

## Linear Phase Portraits: Matrix Entry

Open up the applet Linear phase portraits: Matrix Entry. Unselect *companion matrix*. This enables you to enter values for  $a$ ,  $b$ ,  $c$ , and  $d$ , between  $-4$  and  $4$ . These numbers are the entries of the matrix  $A$  of a first order linear system, which you see on the left. You can also see some of the solution curves  $\mathbf{u}(t)$  in the  $xy$ -plane. If you click on a point in the plane, the curve through that point will appear.

Ignore all the other features of the applet for now; they will be used, and explained, later on.

1. Set the matrix to be  $\begin{pmatrix} 0.3 & 0.1 \\ 0.2 & 0.4 \end{pmatrix}$ . This corresponds to the system we looked earlier in this session in the note called *describing a first order system using matrix notation* (about farmers Jones and McGregor). Can you see the two rays that were described at the end of that section? What do the other curves look like? Do you notice anything about their behavior near zero? Examine the expression for the solution again, to see whether you can find an explanation for this.

2. Set the matrix to be  $\begin{pmatrix} 1 & 3 \\ 1 & -1 \end{pmatrix}$ . This corresponds to the system that we studied earlier in this session. What do the rays correspond to? What do the other curves look like? Examine the expression for the solution again. Why does one ray point towards zero, and one away from it?

By the end of session phase portrait, you should have a thorough understanding of the geometry of these examples. In the mean time, this applet will be a very important tool, notably for illustrations.

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