

README file for CLUexercise 1

In this exercise, you are going to work with the AUTO program. This is a code for bifurcation analysis of ordinary differential equations.

A complete manual (auto.pdf) is in this directory; you will not need to read the manual for this exercise. This version of AUTO is written in FORTRAN, but you will not need to know anything about FORTRAN to go through the exercise.

In the directory there are two files:

4mode.f90:

This is the basic auto file containing the equations of the 4-mode model. You see them listed in the function 'func', with $\sigma = \text{par}(1)$.

In subroutine 'stpnt' you see the starting point of both the parameter and the state vector. You will not need to modify this file.

c.4mode:

This is the control file, telling AUTO what to do with the equations.

You will only need to modify a few of these parameters, as will be explained below.

The file c.4mode is set-up for problem a. from the exercise. $\text{IPS} = 1$ means that steady state computation versus one parameter ($\text{NICP} = 1$) is done and bifurcations are detected. The control parameter $\text{ICP} = [1]$ ($\text{par}(1)$). You start from the state in `stpnt` ($\text{IRS} = 0$) and no saddle-node bifurcations will be detected ($\text{ILP} = 0$). $\text{NMX} = 100$ steps will be performed with $\text{DS} = 0.1$.

You run AUTO by typing:

```
@r 4mode
```

On the screen, auto will show only special points (starting point, bifurcation point BP, Hopf bifurcation points HB, saddle-node bifurcation

LP, and endpoint EP). Each of these points gets a label IRS. The solutions at these labelled points can be used for restarts of AUTO (with the specified IRS in c.4mode).

AUTO produces three files as output:

fort.7: contains the bifurcation diagram (solution components versus parameter)

fort.8: contains the full solutions at the labeled points
fort.9: contains information on the numerics

If a run is successful, you can append the results to those already computed by typing

@ap 4mode

fort.7 will be appended to b.4mode
fort.8 will be appended to s.4mode
fort.9 will be appended to d.4mode

At question e), you will need to compute branches of periodic solutions. Thereto

- change IPS = 2
- change IRS = the label of a HB
- change ICP = [1, 11] (this is the period of the orbits)

You can plot bifurcation diagrams by stripping fort.7 and using your favourite plotting program on your laptop. Alternatively, you can use the plotting program PLAUT. To plot the results in fort.7 and fort.8, type.

@p

If you want to plot everything in b.4mode and s.4mode, use

@p 4mode