

GUIs

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Overview

- 1 GUIs
 - Hello World!
- 2 Layout
 - Containers
- 3 Events
 - Event arguments
- 4 Recap

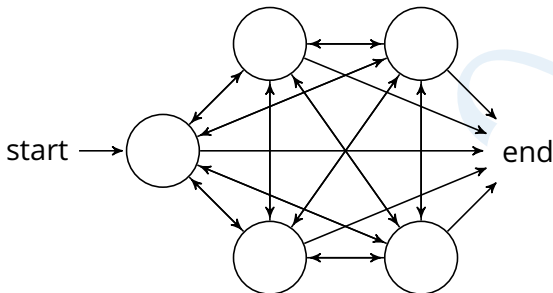
Your programs so far have followed a procedural pattern.

- Program is a series of steps.
- Moves through those steps in a predetermined pattern.
- Expects user input in a very specific order.



Going to look at event driven programming.

- Program reacts to events.
- Events have actions associated with them.
- Order and frequency of events is unpredictable.
- Does not have a predefined sequence of actions to perform.
- Does not have a predefined end.



What sort of applications would benefit from an event driven paradigm?

What sort of applications would benefit from an event driven paradigm?

- GUIs
- Control systems
- Embedded systems

GUI events would include...

- Button presses
- Text entry
- Keyboard events
 - Pressing a key
 - Releasing a key
- Mouse events
 - Pressing a button
 - Releasing a button
 - Moving
 - Scrolling

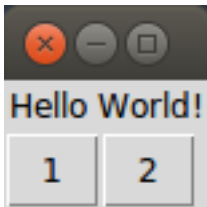
Hello World!

C

How to create a GUI.

- Wide range of different libraries available.
 - Depends on language and platform.
- Tkinter is the built-in Python default.

- Window
- Component/widget/element



```
import sys
from tkinter import *

def main():
    root = Tk()

    label = Label(root, text='Hello World!')
    label.pack()

    root.mainloop()

if __name__ == '__main__':
    sys.exit(main())
```

lec_getting_started.py

```
import sys
from tkinter import *

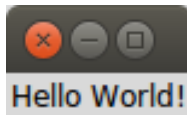
def main():
    root = Tk()

    label = Label(root, text='Hello World!')
    label.pack()

    root.mainloop()

if __name__ == '__main__':
    sys.exit(main())
```

lec_getting_started.py



GUI code should be structured as a class.

- Become clear later.

```
class Gui:
    def __init__(self, root):
        self.root = root

        self.label = Label(self.root, \
                           text='Hello World!')
        self.label.pack()

def main():
    root = Tk()
    gui = Gui(root)
    root.mainloop()
```

lec_classes.py

So far we have seen how elements are added to window.

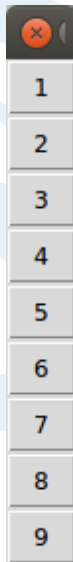
```
class Gui:  
    def __init__(self, root):  
        self.root = root  
  
        for i in range(1,10):  
            button = Button(self.root, text=i)  
            button.pack()
```

lec_layout.py

So far we have seen how elements are added to window.

```
class Gui:  
    def __init__(self, root):  
        self.root = root  
  
        for i in range(1,10):  
            button = Button(self.root, text=i)  
            button.pack()
```

lec_layout.py

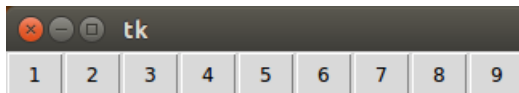


Can use the side parameter for `.pack()`.

- TOP (default).
- Also LEFT, RIGHT and BOTTOM.

```
class Gui:  
    def __init__(self, root):  
        self.root = root  
  
        for i in range(1,10):  
            button = Button(self.root, text=i)  
            button.pack(side=LEFT)
```

lec_layout2.py



Use side to control layout?

```
class Gui:
    def __init__(self, root):
        self.root = root

        Button(self.root, text=1).pack(side=TOP)
        Button(self.root, text=2).pack(side=LEFT)
        Button(self.root, text=3).pack(side=LEFT)
        Button(self.root, text=4).pack(side=TOP)
        Button(self.root, text=5).pack(side=LEFT)
        Button(self.root, text=6).pack(side=LEFT)
        Button(self.root, text=7).pack(side=TOP)
        Button(self.root, text=8).pack(side=LEFT)
        Button(self.root, text=9).pack(side=LEFT)
```

lec_layout3.py

Use side to control layout?

```
class Gui:
    def __init__(self, root):
        self.root = root

        Button(self.root, text=1).pack(side=TOP)
        Button(self.root, text=2).pack(side=LEFT)
        Button(self.root, text=3).pack(side=LEFT)
        Button(self.root, text=4).pack(side=TOP)
        Button(self.root, text=5).pack(side=LEFT)
        Button(self.root, text=6).pack(side=LEFT)
        Button(self.root, text=7).pack(side=TOP)
        Button(self.root, text=8).pack(side=LEFT)
        Button(self.root, text=9).pack(side=LEFT)
```

lec_layout3.py



Need to learn about containers.

- Windows are containers.
 - Elements are 'contained' inside.
- Tkinter also has frames.
 - Special type of element.
 - Contains other elements.
- Group elements together using frames.
 - Can be visible/invisible.

```
class Gui:
    def __init__(self, root):
        self.root = root

        self.frame1 = Frame(self.root)
        self.frame1.pack()

        self.frame2 = Frame(self.root)
        self.frame2.pack()
```

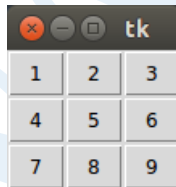
```
Button(self.frame1, text=1).pack(side=LEFT)
Button(self.frame1, text=2).pack(side=LEFT)
Button(self.frame1, text=3).pack(side=LEFT)
```

```
Button(self.frame3, text=7).pack(side=LEFT)
Button(self.frame3, text=8).pack(side=LEFT)
Button(self.frame3, text=9).pack(side=LEFT)
```

```
class Gui:
    def __init__(self, root):
        self.root = root

        self.frame1 = Frame(self.root)
        self.frame1.pack()

        self.frame2 = Frame(self.root)
        self.frame2.pack()
```

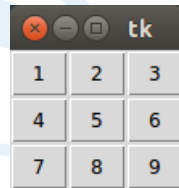
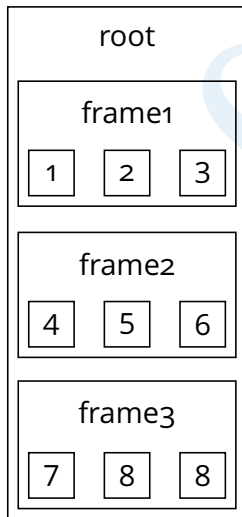


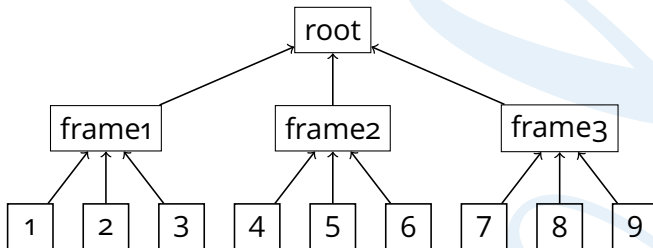
```
Button(self.frame1, text=1).pack(side=LEFT)
Button(self.frame1, text=2).pack(side=LEFT)
Button(self.frame1, text=3).pack(side=LEFT)
```

```
Button(self.frame3, text=7).pack(side=LEFT)
Button(self.frame3, text=8).pack(side=LEFT)
Button(self.frame3, text=9).pack(side=LEFT)
```

So what's happening?

- Elements are nested in containers.
- Containers are nested in other containers.





Break

How do we get our code to actually DO stuff?

- Using Python/Tkinter.
- Other languages/frameworks == different syntax.
 - Same concepts.
- Event handling.
 - Bind events to callback functions.

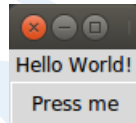

```
class Gui:
    def __init__(self, root):
        self.root = root

        self.label = Label(self.root, text='Hello World!')
        self.label.pack()

        self.button = Button(self.root, text='Press me')
        self.button.bind('<Button-1>', self.say_bye)
        self.button.pack()

    def say_bye(self, event):
        self.label.config(text='Bye!')
```

lec_events.py



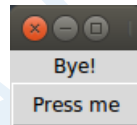
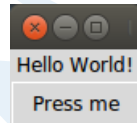
```
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        self.button = Button(self.root, text='Press me')
        self.button.bind('<Button-1>', self.say_bye)
        self.button.pack()

    def say_bye(self, event):
        self.label.config(text='Bye!')
```

lec_events.py



Callbacks are how we respond to events.

- Functions that are passed to another function as an argument.

```
class Gui:
    def __init__(self, root):
        self.root = root

        self.label = Label(self.root, text='Hello World!')
        self.label.pack()

        self.button = Button(self.root, text='Press me')
        self.button.bind('<Button-1>', self.say_bye)
        self.button.pack()

    def say_bye(self, event):
        self.label.config(text='Bye!')
```

lec_events.py

User → Event → Listener → Callback

User actions can consist of multiple events.

- I.e. clicking on button.

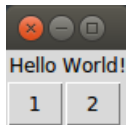
- 1 Press LMB whilst pointer over button.
- 2 Release LMB whilst pointer over button.

- Standard behaviour already programmed into Tkinter.
 - Use `command` parameter.

```
class Gui:
    def __init__(self, root):
        self.root = root

        self.button = Button(self.root, text='Press me' , \
                             command=self.say_bye)
        self.button.pack()

    def say_bye(self):
        self.label.config(text='Bye!')
```



```
class Gui:
    def __init__(self, root):

        Button(self.root, text='1', \
               command=self.pressed_1).pack(side=LEFT)
        Button(self.root, text='2', \
               command=self.pressed_2).pack(side=LEFT)

    def pressed_1(self): # separate functions to each button
        self.label.config(text='Pressed 1')

    def pressed_2(self): # very similar code
        self.label.config(text='Pressed 2')
```

Much better to have one function.

- Function takes argument.
- Reuse of each button.

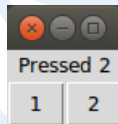
```
class Gui:
    def __init__(self, root):

        Button(self.root, text='1', \
               command=self.pressed_button(1)).pack(side=LEFT)
        Button(self.root, text='2', \
               command=self.pressed_button(2)).pack(side=LEFT)

    def pressed_button(self, number):
        self.label.config(text='Pressed %d' % number)
```

Much better to have one function.

- Function takes argument.
- Reuse of each button.
- Doesn't work.
 - Calls function immediately.
- DEMO



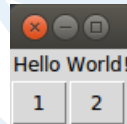
```
class Gui:
    def __init__(self, root):

        Button(self.root, text='1', \
               command=self.pressed_button(1)).pack(side=LEFT)
        Button(self.root, text='2', \
               command=self.pressed_button(2)).pack(side=LEFT)

    def pressed_button(self, number):
        self.label.config(text='Pressed %d' % number)
```

`lambda` functions.

- Only calls function when button is pressed.



```
class Gui:
    def __init__(self, root):

        Button(self.root, text='1', \
               command=lambda: self.pressed_button(1)).pack(side=LEFT)
        Button(self.root, text='2', \
               command=lambda: self.pressed_button(2)).pack(side=LEFT)

    def pressed_button(self, number):
        self.label.config(text='Pressed %d' % number)
```

lec_event_args3.py

- Everyone
 - Ability to create simple Graphical User Interfaces (GUIs).
 - Experience in using 3rd party libraries/modules in software.
 - Introduction to event driven programming.
 - Introduction to lambdas.
- Games Tech & MC - Tkinter like APIs are not suited for games but can be used for game menus.
 - Particular attention to callbacks for game input.
- Computing - Similar APIs used in mobile applications.
 - Event driven programming used in ubiquitous computing.
- Ethical Hackers - Security flaws in event driven applications.
- ITB - GUIs programs have lower entry barrier, important for being user friendly.

Quiz

What is it called when a program is written to respond to button clicks, menu selections and other actions the user performs?

- 1 Event driven programming
- 2 Action driven programming
- 3 User driven programming
- 4 Mouse driven programming

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What is wrong with this code?

```
class Gui:
    def __init__(self, root):
        for i in range(1,10):
            b = Button(self.root, text=i, command=self.pressed_button(i))
            b.pack(side=LEFT)

    def pressed_button(self, number):
        print( 'Pressed button {}'.format(number) )
```

- 1 All the buttons will say they are button 10
- 2 Each button will print a message twice for each mouse click
- 3 Each button will only print a message once, as it is created.
- 4 There will be no buttons

What is wrong with this code?

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- 1 All the buttons will say they are button 10
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What is a callback?

- 1 The code that deals with GUI events.
- 2 Unlikely if your first date went badly.
- 3 A named piece of code that can be repeated multiple times.
- 4 A function that is passed to another function as an argument.

What is a callback?

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What is a container?

- 1 The class containing your GUI code.
- 2 A GUI object that can hold other objects within it.
- 3 A function containing the code to run when a button is pressed.
- 4 Tupperware.

What is a container?

- 1 The class containing your GUI code.
- 2 A GUI object that can hold other objects within it.
- 3 A function containing the code to run when a button is pressed.
- 4 Tupperware.

- GUIs are an example of event driven programming.
- GUI elements are arranged in containers.
- Containers can hold other containers.
- User actions generate events.
- Callbacks are functions that are run in response to events.

The End