

**Math 430 and Math 635: Analytical and Computational
Neuroscience
Fall 2001, Prof. V. Booth
Homework 5, Due Wednesday, Nov 7, 2001**

Construct the bifurcation diagram of stable and unstable solutions of the Morris-Lecar model for values of I_{app} between 0 and $250 \mu\text{A}/\text{cm}^2$. Use the XPP file *morrislecar.ode* available on the course webpage. Change I_{app} in the model by varying the parameter *basei* in XPP. In the bifurcation diagram, plot the value of voltage V at steady equilibrium solutions (y-axis) vs. the value of I_{app} (x-axis). To represent stable repetitive (periodic) spiking, plot the max V value and min V value of the spike at the appropriate I_{app} level.

Find all stable solutions by integrating until V reaches its equilibrium value or until repetitive spiking in V is periodic. Verify the stability or instability of equilibrium solutions by clicking “Sing Pts” and “Go” and checking the computed eigenvalues of the Jacobian matrix. Determine the two Hopf bifurcation points where there is a change in stability of the equilibrium solutions.

Determine the region of bistability (range of I_{app} values) where both a steady equilibrium solution and a repetitive spiking solution are stable. Remember that you can change the initial conditions to be on a stable solution by clicking “Initial Conds” and “Last”. Or in a phase plane w vs. V window, you can choose initial conditions with the mouse by clicking “Initial Conds” and “Mouse”.

Find all unstable solutions by integrating backwards in time (click “Numerics” and “Dt” and change the value to its negative). For the system to be attracted to an unstable solution, you may have to choose initial conditions to be near the unstable solution.

For each type of solution found, i.e. stable equilibrium solution, unstable equilibrium solution, stable periodic solution and unstable periodic solution, print out a phase plane plot showing the solution trajectory and the nullclines at that value of I_{app} . You can save a postscript file of the XPP graphing window by clicking “Graphic Stuff” and “Postscript” and following the prompts. The postscript file will be saved in your directory where XPP was initiated and then you can send that file to a printer.