_3}{1 + y_3}$$

```
par a=150,b=0.2,c=15
```

```
y1(0)=68.182
```

```
y2(0)=68.182
```

```
y3(0)=10
```

```
y1'=a/(1+y3)-b*y1
```

```
y2'=b*(y1-y2)
```

```
y3'=b*y2-c*y3/(1+y3)
```

```
@ meth=rungekutta,dt=0.01,total=100,maxstore=100000,bounds=1000000
```

```
@ xp=y1,xlo=0,xhi=200,yp=y2,ylo=0,yhi=120
```

```
done
```

Delayed feedback

$$\dot{x} = -x + f(ax - bx(t - \tau) + p), \quad f(x) = \frac{1}{1 + e^{-x}}$$

```
par tau=0,b=4.8,a=4,p=-.8
```

```
x(0)=1.0
```

```
f(x)=1.0/(1.0+exp(-x))
```

```
x'=-x+f(a*x-b*delay(x,tau)+p)
```

```
@ delay=11
```

```
done
```