## The current topic: Tkinter

- ✓ Introduction
- ✓ Object-oriented programming: Python
- ✓ Functional programming: Scheme
  - ✓ Introduction
  - ✓ Numeric operators, REPL, quotes, functions, conditionals
  - ✓ Function examples, helper functions, let, let*
  - ✓ More function examples, higher-order functions
  - ✓ More higher-order functions, trees
  - ✓ More trees, lambda reductions, mutual recursion, examples, letrec
- Python GUI programming (Tkinter)
- Types and values
- Logic programming: Prolog
- Syntax and semantics
- Exceptions



## Announcements

- Lab 2 was due today at 10:30 am.
- Reminder: Term Test 2 is on Monday November 3rd in **GB405**, *not in the regular lecture room*.
  - 50 minutes (11:10 – 12:00).
  - You're allowed to have one double-sided aid sheet for the test. You must use standard letter-sized (that is, 8.5" x 11") paper. The aid sheet can be produced however you like (typed or handwritten).
  - **Bring your TCard.**
  - What's covered?
    - Everything from September 29 up to and including October 24.
    - Lab 2.
  - An old Term Test 2 has been posted.
  - The exercises at the end of each lecture are also good practice.



## What is Tkinter?

- Tkinter is a Python interface to Tk.
  - Tkinter = ***Tk inter***face
- Tk is a cross-platform GUI library.
  - It lets you write GUI code that runs (without modification) on Windows, Linux, Mac OS, etc.
  - Tk uses native widgets on each platform, so your program gets a native look-and-feel on each platform even though you've only written the code once.
    - That is, it looks like a Windows application when run on Windows, it looks like a Mac application when run on Mac OS, etc., without any extra programming effort.

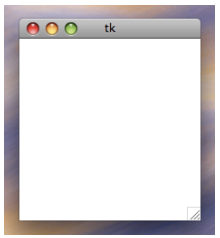



## Overview

- This lecture is meant to be just an introduction to Tkinter.
  - It will **not** include everything you need for the project.
  - Learning Tkinter is still part of the project.
- We'll look at:
  - The basic structure of Tkinter code.
  - Some of the Tkinter widgets that you might find useful.
  - Registering callback functions.

## A simple Tkinter program

```
import Tkinter

root = Tkinter.Tk()
Tkinter.mainloop()
```




- Observe that:
  - You need to import the `Tkinter` module.
  - Calling `Tkinter.Tk()` creates a "root" (top-level) window.
  - Calling `mainloop()` starts Tkinter's *event loop*. Without this call, nothing will be displayed (unless you're working in the Python interpreter).
  - The call to `mainloop()` does not return until all Tkinter windows are closed. This means that any code after this call won't get executed until all windows are closed.



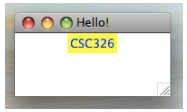
## The Tkinter event loop

- Calling `mainloop()` starts Tkinter's event loop.
- In the event loop, Tkinter "listens" for and responds to particular events (like clicks and key presses).
  - This is called *event-driven programming*. Instead of a sequence of steps that is fixed ahead of time by the programmer, the program's behaviour depends on events that occur at runtime.
  - We'll see later that we can *register* callback functions that act in response to particular events.
- In the event loop, Tkinter periodically redraws windows.
  - No drawing occurs outside of the event loop, so nothing appears on the screen before the call to `mainloop()`.
- Since the call to `mainloop()` does not return until all windows are closed (which, essentially, is the end of your program), you need to do all initial setup of your GUI *before* the call to `mainloop()`.



## Another simple Tkinter program

```
import Tkinter

root = Tkinter.Tk()
root.title("Hello!")
myLabel = Tkinter.Label(root, text="CSC326", fg="blue", bg="yellow")
myLabel.pack()

Tkinter.mainloop()

# The following produces an error since it isn't run till the window
# is closed.
label2 = Tkinter.Label(root, text="Project", fg="green")
label2.pack()
```






## Creating widgets

- When creating a widget (for example, a Label), we need to specify its parent (where it's going to go).
  - We can optionally specify other properties using keyword arguments.

    ```
    myLabel = Tkinter.Label(root, text="CSC326", fg="blue", bg="yellow")
    ```

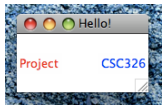
  - The above line creates a Label widget whose *parent* is the root window.
  - It also specifies the Label's text, foreground colour, and background colour.
  - It does *not* actually place the Label on the window. The Label is placed on the window by the line:

    ```
    myLabel.pack()
    ```

  - Notice that we're not specifying *where* on the window the Label should go. The default is to place the first widget on top, the next one underneath it, and so on, from top to bottom.

## Arranging widgets

```
import Tkinter

root = Tkinter.Tk()
root.title("Hello!")

myLabel = Tkinter.Label(root, text="CSC326", fg="blue")
myLabel.pack(side=Tkinter.RIGHT)

label2 = Tkinter.Label(root, text="Project", fg="red")
label2.pack(side=Tkinter.LEFT)

Tkinter.mainloop()
```





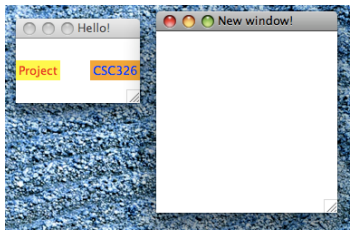

## Arranging widgets

- Observe that we can pass a `side` argument to `pack()`, giving us some basic control over layout.
  - The side argument can be `Tkinter.TOP` (this is the default value), `Tkinter.BOTTOM`, `Tkinter.LEFT`, or `Tkinter.RIGHT`.
  - The layout depends on *both* the order in which widgets are packed, and the side arguments given to the `pack()` calls.
- For more sophisticated layouts (for example, when you have lots of widgets), you can use `grid()` instead of `pack()`.
  - This lets you specify a row and column for each widget.
  - Note that you can't combine `grid()` and `pack()` within the same window.
- Another option for sophisticated layouts is using Frame widgets within a window.
  - The window is the parent of the Frame widgets.
  - Other widgets are created with a Frame as a parent, so packing them positions them inside the Frame.



## Creating additional windows

```
import Tkinter

root = Tkinter.Tk()
win = Tkinter.Toplevel(root)
root.title("Hello!")
win.title("New window!")
myLabel = Tkinter.Label(root, text="CSC326", fg="blue", bg="orange")
myLabel.pack(side=Tkinter.RIGHT)

label2 = Tkinter.Label(root, text="Project", fg="red", bg="yellow")
label2.pack(side=Tkinter.LEFT)

root.mainloop()
```



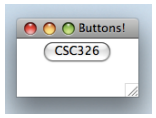



## Creating additional windows

- As we've seen, the call
  `root = Tkinter.Tk()`
  creates a "root" window for our application.
- To create an additional window, we can call `Tkinter.Toplevel()`.
  - This window then "belongs" to whichever root window we've specified.
  - Closing that root window will close this window too.
- To create an additional root window (that is, to create a new window whose existence doesn't depend on another root window), make another call to `Tkinter.Tk()`:
  `root2 = Tkinter.Tk()`

## Buttons

```
import Tkinter

root = Tkinter.Tk()
root.title("Buttons!")

myButton = Tkinter.Button(root, text="CSC326")
myButton.pack()

root.mainloop()
```

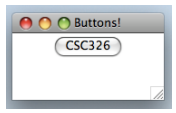



- The button can be clicked, but it doesn't do anything (yet).



## Responding to a button click

```
import Tkinter

root = Tkinter.Tk()
root.title("Buttons!")

def changeCol():
    root.config(bg="blue")

myButton = Tkinter.Button(root, text="CSC326", command=changeCol)
myButton.pack()

root.mainloop()
```





- Clicking the button changes the window's colour to blue.
- Observe that we used the keyword argument `command` to set the function `changeCol` as a *callback* function that is called whenever the button is clicked.



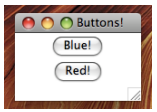
## Responding to a button click

- Note that the previous slide has bad coding style.
  - The function `changeCol` accesses the global variable `root`.
- Better style:
  - Define classes.
  - Let `root` be an instance variable and let `changeCol` be an instance method of the same class.
- For the sake of simplicity, we'll continue using the "bad" approach in this lecture (rather than defining classes), but you're expected to use good coding style for the project.
- There's another problem with the previous slide:
  - What if we want multiple buttons, each changing the background to a different colour?



## Responding to button clicks

```
import Tkinter

def blueCol():
    root.config(bg="blue")

def redCol():
    root.config(bg="red")

root = Tkinter.Tk()
root.title("Buttons!")

blueBtn = Tkinter.Button(root, text="Blue!", command=blueCol)
redBtn = Tkinter.Button(root, text="Red!", command=redCol)
blueBtn.pack()
redBtn.pack()

root.mainloop()
```






- Problem: Code duplication (`redCol` and `blueCol`).

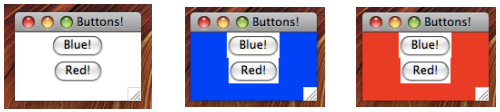
## Callbacks and arguments

- Observe that the code duplication problem gets worse if we add buttons for more colours (green, orange, etc.).
- To solve this problem, we need to have just a single function, `changeCol`, that takes a colour as an argument and sets the background to this colour.
  - But the callback function for a button is called with *no* arguments.
  - So we can't set such a `changeCol` function as the callback for a button.
- Solution: lambda expressions!
  - Just like in Scheme, lambda expressions in Python create functions.
  - However, in Python, the body of a lambda expression must be just a single expression, so lambda expressions cannot always replace a `def` statement.
  - Python lambda expression syntax:
    `(lambda arg1, arg2, ...: expression)`
    For example:
    `(lambda x, y: x+y) (3, 4)  # This evaluates to 7.`



## Using lambda to create a callback function

```
import Tkinter

def changeCol(colour):
    root.config(bg=colour)

root = Tkinter.Tk()
root.title("Buttons!")

blueB = Tkinter.Button(root, text="Blue!",command=(lambda: changeCol("blue")))
redB = Tkinter.Button(root, text="Red!", command=(lambda: changeCol("red")))
blueB.pack()
redB.pack()

root.mainloop()
```

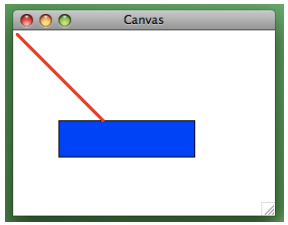



- Observe that we've use lambda to create callback functions for each button.
  - These functions take no arguments (as required for button callbacks).
  - These functions call `changeCol` with an appropriate argument.



## Canvasses

- The Canvas widget lets you draw various shapes.
  - Recall that you're required to use a Canvas widget for the project's game board.
- An example:

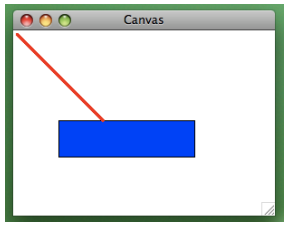



```
import Tkinter

root = Tkinter.Tk()
root.title("Canvas")

myC = Tkinter.Canvas(root)
myC.pack()
r = myC.create_rectangle(50,100,200,140, fill="blue")
l = myC.create_line(0,0,100,100, fill="red", width=2.0)

root.mainloop()
```

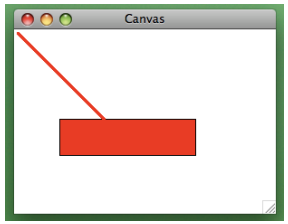


## Canvas events

```
import Tkinter

root = Tkinter.Tk()
root.title("Canvas")

def makeRed(i):
    myC.itemconfig(i,fill="red")

myC = Tkinter.Canvas(root)
myC.pack()
r = myC.create_rectangle(50,100,200,140,fill="blue")
l = myC.create_line(0,0,100,100,fill="red",width=2.0)
myC.bind("<Button-1>", (lambda e: makeRed(r)))
root.mainloop()
```




- Clicking the canvas makes the rectangle red.



## Canvas events

- Observe that the `bind()` method is used to set callbacks for a canvas.
  - The event called "`<Button-1>`" is a left-click.
  - A canvas callback function takes a single argument (we didn't do anything with this argument).
- Observe that `itemconfig()` method can be used to configure objects that have already been added to the canvas.
- The argument passed to a canvas callback function is an event object that provides information about the event that caused the callback to be called.
  - For example, the location of the pointer on the canvas when the mouse was clicked.



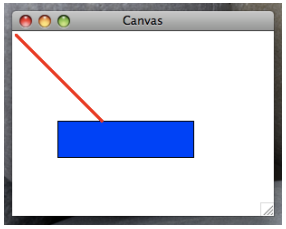
## Using canvas event objects

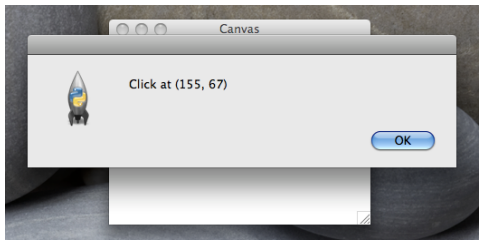
```
import Tkinter
import tkMessageBox

root = Tkinter.Tk()
root.title("Canvas")

def announce(event):
    message = "Click at "+ str((event.x, event.y))
    tkMessageBox.showinfo("Position", message)

myC = Tkinter.Canvas(root)
myC.pack()
r = myC.create_rectangle(50,100,200,140,fill="blue")
l = myC.create_line(0,0,100,100,fill="red",width=2.0)
myC.bind("<Button-1>", announce)
root.mainloop()
```

- Look at the next slide to see what happens when we click inside the canvas.



## Using canvas event objects



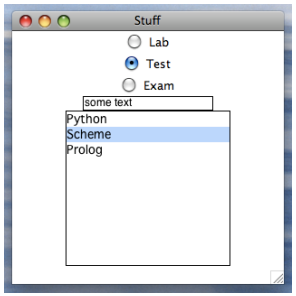



## Using canvas event objects

- Observe that the `x` and `y` instance variables of the event object passed to a canvas callback function provide the canvas co-ordinates of the pointer when the event (in our case, a left-click) occurred.
- The `tkMessageBox` module provides a collection of dialog boxes (`showinfo`, `askyesno`, `askokcancel`, etc.).
- The call:
  `tkMessageBox.showinfo("Position", message)`
  creates a dialog box that displays the given `message` and has an OK button.
  - The first argument (`"Position"`) is meant to set the title of the dialog box, but this seems to have no effect on Mac OS. Try this out on your system to see what happens.

## Some other useful widgets

- Entry widgets
  - These allow the user to enter text.
- Radiobutton widgets
  - These allow the user to choose exactly one item from a collection.
- Listbox widgets
  - These allow to user to choose an item from a list.
- And more!






## What we've left out

- Object-oriented design.
  - For the project, you need to create appropriate classes for your GUI.
  - And, more generally, you need to follow good programming style (unlike what we've seen in many of these examples).
- Tkinter.
  - There's (not surprisingly) ***much more*** than what we've covered in this lecture.
  - Widgets, methods, settings, etc.
  - This lecture was just meant to be a starting point.



## Exercises

- Create a simple Tkinter application. Like we did in this lecture, start with an application that displays an empty window. Then add some widgets.
- Experiment with callback functions. First create a callback function for a button. Then create a callback function for a canvas.
- Go beyond what we did in this lecture. Read about some widgets that we didn't cover (such as the widgets on slide 25), and add them to your application.