

Lecture 6: Visualization and Data Management

A8B17CAS

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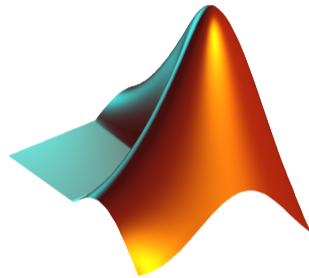
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1. Visualization in MATLAB
2. Visualization – Good Practice
3. Data Management



Warm Up: Fibonacci Sequence



- ▶ Fibonacci sequence: $F_1 = 0$, $F_2 = 1$, $F_n = F_{n-1} + F_{n-2}$ for $n > 2$.

Warm Up: Function Generating Fibonacci Sequence

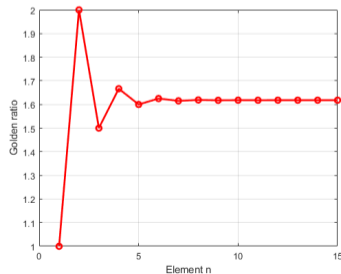
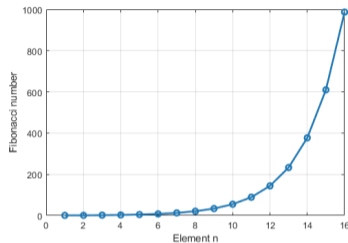


Implement function `fibonacci` to calculate values of Fibonacci sequence up to a certain value `limit`.

- ▶ Plot the resulting series using function:
`figure(1); plot(F, '-o');`
- ▶ Calculate the length of the Fibonacci spiral.
- ▶ Calculate approximations to the golden ratio:

$$\varphi = \lim_{n \rightarrow \infty} \frac{F_{n+1}}{F_n} = \frac{1 + \sqrt{5}}{2} \approx 1.618033$$

- ▶ Plot it: `figure(2); plot(phi, '-or');`





Introduction to Visualizing

- ▶ We have already got acquainted (marginally) with some of MATLAB graphs.
 - ▶ `plot`, `stem`, `surf`, `pcolor`, etc.
- ▶ Graphical functions in MATLAB can be used at **higher** level or **lower** level.



Introduction to Visualizing

- ▶ We have already got acquainted (marginally) with some of MATLAB graphs.
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Many ways how to get your data in:

- ▶ Upload them with Wizard (`uiimport` function, *Import Data*).
- ▶ Drag file and drop it to MATLAB Workspace window.
- ▶ You have already mat file, use `load('myFile.mat');`
- ▶ Use MATLAB to calculate what you need and generate data directly.

Process the data to their final form:

- ▶ Normalization.
- ▶ Averages, etc.



Graph Overview (to get one: MATLAB → Plots → Catalog)

Plot Catalog
— □ ×

Line Plots

Stem and Stair Plots

Bar Plots

Scatter Plots

Graph Plots

Pie Charts

Histograms

Polar Plots

Geographic Plots

Contour Plots

Image Plots

3-D Surfaces

Volumetrics

Vector Fields

Analytic Plots

Control Toolbox Plots

Curve Fitting Toolbox Plots

DSP System Toolbox Plots

Finance Toolbox Plots

Image Processing Toolbox Plots

Mapping Toolbox: Projected X-Y Plots

Mapping Toolbox: Geographic Data Plots

Signal Processing Toolbox: Filter Analysis

Signal Processing Toolbox: Window Visualization

Signal Processing Toolbox: Spectral Estimation

Statistics And Machine Learning Toolbox Plots

System Id: Parametric Model Evaluation

System Id: Non-Parametric Analysis

System Id: IDLTI Model Visualization

System Id: IDLTI Model Simulation

plot(Data)
2-D line graph using linear axes

Plot as multiple series
Plots each series on the same plot

Plot as multiple series vs. first input
Plots the second and later series again...

plotyy(Data)
Graphs with y tick labels on the left an...

semilogx(Data)
Semi-log scale plot

semilogy(Data)
Semi-log scale plot

loglog(Data)
Log-log scale plot

area(Data)
Filled area plot

errorbar(Data)
Error bar plot

errorbar(horizontal)
Horizontal error bar plot

plot3(Data)
3-D line graph using linear axes

comet(Data)
Comet-like trajectory

Plotted Variables:

Syntax

```
plot(X,Y)
plot(X,Y,LineStyle)
plot(X1,Y1,...,Xn,Yn)
plot(X1,Y1,LineStyle1,...,Xn,Yn,LineStylen)

plot(Y)
plot(Y,LineStyle)

plot(__,Name,Value)
plot(ax, __)

h = plot(__)
```

Description

`plot(x,y)` creates a 2-D line plot of the data in `y` versus the corresponding values in `x`. [example](#)

- If `x` and `y` are both vectors, then they must have equal length. The `plot` function plots `y` versus `x`.
- If `x` and `y` are both matrices, then they must have equal size. The `plot` function plots columns of `y` versus columns of `x`.
- If one of `x` or `y` is a vector and the other is a matrix, then the matrix must have dimensions such that one of its dimensions equals the vector length. If the number of matrix rows equals the vector length, then the `plot` function plots each matrix column versus the vector. If the number of matrix columns equals the vector length, then the function plots each matrix row versus the vector. If the matrix is square, then the function plots each column versus the vector.
- If one of `x` or `y` is a scalar and the other is either a scalar or a vector, then the `plot` function plots discrete points. However, to see the points you must specify a marker symbol, for example, `plot(X,Y,'o')`.

`plot(X,Y,LineStyle)` sets the line style, marker symbol, and color.

`plot(X1,Y1,...,Xn,Yn)` plots multiple `x`, `y` pairs using the same axes for all lines. [example](#)

`plot(X1,Y1,LineStyle1,...,Xn,Yn,LineStylen)` sets the line style, marker type, and color for each line. You can mix `X`, `Y`, `LineStyle` triplets with `X`, `Y` pairs. For example, `plot(X1,Y1,X2,Y2,LineStyle2,X3,Y3)`. [example](#)

`plot(Y)` creates a 2-D line plot of the data in `Y` versus the index of each value. [example](#)

- If `Y` is a vector, then the `x`-axis scale ranges from 1 to `length(Y)`.
- If `Y` is a matrix, then the `plot` function plots the columns of `Y` versus their row number. The `x`-axis scale ranges from 1 to the number of rows in `Y`.

Plot
Plot in New Figure
Close



Components of a Graph – Example

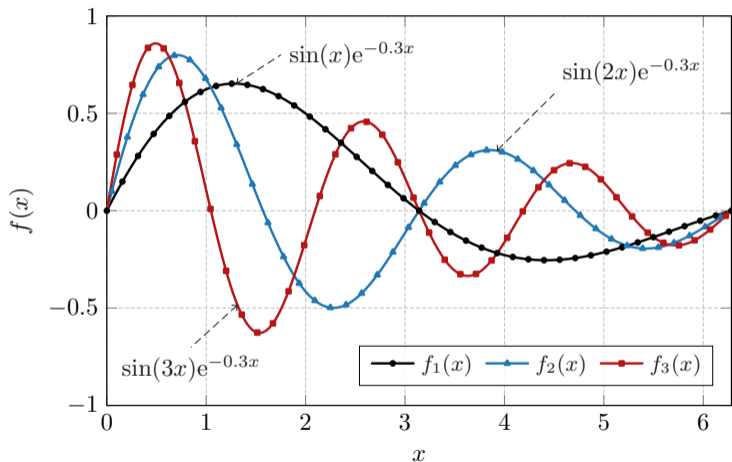


Fig. 1: Functions $\sin(nx) \exp(-0.3x)$.



Components of a Graph – Example

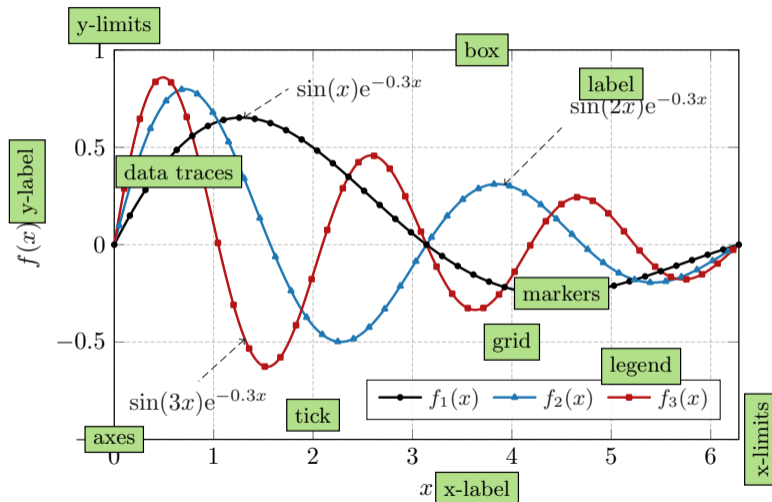


Fig. 1: Functions $\sin(nx) \exp(-0.3x)$.



Selected Functions for Graph Modification

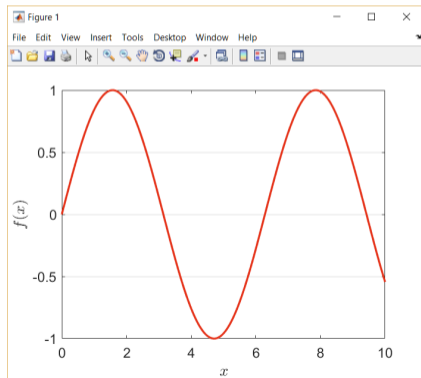
- Graphs can be customized in many ways, the basic ones are:

function	description
<code>title</code>	title of the graph
<code>xlabel, ylabel, zlabel</code>	label axes
<code>x-, y-, ztickformat</code>	specify axis tick label format
<code>grid on, grid off</code>	turns grid on / off
<code>hold on</code>	enables to add another graphical elements while keeping the existing ones
<code>xlim, ylim, zlim</code>	set axes' range
<code>legend</code>	display legend
<code> tiledlayout, nexttile</code>	create more axes in one figure
<code>yyaxis</code>	create chart with two y-axes
<code>box on</code>	display axes outline
<code>text</code>	adds text to graph
and others	



Adjusting MATLAB Graph

- ▶ To realize what are the properties: `properties(obj)` or `get(obj)` (object has to exist).
- ▶ `obj.` + TAB to use whispering mode.



```
x = 0:0.01:10;
fx = sin(x);

fg = figure('color', 'w');
ax = axes('parent', fg);

trl = plot(x, fx);
trl.Color = [0.9 0.2 0.1];

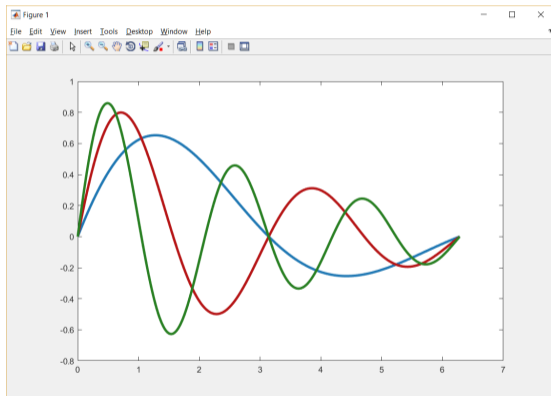
ax.YGrid = true;
ax.YTick = -1:0.5:1;
ax.GridColor = [0 0 0];
ax.XLabel.String = '$x$';
ax.XLabel.Interpreter = 'LaTeX';

ax.YLabel.String = '$f(x)$';
ax.YLabel.Interpreter = 'LaTeX';

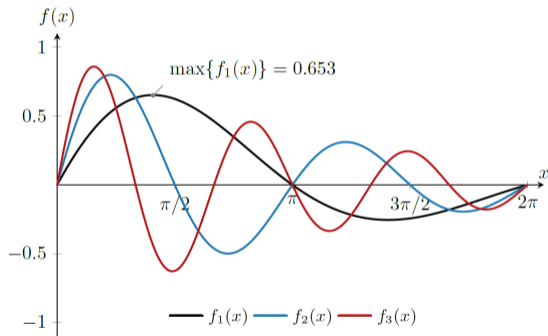
ax.FontSize = 14;
```



Decouple SW for Data Preparation and SW for Visualization



Default graph depicted in MATLAB.



Graphics prepared in $\text{\LaTeX} + \text{PGFPlots} + \text{TikZ}$.

MATLAB2Tikz



(Live demo)

MATLAB Templates (PDF, EPS)



(Live demo)



export_fig

(Live demo)

Recommended Practice



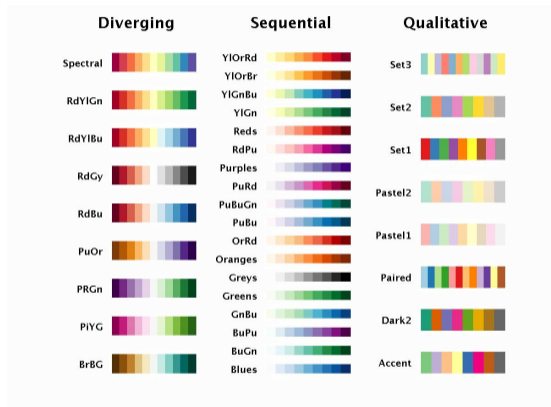
▶ Math Nomenclature (Capek, M.)

▶ L^AT_EX, Overleaf, etc. (Capek, M.)



Colors and Color Maps

- ▶ Color perception is a science of its own.
- ▶ Purpose of a document: printed/on-line article × presentation (Beamer).
- ▶ Do not reduce contrast and readability (keep the number of colors low).
- ▶ Black and white printing, colorblindness.



▶ [ColorBrewer2](#)

▶ [Selecting Semantically-Resonant Colors](#)

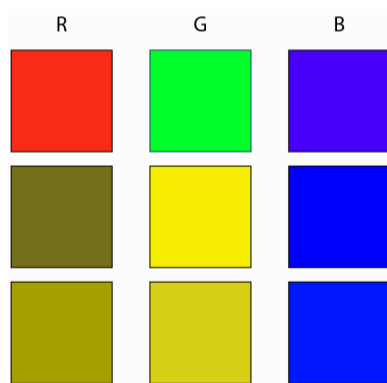
▶ [A Colour Alphabet](#)

Stone, M. C.: A Field Guide to Digital Color



Colorblindness

- ▶ Approx. 8-9% of people are color blind (do not use red and green)!
- ▶ You can/should check your colormap, *e.g.*, in Adobe Illustrator.
 - ▶ Second line: *protanopie*, third line: *deuteranopie*.





Data Externalization

- ▶ Always externalize data used for the figure.
- ▶ Decouple settings of a figure and data.
- ▶ Make a note of what code and settings have been used to generate data sets.





Overleaf

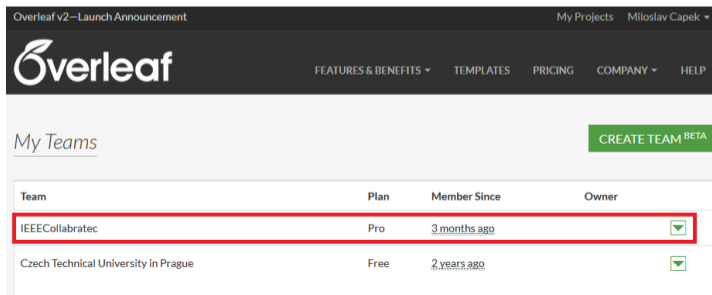
- ▶ On-line tool for collaborative L^AT_EX writing.
- ▶ Standard account for free (some limitations).
- ▶ A plethora of standardized templates.
- ▶ Sharing, GIT, Grammarly, spellchecking, versioning and history, review mode.

▶ Overleaf



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Overleaf v2—Launch Announcement My Projects Miloslav Capek ▾

Overleaf FEATURES & BENEFITS ▾ TEMPLATES PRICING COMPANY ▾ HELP

My Teams CREATE TEAM ^{BETA}

Team	Plan	Member Since	Owner
IEEECollabratec	Pro	3 months ago	
Czech Technical University in Prague	Free	2 years ago	

Questions?

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