LVE.ode Example

Plotting Solutions

- 1. Start Xming
- 2. drag and drop LVE.ode onto XPP-shortcut on desktop
- 3. Open Params and ICs
- 4. Initialconds > Go
- 5. Viewaxes>2D set parameters:

	X 2D View
*X-axis:T	Xmax:200
*Y-axis:X	Ymax:1.0
Xmin:0	Klabel:time
Ymin:0	Ylabel:x

- 6. nUmerics >Total > change from 20 to 200> enter >esc
- 7. Initial conds > Go (can just type $I \rightarrow G$).

	X Parameters		000		X XPP Ver 7.0 >	> LVE.ode		
Close Ok	Default Cancel	60	ICs BCs	Delay Param Eqns	Data			
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К	0.25		plmerics					
			File	0.6				11
			Parameters					
			Erase					
			Makewindow	0.4				
			Text,etc					
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		\square				time		
			Par/Var?		Par/Var?	P	ar/Var?	
				90				90

8. In Parameters window change K to 0.5 and hit Go button, change K to 0.75 and hit Go button.



Phase Plane

- 9. Makewindow
- 10. Click on new window, then go to Viewaxes >2D and set parameters:

	2D View
*X-axis:X	Xmax:1
*Y-axis‡Y	Ymax:1
Xmin:0	Xlabel:×
Ymin:0	Ylabel:g
_Ok	Lancel

- 11. Dir.field/flow> Direction field> grid set to 10 > enter.
- 12. Nullcline > New
- 13. Intialconds > mIce, click on points to see trajectories



Stability

- 14. Back to main window time plot, Erase
- 15. Set K back to 0.25, $I \rightarrow G$.
- 16. Get Initial Data to the equilibrium point: $I \rightarrow L$, $I \rightarrow L$
- 17. Sing. Pts > Go. Print eigenvalues Yes, Draw Strong Sets No.



- 18. See this is stable and eigenvalues have negative real parts, zero im parts.
- 19. Change K to 0.5 and repeat steps 16 and 17.

Close STABLE Import c+ = 0 c- = 2 im = 0	Eigenvalues: -0.458579 + i -0.143049 + i	0.000000 0.000000
r+=0 r-=0	Eigenvalues: -0.033148 + i	0.350815
X=0,16026	-0.033148 + i	-0.350815
Y=0.41815		

20. See this is stable and eigenvalues have negative real parts, nonzero im parts

21. Change K to 0.75 and recheck stability of current equilibrium.



22. See this is now unstable.

Bifurcation dynamics with AUTO

- 23. Before we go to AUTO to create a bifurcation diagram we have to be on a stable equilibrium value. Set K = 0.25, $I \rightarrow L$, $I \rightarrow L$.
- 24. File>Auto.
- 25. Parameter. Set K as Par1.
- 26. Axes> hI-lo (good for limit cycles), and set parameters up:

X Parameters
Ok Cancel

🛑 😑 🖂 X AutoPlot
*Y-axis:X
*Main Parm:K
*Secnd Parm:theta
Xmin:0
Ymin:0
Xmax:1
Ymax:2
Ok Cancel

27. Numerics, set the following parameters:



29. Grab the HB: Grab (click up arrow on keyboard and choose HB, enter) 30. Run>Periodic

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Close Parameter Axes Numerics Run Grab Usr period Clear	2					Used XPPAL Okay TrueC Eige -0.4 -0.1 Eige -0.0	13 constant IT 7.0 Copyr in make_eqn color visual envalues: 158579 + i 43049 + i envalues: 133148 + i	s and 114 symbo ight (C) 2002-n =1 no colormap 0.000000 0.000000 0.350815	ils iow Bard Ermen needed	trout		
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be plotted on the axes and what parameter(s) 31. Save data: File>Write points. 32. To close: File>Quit>Yes.

MorrisLecar.ode example

Plotting solutions

- 1. 1. drag and drop LVE.ode onto XPP-shortcut on desktop
- 2. Open Params and ICs
- 3. Viewaxes>2D set parameters so ymin= -80.
- 4. $I \rightarrow G$. Should already be at equilibrium.

Bifurcation dynamics with AUTO

- 5. File>Auto
- 6. Axes> hI-lo (good for limit cycles), and set parameters up
 - Y-axis: V
 - Main Parm: i
 - 2nd Parm: vl
 - Xmin: -10
 - Ymin: -80
 - Xmax: 250
 - Ymax: 120

e 😑 🔿 📉 AutoPlot
*Y-axis‡V
*Main Parm:i
*Secnd Parm:vl
Xmin:-10
Ymin:-80
Xmax:250
Ymax:120
Ok Cancel

- 7. Numerics, set the following parameters:
 - Ds: 0.02
 - Dsmin: 0.0001
 - Dsmax: 5
 - Par Min: -10
 - Par Max: 245
 - Norm Max: 1000

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Ntst:15	Dsmax:5
Nmax:200	Par Min:-10
NPr:50	Par Max:245
Ds:0.02	Norm Min:0
Dsmin:0.0001	Norm Max:1000
Ncol:4	EPSU:0.0001
EPSL:0.0001	EPSS:0.0001
Ok	Cancel

- 8. Run>Steady state.
- 9. Grab the HB: Grab (click up arrow on keyboard and choose HB, enter)
- 10. Run>Periodic



Notice how the unstable branch that emanates from the Hopf bifurcation bends to the left and thet the steady state solution loses stability to the right. If the direction of the bifurcating branch is opposite the direction at which stability of the main branch is lost, the branch is called **subcritical** and it is generally **unstable**. Note that there are two subcritical Hopf bifurcations; the second one is for a high current of about 220. (It is subcritical because the steady state branch loses the stability going *left* and the periodic branch goes *right*



11. See region of bistability: axes change y region to be (90, 110). Redraw.

viralBlips.ode

