

AE0B17MTB – Matlab

# Part #10



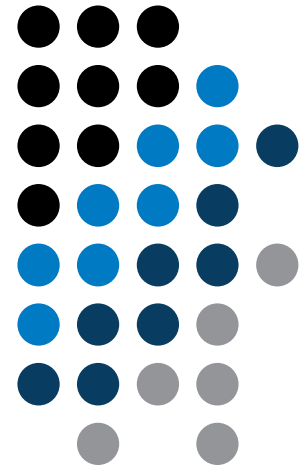
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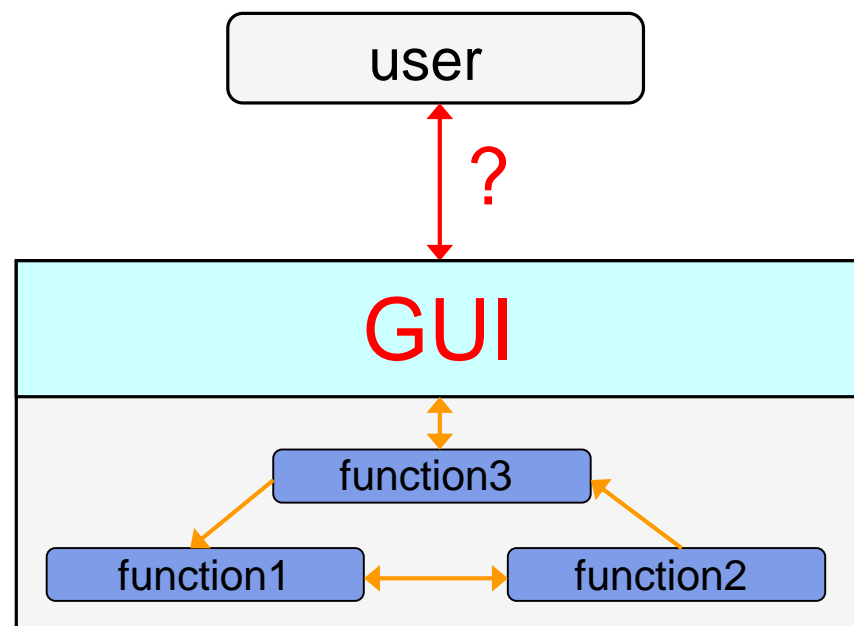
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# Learning how to ...

GUI #2



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

# Techniques of GUI design - sorting

- there exist several approaches (methodologies) to create GUI
  - design using GUIDE tool
    - not recommended
  - design using App Designer (from R2016a)
    - new graphic objects ('old' objects are not supported)
  - switch-board technique
    - not recommended
  - utilization of side and nested functions as callback functions
    - standard
  - fully OOP approach (including functional part of the code)
    - ideal

```
>> guide
```

```
>> appdesigner
```


# Callback function

- there are user-evoked events defined related to each object (button click, list selection, ...)
- these events are served by so called callback functions
  - in other words, when user pushes button, callback function of this event is activated (if defined).
- when GUI is not to be static, it has to contain at least one callback function
- callback function is stored as an object property – it is possible to change it, delete it, copy it etc.

# Evaluation of callback function

- callback function is evaluated as a handle function

```
hb = uicontrol('Style', 'pushbutton', 'String', 'Plot line')  
  
% Calling function using handle function  
set(hb, 'Callback', @myFunc)
```




```
function myFunc(hObject, callbackdata)  
% Callback function always adds two basic inputs  
  
hObject      % reference to the object raising the callback  
callbackdata % object describing event
```

# Evaluation of callback function

- callback function is evaluated as an anonymous function

```
hb = uicontrol('Style', 'pushbutton', 'String', 'Plot line')  
  
% TIP - anonymous function can be used in the case of  
calling a function that doesn't support basic inputs of  
callback function  
set(hb, 'Callback', @(src, event)myFunc(inp))
```




```
function myFunc(inp)
```

```
inp % the input are only variables defined by user
```

# Evaluation of callback function

- callback function is evaluated as a handle function

```
hb = uicontrol('Style', 'pushbutton', 'String', 'Plot line')  
  
% Cell array, where first element is a handle function  
set(hb, 'Callback', {@myFunc, inp1, ..., inpN})
```



```
function myFunc(hObject, callbackdata, inp1, ..., inpN)  
% Basic inputs added to first positions again  
  
 hObject      % reference to the object raising the callback  
callbackdata  % structure of various events (can be empty)  
  
inp1, ..., inpN % other inputs
```

# Evaluation of callback function

- **Ex.:** change background color of push button and change its label to 'Done' when clicked

```
function GUI
close all
hButt = uicontrol('Units', 'normalized', 'Style', 'pushbutton', 'String', ...
    'pushbutton', 'ForegroundColor', 'white', ...
    'BackgroundColor', [0.7 0.2 0], 'FontWeight', 'bold', ...
    'FontSize', 11, 'Position', [0.1 0.65 0.15 0.1]);
hButt.Callback = @pressButton;
end

function pressButton(scr, event)
% scr and event are default parameters returned by callback functions
% scr - callback source (button handle object in this case)
% event - info on event raised (sometimes usefull)

disp(scr); % check list - object handle
disp(event); % show info on raised event
set(scr, 'String', 'Done', 'BackgroundColor', rand(1, 3));
end
```



# Evaluation of callback function

- callback function is evaluated as a string

```
hb = uicontrol('Style', 'pushbutton', 'String', 'Plot line')  
hb.Callback = 'plot(rand(20,3))';
```

- very limited possibilities
  - the string can contain variables as well
    - only the variables from base Workspace are evaluated correctly
  - GUI is usually created in functions
    - source handle object is not available
    - it is possible to call just scripts or main functions with predefined inputs

# Callback functions – list

Callback	context menu, uiobjects
CellEditCallback	uitable
CellSelectionCallback	uitable
ButtonDownFcn	axes, figure, button group, panel, uiobjects
ClickedCallback	push tool, toggle tool
CreateFcn, DeleteFcn	axes, button group, context menu, figure, menu, panel, uiobjects, ...
OffCallback, OnCallback	toggle tool
<b>ResizeFcn (&lt;R2014b)</b>	figure, panel, button group
SelectionChangeFcn	button group
KeyPressFcn	figure, uiobjects
KeyReleaseFcn	figure
WindowButtonDownFcn	figure
WindowButtonMotionFcn	figure
WindowButtonUpFcn	figure
WindowKeyPressFcn	figure
WindowKeyReleaseFcn	figure
WindowScrollWheelFcn	figure
CloseRequestFcn	figure

# Callback functions – list

Callback	context menu, uiobjects
CellEditCallback	uitable
CellSelectionCallback	uitable
ButtonDownFcn	axes, figure, button group, panel, uiobjects
ClickedCallback	push tool, toggle tool
CreateFcn, DeleteFcn	axes, button group, context menu, figure, menu, panel, uiobjects, ...
OffCallback, OnCallback	toggle tool
<b>SizeChangedFcn (&gt;=R2014b)</b>	figure, panel, button group
SelectionChangeFcn	button group
KeyPressFcn	figure, uiobjects
KeyReleaseFcn	figure
WindowButtonDownFcn	figure
WindowButtonMotionFcn	figure
WindowButtonUpFcn	figure
WindowKeyPressFcn	figure
WindowKeyReleaseFcn	figure
WindowScrollWheelFcn	figure
CloseRequestFcn	figure

# Functions `gcf`, `gca` and `gco`

- serve to easily access identifiers of objects that are currently active, in particular:
  - `gcf` – returns identifier of current object `figure`
  - `gca` – returns identifier of current object `axes`
  - `gco` – returns identifier of the object that was last to mouse-click on (tolerance is 5 px)

```
figure
figRef = gcf
```

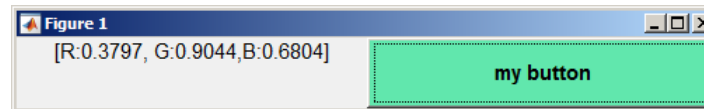
- these functions can be used as input identifiers for other functions requiring reference to object `figure` or `axes`

```
set(gcf, 'color', [0 0 0])
```

# Exercise – button callback

600 s ↑

- create figure with button and text box
- when clicking on button background color of button changes to random and displays individual RGB components in text box



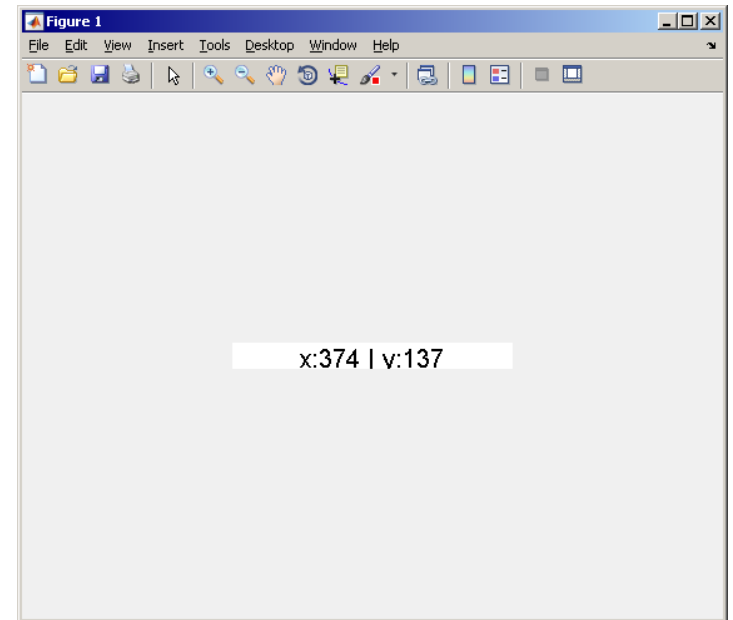
# Exercise – button, solution

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# Exercise – mouse position

600 s ↑

- create a text array showing mouse position over figure.
  - figure's callback for mouse movement is `WindowButtonMotionFcn`
  - mouse position can be found in figure property `CurrentPoint`



# Function `findobj`

- finds an object(s) with required property
- returns reference to the object (or an array of references)

```
>> figHndl = gcf;      % figHndl = figure;
>> axsHndl = gca;      % axsHndl = figure;
>> hTx1 = uicontrol('Style','text','String','hello','Tag','tx1');
>> hTx2 = uicontrol('Style','text','String','test1','Tag','tx2');
```

```
>> h = findobj('Style','text','-and','Tag','tx1')
```

h =

[UIControl](#) (tx1) with properties:

```
      Style: 'text'
      String: 'hello'
Background Color: [0.9400 0.9400 0.9400]
      Callback: ''
      Value: 0
      Position: [20 20 60 20]
      Units: 'pixels'
```

Show [all properties](#)

```
>> h = findobj('Style','text')
```

h =

2x1 UIControl array:

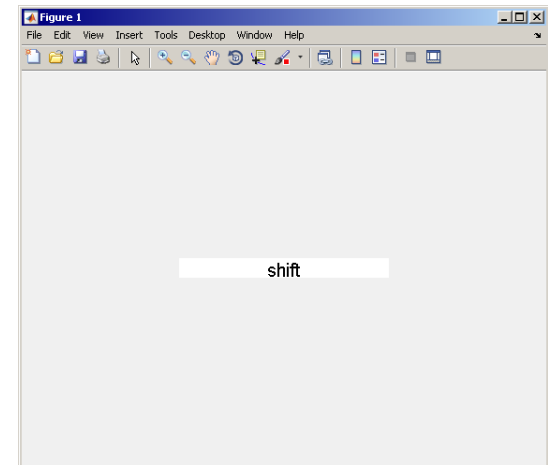
```
UIControl      (tx2)
UIControl      (tx1)
```



# Exercise – keyboard scan

600 s ↑

- create a text array that displays last key pressed
  - information on the key pressed is to be found in `event` parameter
  - figure's callback for pressing key is `WindowKeyPressFcn`
  - get the reference to the text array using `findobj`



# Function `findall`, `allchild`

- `findall` finds all graphic objects (including hidden)
- `allchild` finds all children of selected object (including hidden)
  - `handle_list` can be for instance `gcf`, `gca`, ...
  - if `handle_list` is a identifier vector, Matlab returns cell array

```
clc, clear, close all
% figure with menu
hFig = figure;
% compare
hFig.Children
get(hFig, 'Children')
findobj('Parent', hFig)
allchild(hFig)
findall(hFig, 'Parent', hFig)
findall(hFig)
```

```
clc, clear, close all
% figure with menu
hFig = figure('MenuBar', 'none');
% compare
hFig.Children
get(hFig, 'Children')
findobj('Parent', hFig)
allchild(hFig)
findall(hFig, 'Parent', hFig)
findall(hFig)
```

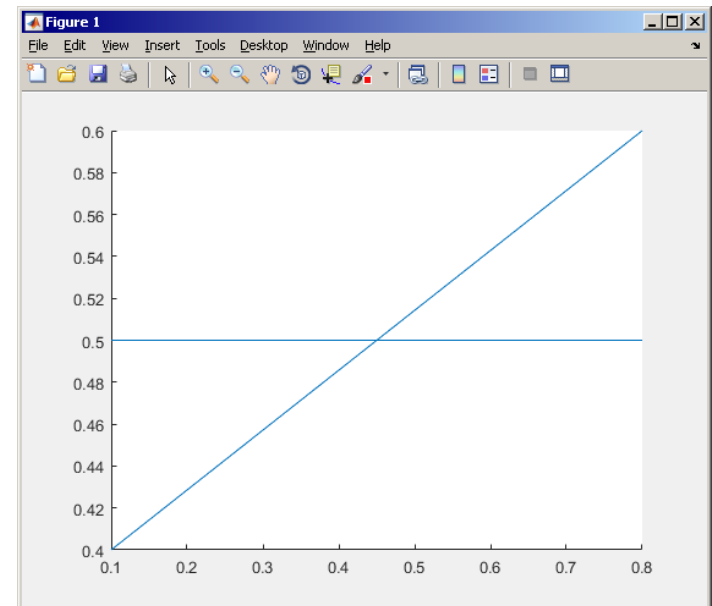
# Function `copyobj`

- this function enables to have an influence on lifecycle of an object
  - copies object and its descendants
- more `>> doc copyobj`

```
>> hf = figure
>> ha = axes
>> hL1 = line([0.1 0.8], [0.5 0.5])
>> hL2 = copyobj(hL1,ha)
>> set(hL2, 'YData', [0.4 0.6])
>> ishandle(hL1) && ishandle(hL2)
```

```
ans =
```

```
1
```



# Function delete, reset

- these functions enable to have an influence on lifecycle of an object
- delete removes file(s) or graphic object(s) together with its descendants

```
>> delete(hf) % hf see previous example
>> ishandle(hL1) && ishandle(hL2)
ans =
     0
```

- reset sets all values of an object back to implicit values

```
reset(h)
```

# Advanced visualizing in Matlab

- function `gobjects` predefines variables

```
% preallocation
h = gobjects(3,1);

h(1) = figure;
h(2) = plot(1:10);
h(3) = gca;
class(h)
arrayfun(@class, h, ...
'UniformOutput', false)
```

- function `isgraphics()`

```
x = 1:10; y = sin(x);

p = plot(x,y);
ax = gca;

isgraphics([p, ax])
```

- function `ishandle` finds out whether variable is a handle object

```
>> figHandle = figure;
>> ishandle(figHandle)
```

- >> doc `Graphics Object Identification`

# Storing data in GUI

- how to store data in GUI?
  - global variables (extreme case, keyword `global`)
    - unacceptable
  - using property `UserData` (depends on size of the application)
    - acceptable
  - using functions `guidata` or `setappdata` and `getappdata`
    - suitable
  - fully OOP access (including functional part of the code)
    - ideal

# Function `guidata`

- enables to store or get data
- the procedure is as follows:
  - get data copy: `data = guidata(object_handle)`
  - carry out data modification / calculation required
  - if the data is changed, store `guidata(object_handle, data)`
- data is therefore related to a handle that exist during whole lifetime of GUI
  - data is saved in object's parent figure

# Function guidata

```
>> hFig = figure('Toolbar', 'none');  
>> allFigHndl = guidata(hFig);  
>> guidata(hFig, allFigHndl);
```

function guidata returns  
references of all visible  
objects in figure

```
function myCallback()  
% ...  
myAllFigHndl = guidata(gcbo);  
myAllFigHndl.time = clock;  
guidata(gcbo, myAllFigHndl);
```

function gcbo returns reference  
of the object callback of which is  
being evaluated



# Functions setappdata, getappdata

- setappdata: enables to define new data (pair name-value) for given application

```
clc, clear, close all

hFig = figure;
hButt = uicontrol('Parent', hFig);

setappdata(hButt, 'speedA', rand(1, 10));
```

- getappdata: enables to get previously defined data of selected object

```
value = getappdata(hFig, 'speedA')

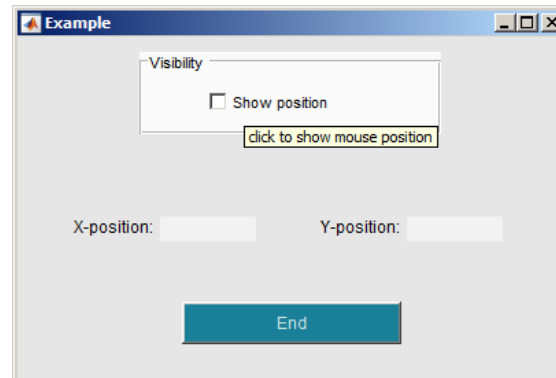
% values is a structure
values = getappdata(hndl)
```

# Exercise – mouse movements + buttons

600 s



- create application according to picture below
  - button „End“ terminates application
    - Callback of `uicontrol`
  - left and right mouse button click on figure changes font type of label „X-position“ and „Y-position“ from normal to bold and vice versa
    - `WindowButtonDownFcn` of figure and event input
  - in the case checkbox is ticked, program displays cursor position
    - Value of `uicontrol` and `CurrentPoint` of figure



# Exercise – mouse movements + buttons

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# Exercise – mouse movements + buttons

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# Predefined dialog windows

- The most common operations used  $\leftrightarrow$  GUI are predefined
- the most common ones are displayed below (most of them):

→ user

helpdlg

msgbox

warndlg

errordlg

→ GUI

inputdlg

listdlg

questdlg

file ←

uigetdir

uigetfile

uiopen

→ file

uiputfile

uisave

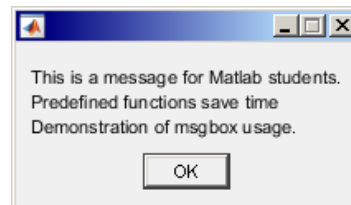
→ user

waitbar

# Function `msgbox`

- displays message for the user

```
>> h = msgbox({'This is a message for Matlab students.', ...  
              'Predefined functions save time', ...  
              'Demonstration of msgbox usage.'})
```



# Function `questdlg`

- displays a question, returns answer

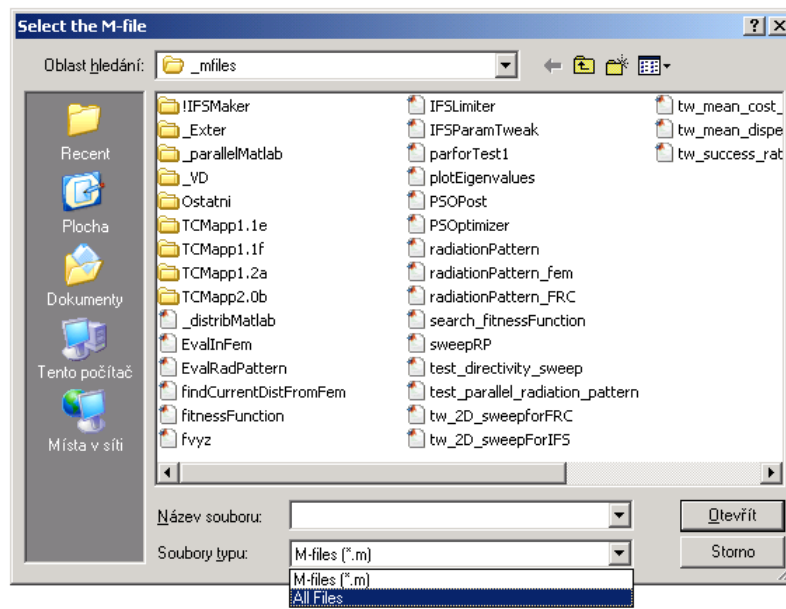
```
>> query = questdlg('Terminate application?', ...  
                    'End of application', 'Yes', 'No', 'Yes')
```



# Function `uigetfile`

- user can select file(s) from file dialog box
  - files can be filtered by their suffix

```
>> [FileName,PathName] = uigetfile('*.*', 'Select the M-file');
```

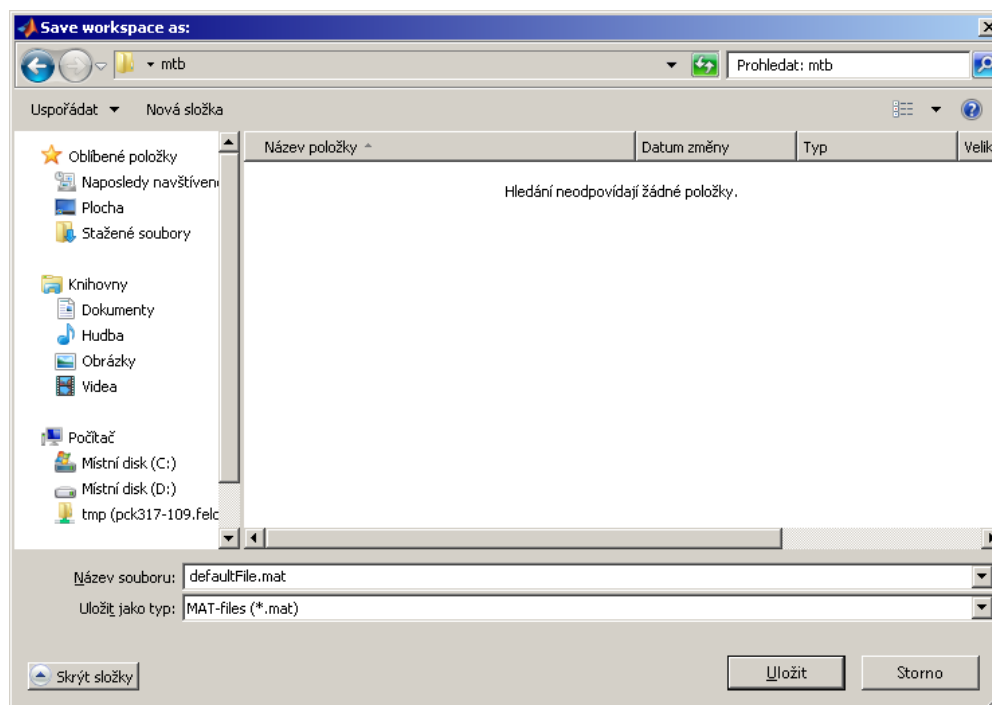




# Function `uiputfile`

- opens dialog for file saving
  - files can be filtered by their suffix

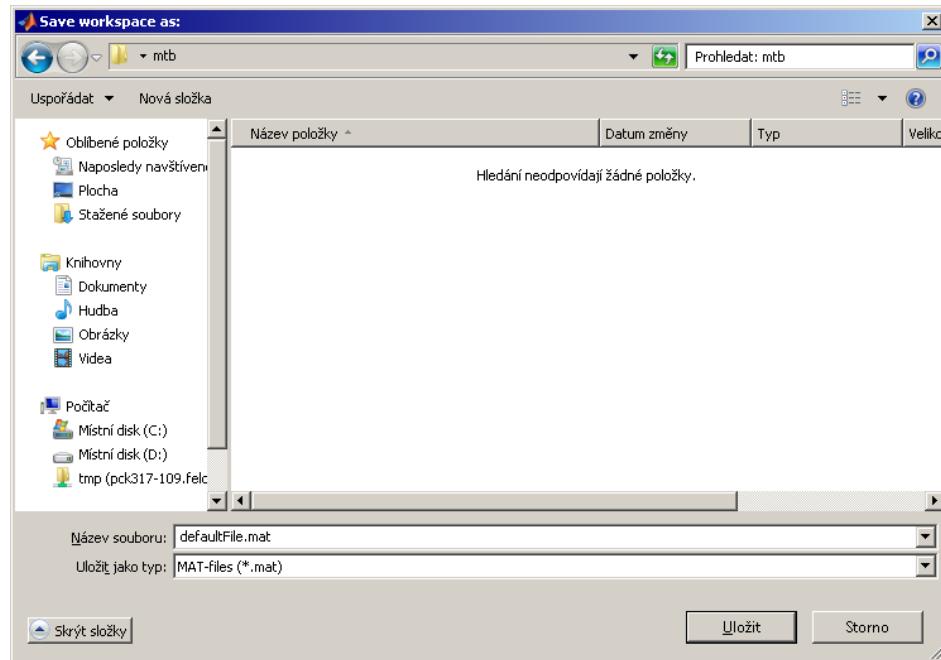
```
>> [file,path] = uiputfile('*.mat', 'Save workspace as:', ...  
    'defaultFile.mat')
```



# Exercise – saving into file

400 s ↑

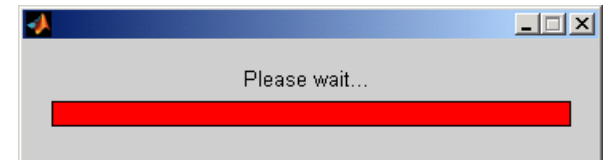
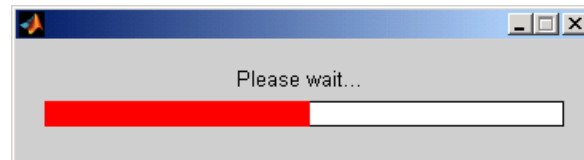
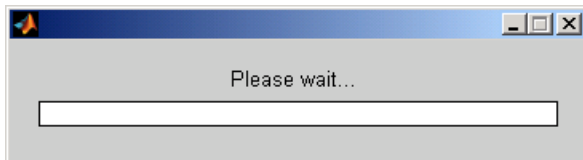
- save variable data from Workspace in a file using dialog box



# Function `waitbar`

- displays state of a process

```
h = waitbar(0, 'Please wait...');  
nsteps = 1000;  
for k = 1:nsteps  
    waitbar(k/nsteps);  
end  
close(h);
```



# Design of a simple GUI #1

- what the GUI should do (detailed description of functionality)
- what are the user inputs
- required outputs
  
- objects used (scheme of GUI, list of elements, design of tags and properties)
- callback functions, dynamic elements
  
- saving of identifiers and data in GUI
- programming style
  
- implementation of individual parts
  
- getting it to work, testing...

# Discussed functions

---

gcf, gca, gco

findobj, findall, allchild

copyobj

delete, reset

gobjects, ishandle, isgraphics

helpdlg, msgbox, warndlg, errordlg

inputdlg, listdlg, questdlg

uigetdir, uigetfile, uiopen

uiputfile, uisave

waitbar

guide

guidata, setappdata, getappdata

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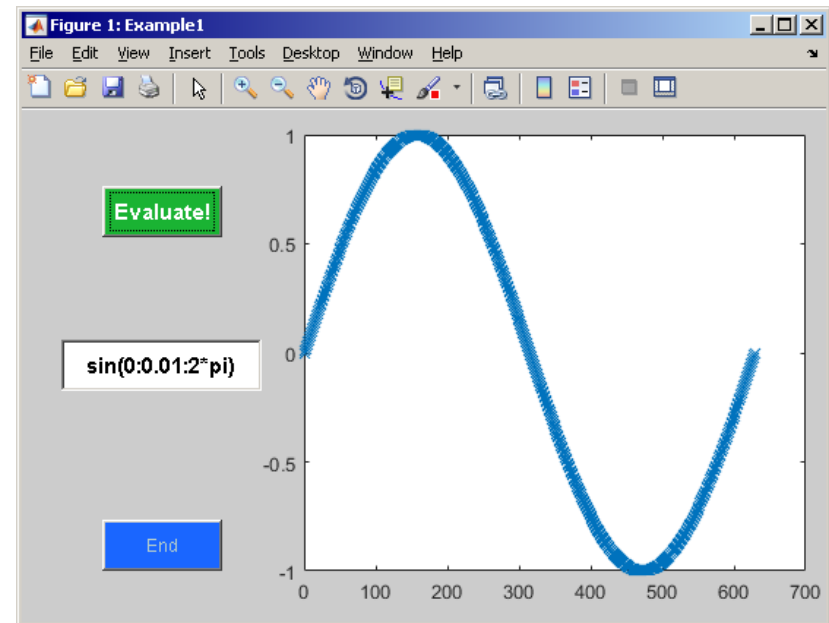
# Exercise – displaying graph of a function

600 s



- create a GUI which shows a graph of a function defined by a user
  - use `try—catch` to eliminate erroneous inputs
  - use function `reset` to clear graph before another drawing
  - what function do you use to evaluate the text input?

```
>> MTB_GUI1edit
```



# Exercise – displaying graph of a function

---

# Exercise – displaying graph of a function

---



# Thank you!



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