Slope Field of Ordinary Differential Equations

MATLAB Implementation

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1 Download and Installation

1.1 Download from MATLAB Central's File Exchange

The `slope_field` function is available for download on MATLAB® Central's File Exchange at https://www.mathworks.com/matlabcentral/fileexchange/85433-slope-field-generator-for-odes-slope_field.

1.2 Download from GitHub

The `slope_field` function is available for download on GitHub® at https://github.com/tamaskis/slope_field-MATLAB.

1.3 Files Included With Download

There are **five** files included in the downloaded `zip` file:

1. `EXAMPLE.M` – *example for using the* `slope_field` *function*
2. `LICENSE` – *license for the* `slope_field` *function*
3. `README.md` – *markdown file for GitHub documentation*
4. `Slope Field of Ordinary Differential Equations - MATLAB Implementation.pdf` – *this PDF*
5. **`slope_field.m` – *MATLAB function that draws slope field***

1.4 Accessing the `slope_field` Function in a MATLAB Script

There are **four** options for accessing the `slope_field` function in a MATLAB script:

1. Copy the `slope_field` function to the *end* of your MATLAB script.
2. Place the `slope_field.m` file in the same folder as the MATLAB script.
3. Place the `slope_field.m` file into whatever folder you want, and then use the `addpath(folderName)` command[1] where the `folderName` parameter is a string that stores the filepath of the folder that `slope_field.m` is in *relative to* the folder that your script is in.
4. Make a toolbox by first opening `slope_field.m`, then going to the `HOME` tab in MATLAB, and finally selecting `Package Toolbox` in the drop-down menu under `Add-Ons`. Once you package the `slope_field` function as a toolbox, you can use it in any script.

[1] https://www.mathworks.com/help/matlab/ref/addpath.html

2 slope_field

Draws the slope field of a first-order, univariate, ordinary differential equation.

Syntax

```
slope_field(f,[xmin,xmax],[ymin,ymax])
slope_field(f,[xmin,xmax],[ymin,ymax],density,color,width)
fig = slope_field(__)
```

Description

`slope_field(f,[xmin,xmax],[ymin,ymax])` draws the slope field of a differential equation $dy/dx = f(x,y)$, where `f` is the function handle of f, and where `[xmin,xmax]` and `[ymin,ymax]` define the domain $D = \{(x,y) \,|\, x_{\min} \le x \le x_{\max}, y_{\min} \le y \le y_{\max}\}$.

`slope_field(f,[xmin,xmax],[ymin,ymax],density,color,width)` draws the slope field of a differential equation $dy/dx = f(x,y)$, where `f` is the function handle of f, and where `[xmin,xmax]` and `[ymin,ymax]` define the domain $D = \{(x,y) \,|\, x_{\min} \le x \le x_{\max}, y_{\min} \le y \le y_{\max}\}$. Additionally, `density` defines the number of lines to draw in the horizontal direction (effectively controlling how many lines are drawn to create the slope field), and `color` and `width` define the color and line width, respectively, of the lines.

`fig = slope_field(__)` draws the slope field and also returns the figure handle of the slope field. You can use any of the input arguments in the previous syntaxes.

Example

Example 2.1

Draw the slope field of

$$\frac{dy}{dx} = \frac{y}{3-x}$$

on the domain

$$D = \{(x,y) \,|\, 0 \le x \le 10, -5 \le y \le 5\}$$

■ *SOLUTION*

First, we define the domain for plotting the slope field.

```
xmin = 0;
xmax = 10;
ymin = -5;
ymax = 5;
```

Next, we define the differential equation as an anonymous function.

```
f = @(x,y) y/(x-3);
```

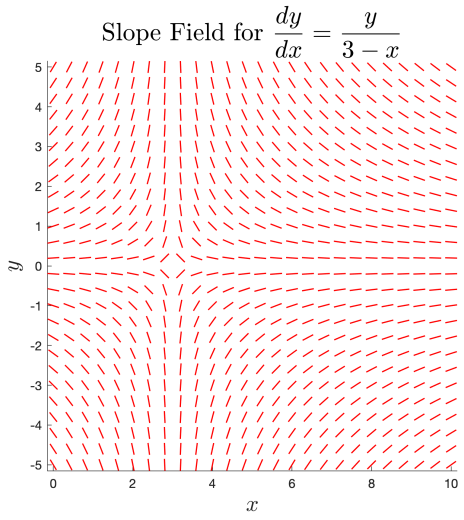
First, we plot the slope field with a line density of 25 and red lines with a line width of 1.

```
slope_field(f,[xmin,xmax],[ymin,ymax],25,'r',1)
```

Adding axes labels and a title,

```
xlabel('$x$','interpreter','latex','fontsize',18);
ylabel('$y$','interpreter','latex','fontsize',18);
title('Slope Field for $\displaystyle\frac{dy}{dx}=\frac{y}{3-x}$',...
    'interpreter','latex','fontsize',20);
```

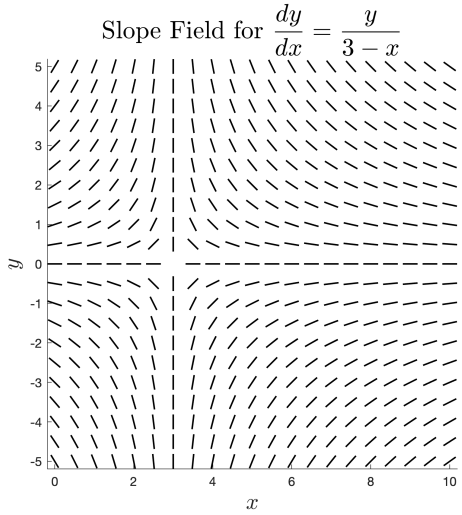
This yields the slope field



We can plot the same slope field with the default settings.

```
slope_field(f,[0,10],[-5,5]);
xlabel('$x$','interpreter','latex','fontsize',18);
ylabel('$y$','interpreter','latex','fontsize',18);
title('Slope Field for $\displaystyle\frac{dy}{dx}=\frac{y}{3-x}$',...
    'interpreter','latex','fontsize',20);
```

This yields the slope field


Slope Field for $\frac{dy}{dx} = \frac{y}{3-x}$
5
4
3
2
1
0
-1
-2
-3
-4
-5
y
0
2
4
6
8
10
x