# Comments on Project 1 - Direction fields and Solution Curves

Some general comments on reading IODE project 1. *Experiment more*! Relate the ODE to the direction field and behavior of the solution curves!

(1) SCALES: This is marked by a **circle S** on your papers if there is a problem. Adjust the $x$ and $y$ scales as needed to capture all the behavior of the ODE. Many people did not do this for problems 3 and 4 and therefore did not see the full behavior of the solutions. For $f(x, y) = 2x(A - x)$, the $x$-axis must be large enough to contain 0 and $A$. Similarly, for the next ODE $f(x, y) = y(B - y)$, the $y$-axis must contain 0 and $B$.

(2) INITIAL CONDITIONS: This is marked by a **circle I** on your papers if there is a problem. Many people did not think about their initial conditions. You want to choose $(x_0, y_0)$ so that a characteristic solution curve is show. For example, some people took $y_0 = 0$ for $y' = ky$. Of course the solution is $y(x) = C_0 e^{kx}$ so we must have $C_0 = 0$. This is not interesting! Instead of just clicking on the Iode plot, you should choose one or two initial conditions. In the case of changing the sign of a constant in the direction field to see what happens, you should think of using similar initial conditions so a comparison can be made. Finally, with reference to the fourth direction field, there are various regimes depending on the initial condition. You should explore all areas of the $x - y$ plane and see how different solution curves behave.

(3) CHOICE OF STEP SIZE $h$: As the direction field becomes more complicated, one should vary $h$ and take it small. This will smooth out the kinks that might be found in the solution curves. This is especially important in later labs.

(4) NUMBER OF LINE SEGMENTS: You can also change the number of line segments show for the direction field in the horizontal and vertical directions.

(5) RELATION TO THE EXACT SOLUTIONS: In the four cases, the ODEs can be solved exactly. Not very many people did this. Why does the solution curve of $y' = 2x(A-x)$ look cubic? Because the solution is $y(x) = Ax^2 - (2/3)x^3 + C$. How about ODE 4? Is is similar to the logistic ODE we studied in section 2.5. Look there and see that the graphs are similar. The exact solution is given on page 82.

(6) ZEROS: The direction fields in these problems have zeros. How do these show up on the plot of the direction fields and the solution curves? Can you see them? Note that in (3.2) and (3.4) the zeros do not correspond to equilibrium solutions. When $f$ is independent of $x$, as in (3.1) and (3.3), then the zeros of $f$ correspond to equilibrium solutions. In (3.4), the line $y = -Cx$ is where the tangent line to a solution curve crossing this line has zero slope.

(7) EXPERIMENT: You want to make sure that you understand how the solution is behaving in all parts of the $x - y$ plane.