

mk_VField Make Vector Field for plotting in 2D and in Prime 2

Arrowheads:

$$ah_std := (0 \ -1 + 0.25i \ 0 \ -1 - 0.25i)^T$$



$$ah_cls := (-1 \ -1 + 0.25i \ -1 - 0.25i \ 0 \ -1 + 0.25i)^T$$



$$ah_str := (0 \ -1 + 0.25i \ -1 - 0.25i \ 0)^T$$



Narrower heads

$$ah_std_narr := (0 \ -1 + 0.15i \ 0 \ -1 - 0.15i)^T$$



$$ah_cls_narr := (-1 \ -1 + 0.15i \ -1 - 0.15i \ 0 \ -1 + 0.15i)^T$$



$$ah_str_narr := (0 \ -1 + 0.15i \ -1 - 0.15i \ 0)^T$$



$$ah_test := \begin{cases} w \leftarrow 0.16 \\ \text{stack}\left(0, -1 + w \cdot j, -1 + \frac{w}{2} \cdot j, 0, -1, -1 - \frac{w}{2} \cdot j, 0, -1 - w \cdot j, -1 + w \cdot j\right) \end{cases}$$

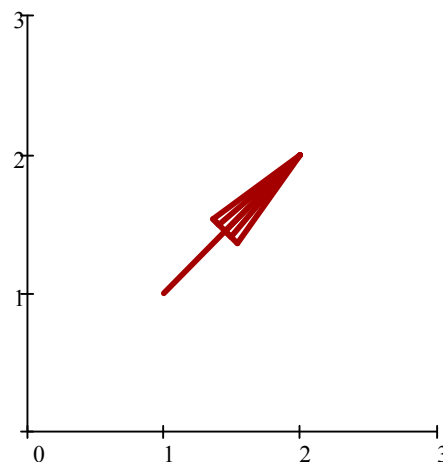
`_ah := ah_test`

`_length := 55%` 50% ... length of arrowhead is 50% of vector length

Method to draw arrows was posted once by Tom Gutman

$$_Vec(P, V) := \begin{cases} r \leftarrow \text{stack}(P, P2 \leftarrow P + V) \\ r \leftarrow \text{stack}[P, P2 + _ah \cdot ((V \cdot _length))] \text{ if } V \neq 0 \\ \text{return } \text{stack}(r, NaN) \end{cases}$$

TP := 1 + 1·j TV := 1 + 1·j



Line thickness and color can be adjusted using the usual 2D formatting menu.

Parameter M can be:

1. A matrix consisting of complex numbers, representing x and y components of the vectors. These vectors are related to the points represented by the matrix indices. That's the same behaviour as the Vector Field Plot in Mathcad 15.
2. A column or a row vector consisting of two matrices: the first consisting of the vectors represented by complex numbers as in 1. and the second consisting of the related points, also represented by complex numbers.

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mk_VField(M) := if IsArray(M_ORIGIN, ORIGIN)
                | M ← MT if cols(M) > 1
                | P ← MORIGIN+1
                | M ← MORIGIN
                otherwise
                | P ← M
                | for r ∈ ORIGIN.. ORIGIN + rows(M) - 1
                |   for c ∈ ORIGIN.. ORIGIN + cols(M) - 1
                |     Pr,c ← r + c·i
                R ← "dummy"
                for r ∈ ORIGIN.. ORIGIN + rows(M) - 1
                for c ∈ ORIGIN.. ORIGIN + cols(M) - 1
                R ← stack(R, _Vec(Pr,c, Mr,c))
                return submatrix(R, ORIGIN + 1, last(R), ORIGIN, ORIGIN)

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mk_VField Make Vector Field for plotting in 2D and in Prime 2

a := 0.3 b := 0.1 c := 0.1 d := 0.5 t_{end} := 50

Given

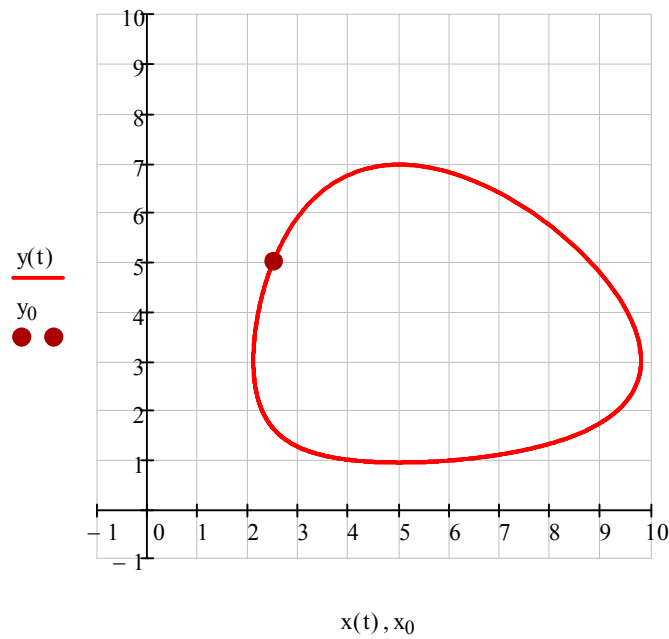
$$x'(t) = x(t) \cdot (a - b \cdot y(t)) \quad x(0) = x_0$$

$$y'(t) = y(t) \cdot (c \cdot x(t) - d) \quad y(0) = y_0$$

$$\text{ODE}(x_0, y_0) := \text{Odesolve} \left[\begin{pmatrix} x \\ y \end{pmatrix}, t, t_{\text{end}}, 10^4 \right]$$

$$\begin{pmatrix} x_0 \\ y_0 \end{pmatrix} := \begin{pmatrix} 2.5 \\ 5 \end{pmatrix} \quad \begin{pmatrix} x_0 \\ y_0 \end{pmatrix} := \begin{pmatrix} 8 \\ 6 \end{pmatrix} \quad \begin{pmatrix} x \\ y \end{pmatrix} := \text{ODE}(x_0, y_0)$$

$$t := 0, \frac{t_{\text{end}}}{1000} .. t_{\text{end}}$$



$$x'(t) = x(t) \cdot (a - b \cdot y(t))$$

$$y'(t) = y(t) \cdot (c \cdot x(t) - d)$$

$$\text{slope}(x, y) := x \cdot (a - b \cdot y) + j \cdot y \cdot (c \cdot x - d)$$

x range:

$$x_{\min} := 1 \quad x_{\max} := 13$$

Number of intervals in x-direction:

$$n_x := 18 \quad i_x := 0 .. n_x$$

y range:

$$y_{\min} := 0 \quad y_{\max} := 10$$

Number of intervals in y-direction:

$$n_y := 15 \quad i_y := 0 .. n_y$$

Create vector of points:

$$P_{i_x, i_y} := \left(x_{\min} + i_x \cdot \frac{x_{\max} - x_{\min}}{n_x} \right) + j \cdot \left(y_{\min} + i_y \cdot \frac{y_{\max} - y_{\min}}{n_y} \right)$$

Create vector of slopes:

$$S := \overrightarrow{\text{slope}(\text{Re}(P), \text{Im}(P))}$$

Scale the slope values:

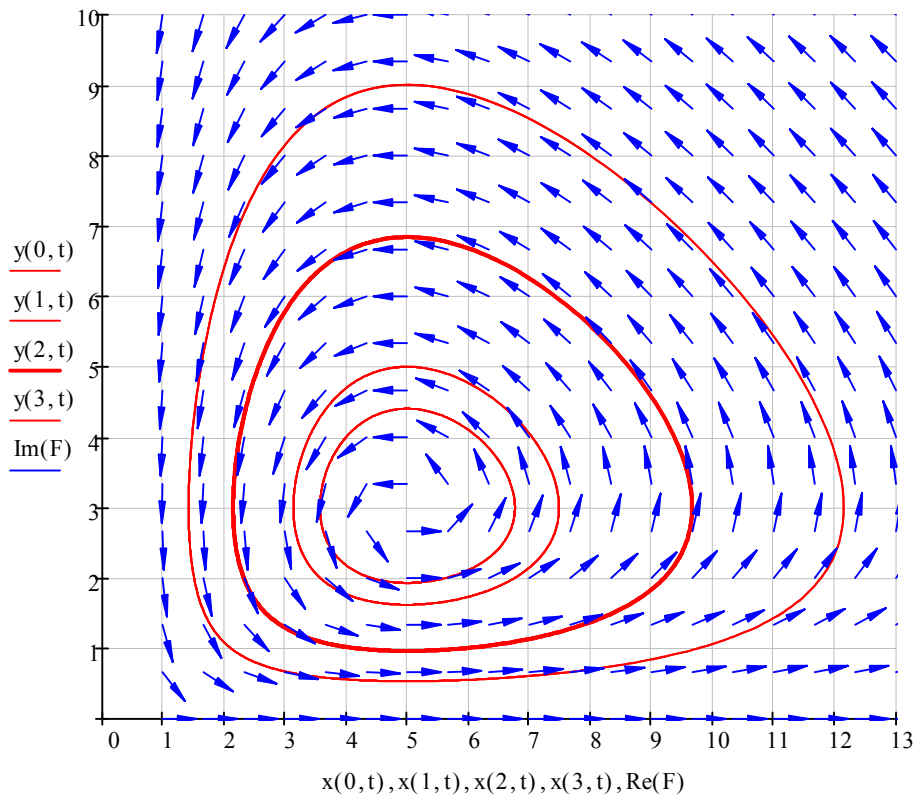
$$\text{scale}(s) := \text{if} \left(s \neq 0, \frac{s}{|s|}, 0 \right)$$

$$S := \overrightarrow{\text{scale}(S)} \cdot 0.55$$

$$F := \text{mk_VField} \left(\begin{pmatrix} S \\ P \end{pmatrix} \right)$$

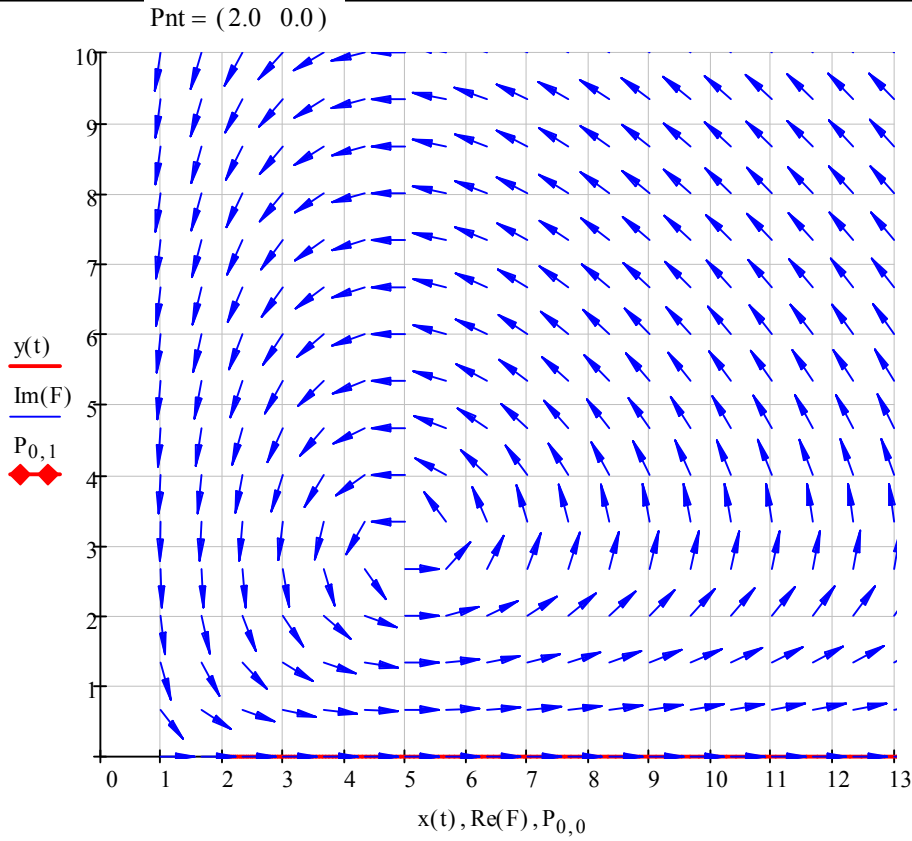
$$f(k) := \text{ODE}(k, k) \quad k := \text{stack}(4, 5, 6.5, 8)$$

$$i := 0.. \text{last}(k) \quad XY_i := f(k_i) \quad g(i) := XY_i \quad x(i) := g(i)_0 \quad y(i) := g(i)_1$$

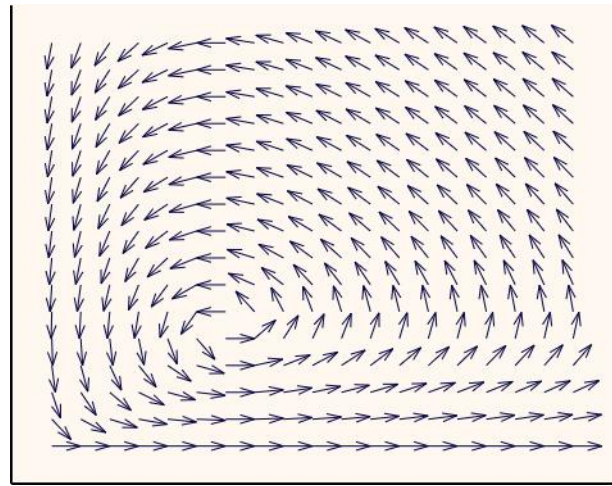
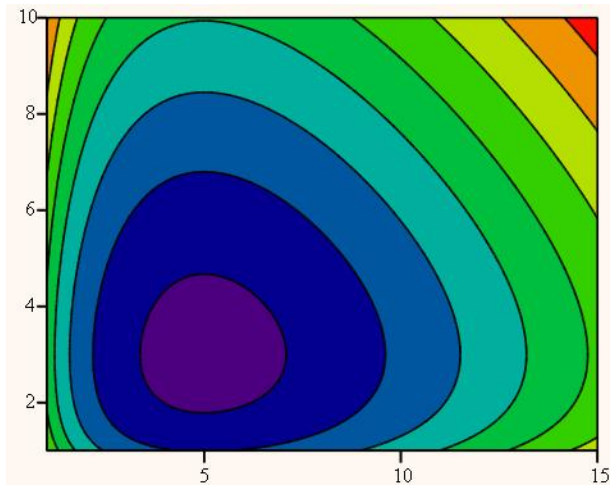


$$K := \frac{\text{FRAME}}{10}$$

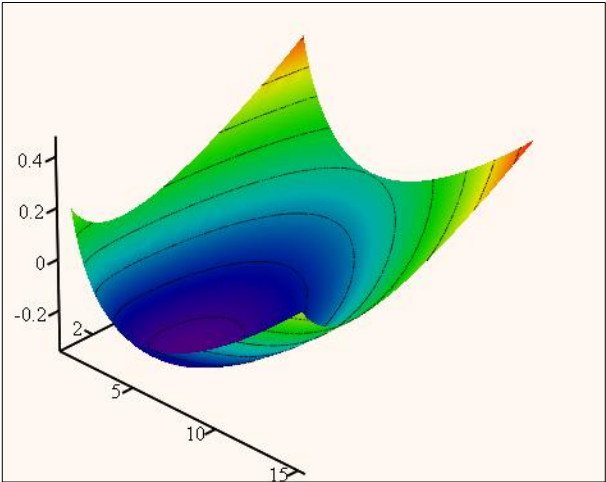
$$\begin{pmatrix} x \\ y \end{pmatrix} := \text{ODE}(K + 2, K) \quad \text{Pnt} := (K + 2 \quad K)$$



$$V(x,y) := c \cdot x - d \cdot \ln(x) + b \cdot y - a \cdot \ln(y)$$



Using the 3D vector plot gives a wrong scale, so I have hidden the scale altogether.



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