

### Direction fields

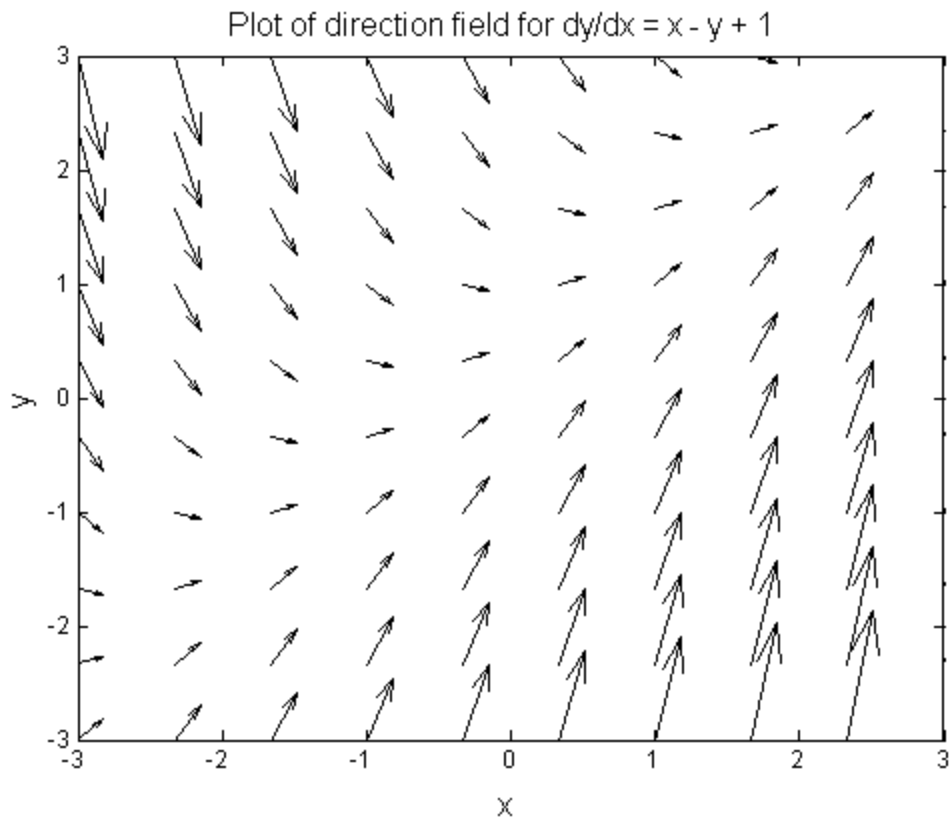
In your first problem set, you were asked to plot the direction field for

$$y' = x - y + 1$$

This can be accomplished by creating the meshgrid, and then using the `*quiver(X, Y, U, V, sc)*` command. At each of the  $m \times n$  points in the meshgrids  $X$  and  $Y$ , `*quiver*` plots the vectors whose  $x$  and  $y$  components are given by  $U$  and  $V$ . The extra argument,  $sc$ , is a numerical value which multiplies the length (over their automatically determined length) of the arrows by  $sc$ .

```
n = 10; m = 10;
x = linspace(-3, 3, n);
y = linspace(-3, 3, m);
[X, Y] = meshgrid(x, y);

quiver(X, Y, ones(m, n), X - Y + 1, 1.5);
axis([-3 3 -3 3]);
xlabel('x', 'FontSize', 16);
ylabel('y', 'FontSize', 16);
title('Plot of direction field for  $dy/dx = x - y + 1$ ', 'FontSize', 16);
```



### Phase plots

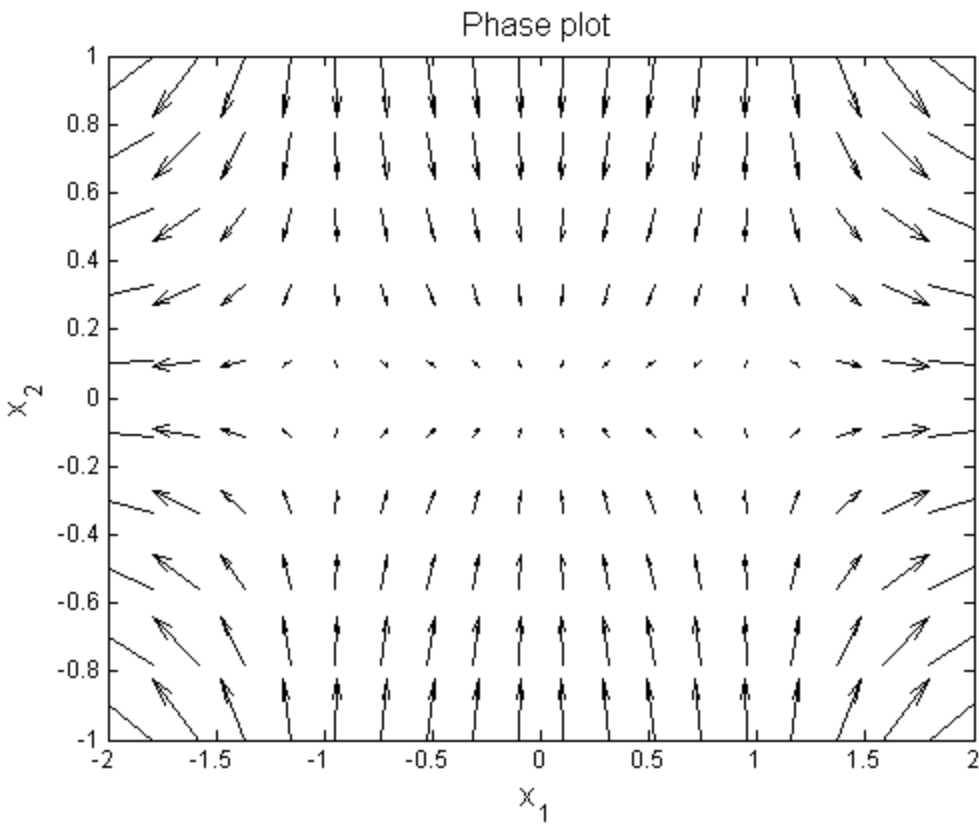
We can also use **quiver** to draw phase plots. As an example, consider

$$x_1' = -x_1 + x_1^3$$

$$x_2' = -2x_2$$

```
x1 = linspace(-2, 2, 20);
x2 = linspace(-1, 1, 10);
[X1,X2] = meshgrid(x1, x2);

quiver(X1, X2, -X1 + X1.^3, -2*X2, 2);
axis([-2 2 -1 1]);
xlabel('x_1', 'FontSize', 16);
ylabel('x_2', 'FontSize', 16);
title('Phase plot', 'FontSize', 16);
```



### DFIELD & PPIANE

John Polking (Rice U.) has written a Matlab program which can create direction fields and phase planes within a graphical user interface (GUI). It can be downloaded from <http://math.rice.edu/~dfield/>

Save the dfield and pplane .m files in a directory on your computer, and simply type 'dfield' or 'pplane' to run the programs.