Start Matlab and find the file ‘ODE_Interface.m’ (the path name will be given at the start of the practical) using the ‘Current Folder’ window in Matlab. Make sure you have selected the file with the .m extension not the .fig extension (both files are needed for this demo to run if you want to use them on your own computer). Right click on the file name and click ‘Run’. Select add to path in pop up window to get the program to run. You may need to wait a short while for the program to run. You should now have a figure window entitled ‘ODE_Interface’. The components are explained below.

1. Input the differential equations
   - The differential equations must be formatted so that the x variable is always called x and the y variable y e.g. if you had an equation for the variables F and R you need to rename the variable x and y before inputting into the interface
   - Equations are entered using standard Matlab syntax i.e. \( 3 \times x \) not \( 3x \)

2. Pull down list of equilibrium points
   - When you have entered a pair of differential equations and pressed the COMPUTE button the program will calculate the location of any equilibrium points. If there are two or more equilibrium points you will need to click on \( \text{equilibrium points} \) to see all the points and select one from the list.

3. Click to add an initial condition using the cursor
4. Click to refresh calculations if you change any values in white boxes

5. Stability of selected equilibrium point
6. List of initial conditions
7. Duration over which to calculate trajectory for given initial conditions

8. Plot of x and y against time \( or \) x vs t \( or \) y vs t for selected initial condition
9. Select plot axis and initial condition
10. Increase this value to decrease spacing between arrows
11. Phase portrait and direction field
12. Plot range – can be adjusted manually
13. Nullclines x-nullcline is red and y-nullcline is blue
14. Trajectory starting at \((-6,9)\)

More details on each component of the interface are given below if required.

1. **Input the differential equations**
   - The differential equations must be formatted so that the x variable is always called x and the y variable y e.g. if you had an equation for the variables F and R you need to rename the variable x and y before inputting into the interface
   - Equations are entered using standard Matlab syntax i.e. \( 3 \times x \) not \( 3x \)

2. **Pull down list of equilibrium points**
   - When you have entered a pair of differential equations and pressed the COMPUTE button the program will calculate the location of any equilibrium points. If there are two or more equilibrium points you will need to click on \( \text{equilibrium points} \) to see all the points and select one from the list.

NEED HELP? ASK A DEMONSTRATOR!
3. **Click to add an initial condition**
   - Initial conditions can be added by clicking on this button which will give you a cursor you can drag to the desired initial position on the phase-plane. This will add a new row to the initial states table showing the exact value of your selected initial condition.

4. **Click to refresh calculations**
   - If you change any of the values in the white boxes, including the differential equations, or in the initial states table you may need to click on this button to re-run the program and for the changes to take effect.

5. **Stability of selected equilibrium point**
   - If there is more than one equilibrium point you can use the pull down list (see (2)) to select each equilibrium point in turn – the information on the stability of that equilibrium point will then be displayed in the grey area.

6. **List of initial conditions**
   - Each time you press the initial condition button and use the cursor to create an initial condition it will be added to this table.
   - NOTE: you can manually change the values of these initial conditions by selecting with the mouse and entering a new value – you will need to press the COMPUTE button to activate your changes.
   - To delete an initial conditions manually delete x and y values from the list – this will produce a NaN and next time you press COMPUTE will clear this row from the list.

7. **Duration over which to calculate the trajectory for given initial conditions**
   - This is the time over which you want to solve the system of differential equations.
   - If you make this value TOO SMALL your trajectory maybe very short.
   - If you make this value TOO BIG you may cause Matlab to hang as you are asking it to carry out a very large calculation.
   - If you set this value to 0 then you will not see any trajectories – you will see an error message in a separate window – just press OK to remove this window.
   - If you change this value you need to press the COMPUTE button to get Matlab to recalculate the solution to the differential equation for all initial conditions in the table – if you have lots of initial conditions this may take a while so be patient.

8. **Plot of x and y against time or x versus y or y versus t for selected initial condition**
   - This graph allows you to look at the trajectories for a given initial condition against time.

9. **Select plot axis and initial condition**
   - Here you have a choice of four types of plot to view in the bottom right hand corner of the interface – the plot will only been drawn for the selected initial condition.
   - Remember to select the initial condition you are interested in – only one trajectory can be plotted on this graph at a time.

10. **Divisions: increase this value to decrease spacing between arrows**
    - Try increasing this value by 10 – what happens to the direction field? Remember to press the COMPUTE button to see the effect.

11. **Phase portrait and direction field**
    - This is phase portrait for the given set of differential equations.

12. **Adjusting plot range manually**
    - If you want to zoom in on a particular region of the plot or zoom out you can change the values in the boxes at either end of the axes – remember to press the COMPUTE button.

13. **Plot of null-clines**
    - The interface automatically plots the null-clines for you.

14. **Plot of trajectory for a given initial condition**
    - Each time you press COMPUTE the interface will re-plot all trajectories. If you cannot see any trajectories check that:
      i. T-final > 0 (see point 7);
      ii. Your initial condition does not start at the equilibrium point.
      iii. Your initial condition is within the plot range.

**NEED HELP? ASK A DEMONSTRATOR!**