AE0B17MTB – Matlab

Part #9

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Learning how to ...

Visualization in Matlab #2

GUI #1

!!! **Attention**: SINCE MATLAB R2014b CHANGES IN GRAPHICS !!!

Advanced visualizing in Matlab

- basic possibilities of visualizing mentioned in 5th part of the course
  - `figure` and basic plotting (`plot`, `stem, `…)
  - setting curve options of a graph `LineSpec (doc LineSpec)`
  - functions for graph description, grid and legend
- graph options
  - graph as a handle object (change since version R2014b)
  - way of setting property values of graphic "objects"
- selected advanced possibilities of visualizing
  - insering more graphs in a single `figure`
  - tens of types of graphs (see Help)
  - projection of 3D graphs
  - `view`, `colormap`

Object identifiers (up to R2014b)

- each individual object has its own identifier (‘handle’ in Matlab terms)
- these handles are practically a reference to an existing object
  - handle is always created by Matlab, it is up to the user to store it
  - complex graphs (contours) may have more identifiers
- `root` has always handle = 0 (more on `root` later), `figure` usually an integer, other objects have handle equal to positive real number (of class `double`)

handles

```
>> figHandle = figure;
>> axHandle  = axes;
```

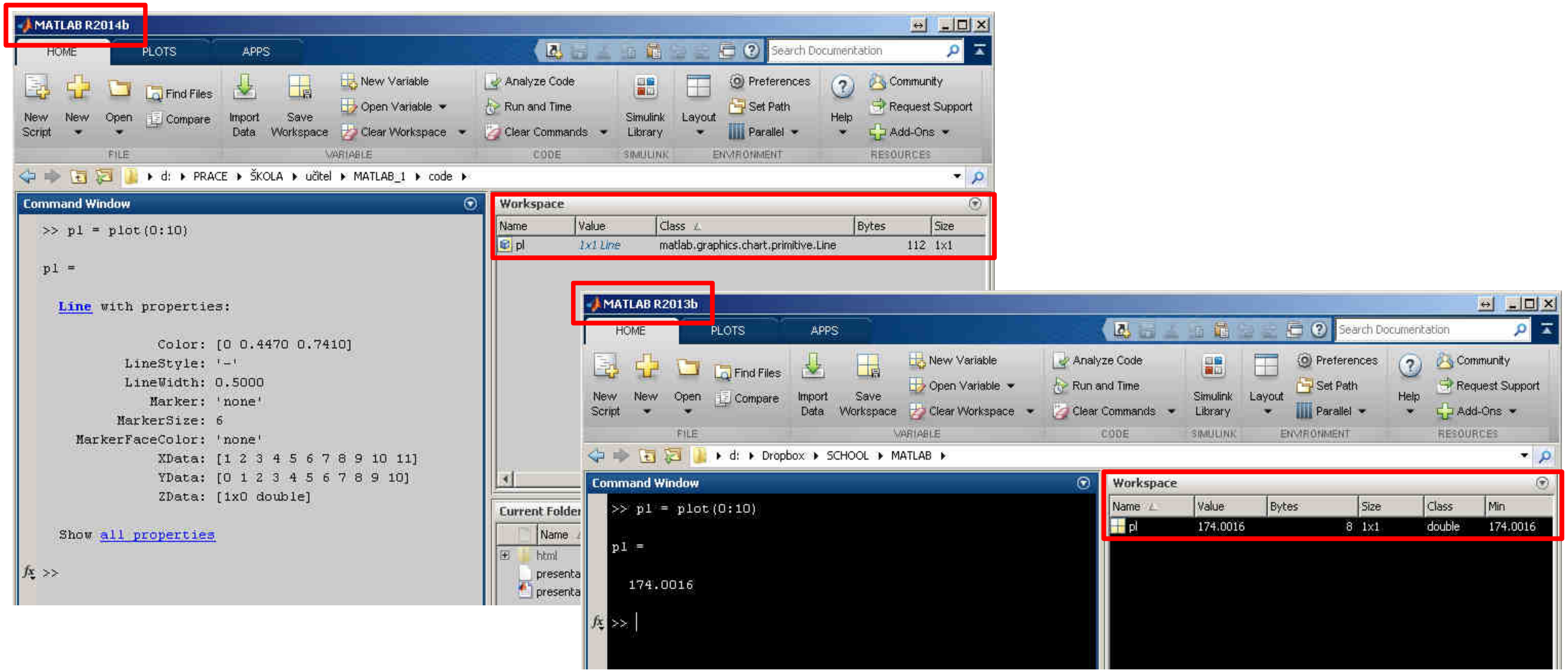
- number stored in `figHandle` variable exists even after closing the window, but it is not a handle any more

Object identifiers (since R2014b)

- each graphic object is marked as an object in workspace
  - an object is defined by its class with its properties and methods
- `root` can still be accessed using function `get()` with parameter 0
  - `root` is newly `groot` object
  - (more in part GUI #1)
- after object destruction (closing `figure`)
  - the object still exists in workspace (it appears as a reference to deleted object)

Advanced visualization in Matlab

- graph as a handle number (version < R2014b)
- graph as an object (since version R2014b)
  - note: in what follows we will reference graphs as handle objects



```
>> pl = plot(0:10)

pl = 

  Line with properties:

              Color: [0 0.4470 0.7410]
          LineStyle: '-'
          LineWidth: 0.5000
             Marker: 'none'
         MarkerSize: 6
    MarkerFaceColor: 'none'
              XData: [1 2 3 4 5 6 7 8 9 10 11]
              YData: [0 1 2 3 4 5 6 7 8 9 10]
              ZData: [1x0 double]

  Show all properties

fx >>
```

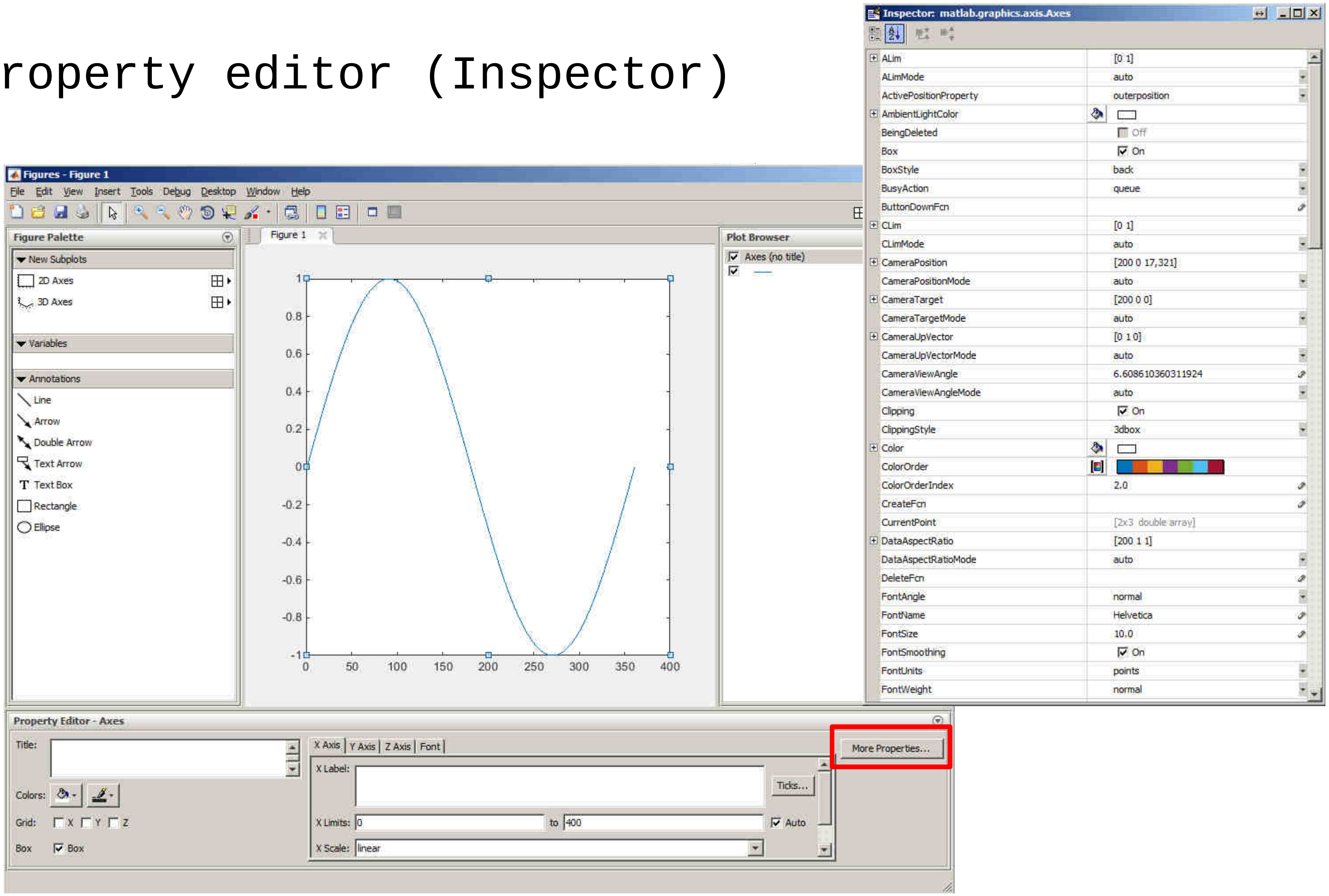
Name	Value	Class	Bytes	Size
pl	1x1 Line	matlab.graphics.chart.primitive.Line	112	1x1

```
>> pl = plot(0:10)

pl =

  174.0016

fx >> |
```

Name	Value	Bytes	Size	Class	Min
pl	174.0016	8	1x1	double	174.0016

Advanced visualization in Matlab

- Property editor (Inspector)



Property Editor - Axes

Title:

Colors:

Grid: □ X □ Y □ Z

Box ☑ Box

X Label:

X Limits: 0 to 400 ☑ Auto

X Scale: linear

Inspector: matlab.graphics.axis.Axes

ALim	[0 1]
ALimMode	auto
ActivePositionProperty	outerposition
AmbientLightColor	□
BeingDeleted	□ Off
Box	☑ On
BoxStyle	back
BusyAction	queue
ButtonDownFcn	
CLim	[0 1]
CLimMode	auto
CameraPosition	[200 0 17,321]
CameraPositionMode	auto
CameraTarget	[200 0 0]
CameraTargetMode	auto
CameraUpVector	[0 1 0]
CameraUpVectorMode	auto
CameraViewAngle	6.608610360311924
CameraViewAngleMode	auto
Clipping	☑ On
ClippingStyle	3dbox
Color	□
ColorOrder	
ColorOrderIndex	2.0
CreateFcn	
CurrentPoint	[2x3 double array]
DataAspectRatio	[200 1 1]
DataAspectRatioMode	auto
DeleteFcn	
FontAngle	normal
FontName	Helvetica
FontSize	10.0
FontSmoothing	☑ On
FontUnits	points
FontWeight	normal

Advanced visualization in Matlab

- the way of setting handle object properties
  - the possibility of using functions `set` a `get` exists for both versions
    - not case sensitive

```
>> myPlotObj = plot(1:10);
>> get(myPlotObj, 'color')
```

```
>> set(myPlotObj, 'color', 'r')
>> get(myPlotObj, 'color')
```

  - dot notation (only for versions R2014b and higher)
    - is cAsE sEnSiTiVe

```
>> myPlotObj = plot(1:10);
>> myPlotObj.Color
```

```
>> myPlotObj.Color = 'r';
>> myPlotObj.Color
```

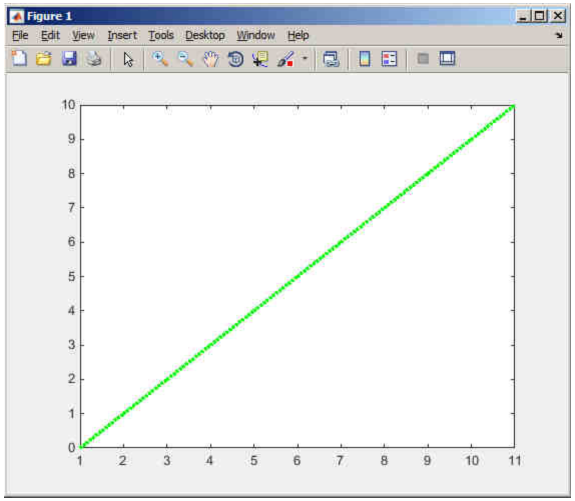
`get` and `set` functions

60 s ↑

- Create a graphic object in the way shown. Then using functions `get` and `set` perform following tasks.

```
myPlotObj = plot(0:10);
```

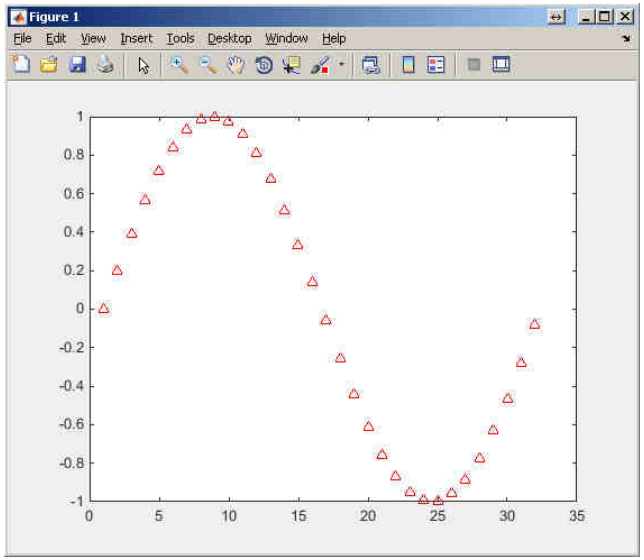
- find out the thickness of the line and increase it by 1.5
- set the line color to green
- set the line style to dotted



Dot notation application

60 s ↑

- Using dot notation change the initial setting of the function shown to get plot as in the figure.



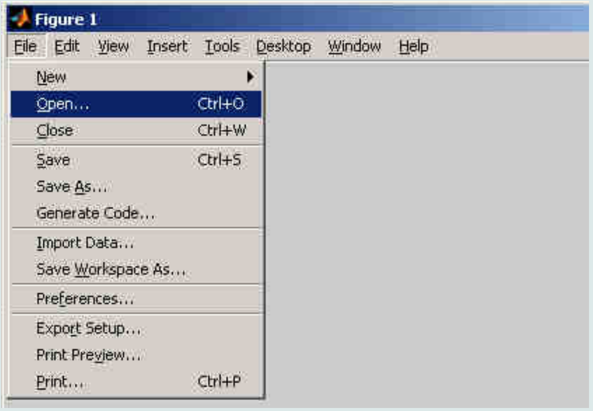
```
myPlotObj = plot(sin(0:0.2:2*pi));
```

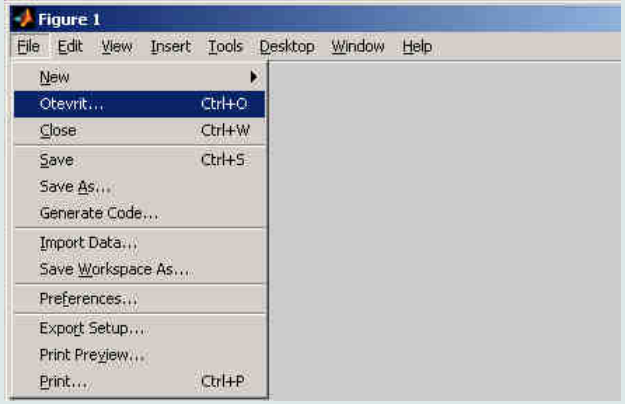
What is handle good for?

- when having a handle, one can entirely control given object

- the example below returns all identifiers existing in window `figure`
- in this way we can, for instance, change item ‘Open’… to ‘Otevrit’…
  - or anything else (e.g. callback of file opening to callback of window closing ☺)

```
fhndl = figure('Toolbar','none');
allFigHndl = guihandles(fhndl);
set(allFigHndl.figMenuOpen,'Label','Otevrit...')
```

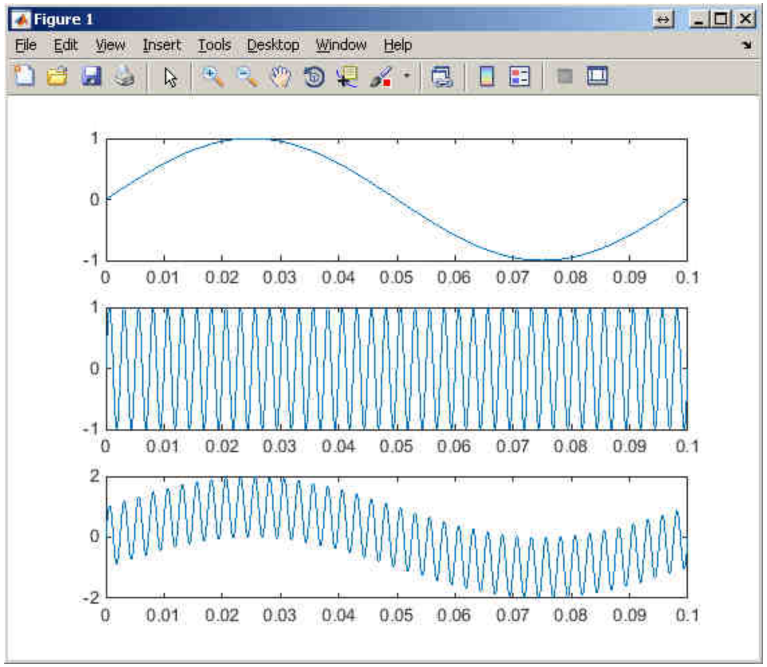




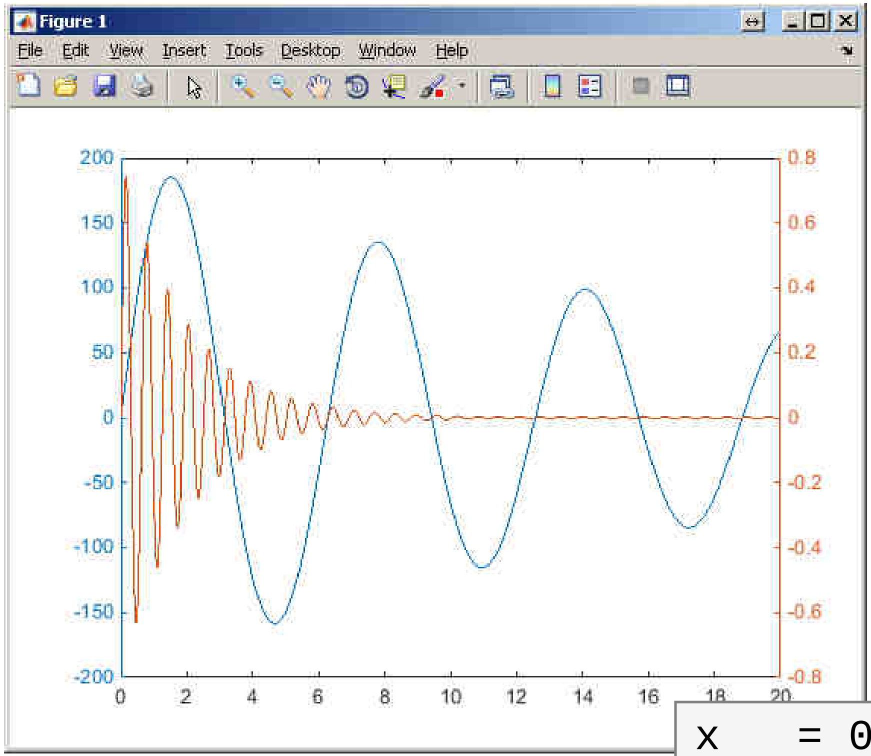
More graphs in a window – `subplot`

- inserting several different graphs in a single window `figure`
  - function `subplot(m,n,p)`
  - `m` – number of lines
  - `n` – number of columns
  - `p` – position

```
t   = linspace(0, 0.1, 0.1*10e3);
f1  = 10;    f2  = 400;

y1  = sin(2*pi*f1*t);
y2  = sin(2*pi*f2*t);
y   = sin(2*pi*f1*t) + sin(2*pi*f2*t);

figure('color', 'w')
subplot(3, 1, 1); plot(t, y1);
subplot(3, 1, 2); plot(t, y2);
subplot(3, 1, 3); plot(t, y);
```



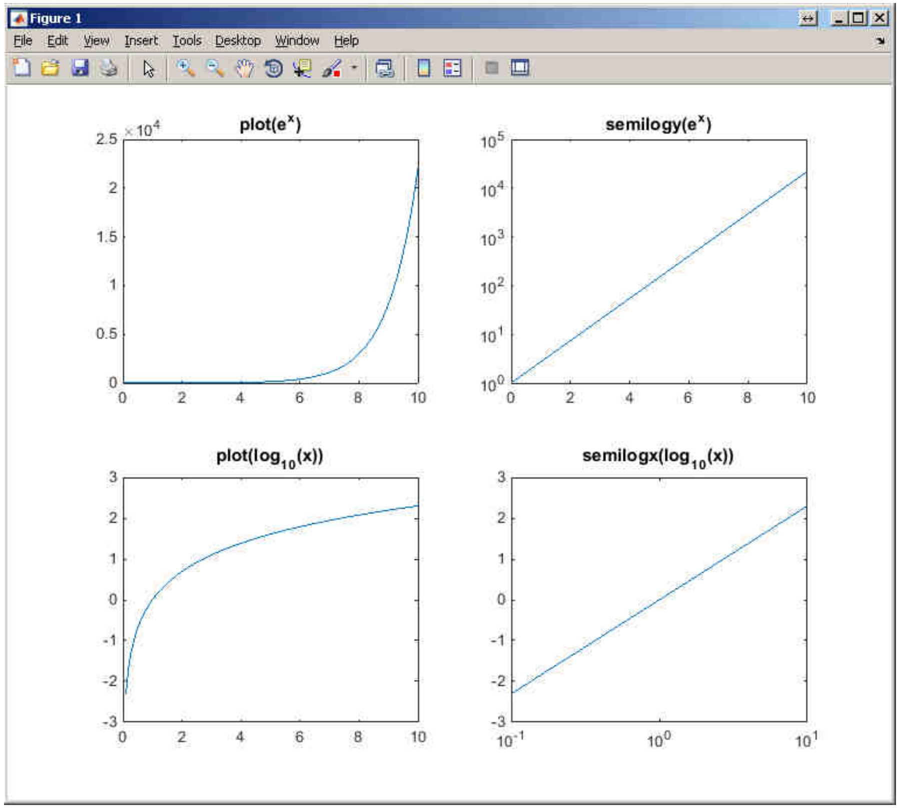
Double y axis – `plotyy`



```
x   = 0:0.01:20;
y1  = 200 * exp(-0.05*x) .* sin(x);
y2  = 0.8 * exp(-0.5*x) .* sin(10*x);

figure('color', 'w');
plotyy(x, y1, x, y2);
```

Logarithmic scale

- functions `semilogy`, `semilogx`, `loglog`



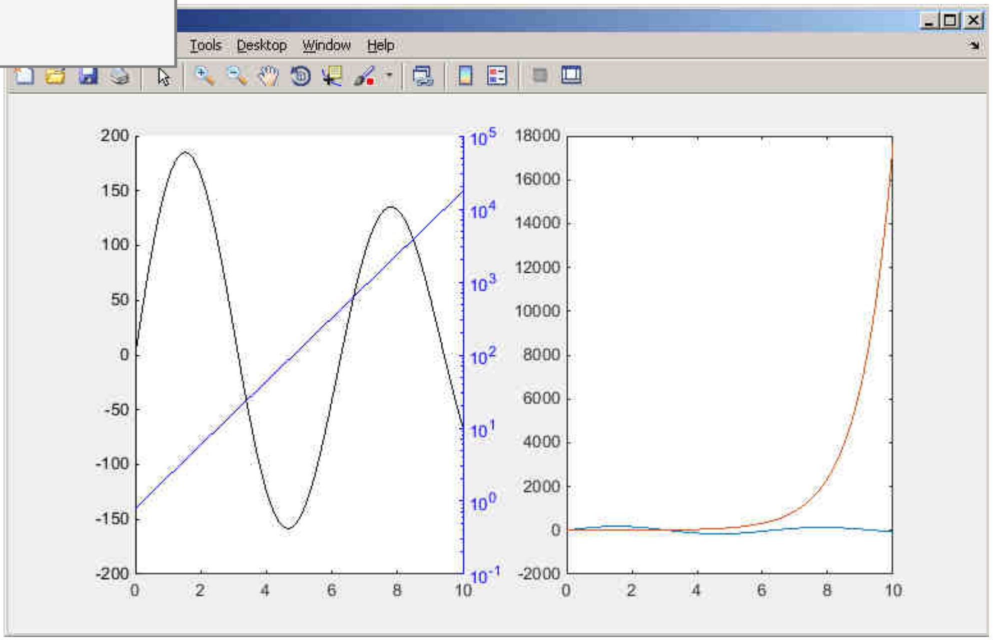
```
x   = 0:0.1:10;
y1  = exp(x);
y2  = log(x);

figure('color', 'w')
subplot(2, 2, 1); plot(x, y1);
title('plot(e^x)');

subplot(2, 2, 2); semilogy(x, y1);
title('semilogy(e^x)')

subplot(2, 2, 3); plot(x, y2);
title('plot(log_1_0(x))')

subplot(2, 2, 4); semilogx(x, y2);
title('semilogx(log_1_0(x))')
```

Example

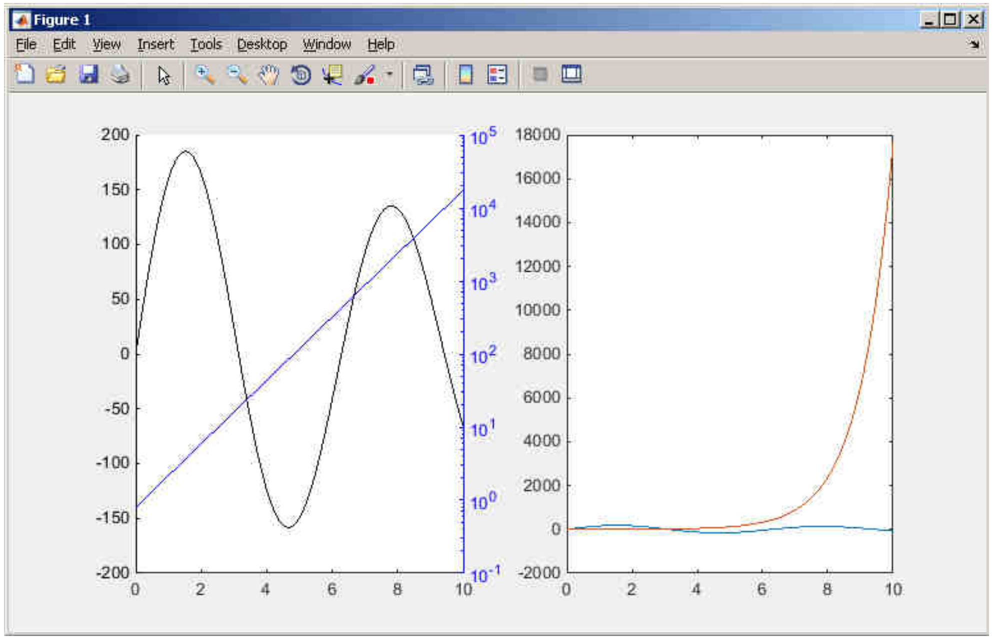
600 s ↑

- compare functions `plot` and `plotyy` in one `figure` object (using `subplot`) for functions shown below
  - in the object created by `plotyy` change default colors of individual lines to blue and black (don't forget about the axes)

```
x  = 0:0.1:10;
y1 = 200 * exp(-0.05*x) .* sin(x);
y2 = 0.8 * exp(x);
```

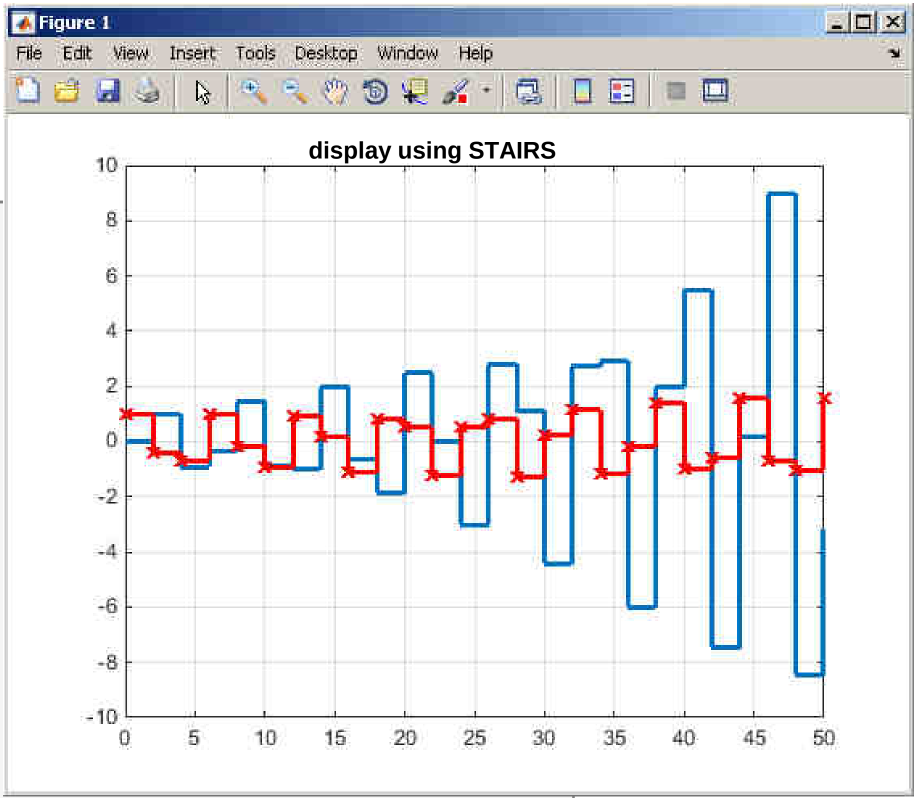


Example - solution



stairs

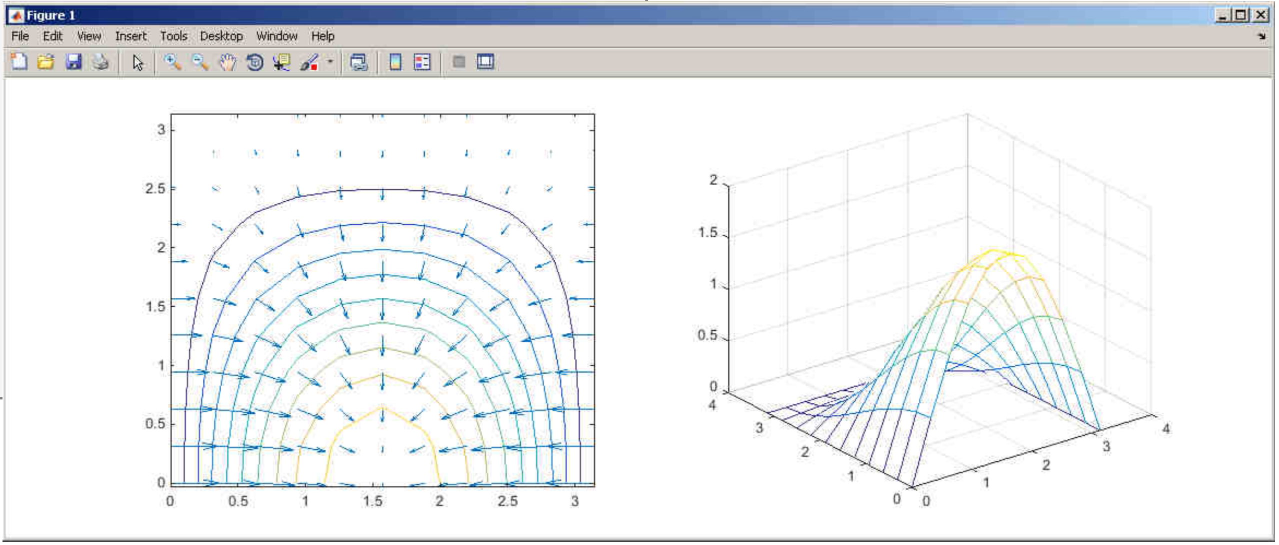
```
x  = 0:2:50;
y1 = exp(0.05*x) .* sin(x);
y2 = exp(0.01*x) .* cos(x);

figure('Color', 'w');
stairs(x, y1, 'LineWidth', 2);
hold on; grid on;
stairs(x, y2, ...
    'Color', 'r', ...
    'Marker', 'x', ...
    'LineWidth', 2);

title('display using STAIRS');
```



Plotting 2-D functions

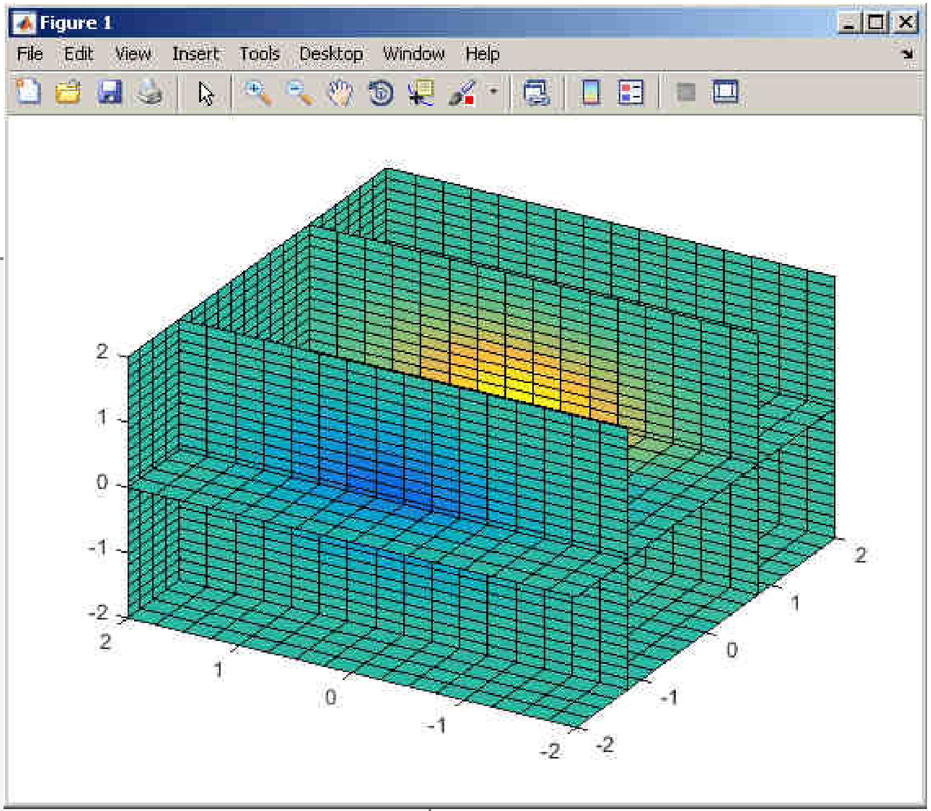
- contour, quiver, mesh

```
t         = 0:pi/10:pi;
[x, y]    = meshgrid(t);
z         = sin(x) + cos(y) .* sin(x);
[gx, gy]  = gradient(z);

figure('Color','w');

subplot(1, 2, 1);
contour(x, y, z);
hold on;
quiver(t, t, gx, gy);

subplot(1, 2, 2);
mesh(x, y, z);
```



Advanced visualizing in Matlab

- function `slice`
- function `view`

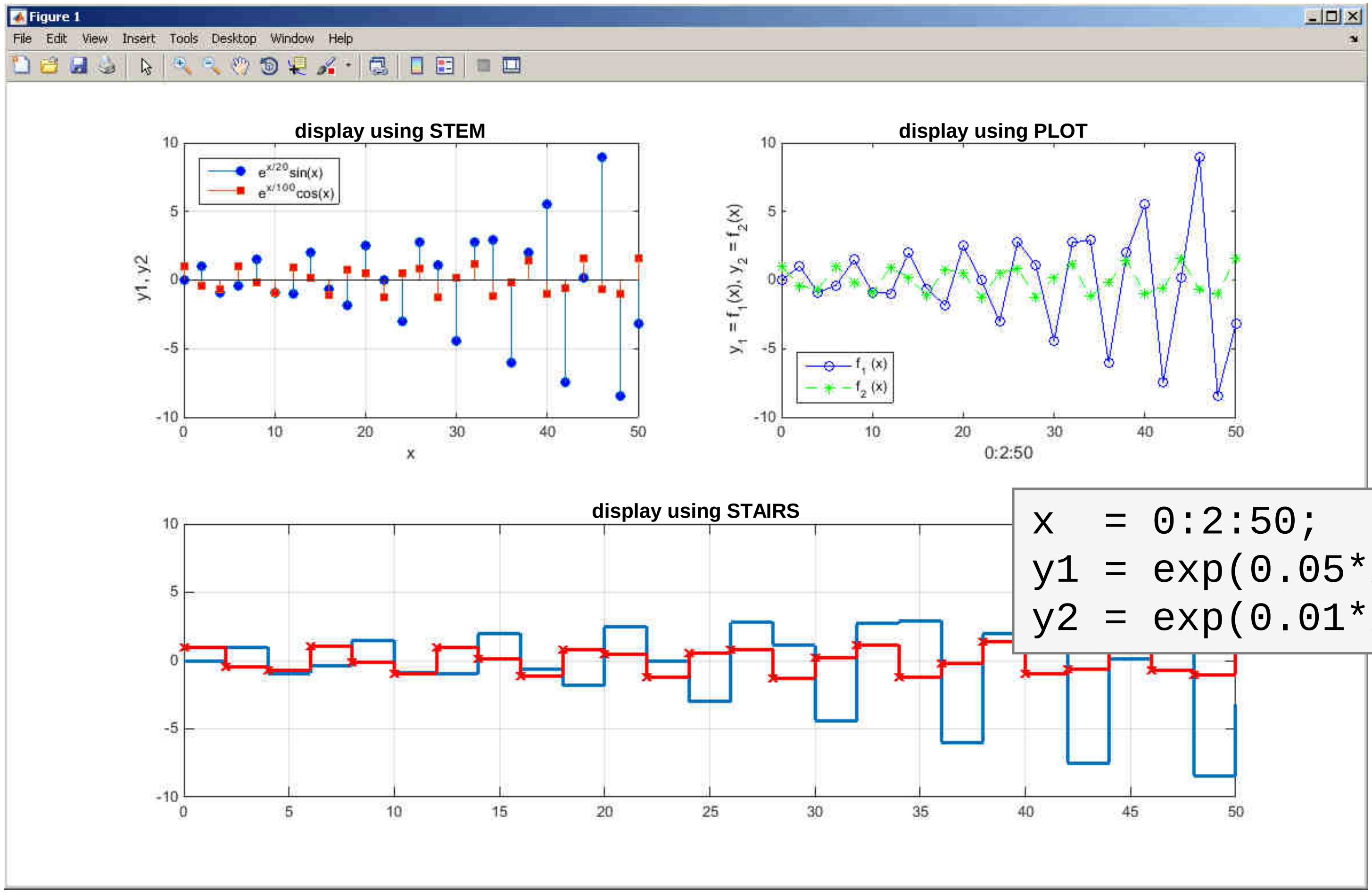


```
[x, y, z] = meshgrid(-2:0.2:2, ...
             -2:0.25:2, ...
             -2:0.16:2);

v = x .* exp(-x.^2 - y.^2 - z.^2);

xslice = [-1.2, 0.8, 2];
yslice = 2;
zslice = [-2, 0];

figure('Color', 'w');
slice(x, y, z, v, xslice, yslice, zslice);
% view(azimuth, elevation)
view(-60, 40);
```

Exercise #1 assignment

600 s ↑

- try to imitate the figure below where functions `y1` and `y2` are defined as:

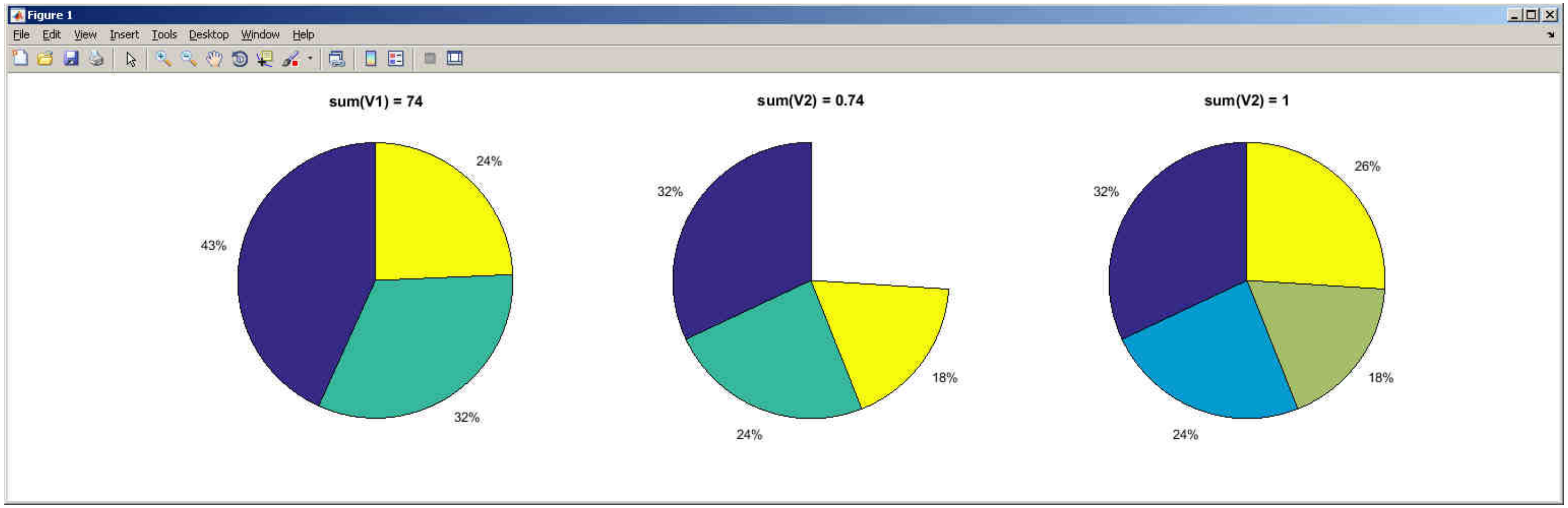


```
x  = 0:2:50;
y1 = exp(0.05*x) .* sin(x);
y2 = exp(0.01*x) .* cos(x);
```

Exercise #1 solution

Pie plot – pie, pie3

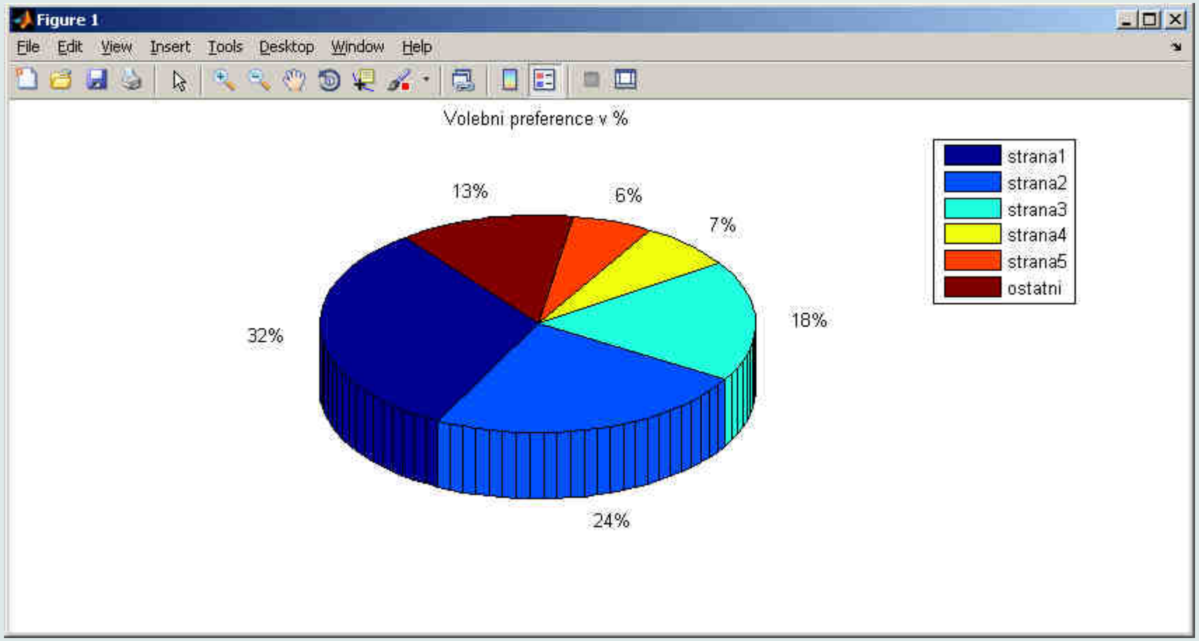
```
V1 = [32 24 18];        % sum(V1) = 74
V2 = V1/100;            % sum(V2) = 0.74
V3 = [V2 1-sum(V2)];   % sum(V3) = 1

figure('Color', 'w');
subplot(1, 3, 1); pie(V1); title('sum(V1) = 74');
subplot(1, 3, 2); pie(V2); title('sum(V2) = 0.74');
subplot(1, 3, 3); pie(V3); title('sum(V2) = 1');
```



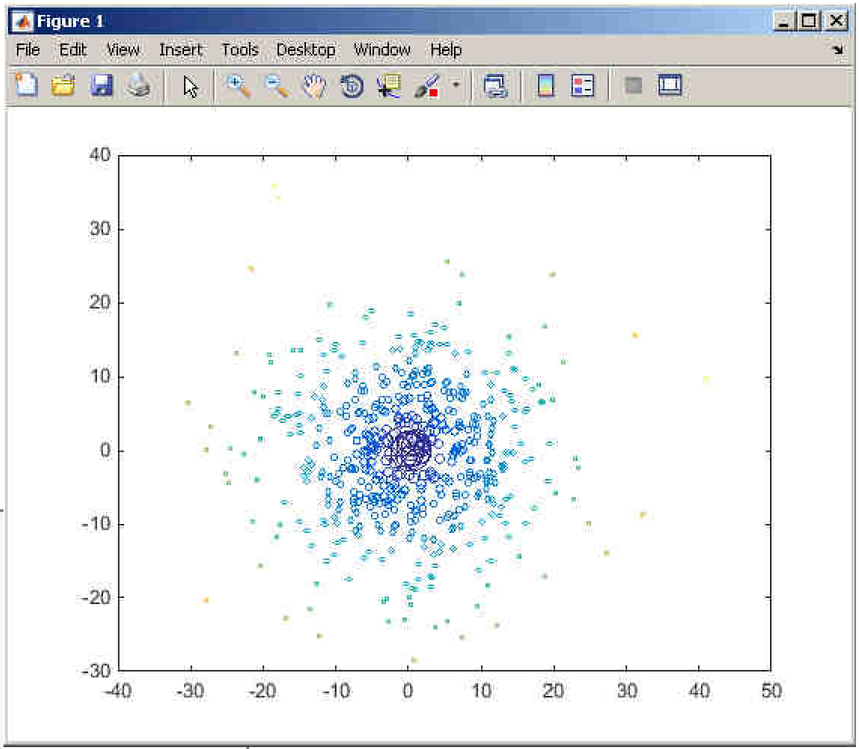
Exercise

600 s ↑

- opinion polls show parties’ preference projections as follows:
- plot the poll result using pie plot including the item 'others'
  - 1st party: 32%
  - 2nd party: 24%
  - 3rd party: 18%
  - 4th party: 7%
  - 5th party: 6%



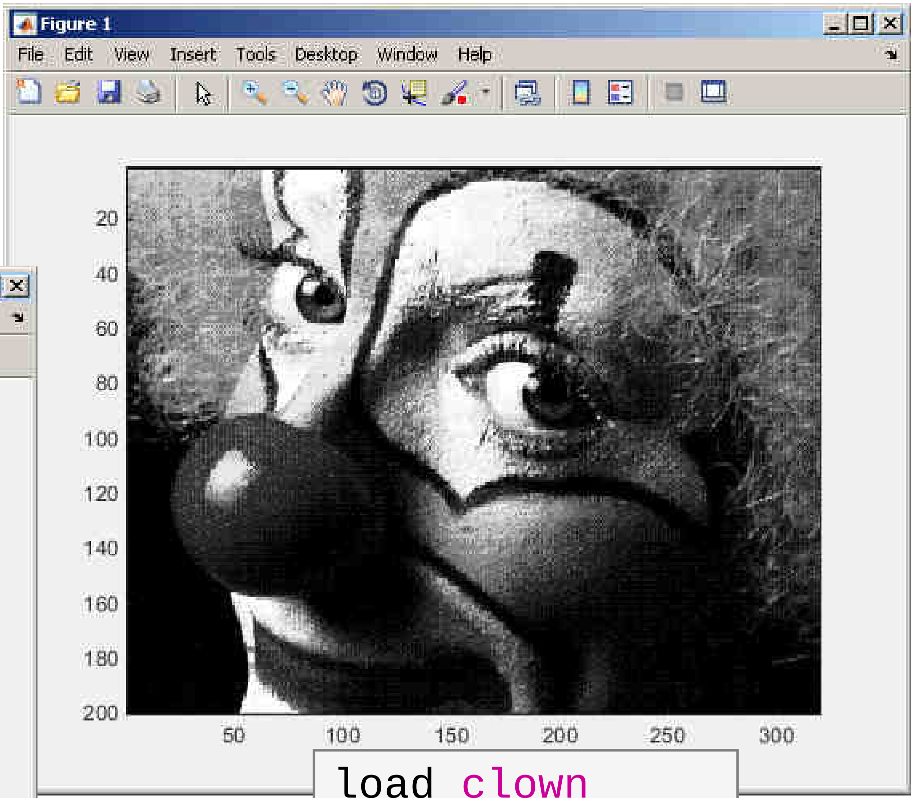
scatter



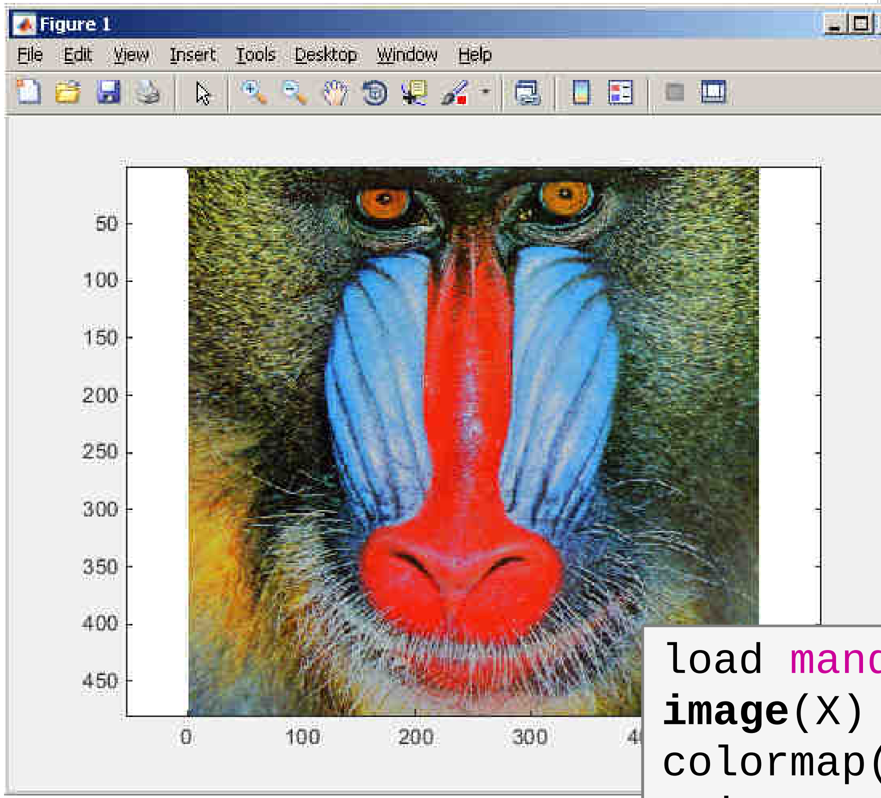
```
x = 10 * randn(500, 1);
y = 10 * randn(500, 1);
c = hypot(x, y);

figure('color', 'w');
scatter(x, y, 100./c, c);
box on;
```

Picture depiction

- functions `image`, `imagesc`
- function `colormap`



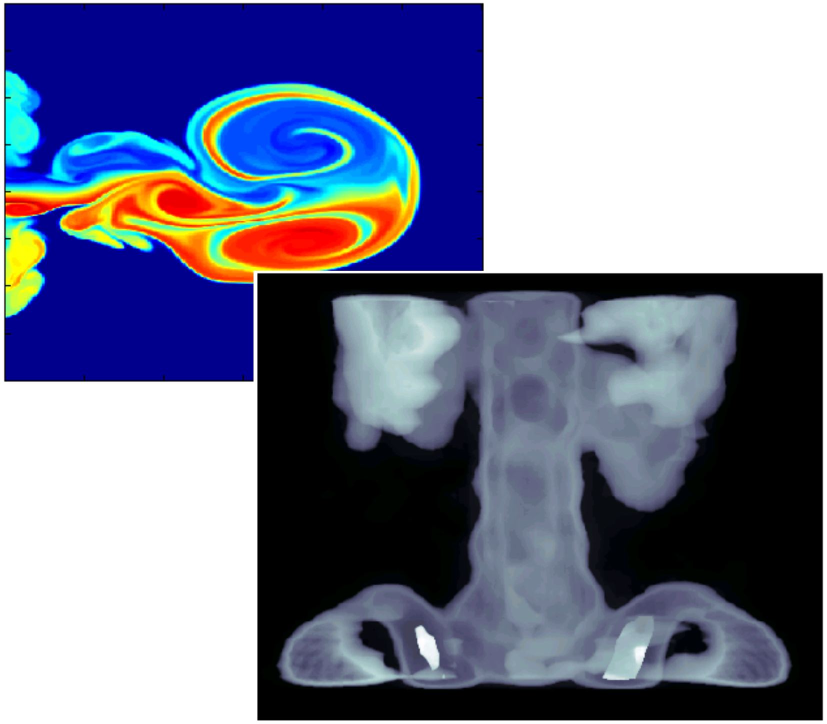
```
load clown
imagesc(X)
colormap(gray)
```

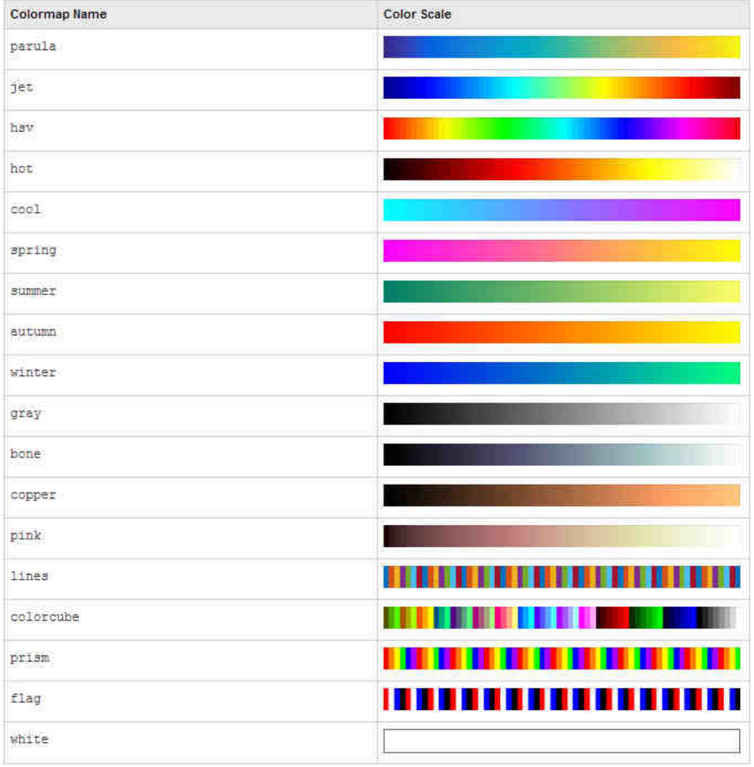


```
load mandrill
image(X)
colormap(map)
axis equal
```

colormap

- determines the scale used in picture color mapping
- it is possible to create / apply an own one: `colormapeditor`



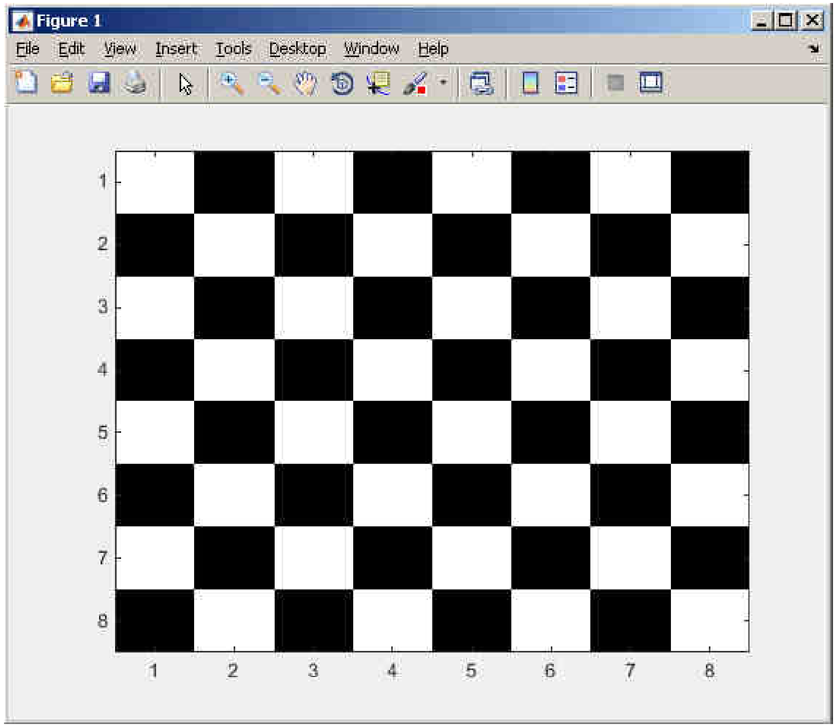


Colormap Name	Color Scale
parula	
jet	
hsv	
hot	
cool	
spring	
summer	
autumn	
winter	
gray	
bone	
copper	
pink	
lines	
colorcube	
prism	
flag	
white	

Exercise

600 s ↑

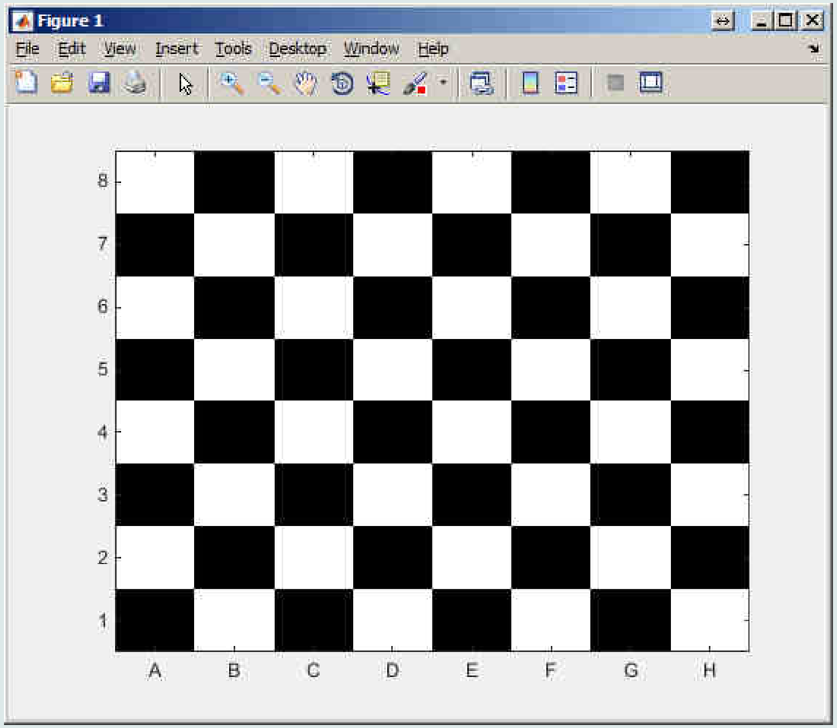
- create a chessboard as shown in the figure:
  - the picture can be drawn using the function `imagesc`
  - consider `colormap` setting



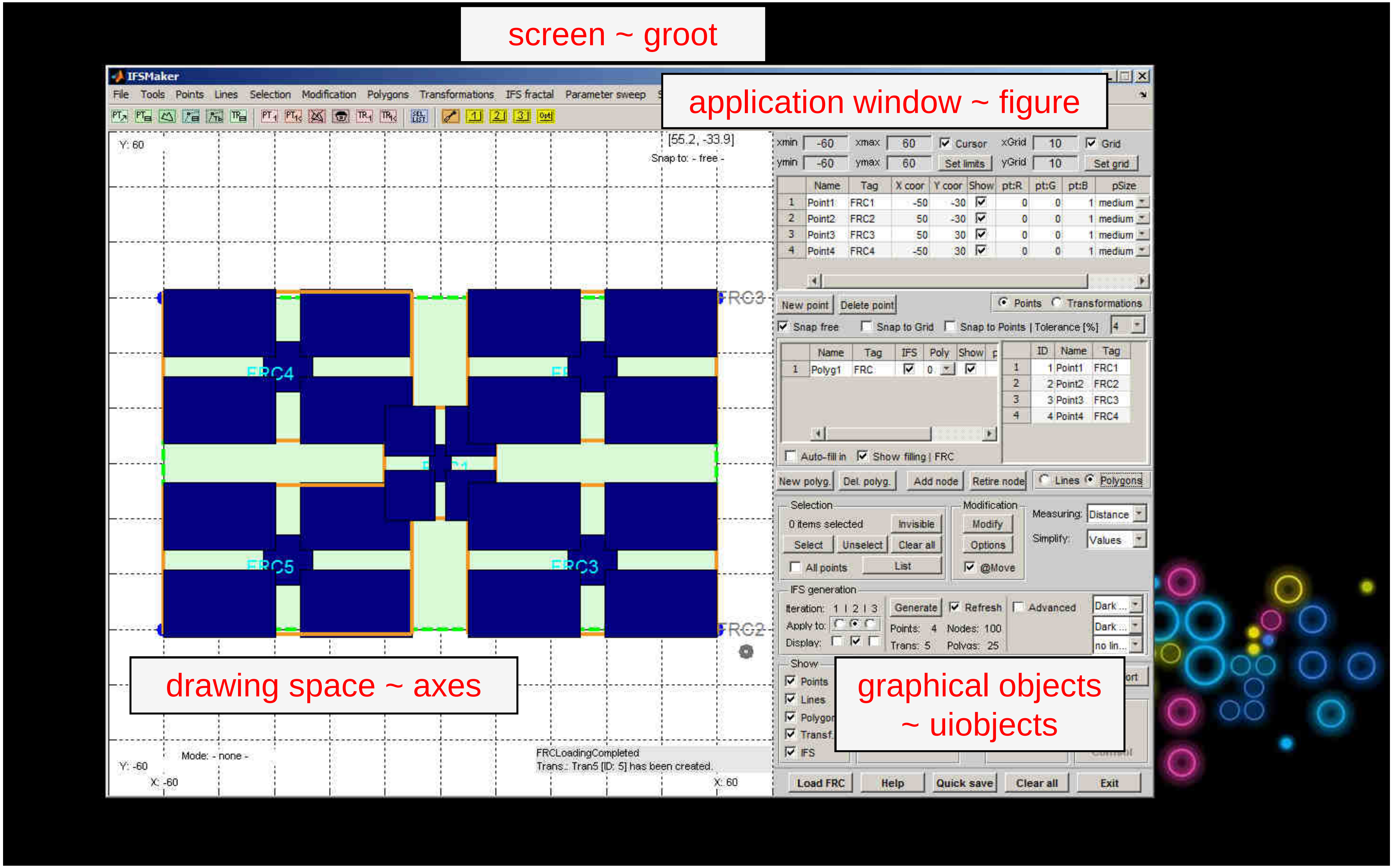
Exercise

600 s ↑

- Modify the axes of the chessboard so that it corresponded to reality :



Structure of GUI #1



screen ~ groot

application window ~ figure

drawing space ~ axes

graphical objects ~ uiobjects

Y: 60

[55.2, -33.9]

Snap to: - free -

Y: -60

X: -60

X: 60

Mode: - none -

FRCLoadingCompleted
Trans.: Trans5 [ID: 5] has been created.

xmin -60 xmax 60 ☑ Cursor xGrid 10 ☑ Grid

ymin -60 ymax 60 Set limits yGrid 10 Set grid

	Name	Tag	X coor	Y coor	Show	pt:R	pt:G	pt:B	pSize
1	Point1	FRC1	-50	-30	☑	0	0	1	medium
2	Point2	FRC2	50	-30	☑	0	0	1	medium
3	Point3	FRC3	50	30	☑	0	0	1	medium
4	Point4	FRC4	-50	30	☑	0	0	1	medium

☑ Snap free □ Snap to Grid □ Snap to Points | Tolerance [%] 4

	Name	Tag	IFS	Poly	Show
1	Polyg1	FRC	☑	0	☑

	ID	Name	Tag
1	1	Point1	FRC1
2	2	Point2	FRC2
3	3	Point3	FRC3
4	4	Point4	FRC4

□ Auto-fill in ☑ Show filling | FRC

0 items selected

□ All points

☑ @Move

Measuring: Distance

Simplify: Values

Iteration: 1 | 2 | 3

Apply to: ○ ● ○

Display: □ ☑ □

☑ Refresh □ Advanced

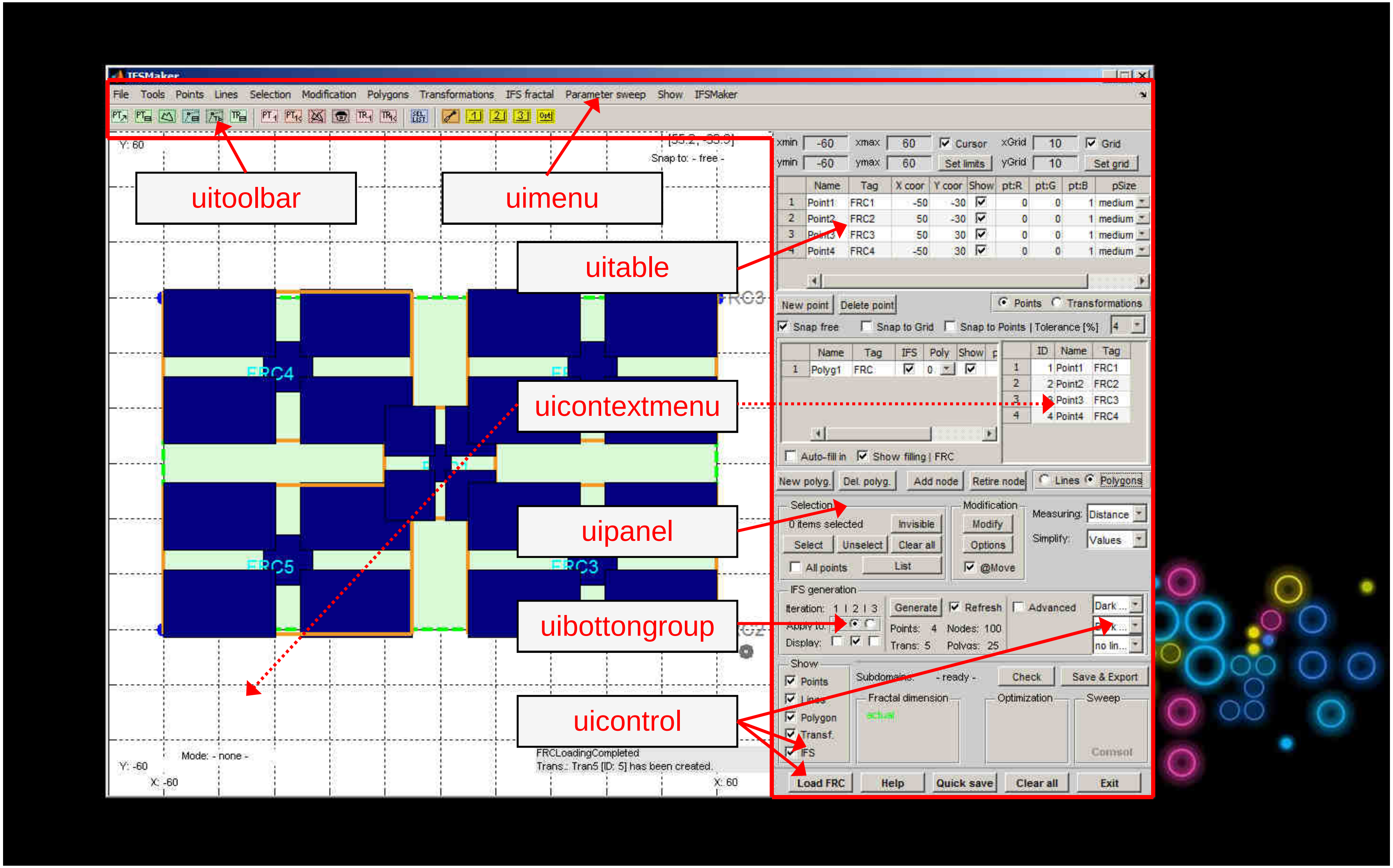
Points: 4 Nodes: 100

Trans: 5 Polygs: 25

Dark ... Dark ... no lin...

☑ Points ☑ Lines ☑ Polygon ☑ Transf. ☑ IFS

Structure of GUI #2



Y: 60

Snap to: - free -

xmin -60 xmax 60 ☑ Cursor xGrid 10 ☑ Grid
ymin -60 ymax 60 Set limits yGrid 10 Set grid

	Name	Tag	X coor	Y coor	Show	pt:R	pt:G	pt:B	pSize
1	Point1	FRC1	-50	-30	☑	0	0	1	medium
2	Point2	FRC2	50	-30	☑	0	0	1	medium
3	Point3	FRC3	50	30	☑	0	0	1	medium
4	Point4	FRC4	-50	30	☑	0	0	1	medium

● Points ○ Transformations

☑ Snap free ☐ Snap to Grid ☐ Snap to Points | Tolerance [%] 4

	Name	Tag	IFS	Poly	Show
1	Polyg1	FRC	☑	0	☑

	ID	Name	Tag
1	1	Point1	FRC1
2	2	Point2	FRC2
3	3	Point3	FRC3
4	4	Point4	FRC4

☐ Auto-fill in ☑ Show filling | FRC

○ Lines ● Polygons

0 items selected

☐ All points

☑ @Move

Measuring: Distance

Simplify: Values

Iteration: 1 | 2 | 3

Apply to: ● ○

Display: ☐ ☑ ☐

☑ Refresh ☐ Advanced

Points: 4 Nodes: 100

Trans: 5 Polygs: 25

Dark ...

Dark ...

no lin...

☑ Points
☑ Lines
☑ Polygon
☑ Transf.
☑ IFS

Subdomains: - ready -

Mode: - none -

FRCLoadingCompleted
Trans.: Trans5 [ID: 5] has been created.

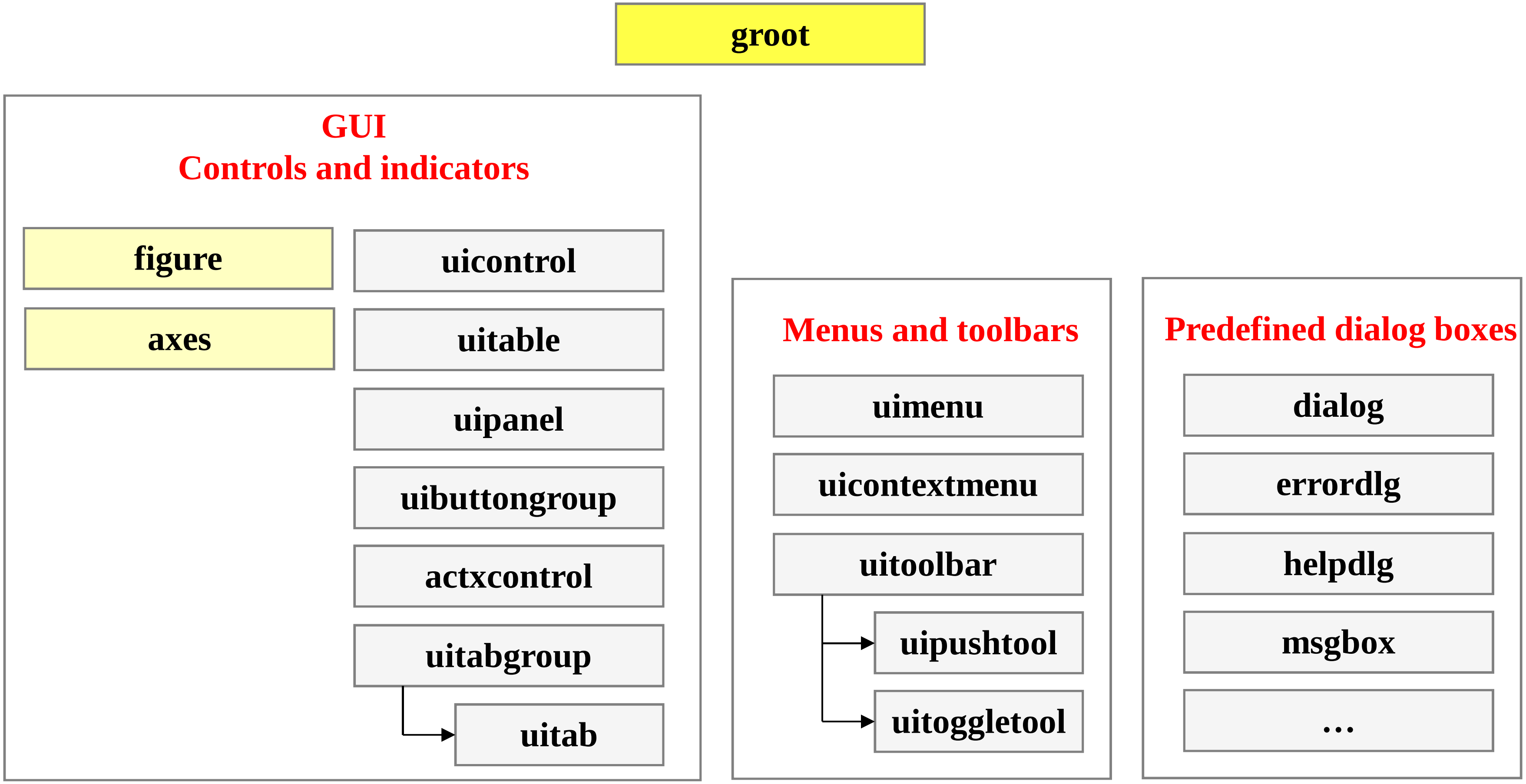
Y: -60

X: -60

X: 60

Structure of GUI

- objects are sorted in a logical way



groot

GUI
Controls and indicators

figure

axes

uicontrol

uitable

uipanel

uibuttongroup

actxcontrol

uitabgroup

uitab

Menus and toolbars

uimenu

uicontextmenu

uitoolbar

uipushtool

uitoggletool

Predefined dialog boxes

dialog

errordlg

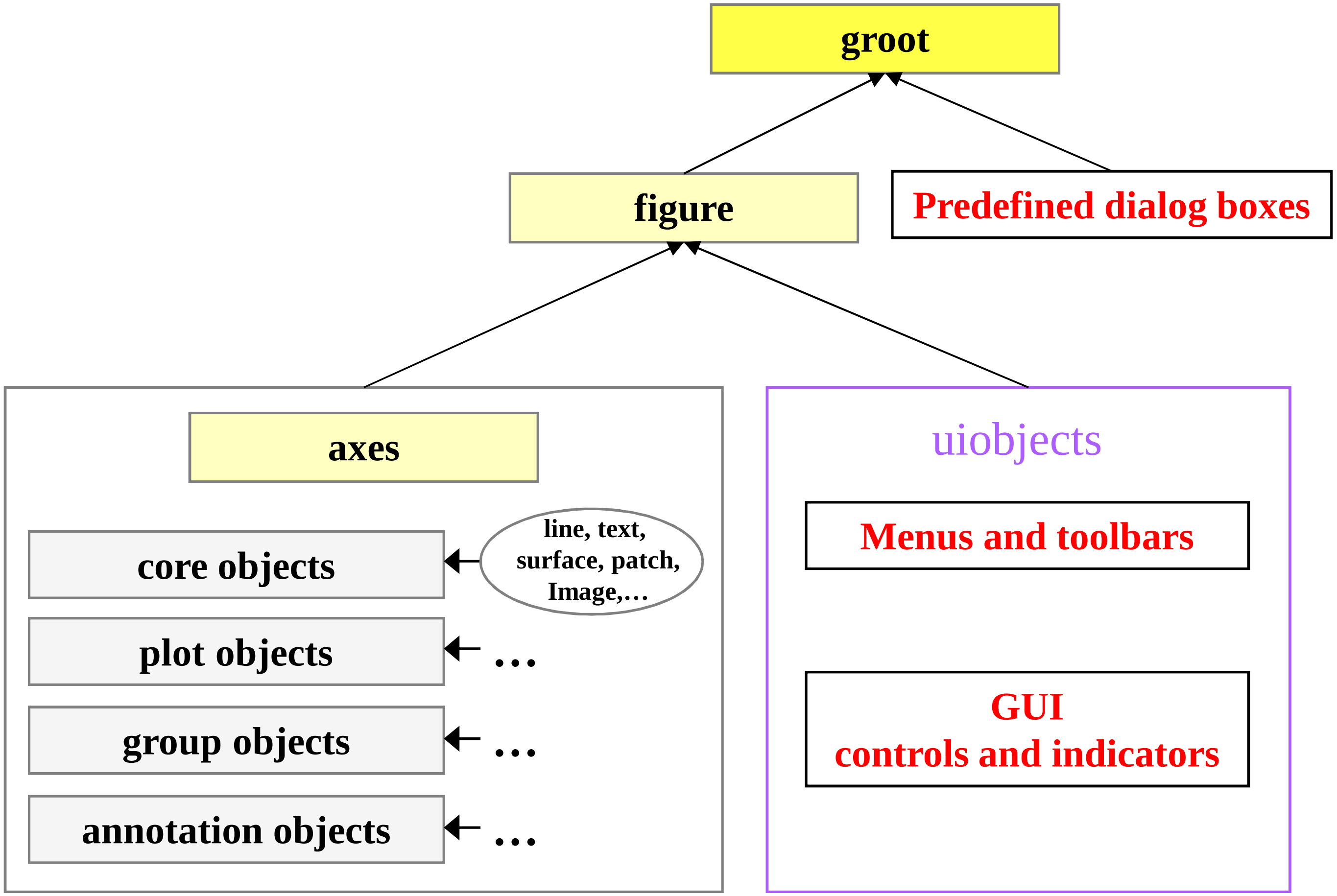
helpdlg

msgbox

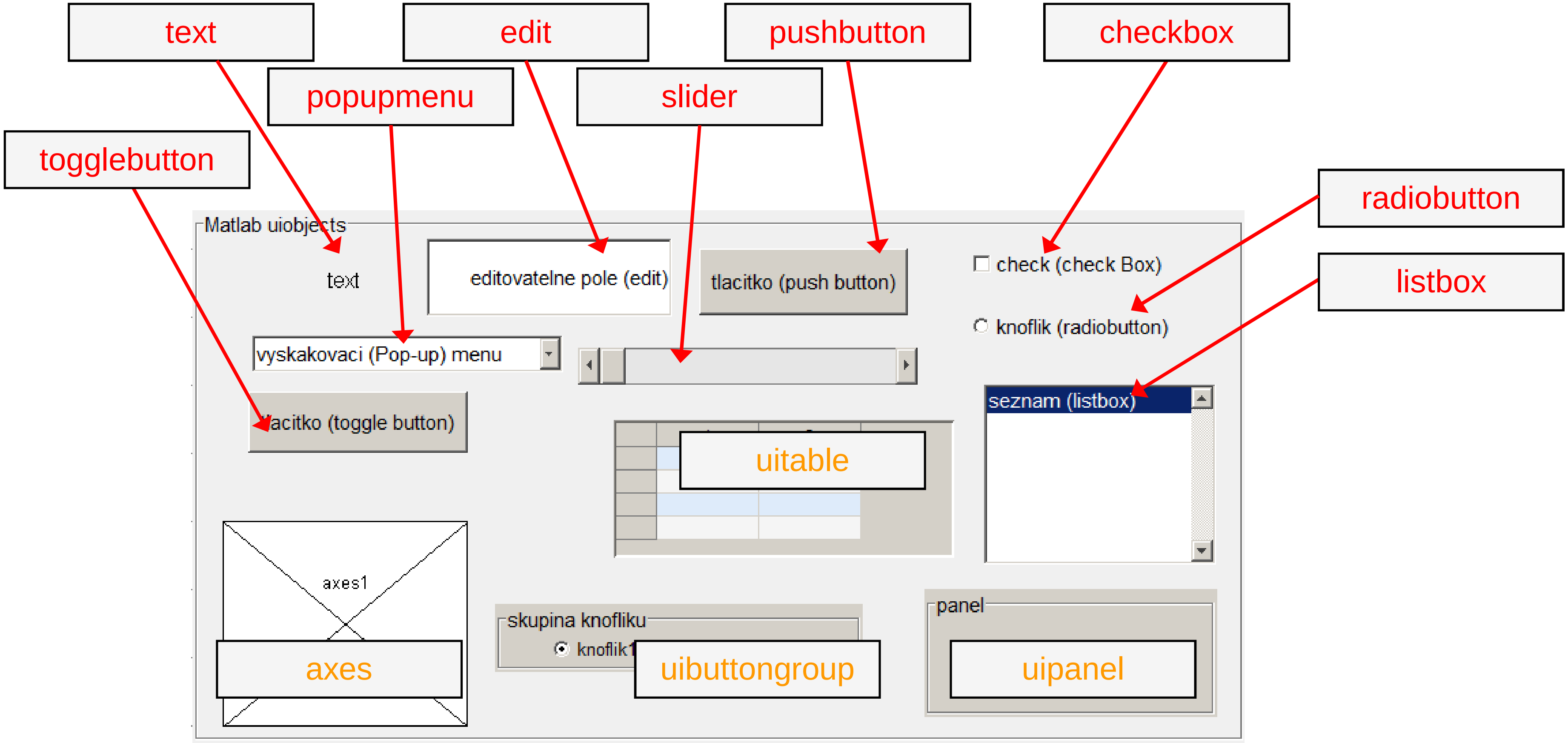
…

Structure of GUI

- object hierarchy

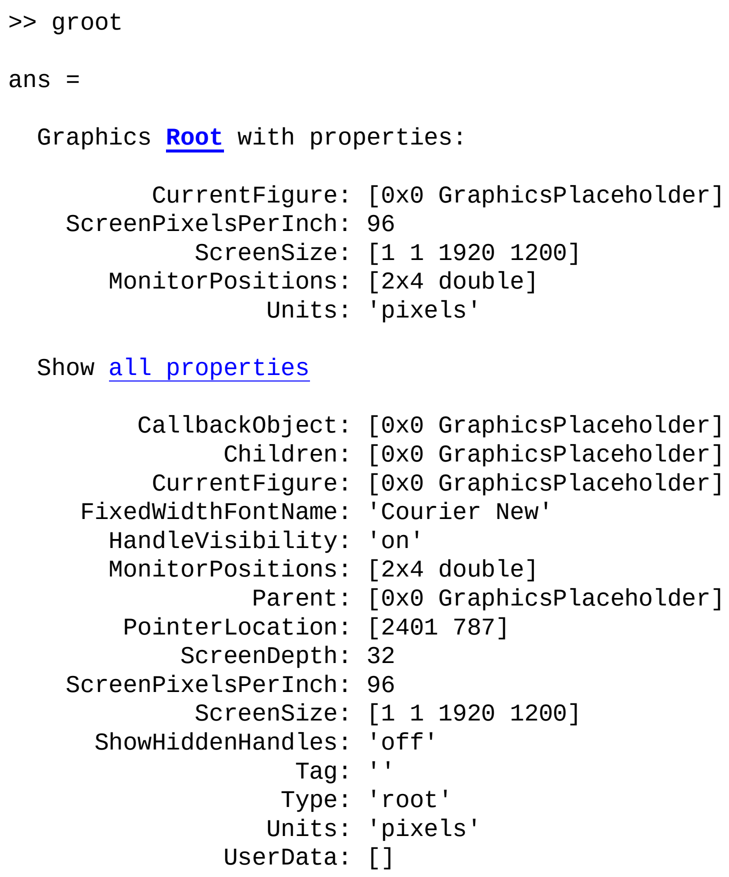


Structure of GUI #3



Screen properties, `groot`

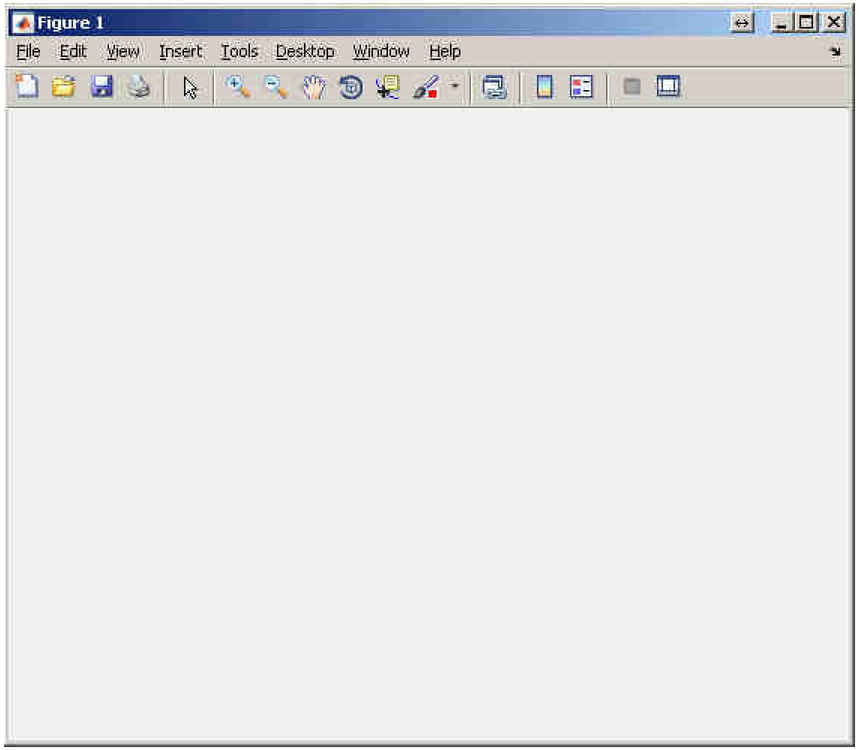
- corresponds to computer screen in Matlab
- is unique and callable using function
  - `get(0)`
    - in workspace – data structure
  - `groot`
    - in workspace – handle object
- all other objects are children (descendants)



```
>> groot

ans =

  Graphics Root with properties:

          CurrentFigure: [0x0 GraphicsPlaceholder]
    ScreenPixelsPerInch: 96
             ScreenSize: [1 1 1920 1200]
       MonitorPositions: [2x4 double]
                  Units: 'pixels'

  Show all properties

         CallbackObject: [0x0 GraphicsPlaceholder]
               Children: [0x0 GraphicsPlaceholder]
          CurrentFigure: [0x0 GraphicsPlaceholder]
     FixedWidthFontName: 'Courier New'
       HandleVisibility: 'on'
       MonitorPositions: [2x4 double]
                 Parent: [0x0 GraphicsPlaceholder]
        PointerLocation: [2401 787]
            ScreenDepth: 32
    ScreenPixelsPerInch: 96
             ScreenSize: [1 1 1920 1200]
      ShowHiddenHandles: 'off'
                    Tag: ''
                   Type: 'root'
                  Units: 'pixels'
               UserData: []
```

Graphical window, `figure`

- object `figure` creates standalone graphical window
  - a new window is created on calling the function when the window doesn't exist
  - all windows are descendants of the object `groot`
  - all secondary graphic objects are descendants of the object `figure` and are drawn in the window
  - `figure` has many properties
    - see `get(figure)`
    - `hFig = figure`



Position property

- Matlab combines size of an object and its position in one matrix
- two ways of entering exist

  (A) absolute position in pixels

  (B) normalized position related to the size of parent object

```
[left bottom width height]
```

```
%% A)
uicontrol('Units','pixels',...
          'Style','pushbutton',...
          'Position',[50 150 75 25]);
%% B)
uicontrol('Units','normalized',...
          'Style','pushbutton ',...
          'Position',[0.05 0.12 0.1 0.05]);
```

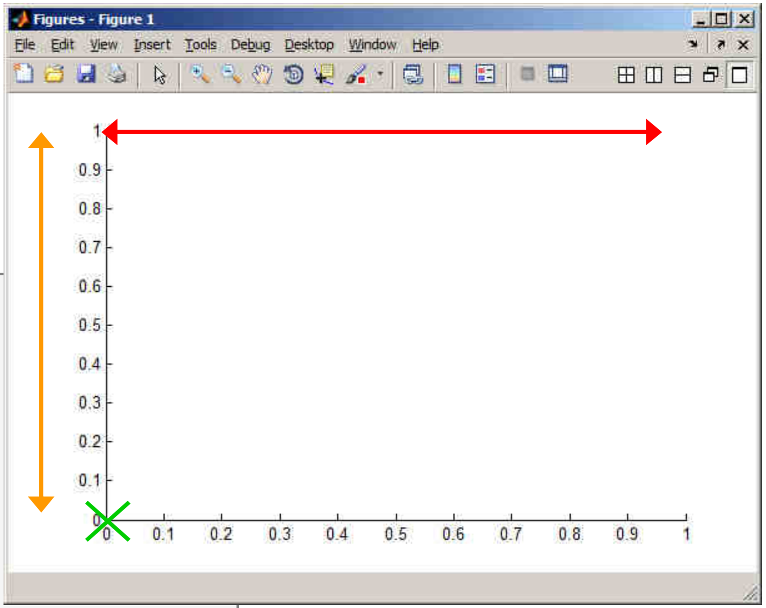
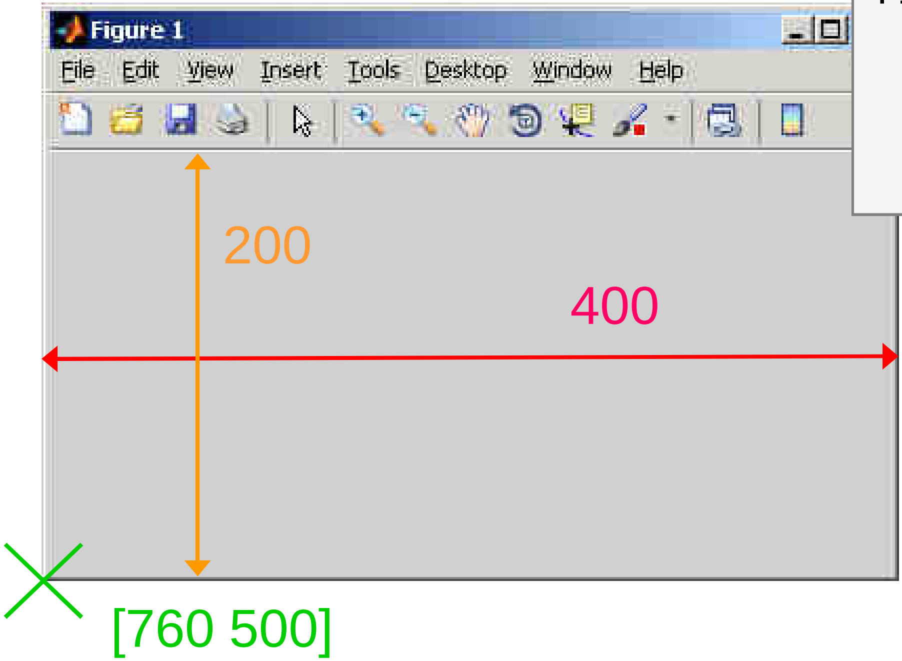


Figure creation

- used when we want, for instance, to put `figure` in the center of the screen
  - window width: 400px, window height: 200px

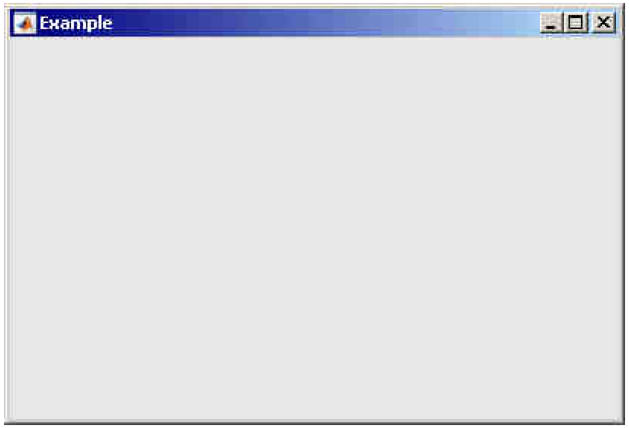
```
dispSize = get(0, 'ScreenSize');
figSize = [400 200];
figHndl = figure('pos', ...
     [(dispSize(3)-figSize(1))/2 ...
      (dispSize(4)-figSize(2))/2 ...
       figSize(1)  figSize(2)]);
```



Exercise – GUI window creation

400 s

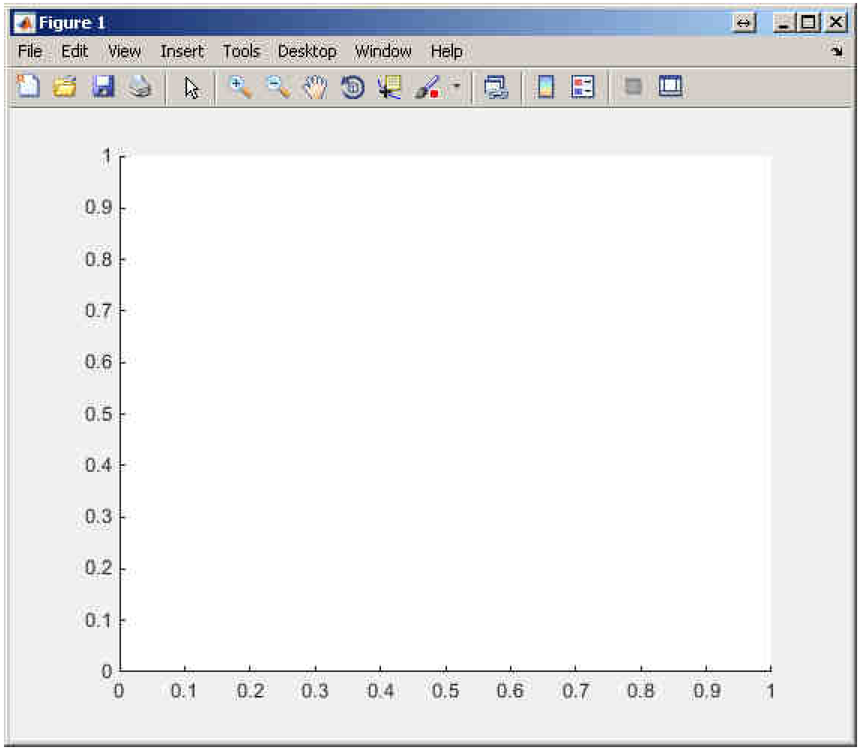
- in a new script that we will be extending throughout todays lecture create a `figure` window that opens in the center of the screen having width of 400 pixels and height of 250 pixels
  - make sure the figure's name is „Example“ and the title `figure 1` doesn’t display
  - use `Tag` property for naming (e.g. `'figExample'`)
  - change window’s color (up to you)



Graph area, `axes`

- defines area where descendants of object `axes` are placed
- all objects related to `axes` object generate axes even when not yet exist (similarly to `figure`)
- `axes` has many properties
  - see `get(axes)`

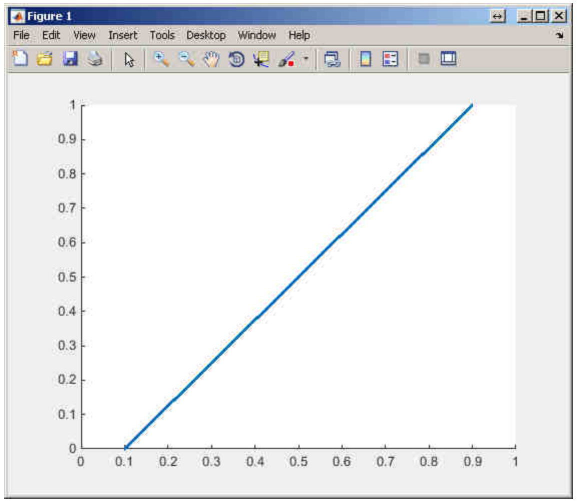
  or
  - `properties(axes)`

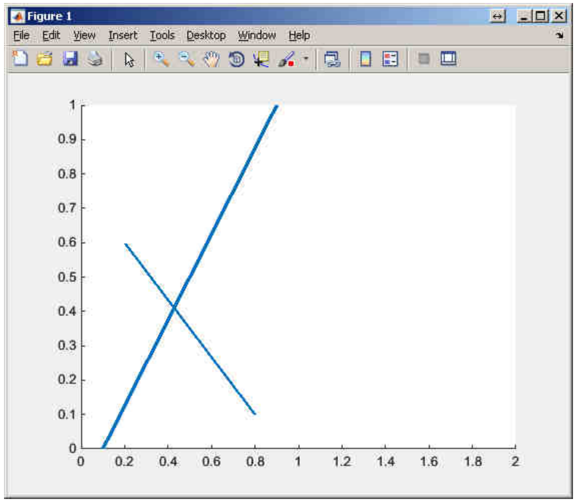


Function axis

- axis scales axes
  - format (2D): [x_min x_max y_min y_max]
  - format (3D): [x_min x_max y_min y_max z_min z_max]

```
line([0.1 0.9], [0 1], 'LineWidth', 3)
axis([0 1 0 1])
```



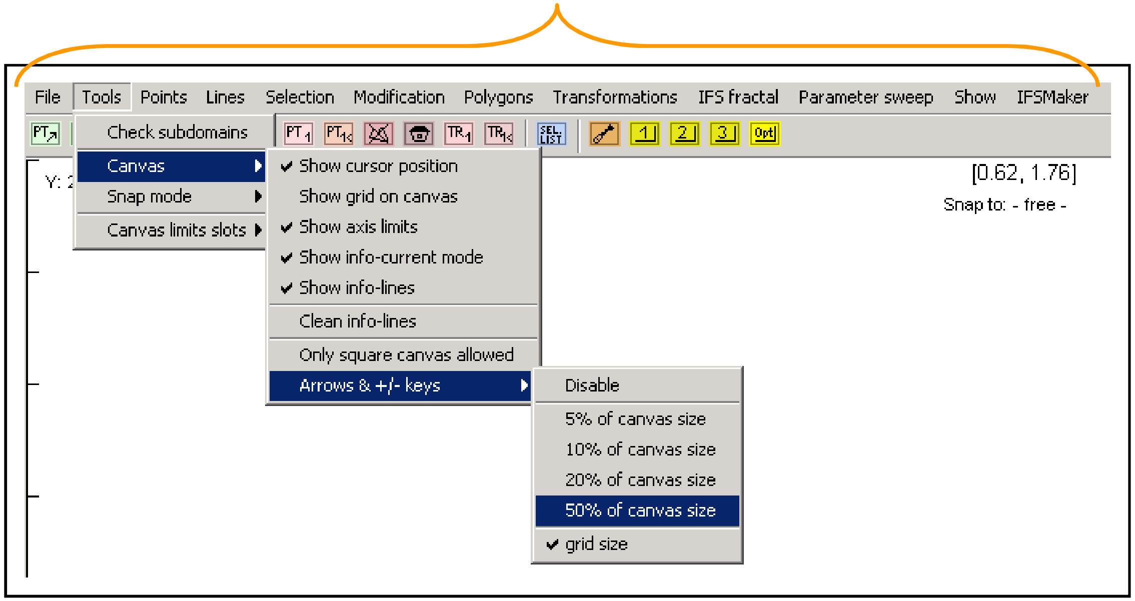


```
line([0.8 0.2], [0.1 0.6], 'LineWidth', 2)
axis([0 2 0 1])
```

Group uiobjects: `uimenu`

- it is possible to define keyboard shortcuts (e.g. CTRL+L)
- it is possible to move in the menu using ALT+character
- `callback` function can be assigned

490 lines of code



- for more see `help uimenu`

uiobjects

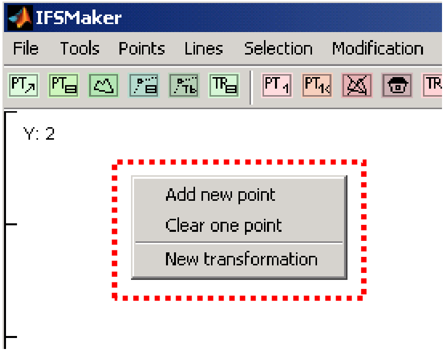
- uimenu
- uicontextmenu
- uitoolbar
- uipanel
- uitabgroup
- uitable
- uibuttongroup
- actxcontrol
- uicontrol

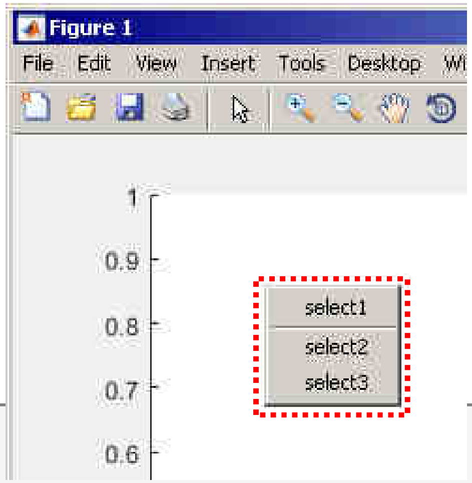
Group uiobjects: `uicontextmenu`

uiobjects

- uimenu
- uicontextmenu
- uitoolbar
- uipanel
- uitabgroup
- uitable
- uibuttongroup
- actxcontrol
- uicontrol

- creates context menu
  - appears upon mouse right-click
  - menu item selection activates related callback

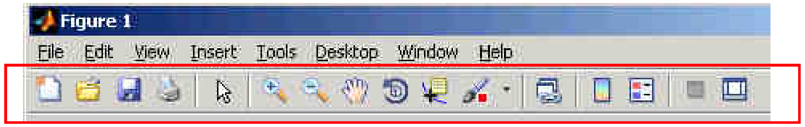


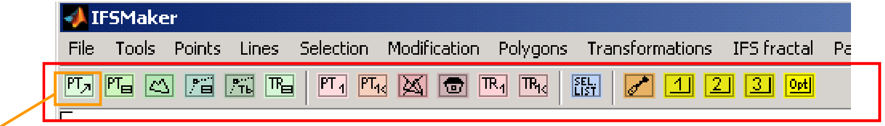


```
figHndl = figure;
cMenu   = uicontextmenu;
axsHndl = axes('Parent',figHndl,'UIContextMenu',cMenu);
uimenu(cMenu,'Label', 'select1','Callback',@callbackFcn1);
uimenu(cMenu,'Label', 'select2','Callback',@callbackFcn2,...
    'Separator','on');
uimenu(cMenu,'Label', 'select3','Callback',@callbackFcn3);
```

Group uiobjects: `uitoolbar`

- it is possible to create own menu icons in Matlab
  - not complicated but out of scope of this course
  - for those interested see >> `doc uitoolbar`




IFSMaker
File Tools Points Lines Selection Modification Polygons Transformations IFS fractal Pa
1
2
3
Opt

icon ‘drawn‘ in m-file

```
pics = [1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 1;...
        1 .6 .6 .6 .6 .6 .6 .6 .6 .6 .6 .6 .6 .6 .6 .6 .6 .6 .6 1;...
        1 .6  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 .6 1;...
        1 .6  1  0  0  0  1  0  0  0  0  0  1  1  1  1  1  1 .6 1;...
        1 .6  1  0  1  1  0  1  1  0  1  1  1  1  1  1  1  1 .6 1;...
        1 .6  1  0  1  1  0  1  1  0  1  1  1  1  1  1  1  1 .6 1;...
        1 .6  1  0  0  0  1  1  1  0  1  1  1  1  1  1  1  1 .6 1;...
        1 .6  1  0  1  1  1  1  1  0  1  1  1  0  0  0  0  1 .6 1;...
        1 .6  1  0  1  1  1  1  1  0  1  1  1  1  1  0  0  1 .6 1;...
        1 .6  1  0  1  1  1  1  1  0  1  1  1  1  0  1  0  1 .6 1;...
        1 .6  1  1  1  1  1  1  1  1  1  1  1  0  1  1  0  1 .6 1;...
        1 .6  1  1  1  1  1  1  1  1  1  1  0  1  1  1  1  1 .6 1;...
        1 .6  1  1  1  1  1  1  1  1  1  0  1  1  1  1  1  1 .6 1;...
        1 .6  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 .6 1;...
        1 .6 .6 .6 .6 .6 .6 .6 .6 .6 .6 .6 .6 .6 .6 .6 .6 .6 .6 1;...
        1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1  1 1];
icon(:,:,1) = .85. * pics;
icon(:,:,2) = .98. * pics;
icon(:,:,3) = .85. * pics;
```

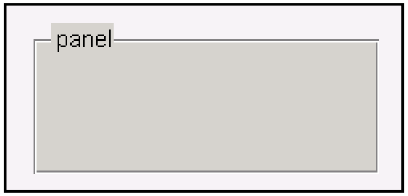
- way of icon placement
  - >> `doc uipushtool`
  - >> `doc uitoggletool`

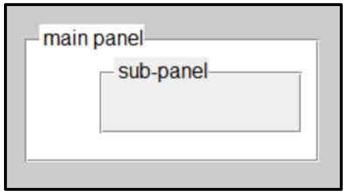
uiobjects

- uimenu
- uicontextmenu
- uitoolbar
- uipanel
- uitabgroup
- uitable
- uibuttongroup
- actxcontrol
- uicontrol

Group uiobjects: uipanel

- create panel as a parent to other objects
- objects inside are oriented related to the panel
- many features available (see >> doc uipanel)





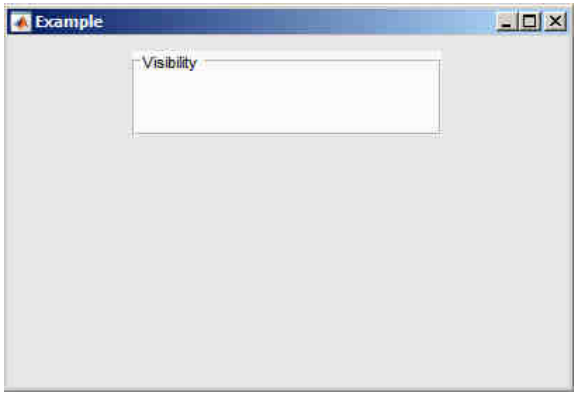
```
fgHnd = figure;
h1p   = uipanel('Title', 'main panel', ...
         'FontSize', 12, 'BackgroundColor', ...
         'white', 'Position', [0.25 0.25 0.4 0.25]);
h2p   = uipanel('Parent', h1p, ...
         'Title', 'sub-panel', 'FontSize', 12, ...
         'Position', [0.25 0.25 0.7 0.7]);
```

uiobjects
uimenu
uicontextmenu
uitoolbar
uipanel
uitabgroup
uitable
uibuttongroup
actxcontrol
uicontrol

Exercise – `panel`

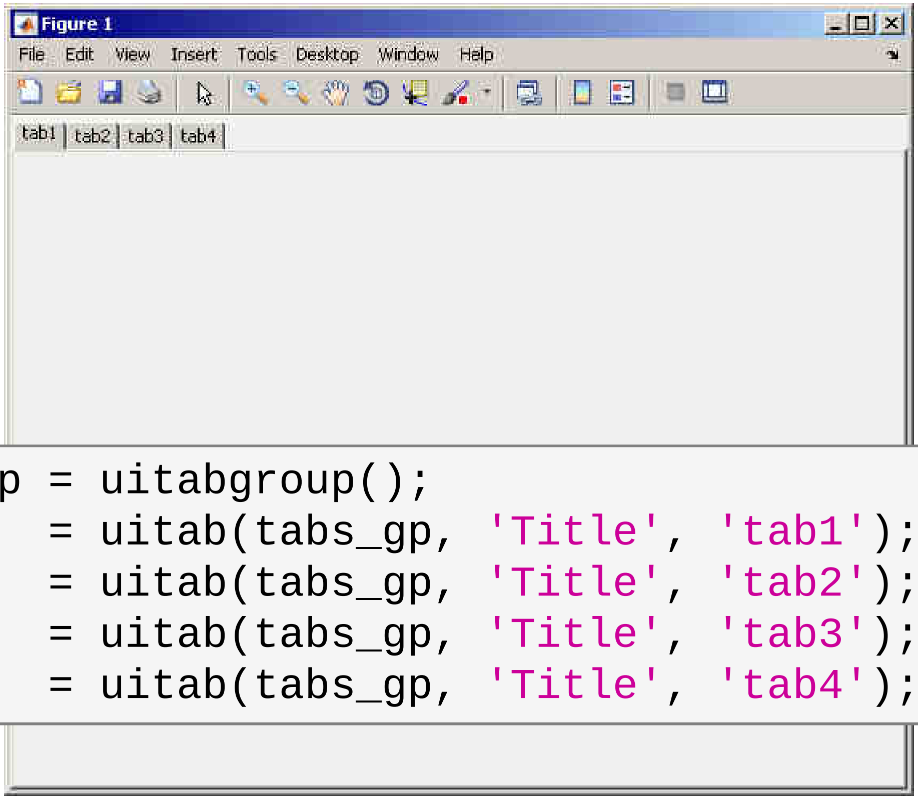
400 s ↑

- create panel and place it to position `[90 180 220 60]` px
- call the panel „Visibility“, set `Tag` to „panelVisibility“
- find out its color and store it in a variable which we will be later using to unify colors of other objects within the panel



Group uiobjects: uitab

- creates a tab that will be parent for other object (same as with panel)
- for more see >> doc uitabgroup



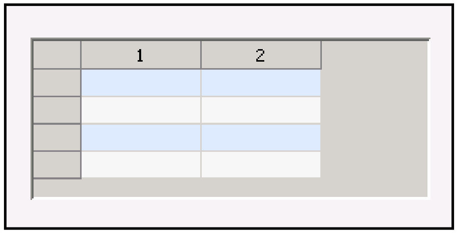
```
tabs_gp = uitabgroup();
tabs_1  = uitab(tabs_gp, 'Title', 'tab1');
tabs_2  = uitab(tabs_gp, 'Title', 'tab2');
tabs_3  = uitab(tabs_gp, 'Title', 'tab3');
tabs_4  = uitab(tabs_gp, 'Title', 'tab4');
```

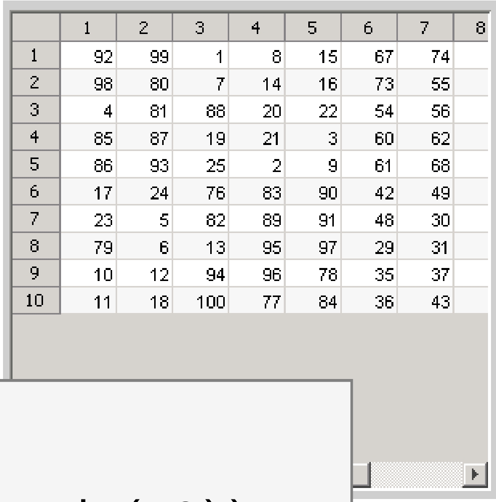
uiobjects

- uimenu
- uicontextmenu
- uitoolbar
- uipanel
- **uitabgroup**
- uitable
- uibuttongroup
- actxcontrol
- uicontrol

Group uiobjects: `uitable`

- creates a 2D table
  - can be placed anywhere in the `figure` window
  - has a wide range of properties and items (check, popup)
- see `>> doc uitable`





	1	2	3	4	5	6	7	8
1	92	99	1	8	15	67	74	
2	98	80	7	14	16	73	55	
3	4	81	88	20	22	54	56	
4	85	87	19	21	3	60	62	
5	86	93	25	2	9	61	68	
6	17	24	76	83	90	42	49	
7	23	5	82	89	91	48	30	
8	79	6	13	95	97	29	31	
9	10	12	94	96	78	35	37	
10	11	18	100	77	84	36	43	

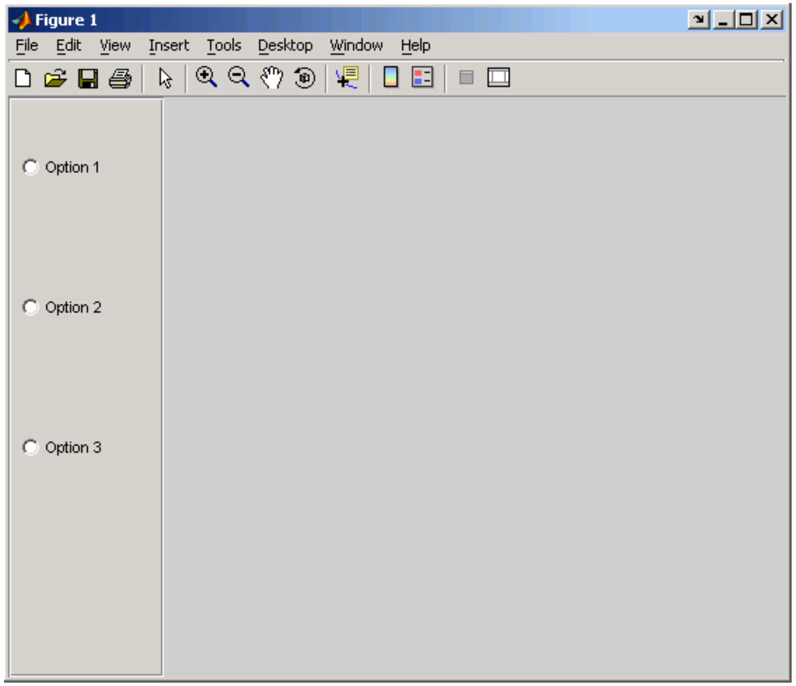
```
>> figure
>> t = uitable;
>> set(t, 'Data', magic(10));
>> set(t, 'ColumnWidth', {35})
```

uiobjects

- uimenu
- uicontextmenu
- uitoolbar
- uipanel
- uitabgroup
- uitable
- uibuttongroup
- actxcontrol
- uicontrol

Group uiobjects: `uibuttongroup`

- block with a group of buttons
- for more see >> `doc uibuttongroup`



Group uiobjects: `actxcontrol`

- enables to create Microsoft ActiveX control in the `figure` window

  - seznam podporovaných Microsoft ActiveX control

```
>> list = actxcontrollist
>> h    = actxcontrolselect
```

  - examples
    - web browser

```
>> h = actxcontrol('AcroPDF.PDF.1',...
```

    - PDF reader

```
>> h = actxcontrol('Shell.Explorer.2',...
```

  - for more information see

```
>> docsearch getting started with COM
```

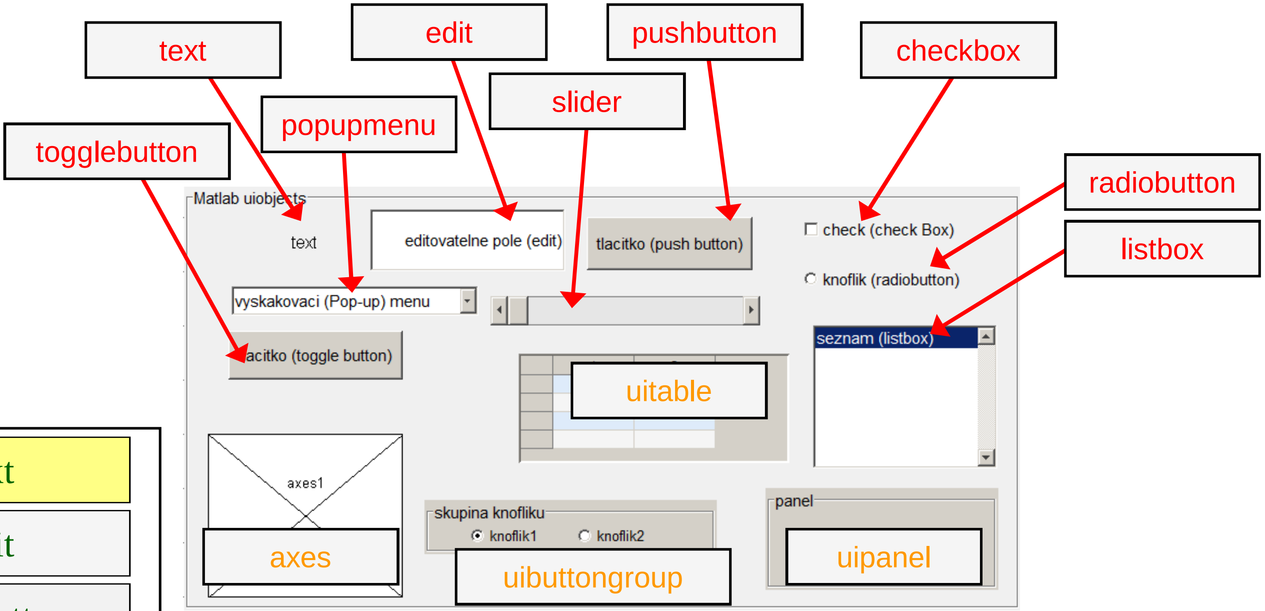
uiobjects

- uimenu
- uicontextmenu
- uitoolbar
- uipanel
- uitabgroup
- uitable
- uibuttongroup
- **actxcontrol**
- uicontrol

Group uiobjects: `uicontrol`

uiobjects

- uimenu
- uicontextmenu
- uitoolbar
- uipanel
- uitabgroup
- uitable
- uibuttongroup
- actxcontrol
- uicontrol
  - text
  - edit
  - pushbutton
  - radiobutton
  - checkbox
  - listbox
  - slider
  - popupmenu
  - togglebutton



Group uiobjects: uicontrol

- uicontrol creates basic functional elements of GUI
- to change style of uicontrol use property style

```
>> t = uicontrol;
>> set(t, 'Style', 'text');
```

- to get properties of uicontrol use

```
>> get(t);
```

- for more see >> doc uicontrol

uiobjects

uimenu

uicontextmenu

uitoolbar

uipanel

uitabgroup

uitable

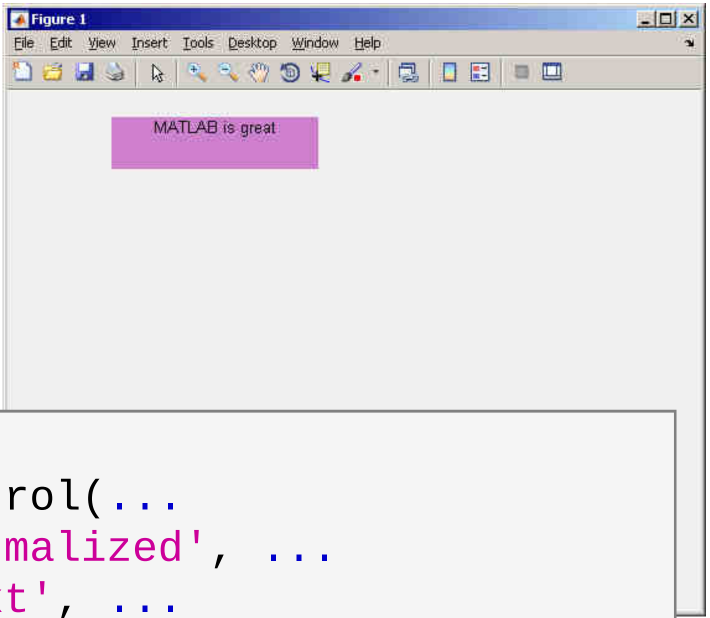
uibuttongroup

actxcontrol

uicontrol

Group uicontrol: `text`

- place text at a given spot
- usually used to
  - as a label for other items
  - information text for user



```
>> figure
>> text1 = uicontrol(...
    'Units', 'Normalized', ...
    'Style', 'Text', ...
    'Position', [0.15 0.85 0.3 0.1], ...
    'Tag', 'MTB', ...
    'FontSize', 10, ...
    'BackgroundColor', [0.8 0.5 0.8], ...
    'HorizontalAlignment', 'center', ...
    'String', 'MATLAB is great');
```

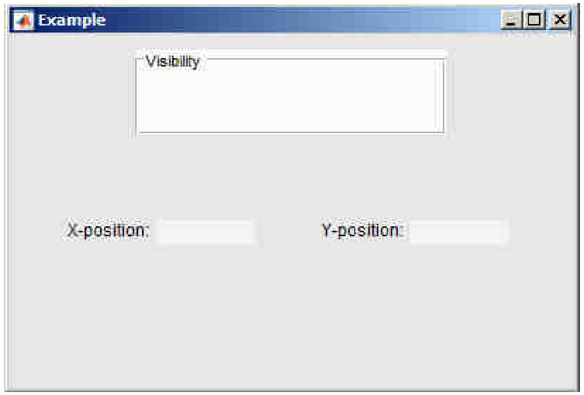
uicontrol

- text
- edit
- pushbutton
- radiobutton
- checkbox
- listbox
- slider
- popupmenu
- togglebutton

Exercise – text

400 s ↑

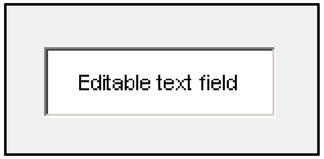
- create four text arrays having following properties that will be placed to following positions (normalized values)
  - `[0.1  0.4 0.15  0.075]  font  9   figureColor`
  - `[0.26 0.4 0.175 0.075]  font 10   textColor`
  - `[0.55 0.4 0.15  0.075]  font  9   figureColor`
  - `[0.71 0.4 0.175 0.075]  font 10   textColor`
- assign labels `X-position/Y-position` to the arrays with `figureColor,` others leave without labels
- assign its own handle to each text array



Exercise – `text`, solution

Group uicontrol: `edit`

- enables to read an array of characters
  - the array of characters is of type `char`
  - the string has to be processed (`str2num`, `str2double`,…)
- CTRL+C,+V,+X,+A,+H shortcuts are available to user
- a console can be created using `edit` in Matlab



Editable text field

uicontrol

text

edit

pushbutton

radiobutton

checkbox

listbox

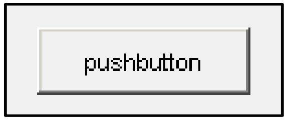
slider

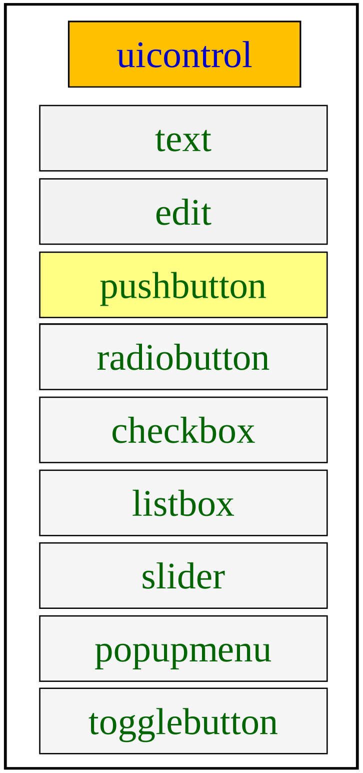
popupmenu

togglebutton

Group uicontrol: `pushbutton`

- one-state button
- `callback` function is called on push
- appearance setting is similar to object `text`




uicontrol

text

edit

pushbutton

radiobutton

checkbox

listbox

slider

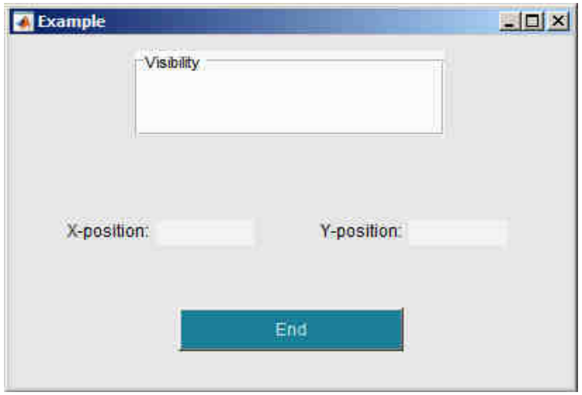
popupmenu

togglebutton

Exercise – `pushbutton`

400 s ↑

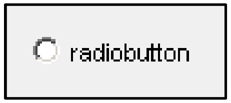
- create a button with label „End“
  - place it at (normalized) position `[0.3 0.1 0.4 0.125]`
  - font size set to 9
  - background color: `[0.1 0.5 0.6]`
  - text color: `[0.8 0.9 0.9]`



Group uicontrol: `radiobutton`

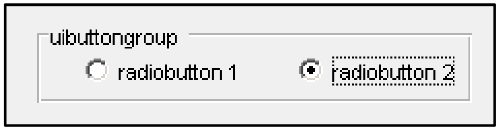
uicontrol
text
edit
pushbutton
radiobutton
checkbox
listbox
slider
popupmenu
togglebutton

- two-state (on/off)



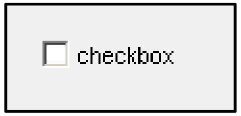
- these elements can be grouped
  - button group (object `uibuttongroup`)

- `callback` function can detect switching from one radiobutton to other



Group uicontrol: checkbox

- similar to `radiobutton`
- tick box (with a text attached)
- `callback` called on state change



```
function checkboxFcn(hObject) % treated
%% to find out, whether the box is ticked
if hObject.Value % ticked
  % ...
else % not ticked
  % ...
end
```

uicontrol

text

edit

pushbutton

radiobutton

checkbox

listbox

slider

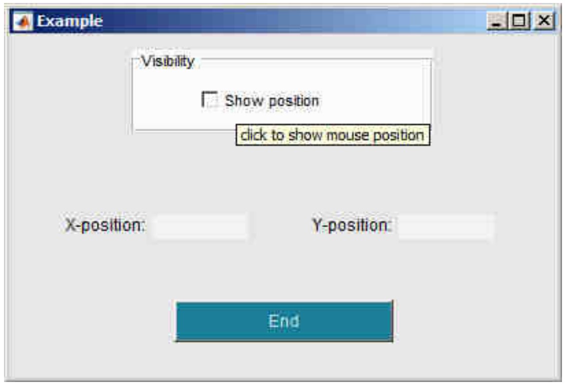
popupmenu

togglebutton

Exercise – checkbox

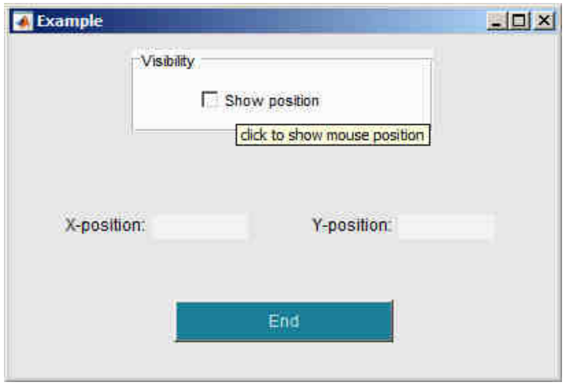
400 s ↑

- create a checkbox placed inside panel `panel1`
- the label is „Show position“
  - make sure to show hint help on mouse cursor close to the checkbox
- assign its own tag to the checkbox
- set the same background color as that of panel



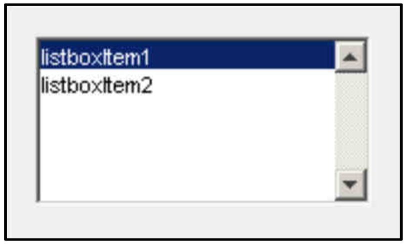
Exercise

- Save your GUI file for later use (during next lecture)



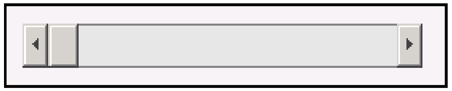
Group uicontrol: `listbox`

- list of items, it is possible to choose one or more items
- property `string` contains list of strings (items)
- property `value` contains matrix of selected items
- values `max` and `min` have impact on selection

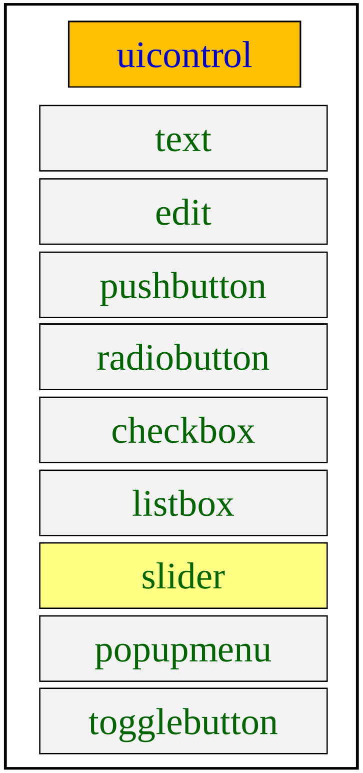


Group uicontrol: `slider`

- input value is a numerical range (`min` and `max`)
- user moves slider by steps (`sliderstep`)
- requires
  - range
  - slider step
  - initial value



```
maxVal = 10;
minVal = 2;
slider_step(1) = 0.4/(maxVal-minVal);
slider_step(2) = 1/(maxVal-minVal);
set(sliderHndl, 'SliderStep', ...
    slider_step, 'Max', maxVal, ...
    'Min', minVal, 'Value', 6.5);
```



uicontrol

text

edit

pushbutton

radiobutton

checkbox

listbox

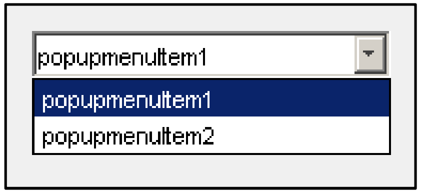
slider

popupmenu

togglebutton

Group uicontrol: popupmenu

- clicking on arrow displays item list and enables to choose one item
  - `string` contains list of strings
  - `value` contains index of the selected item
- more info >> `doc uicontrol`



```
function popupFcn(hObj) % treated
val = get(hObj,'Value');

string_list     = get(hObj,'String');
selected_string = string_list{val};
% ...
```

uicontrol

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checkbox

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slider

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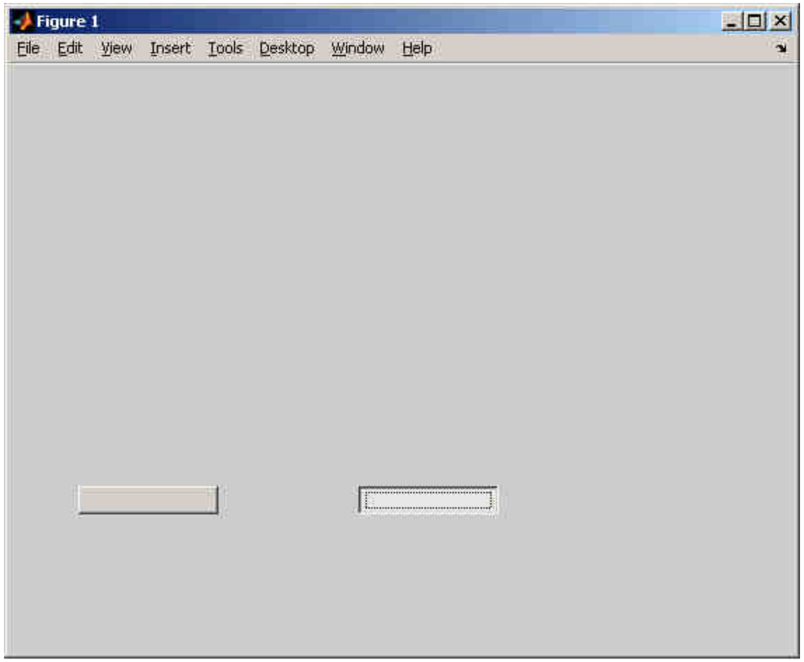
togglebutton

Group uicontrol: `togglebutton`

- toggle button
    - stays turned on after clicking
- more info >> `doc uicontrol`



uicontrol

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checkbox

listbox

slider

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togglebutton

Discussed functions

`get, set`	get or set object’s property	●
`subplot`	placing more graphs in one figure	●
`plotyy, semilogy, semilogx, loglog,`	2D graphs with modified axis/axes	●
`pie, stairs, contour, quiver`	2D graphs	●
`image, imagesc`	draw matrix as a picture	●
`pie3, mesh, slice, scatter`	3D graphs	●
`colormap`	change colormap of a plot	●
`view`	defines view of 3D graph	●
`axis`	sets axis range	●

Exercise 1

600 s

- create function with two inputs and one output

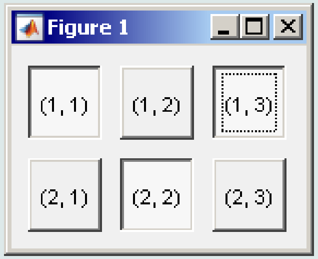
```
function logicState = createToggles(nRows, nColumns)
% function generating GUI with toggle buttons
```

- function creates figure with toggle buttons arranged in matrix `nRows` x `nColumns`
- after clicking on toggle buttons and close window function returns matrix of logical values representing state of toggle buttons

```
>> logicState = createToggles(2, 3)

logicState =

     1     0     1
     0     1     0
```



Exercise 1 - solution

Thank you!

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