Nullclines for the two neuron system

$$\dot{v}_1 = -5v_1 + 17\tan^{-1}(v_1) - 13\tan^{-1}(v_2)$$
$$\dot{v}_2 = -v_2 + 4\tan^{-1}(v_1) - 5\tan^{-1}(v_2)$$

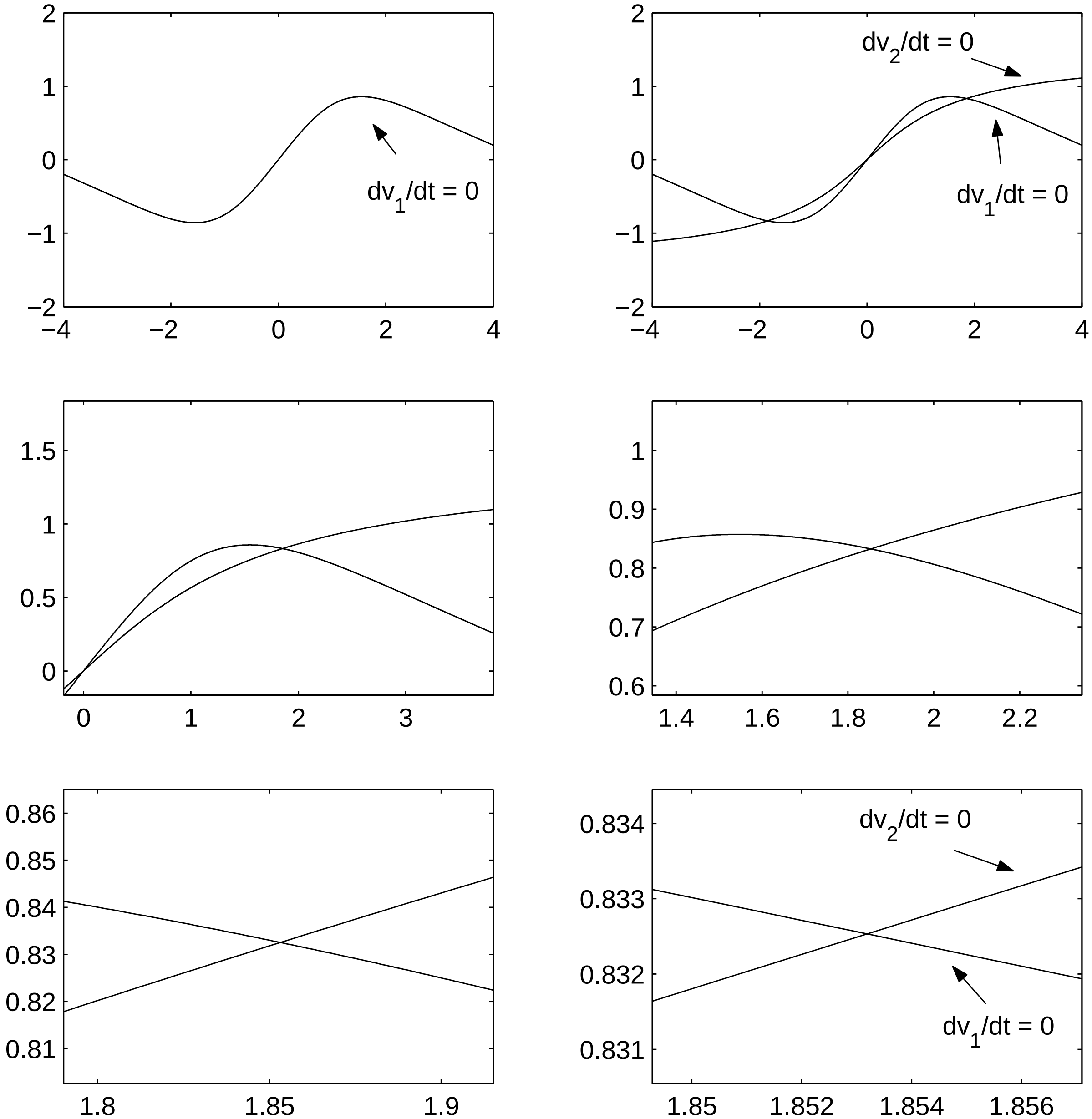

Figure 1: Nullclines for the two neuron system, showing (left-right, top-bottom) $\dot{v}_1 = 0$, then both $\dot{v}_1 = 0$ and $\dot{v}_2 = 0$ (the code for this is on the next page), and then a sequence of zooming in around the critical point near $(2, 1)$.

The following MATLAB commands produced the upper right graph on the previous page:

```
v1 = [-10:.001:10];                              % make v1 grid
atanv2 = (-5*v1+17*atan(v1))/13;                 % get atan(v2)
v2zero = tan(atanv2);                            % compute v2 on v1-nullcline
good1 = find(atanv2 > -pi/2 & atanv2 < pi/2);    % find indices where a solution exists
plot(v1(good1),v2zero(good1))                    % plot the nullcline

v2 = [-10:.001:10];                              % make v2 grid
atanv1 = (v2+5*atan(v2))/4;                      % get atan(v1)
v1zero = tan(atanv1);                            % compute v1 on v2-nullcline
good2 = find(atanv1 > -pi/2 & atanv1 < pi/2);    % find indices where a solution exists
hold on, plot(v1zero(good2),v2(good2)), hold off % plot the nullcline on the same graph

axis([-4 4 -2 2])                                % zoom to the region of interest
zoom on                                          % turn on manual zoom to look closer
```

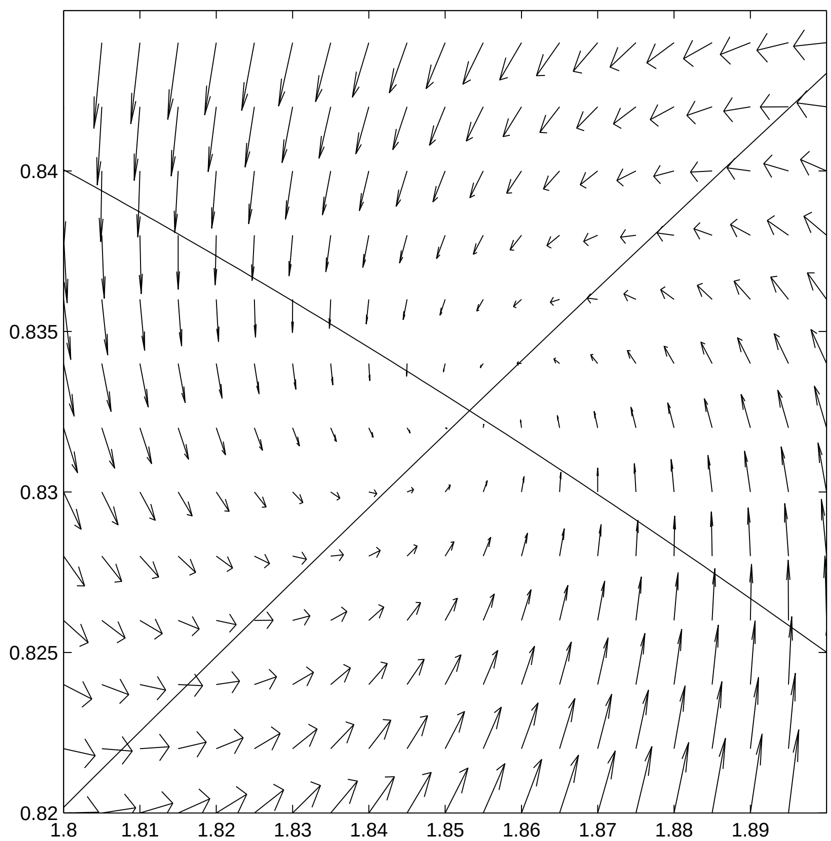

Figure 2: Phase plane for the two neuron at the critical point near $(2, 1)$. The two lines are the two nullclines. Note that it looks very similar to a linear system with a stable equilibrium point.

The above figure was created by first using the commands at the top of the page to make the nullclines and then using the following commands to draw the direction field and scale. The function `ODE2D_Quiver_Neuron.m` is on a handout from an earlier class.

```
hold on
ODE2D_Quiver_Neuron(1.8,.005,1.9,.82,.002,.845,17,-13,4,-5)
hold off
axis([1.8 1.9 .82 .845])
```