

PHASE PORTRAITS

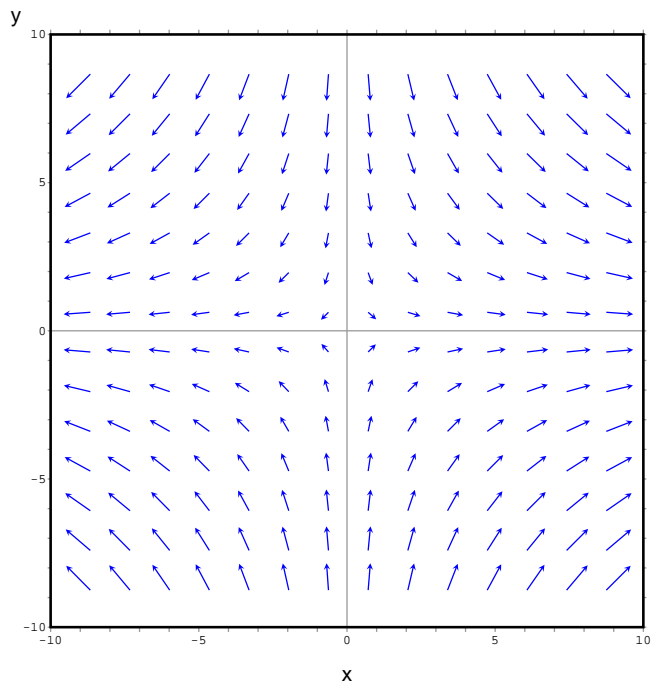
Direction fields in the phase plane for 2-dimensional linear systems $\dot{\mathbf{x}} = A\mathbf{x}$.

Phase portraits drawn using Maxima's `plotdf`. To plot the direction field for a matrix $A = \begin{pmatrix} a & b \\ c & d \end{pmatrix}$ together with a trajectory starting at (x_0, y_0) we need the command

```
plotdf([a*x+b*y,c*x+d*y],[x,y],[trajectory_at,x0,y0])$
```

...

The matrix $A = \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix}$ produces a “saddle”



...

...

to explore the “trace-determinant” plane we can plot the direction field corresponding to a matrix $A = \begin{pmatrix} s & -d \\ 1 & 0 \end{pmatrix}$, which has $\text{tr}A = s$ (s is from “spur” which is trace in German) and $\det A = d$, we can plot for example

```
plotdf([s*x-d*y,x],[x,y],[parameters,'s=1,d=0'],[trajectory_at,6,0])$
```

with different values of s and t (in this particular case $s = 2$ and $d = 0$) and a sample trajectory which at time $t = 0$ starts at $x_0 = 6$ and $y_0 = 0$

... here is the plot and one more nest to it

