Lecture 8: Static Graphical User Interface

B0B17MTB, BE0B17MTB – MATLAB

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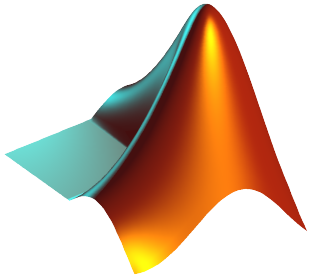
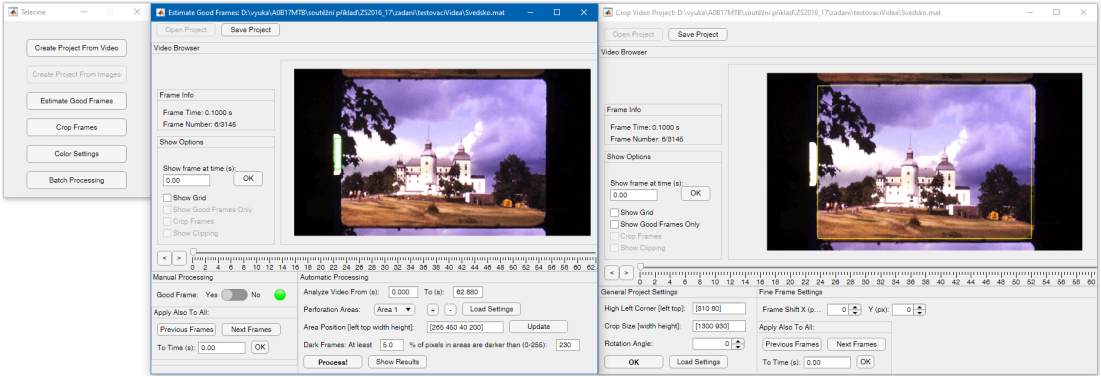
Outline

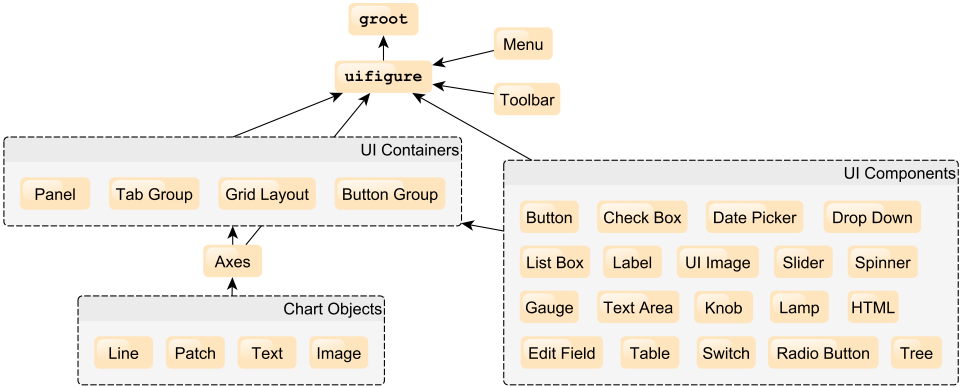


Structure of GUI I.



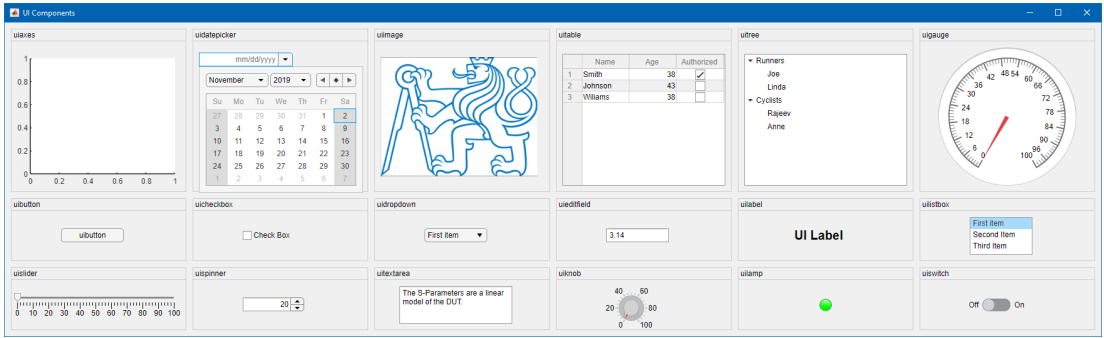
Structure of GUI II.

- Object Hierarchy (simplified):



Structure of GUI III.

- Basic UI components:



Screen Properties – `groot`

- Corresponds to computer screen in Matlab.
- All other graphical objects are children (descendants) of Root object.
- In workspace is handle object of class `matlab.ui.Root`.
- Usually used to find out the number of screens and their resolution.

```
hG = groot();
nScreens = size(hG.MonitorPositions, 1);
mainScreenRes = hG.ScreenSize(3:4);
```

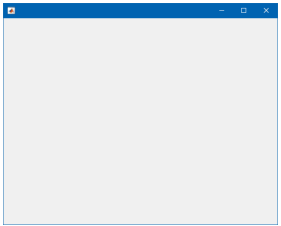
```
mainScreenRes = groot().ScreenSize(3:4);
```

```
>> groot

ans =

  Show all properties
        CallbackObject: [0x0 GraphicsPlaceholder]
              Children: [0x0 GraphicsPlaceholder]
         CurrentFigure: [0x0 GraphicsPlaceholder]
    FixedWidthFontName: 'Courier New'
      HandleVisibility: 'on'
      MonitorPositions: [2x4 double]
                Parent: [0x0 GraphicsPlaceholder]
       PointerLocation: [311 870]
           ScreenDepth: 32
  ScreenPixelsPerInch: 96
            ScreenSize: [1 1 1920 1200]
     ShowHiddenHandles: off
                   Tag: ''
                  Type: 'root'
                 Units: 'pixels'
              UserData: []
```

Graphical Window – `uifigure`

- Function `uifigure` creates standalone graphical window:

```
hFig = uifigure()
```



- All figures are descendants of the object `groot`.
- All secondary graphic objects are descendants of the object figure and are drawn in the figure.
- Object `uifigure` has many properties (see `get(uifigure)`).

- Figure can be closed using:
  - `close(hFig)` which call the `CloseRequestFcn` callback:

```
hFig = uifigure('CloseRequestFcn', 'disp(''Your figure will be closed!'')');
```

  - `hFig.delete()`, or `delete(hFig)` directly deletes the figure.
  - `close all force` is for debugging purposes!

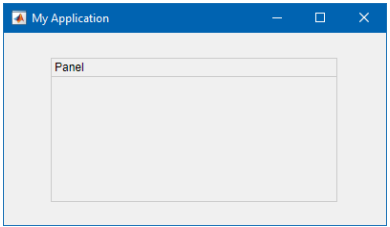
Position of Components

- MATLAB combines the size of UI components and their position in one vector (property `Position`):

```
uifigure('Position', [left, bottom, width, height]);
```

- Position is absolute in pixels relative to the parent container by default.
  - Property `Units` of UI components set to `'pixels'`.
  - `uifigure`, `uitab` and `uipanel` supports also `'normalized'`, `'centimeters'`, `'inches'`, `'characters'`, ...
- Creation of the figure in the center of the screen and a panel in the center of the figure:

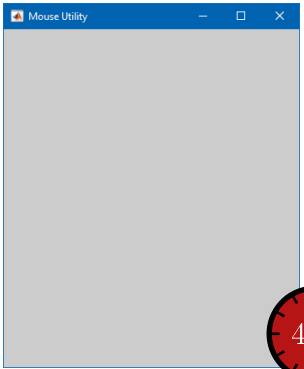
```
figSize = [400, 200];
panelSize = [300 150];
screenSize = get(groot, 'ScreenSize');
hFig = uifigure('Position', ...
  [(screenSize(3:4) - figSize)/2, figSize], ...
  'Name', 'My Application');
hPanel = uipanel(hFig, 'Position', ...
  [(figSize - panelSize)/2, panelSize], ...
  'Title', 'Panel');
```




```
hFig = uifigure('Units', 'normalized', ...
  'Position', [0.4 0.4 0.2 0.2]);
```

GUI Window Creation

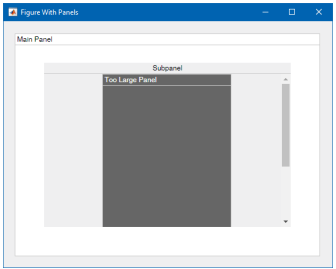
- In a new script that we will be extending throughout today's lecture create a figure window that opens in the center of the screen having a width of 350 pixels and a height of 400 pixels.
  - Make sure the figure's `Name` is "Mouse Utility".
  - Change window's `Color` (up to you).



Container Components – `uipanel`

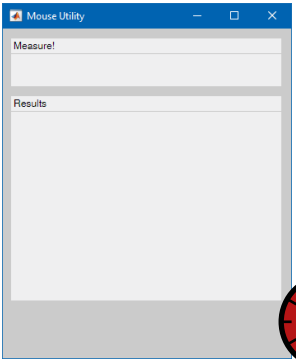
- Create panel as a parent to other objects.
- Objects inside are positioned related to the panel.
- Many features available (see `>> doc uipanel`)
- Generally, `string` class can be used to define properties of UI components.

```
hFig = uifigure("Name", "Figure With Panels");
hPanel1 = uipanel(hFig, "Title", "Main Panel", ...
  "FontSize", 12, "BackgroundColor", "white", ...
  "Position", [20, 20, 520, 380]);
hPanel2 = uipanel(hPanel1, "Title", "Subpanel", ...
  "TitlePosition", "centertop", ...
  "Scrollable", true, "BorderType", "none", ...
  "Position", [50 50 420 280]);
hPanel3 = uipanel(hPanel2, ...
  "Title", "Too Large Panel", ...
  "ForegroundColor", "white", ...
  "BackgroundColor", 0.4*ones(1, 3), ...
  "Position", [100 20 220 400]);
```



Panel Creation

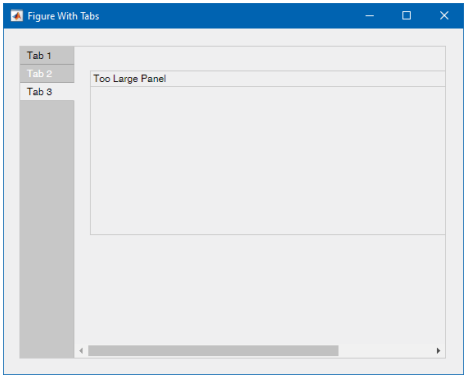
- Into previously created figure create two panels with `Position` and `Title`:
  - `[10, 330, 330, 60]` px, `'Measure!'`,
  - `[10, 70, 330, 250]` px, `'Results'`.
- Set proper `Backgroundcolor`, `FontWeight`, ... (up to you).



Container Components – uitab

- Creates a tab that will be a parent for other objects (same as with panel).
- uitab object has to be children of uitabgroup object.
  - Manage the tab switching, title positioning, ...

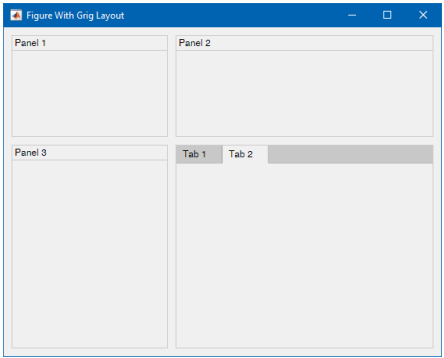
```
hFig = uifigure('Name', 'Figure With Tabs');
hTabGroup = uitabgroup(hFig, ...
  'Position', [20, 20, 520, 380], ...
  'TabLocation', 'left');
hTab1 = uitab(hTabGroup, 'Title', 'Tab 1');
hTab2 = uitab(hTabGroup, 'Title', 'Tab 2', ...
  'BackgroundColor', 'k', ...
  'ForegroundColor', 'w');
hTab3 = uitab(hTabGroup, 'Title', 'Tab 3', ...
  'Scrollable', true);
hPanel = uipanel(hTab3, ...
  'Title', 'Too Large Panel', ...
  'Position', [20, 150, 600, 200]);
hTabGroup.SelectedTab = hTab3;
```



Container Components – uigridlayout

- Grid layout manages position UI components along the rows and columns of an invisible grid that spans the entire figure or a container within the figure.
- Gradually added components are placed in column-wise order (as with `subplot`).
- It is always possible to edit `Layout` property of children component to place it to arbitrary cell.

```
hFig = uifigure('Name', 'Figure With Grig Layout');
hGrid = uigridlayout(hFig, ...
  'ColumnWidth', {200, '1x'}, ...
  'RowHeight', {'1x', '2x'});
hPanel1 = uipanel(hGrid, 'Title', 'Panel 1');
hPanel2 = uipanel(hGrid, 'Title', 'Panel 2');

hTabGrop = uitabgroup(hGrid);
hTabGrop.Layout.Column = 2;
hTabGrop.Layout.Row = 2;
uitab(hTabGrop, 'Title', 'Tab 1');
uitab(hTabGrop, 'Title', 'Tab 2');

hPanel3 = uipanel(hGrid, 'Title', 'Panel 3');
hPanel3.Layout.Row = 2;
hPanel3.Layout.Column = 1;
```

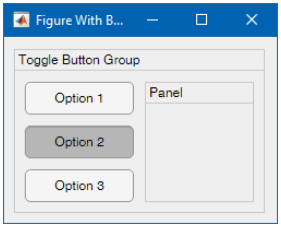


GUI

Container Components – uibuttongroup

- Create a button group to manage radio buttons and toggle buttons.
  - It is not possible to mix these objects in one button group.
- The children of a button group object can be, beside that, any UI component.

```
hFig = uifigure('Name', 'Figure With Button Group', ...
  'Position', [200 200 250 170]);
hGroup = uibuttongroup(hFig, 'Position', [10, 10, 230, 150], ...
  'Title', 'Toggle Button Group');
hButt1 = uitogglebutton(hGroup, 'Text', 'Option 1', ...
  'Position', [10 90 100 30]);
hButt2 = uitogglebutton(hGroup, 'Text', 'Option 2', ...
  'Position', [10 50 100 30]);
hButt3 = uitogglebutton(hGroup, 'Text', 'Option 3', ...
  'Position', [10 10 100 30]);
hPanel = uipanel(hGroup, 'Title', 'Panel', ...
  'Position', [120, 10, 100, 110]);
```



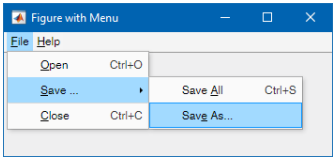

```
%% Selection via button group
hGroup.SelectedObject = hButt2;
% or use button Value property
hButt2.Value = true;
% get values
values = [hGroup.Buttons.Value]
```

GUI

Figure Menu – uimenu

- Create figure menu items with arbitrary hierarchy.
- Mnemonic keyboard shortcut (Alt+*mnemonic*) by using the ampersand (&) character in the text for the label.
  - To use mnemonics, you must specify a mnemonic for all menus and menu items.
- `Accelerator` define a keyboard shortcut for selecting a menu item (Ctrl+*acc.*).

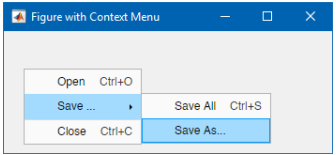
```
hFig = uifigure('Name', 'Figure with Menu', ...
  'Position', [200, 200, 350, 110]);
hMenuFile = uimenu(hFig, 'Text', '&File');
hMenuOpen = uimenu(hMenuFile, 'Text', '&Open', ...
  'Accelerator', 'O');
hMenuSave = uimenu(hMenuFile, 'Text', '&Save ...');
hMenuSaveAll = uimenu(hMenuSave, 'Text', 'Save &All', ...
  'Accelerator', 'S');
hMenuSaveAs = uimenu(hMenuSave, 'Text', 'Sav&e As...');
hMenuClose = uimenu(hMenuFile, 'Text', '&Close', ...
  'Accelerator', 'C', 'Separator', true);
hMenuHelp = uimenu(hFig, 'Text', '&Help');
hMenuShowHelp = uimenu(hMenuHelp, 'Text', 'Show &Help');
hMenuWhisper = uimenu(hMenuHelp, 'Text', 'Whis&per', ...
  'Checked', true);
```



Context Menu – `uicontextmenu`

- Context menu is invoked by right-click on an assigned UI object.
- To assign the context menu to the UI object set its `ContextMenu` property.
- Individual items in context menu are `uimenu` objects.
- `Accelerator` shortcuts works even when the context menu is not shown.

```
hFig = uifigure('Name', 'Figure with Context Menu', ...
  'Position', [200, 200, 350, 130]);
hContMenu = uicontextmenu(hFig);
hMenuOpen = uimenu(hContMenu, 'Text', 'Open', ...
  'Accelerator', 'O');
hMenuSave = uimenu(hContMenu, 'Text', 'Save ...');
hMenuSaveAll = uimenu(hMenuSave, 'Text', 'Save All', ...
  'Accelerator', 'S');
hMenuSaveAs = uimenu(hMenuSave, 'Text', 'Save As...');
hMenuClose = uimenu(hContMenu, 'Text', 'Close', ...
  'Accelerator', 'C', 'Separator', true);
%% Assign menu to proper object
hFig.ContextMenu = hContMenu;
%% Open menu programmatically
% at specified position of low left corner
open(hContMenu, 10, 10);
```



GUI

Graph Area – uiaxes

- Defines area where descendants of object `uiaxes` are placed.
- Axes is created using `uiaxes` command even without actual existence of parental `uifigure` object.

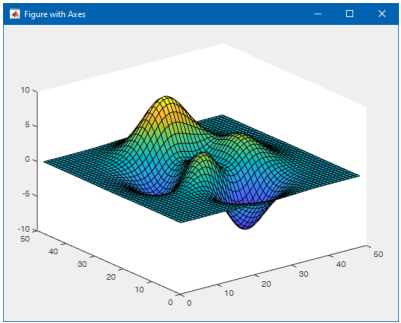
```
hFig = uifigure('Name', 'Figure with Axes');
hAx = uiaxes(hFig, ...
  'Position', [20, 20, 520, 380]);
surf(hAx, peaks);
```

- Turn off interactivity:

```
hAx.Toolbar.Visible = false;
disableDefaultInteractivity(hAx)
```

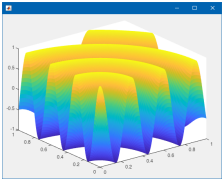
- Usual plotting functions as `plot`, `surf`, `pcolor`, `stem`, ... support `uiaxes` objects but its handle is needed:

```
plot(hAx, rand(10, 5));
```



Fast Graphics Update

- Graphics made from user interface (UI) components is significantly slower than graphics made within "old" `figure`.
- `drawnow` and `pause` works in the same way as with `figure`.



```
f0 = 1e9;
x = linspace(0, 1, 201);
y = x.';
c0 = 3e8;
lambda = c0/f0;
t = linspace(0, 1/f0);
k = 2*pi/lambda;
R = sqrt(x.^2 + y.^2);
```

```
hFig = uifigure;
hAx = uiaxes('Parent', hFig, 'Position', [10 10 540 400]);
hSurf = surf(hAx, 'Parent', hAx, 'LineStyle', 'none', ...
  'XData', x, 'YData', y, 'ZData', nan(size(R)));
drawnow();
tic;
for thisTime = t
  E = exp(1j*(-k*R + 2*pi*f0*thisTime));
  hSurf.ZData = real(E);
  drawnow();
end
tEnd = toc;
fprintf('Reached FPS: %.2f Hz.\n', length(t)/tEnd);
```

GUI

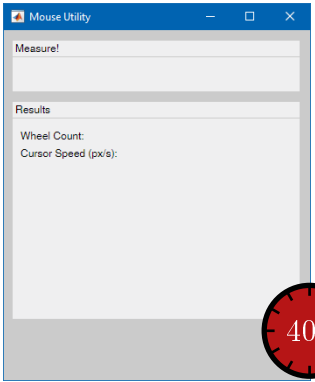
UI Components – `uilabel`

- Labels contain static text for labelling parts of an application.
- Property `Interpreter` can be `'tex'`, `'latex'` and `'html'` for additional formatting.
- Labels can be children of all UI containers.
- All UI component labels and titles can contain unicode characters (`char(uniNumber)`).
  - Can be found, *e.g.*, here: http://unicode-table.com/.

```
hFig = uifigure('Name', 'Figure with Label', ...
  'Position', [200, 200, 400, 100]);
hLabel = uilabel(hFig, 'Text', ...
  ['Fancy Label with ', char(960)], ...
  'HorizontalAlignment', 'Center', ...
  'Position', [10, 10, 380, 80], ...
  'FontName', 'Times New Roman', ...
  'FontSize', 40, ...
  'FontWeight', 'bold', ...
  'FontAngle', 'italic', ...
  'FontColor', 'm', ...
  'BackGroundColor', 0.3*ones(1, 3));
```

Label Creation

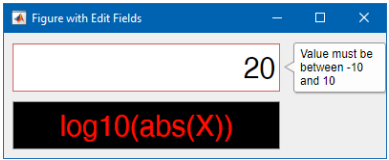
- Create two labels into panel called `'Results'` with `Position` and `Text` properties as:
  - `[10, 200, 90, 20]`, `'Wheel Count:'`,
  - `[10, 180, 120, 20]`, `'Cursor Speed (px/s):'`.
- Set proper `Backgroundcolor`, `FontWeight`, ...(up to you).



UI Components – uieditfield

- Create text or numeric edit field component.
- Function `uieditfield` or `uieditfield('text')` creates edit field handling strings.
  - See >> `doc EditField` for formatting possibilities.
- Function `uieditfield('numeric')` creates edit field handling numerical values.
  - Moreover offers rounding, limits and format (see >> `doc NumericEditField`).

```
hFig = uifigure('Name', 'Figure with Edit Fields', ...
  'Position', [200, 200, 400, 130]);
hEdit1 = uieditfield(hFig, 'numeric', 'Value', pi, ...
  'Position', [10, 70, 280, 50], ...
  'Limits', [-10, 10], ...
  'ValueDisplayFormat', '%.2e V/m', ...
  'FontSize', 30);
hEdit2 = uieditfield(hFig, 'text', ...
  'Value', 'log10(abs(X))', ...
  'HorizontalAlignment', 'center', ...
  'FontSize', 30, 'Position', [10, 10, 280, 50], ...
  'FontColor', 'r', 'BackgroundColor', 'k');
% value regardless of display format:
setValue = hEdit1.Value
```



Edit Field Creation

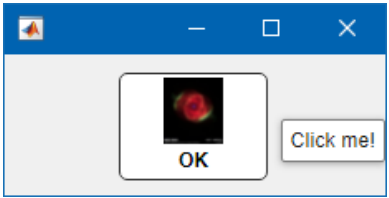
- In panel titled `'Results'` create numeric edit box with `Position` property as `[120, 200, 90, 22]` px.
- Set proper `Backgroundcolor`, `FontWeight`, ... (up to you).

UI Components – uibutton

- Create push button or state button component.
- The state button can be done by `style` argument as `uibutton('state')`.
  - It is not the same as `uitogglebutton`, can't be managed by `uibuttongroup`!
- `Icon` can be defined also as m-by-n-by-3 truecolor image array.
- Properties can be aggregated into a cell array and used as comma-separated list by `{:}` as function inputs (holds generally).

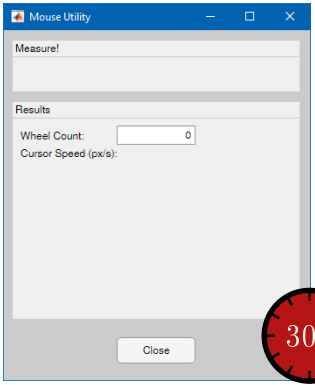
```
buttProperties = {'Text', 'OK', ...
  'Position', [70, 10, 90, 65], ...
  'Icon', 'ngc6543a.jpg', ...
  'IconAlignment', 'top', ...
  'FontWeight', 'bold', ...
  'ToolTip', 'Click me!'};
hFig = uifigure('Position', [200, 200, 230, 85]);
hButt = uibutton(hFig, buttProperties{:});
```

```
% Icon as a random color image
hButt.Icon = uint8(rand(20, 20, 3)*255);
```



Push Button Creation

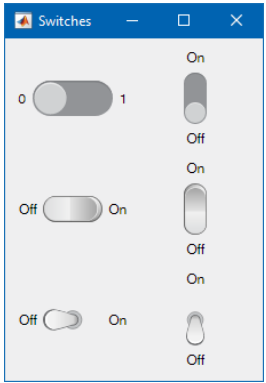
- Create push button labelled `'Close'` positioned in figure with `Position` property `[130, 20, 90, 30]` px.
- Set proper `Backgroundcolor`, `FontWeight`, ... (up to you).



UI Components – `uiswitch`

- Create slider switch, rocker switch, or toggle switch component.
- All switches can be oriented vertically or horizontally (`Orientation` property).
- Labels can be modified (`Items` property).

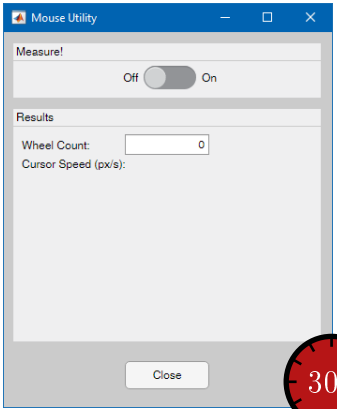
```
hFig = uifigure('Name', 'Switches', ...
   'Position', [200, 200, 225, 300]);
hGrid = uigridlayout(hFig, ...
   'ColumnWidth', {'1x', '1x'}, ...
   'RowHeight', {'1x', '1x', '1x'});
hSwitch1 = uiswitch(hGrid, 'slider', ...
   'Orientation', 'horizontal', ...
   'Items', {'0', '1'}, 'ItemsData', {false, true});
hSwitch2 = uiswitch(hGrid, 'slider', ...
   'Orientation', 'vertical');
uiswitch(hGrid, 'rocker', 'Orientation', 'horizontal');
uiswitch(hGrid, 'rocker', 'Orientation', 'vertical');

uiswitch(hGrid, 'toggle', 'Orientation', 'horizontal');
uiswitch(hGrid, 'toggle', 'Orientation', 'vertical');
% Value as corresponding 'ItemsData' element
logValue = hSwitch1.Value % vs. hSwitch2.Value
```



GUI

Switch Creation

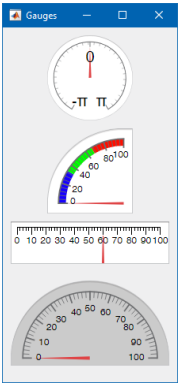
- Create switch positioned in panel titled `'Measure!'` with `Position` property `[140, 10, 100, 25]` px, `Items` as `{'Off', 'On'}` and `ItemsData` as `[false, true]`.
- Set proper `Style`, `Items`, `FontWeight`, ... (up to you).



UI Components – uigauge

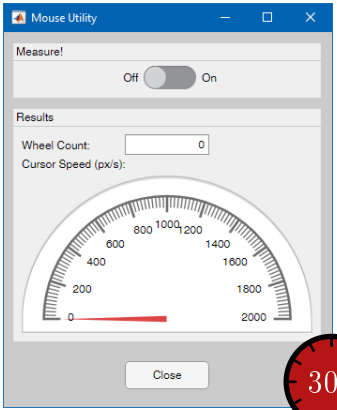
- Create gauge component for indicating numerical value.
- Several *style* options `uigauge(`*style*`)`:
  - `'circular'`, `'linear'`, `'ninetydegree'`, `'semicircular'`.
  - Different orientation possibilities (`'counterclockwise'`, `'north'`, `'vertical'`, ...).

```
hFig = uifigure('Name', 'Gauges', ...
  'Position', [200, 200, 220, 450]);
hGrid = uigridlayout(hFig, ...
  'ColumnWidth', {'1x'}, ...
  'RowHeight', {'1x', '1x', '0.5x', '1.2x'});
hGauge1 = uigauge(hGrid, 'circular', ...
  'Limits', [-pi, pi], ...
  'ScaleDirection', 'counterclockwise', ...
  'MajorTicks', -pi:pi:pi, ...
  'MajorTickLabels', ...
  {char(960), '0', ['-', char(960)]}, ...
  'FontSize', 20);
hGauge2 = uigauge(hGrid, 'ninetydegree', ...
  'ScaleColors', {'b', 'g', 'r'});
hGauge3 = uigauge(hGrid, 'linear', 'Value', 60);
hGauge4 = uigauge(hGrid, 'semicircular', ...
  'BackgroundColor', 0.8*ones(1, 3));
```



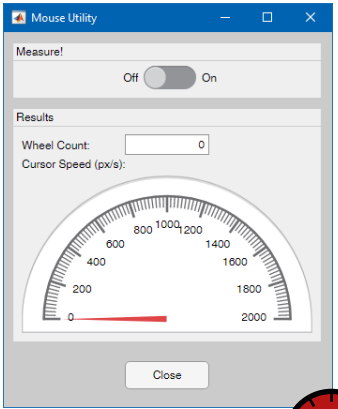
Gauge Creation

- Create gauge with proper style, `Limits [0 2e3]` and `Position [10, 10, 310, 170]` px in panel titled `'Results'`.
- You can freely change display settings.



Save Static GUI

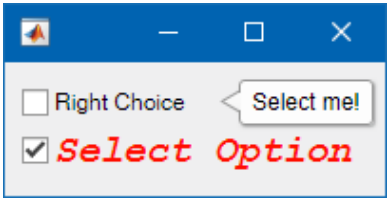
- Save the creation of static GUI as a script or as a function for later use (the next lecture).



UI Components – uicheckbox

- UI component for indicating the state of a preference or option.
- Can be children of any container component.
- Always has the same background color as `BackgroundColor` property of parent container.

```
hFig = uifigure('Position', ...
  [200, 200, 200, 70]);
hCheck1 = uicheckbox(hFig, ...
  'Text', 'Right Choice', ...
  'Position', [10, 40, 100, 20], ...
  'Tooltip', 'Select me!');
hCheck2 = uicheckbox(hFig, ...
  'Value', true, ...
  'Text', 'Select Option', ...
  'FontName', 'Courier New', ...
  'FontSize', 20, ...
  'FontWeight', 'bold', ...
  'FontAngle', 'italic', ...
  'FontColor', 'r', ...
  'Position', [10, 10, 180, 30]);
```

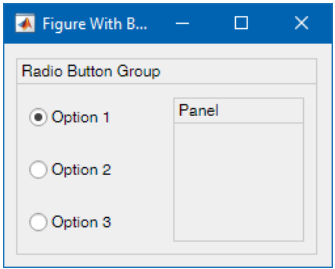


UI Components – uiradiobutton

- Create radio button within a button group (`uibuttongroup`).
- Only one radio button can be selected.
- Always has the same background color as `BackgroundColor` property of parent container.

```
hFig = uifigure('Name', 'Figure with Button Group', ...
  'Position', [200 200 250 170]);
hGroup = uibuttongroup(hFig, 'Position', [10, 10, 230, 150], ...
  'Title', 'Radio Button Group');
hButt1 = uiradiobutton(hGroup, 'Text', 'Option 1', ...
  'Position', [10 90 100 30]);
hButt2 = uiradiobutton(hGroup, 'Text', 'Option 2', ...
  'Position', [10 50 100 30]);
hButt3 = uiradiobutton(hGroup, 'Text', 'Option 3', ...
  'Position', [10 10 100 30]);
hPanel = uipanel(hGroup, 'Title', 'Panel', ...
  'Position', [120, 10, 100, 110]);
```

```
% Button selection programmatically:
hButt2.Value = true;
% or
hGroup.SelectedObject = hButt2;
```

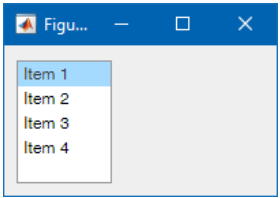


UI Components – uilistbox

- UI component for displaying items in a list.
- It is possible to select more options using Ctrl and Shift keys.
- It is possible to get the selected items via `Value` property.
  - Values are elements from `ItemsData` vector, if defined.

```
hFig = uifigure('Name', 'Figure with List Box', ...
  'Position', [200 200 200 110]);
hList = uilistbox(hFig, 'Position', [10, 10, 70, 90], ...
  'Items', {'Item 1','Item 2','Item 3','Item 4'}, ...
  'Multiselect', true);
```

```
% get selected items from Items vector
selItems = hList.Value
% get selected items from ItemsData vector
hList.ItemsData = 1:4;
selItems = hList.Value
```

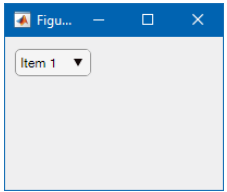


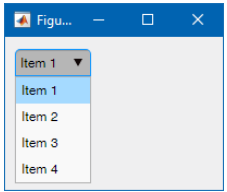
UI Components – uidropdown

- UI component that enables the user to select an option.
- Only one option can be selected.

```
hFig = uifigure('Name', 'Figure with Drop Down', ...
  'Position', [200 200 200 140]);
hList = uidropdown(hFig, 'Position', [10, 105, 70, 25], ...
  'Items', {'Item 1','Item 2','Item 3','Item 4'});
```

```
% get selected item from Items vector
selItems = hList.Value
% get selected item from ItemsData vector
hList.ItemsData = 1:4;
selItems = hList.Value
```



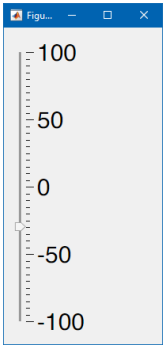


UI Components – uislider

- UI component that allows the user to select a value along a continuum.
- Orientation can be 'horizontal' or 'vertical'.
  - Height, or width, respectively, can't be changed and is always 3 px.
  - Position property defines the slider's position excluding tick marks and tick labels.
  - OuterPosition property (read-only) is a position of the whole slider.

```
hFig = uifigure('Name', 'Figure with Slider', ...
  'Position', [200, 200, 200, 400], ...
  'Scrollable', true, 'AutoResizeChildren', false);
hSlider = uislider(hFig, 'Limits', [-100, 100], ...
  'Orientation', 'vertical', ...
  'Position', [20, 20, 3, 360], ...
  'FontSize', 30, ...
  'MajorTicks', -100:50:100, ...
  'Value', -30);
```

```
hSlider.OuterPosition
```

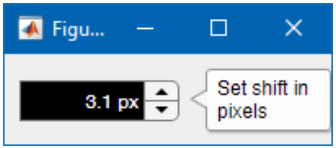


GUI

UI Components – uispinner

- UI component for selecting a numeric value from a finite set.
- Offers rounding, limits, step and format (see >> doc Spinner).
- Value property contains a set value regardless of display format.

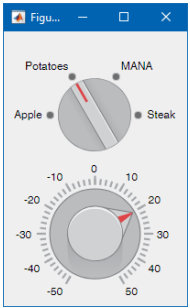
```
hFig = uifigure('Name', 'Figure with Spinner', ...
  'Position', [200, 200, 200, 55]);
hSpinner = uispinner(hFig, 'Value', pi, ...
  'Limits', [-10, 10], ...
  'Step', 5, ...
  'ValueDisplayFormat', '%.1f px', ...
  'FontColor', 'white', ...
  'BackgroundColor', [0 0 0], ...
  'ToolTip', 'Set shift in pixels', ...
  'Position', [10, 15, 100, 25]);
value = hSpinner.Value
```



UI Components – uiknob

- UI components representing instrument control knobs that the user can adjust to control a value.
- `uiknob()` and `uiknob('continuous')` creates knob with continuous values.
- `uiknob('discrete')` creates knob with discrete values.
  - `Value`, `Items` and `ItemsData` properties works the same way as for, *e.g.*, `uidropdown`.

```
hFig = uifigure('Name', 'Figure with Knobs', ...
  'Position', [200, 200, 200, 300]);
hKnob1 = uiknob(hFig, 'discrete', 'Items', ...
  {'Apple', 'Potatoes', 'MANA', 'Steak'}, ...
  'ItemsData', 1:4, ...
  'Value', 2, ...
  'Position', [60, 170, 80, 140]);
hKnob2 = uiknob(hFig, ...
  'Position', [50, 30, 100, 140], ...
  'Value', 20, ...
  'Limits', [-50, 50]);
```

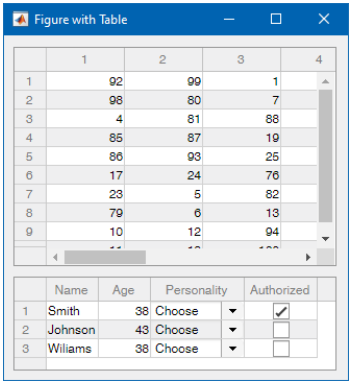


GUI

UI Components – uitable

- Create table user interface component.
- Table offers many of formatting and interactive options (see >> doc uitable).

```
hFig = uifigure('Name', 'Figure with Table', ...
  'Position', [200, 200, 330, 330]);
% simple table:
hTab1 = uitable(hFig, 'Data', magic(10), ...
  'Position', [10 110 310 210]);
% advanced table:
hTab2 = uitable(hFig, 'Data', ...
  {'Smith', 38, 'Choose', true;
  'Johnson', 43, 'Choose', false;
  'Wiliams', 38, 'Choose', false}, ...
  'ColumnName', ...
  {'Name', 'Age', 'Personality', ...
  'Authorized'}, ...
  'ColumnFormat', ({[], [], {'Analyst', ...
  'Diplomat', 'Explorer', 'Idiot'}, []}), ...
  'ColumnWidth', {50, 50, 90, 70}, ...
  'Position', [10 10 310 90], ...
  'ColumnEditable', true(1, 4));
```



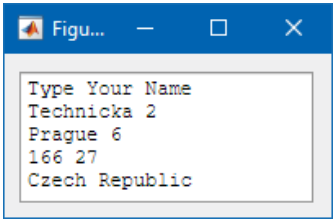
GUI

UI Components – `uitextarea`

- UI component for entering multiple lines of text.
- If the text does not fit into the width of the text area, the text is wrapped.
- `focus` gives keyboard focus to the UI component.
  - Users can interact with the UI component using the keyboard.

```
hFig = uifigure('Name', 'Figure with Text Area', ...
  'Position', [200, 200, 200, 100]);
hText = uitextarea(hFig, 'Value', ...
  ["Type Your Name"; "Technicka 2"; "Prague 6";
  "166 27"; "Czech Republic"], ...
  'FontName', 'Courier New', ...
  'FontColor', [0.1, 0.1, 1], ...
  'Position', [10, 10, 180, 80]);
% get entered address
yourAddress = hText.Value % cell
```

```
focus(hText)
```

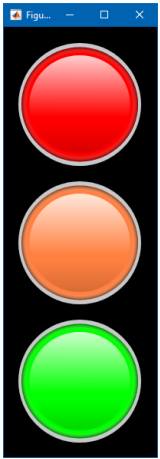


UI Components – uilamp

- Lamp is UI component that indicates state using color.

```
hFig = uifigure('Name', 'Figure with Lamps', ...
  'Position', [200, 200, 200, 560], ...
  'Color', 'k');
hLamp1 = uilamp(hFig, 'Color', [1 0 0], ...
  'Position', [20, 380, 160, 160]);
hLamp2 = uilamp(hFig, 'Color', [1 0.5 0.25], ...
  'Position', [20, 200, 160, 160]);
hLamp3 = uilamp(hFig, 'Color', [0 1 0], ...
  'Position', [20, 20, 160, 160]);
```

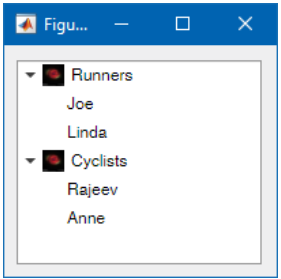
```
% Turn the light off
hLamp1.Enable = false;
```



UI Components – uitree

- Create tree component capable of showing data hierarchy.
- Individual items in tree are objects created by `uitreenode`.
  - The nodes has to be children of `uitree` object.
  - Items can have `Icon` defined as path to a figure.

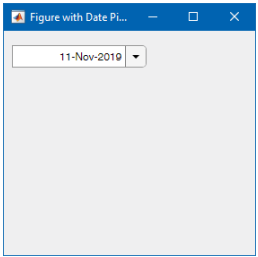
```
hFig = uifigure('Name', 'Figure with Tree', ...
  'Position', [200, 200, 200, 170]);
hTree = uitree(hFig, 'Position', [10 10 180 150]);

category1 = uitreenode(hTree, 'Text', 'Runners', ...
  'Icon', 'ngc6543a.jpg');
p1 = uitreenode(category1, 'Text', 'Joe');
p2 = uitreenode(category1, 'Text', 'Linda');

category2 = uitreenode(hTree, 'Text', 'Cyclists', ...
  'Icon', 'ngc6543a.jpg');
p3 = uitreenode(category2, 'Text', 'Rajeev');
p4 = uitreenode(category2, 'Text', 'Anne');
% Expand the tree
expand(hTree);
```

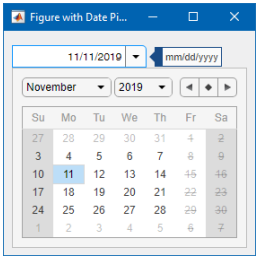


UI Components – `uidatepicker`

- Date pickers allow users to select dates from an interactive calendar.
- Accepts and returns `datetime` objects (see `>> doc datetime`).
- Some dates and days in week can be disabled.

```
hFig = uifigure('Name', ...
   'Figure with Date Picker', ...
   'Position', [200, 200, 280, 250]);
hDate = uidatepicker(hFig, ...
   'Value', datetime('today'), ...
   'Position', [10, 210, 150, 25], ...
   'DisabledDaysOfWeek', [6, 7]);
% get selected date
setDate = hDate.Value
```

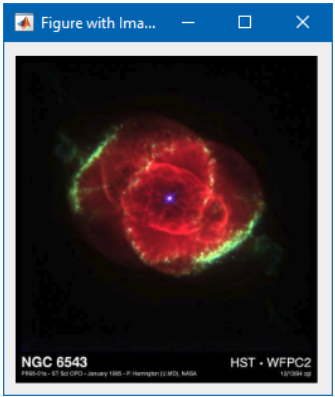




UI Components – uiimage

- UI component that allow you to display an picture in your app.
- Can be children of any container component.
- `ImageSource` can be a file path to an existing figure, or m-by-n-by-3 numeric array.
  - In case of floating-point values (`double`, `single`), data can have range between 0 and 1.
  - In case of integer values (`uint8`, `uint16`), data can have range from 0 up to 255 and 65535, respectively.

```
hFig = uifigure('Name', ...
  'Figure with Image', ...
  'Position', [200, 200, 260, 280]);
hImage = uiimage(hFig, ...
  'ImageSource', 'ngc6543a.jpg', ...
  'Position', [10, 10, 240, 260]);
```



UI Components – uitoolbar, uipushtool, uitoggletool

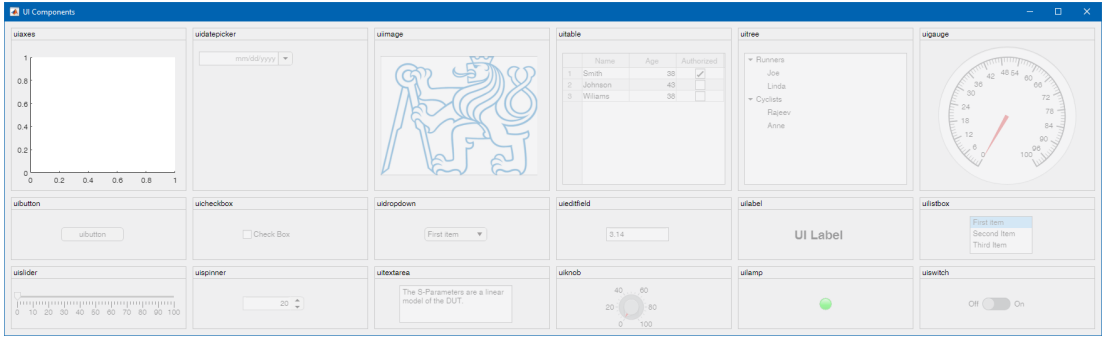
- A toolbar is a container for a horizontal list of buttons at the top of a figure window.
- Can contain push buttons and toggle buttons.
- Does not provide management of the toggle tools.

```
iconFolder = fullfile(matlabroot, 'toolbox', 'matlab', 'icons');
hFig = uifigure('Position', [200, 200, 180, 40]);
hTool = uitoolbar(hFig);
hPushNew = uipushtool(hTool, 'Icon', fullfile(iconFolder, 'file_new.png'), ...
  'ToolTip', 'Open File');
hPushSave = uipushtool(hTool, 'Icon', fullfile(iconFolder, 'file_save.png'), ...
  'ToolTip', 'Save File');
hPushOpen = uipushtool(hTool, 'Icon', fullfile(iconFolder, 'file_open.png'), ...
  'ToolTip', 'Open File');
hToggPlay = uitoggletool(hTool, 'Icon', fullfile(iconFolder, 'greenarrowicon.gif'), ...
  'State', true, 'Separator', true, 'Tooltip', 'Play');
hToggZoom = uitoggletool(hTool, 'Icon', fullfile(iconFolder, 'view_zoom_in.gif'), ...
  'ToolTip', 'Zoom');
```

```
% Set state of toggletool programmatically
hToggZoom.State = true;
```

Enabling UI Components

- Majority of UI components have `Enable` property which defines its operational state.
- Possible values are `'on'` and `'off'`, or `true` and `false`.
- When the component is disabled it doesn't respond to events.
- It is also possible to let the component disappear using `Visible` property.

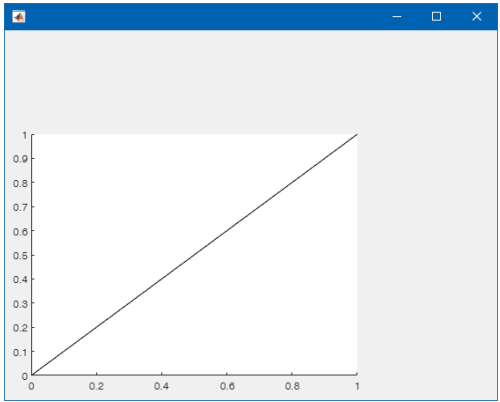


Preallocation of UI Components

- Function `gobjects` initialize array of graphical objects.
  - It has the same usage as function `zeros`, `ones`, ... for numeric values.

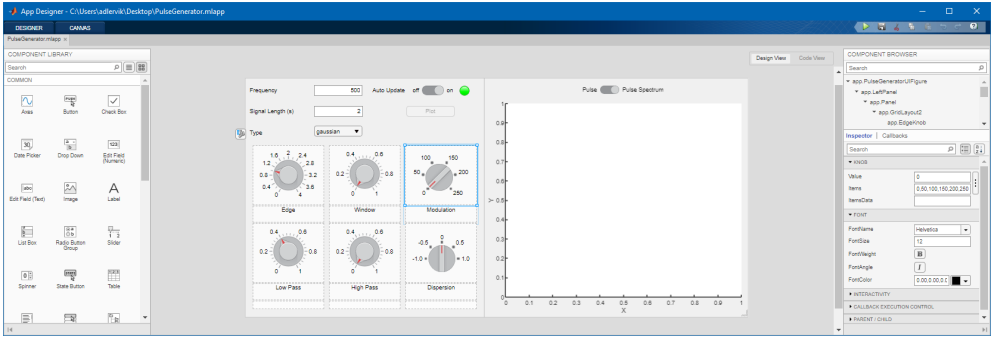
```
>> hObjs = gobjects(3, 1)

hObjs =

  3x1 GraphicsPlaceholder array:

  GraphicsPlaceholder
  GraphicsPlaceholder
  GraphicsPlaceholder
```

```
hObjs(1) = uifigure();
hObjs(2) = uiaxes(hObjs(1));
hObjs(3) = line(hObjs(2));
```



App Designer

- App Designer is a development environment that provides an interactive design of applications using UI components.
  - `appdesigner`
  - Designed application using object-oriented programming (OOP).
  - It is possible to use App Designer for semester projects.



Exercises

Exercise I.a

- Create a function with two inputs and one output:

```
function logicState = createButtons(nRows, nColumns)
% function generating GUI with state buttons
```

- Function creates figure with state buttons arranged in matrix `nRows` × `nColumns`.
- After clicking on state buttons and close window function returns a matrix of logical values representing state of state buttons.

```
>> logicState = createButtons(3, 5)

logicState =

  3x5 logical array

   1   0   1   0   1
   0   1   0   1   0
   1   0   1   0   1
```

Exercise I.b

```
function logicState = createButtons(nRows, nColumns)
% function generating GUI with state buttons
screenSize = get(groot, 'ScreenSize'); % size of screen

figSize = [500, 500]; % size of generated figure
figPos = [(screenSize(3)-figSize(1))/2, ...
   (screenSize(4)-figSize(2))/2]; % position of centered figure

hFig = uifigure('Name', 'Figure', 'Position', [figPos, figSize]);
hGrid = uigridlayout(hFig, 'RowHeight', repmat({'1x'}, 1, nRows), ...
   'ColumnWidth', repmat({'1x'}, 1, nColumns));
% allocatinon of state buttons
hStateButt = gobjects(nRows, nColumns);
% creating state buttons (automatically placed column-wise into grid)
for iRow = 1:nRows
   for iCol = 1:nColumns
      hStateButt(iRow, iCol) = uibutton(hGrid, 'state', ...
         'Text', sprintf('(%d, %d)', iRow, iCol));
   end
end
% set CloseRequestFcn to figure
hFig.CloseRequestFcn = @getLogicalState;
uiwait(hFig); % wait until figure exists

   function getLogicalState(hFig, ~)
      valuesInRow = [hStateButt.Value]; % states of buttons
      logicState = reshape(valuesInRow, size(hStateButt));
      hFig.delete();
   end
end
```

Questions?

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