Computational Thinking with Programming

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Topics

- Graphical User Interfaces
- Using the `tkinter` Module
- Display Text with `Label` Widgets
- Organizing Widgets with Frames
- `Button` Widgets and Info Dialog Boxes
- Getting Input with the `Entry` Widget
- Using Labels as Output Fields
- Radio Buttons and Check Buttons
- Drawing Shapes with the `Canvas` Widget

Using the `tkinter` Module

- No GUI programming features built into Python
- `tkinter` module: allows you to create simple GUI programs
  - Comes with Python
- Widget: graphical element that the user can interact with or view
  - Presented by a GUI program

Website resources:

https://www.tutorialspoint.com/python/python_gui_programming.htm

https://www.geeksforgeeks.org/python-gui-tkinter/

Widget	Description
`Button`	A button that can cause an action to occur when it is clicked.
`Canvas`	A rectangular area that can be used to display graphics.
`Checkbutton`	A button that may be in either the “on” or “off” position.
`Entry`	An area in which the user may type a single line of input from the keyboard.
`Frame`	A container that can hold other widgets.
`Label`	An area that displays one line of text or an image.
`Listbox`	A list from which the user may select an item
`Menu`	A list of menu choices that are displayed when the user clicks a `Menubutton` widget.
`Menubutton`	A menu that is displayed on the screen and may be clicked by the user
`Message`	Displays multiple lines of text.
`Radiobutton`	A widget that can be either selected or deselected. `Radiobutton` widgets usually appear in groups and allow the user to select one of several options.
`Scale`	A widget that allows the user to select a value by moving a slider along a track.
`Scrollbar`	Can be used with some other types of widgets to provide scrolling ability.
`Text`	A widget that allows the user to enter multiple lines of text input.
`Toplevel`	A container, like a `Frame`, but displayed in its own window.

Using the `tkinter` Module (cont'd.)

- Programs that use `tkinter` do not always run reliably under IDLE
  - For best results run them from operating system command prompt
- Most programmers take an object-oriented approach when writing GUI programs
  - `__init__` method builds the GUI
  - When an instance is created the GUI appears on the screen

```
import tkinter as tk

# if you are still working under a Python 2 version,
# comment out the previous line and uncomment the following
line
#import Tkinter as tk

root = tk.Tk()

w = tk.Label(root, text="Hello Tkinter!")
w.pack()

root.mainloop()
```

```
from tkinter import *

top = Tk()
top.geometry("500x500")
var = StringVar()
label = Label( top, textvariable=var, relief=RAISED )

var.set("Hey!? How are you doing?")
label.pack()
top.mainloop()
```

```
from tkinter import *

top = Tk()

C = Canvas(top, bg="blue", height=250, width=300)

coord = 10, 50, 240, 210
arc = C.create_arc(coord, start=0, extent=150, fill="red")

C.pack()
top.mainloop()
```

```
from tkinter import *

top = Tk()
CheckVar1 = IntVar()
CheckVar2 = IntVar()
C1 = Checkbutton(top, text = "Music", variable = CheckVar1, \
                 onvalue = 1, offvalue = 0, height=5, \
                 width = 20)
C2 = Checkbutton(top, text = "Video", variable = CheckVar2, \
                 onvalue = 1, offvalue = 0, height=5, \
                 width = 20)
C1.pack()
C2.pack()
top.mainloop()
```

```
from tkinter import *

root = Tk()
frame = Frame(root)
frame.pack()

bottomframe = Frame(root)
bottomframe.pack( side = BOTTOM )

redbutton = Button(frame, text="Red", fg="red")
redbutton.pack( side = LEFT)

greenbutton = Button(frame, text="Brown", fg="brown")
greenbutton.pack( side = LEFT )

bluebutton = Button(frame, text="Blue", fg="blue")
bluebutton.pack( side = LEFT )

blackbutton = Button(bottomframe, text="Black", fg="black")
blackbutton.pack( side = BOTTOM)
root.mainloop()
```

```
#Import tkinter library
from tkinter import *
#Create an instance of Tkinter frame or window
win= Tk()
#Set the geometry of tkinter frame
win.geometry("750x250")
def callback():
   Label(win, text="Hello World!", font=('Century 20 
bold')).pack(pady=4)
#Create a Label and a Button widget
btn=Button(win, text="Press Enter", command= callback)
btn.pack(ipadx=10)
win.bind('<Return>',lambda event:callback())
win.mainloop()
```

Display Text with `Label` Widgets

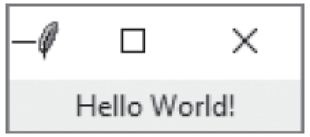
- `Label` widget: displays a single line of text in a window
  - Made by creating an instance of `tkinter` module’s `Label` class
  - Format: `tkinter.Label(self.main_window,`
    `text = 'my text')`
    - First argument references the root widget, second argument shows text that should appear in label

Display Text with `Label` Widgets (cont'd.)

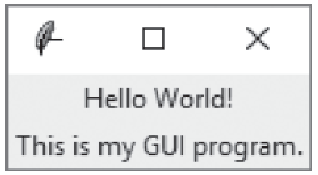
- `pack` method: determines where a widget should be positioned and makes it visible when the main window is displayed
  - Called for each widget in a window
  - Receives an argument to specify positioning
    - Positioning depends on the order in which widgets were added to the main window
    - Valid arguments: `side='top', side='left', side='right'`

Display Text with `Label` Widgets (cont'd.)

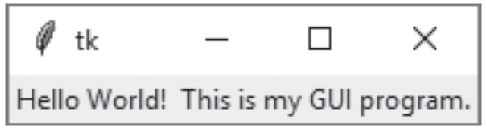
Window displayed by Program 13-3


Hello World!

Window displayed by Program 13-4


Hello World!
This is my GUI program.

Window displayed by Program 13-5



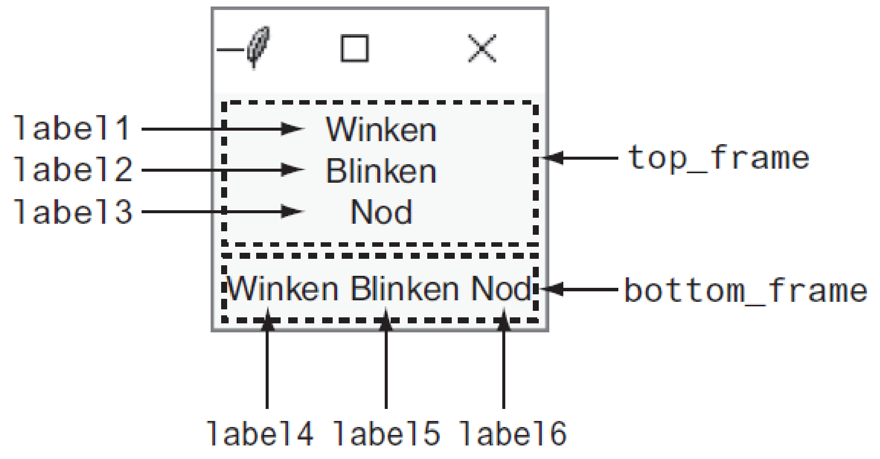
Hello World! This is my GUI program.

Organizing Widgets with Frames

- `Frame` widget: container that holds other widgets
  - Useful for organizing and arranging groups of widgets in a window
  - The contained widgets are added to the frame widget which contains them
    - Example:

```
tkinter.Label(self.top_frame, text = 'hi')
```

Arrangement of widgets



`Button` Widgets and Info Dialog Boxes

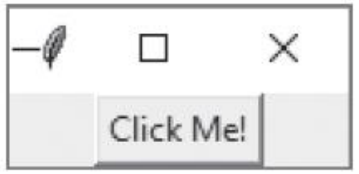
- `Button` widget: widget that the user can click to cause an action to take place
  - When creating a button can specify:
    - Text to appear on the face of the button
    - A callback function
- Callback function: function or method that executes when the user clicks the button
  - Also known as an event handler

`Button` Widgets and Info Dialog Boxes (cont'd.)

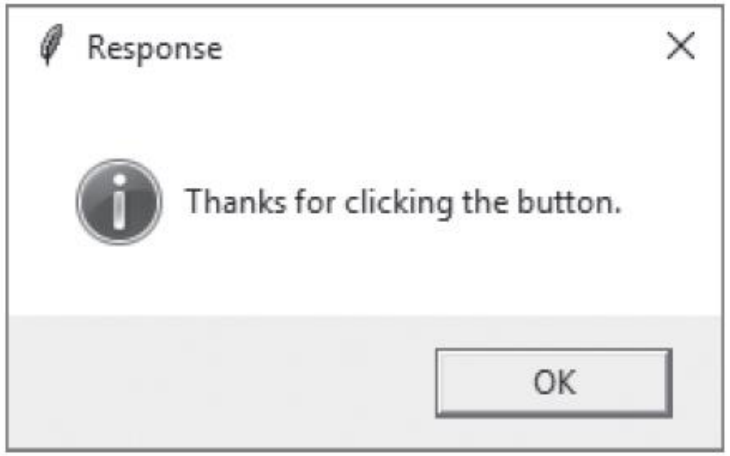
- Info dialog box: a dialog box that shows information to the user
  - Format for creating an info dialog box:
    - Import `tkinter.messagebox` module
    - `tkinter.messagebox.showinfo(`*`title`*`,`
      `message``)`
      - *`title`* is displayed in dialog box's title bar
      - *`message`* is an informational string displayed in the main part of the dialog box

Button Widgets and Info Dialog Boxes (cont'd.)

The main window displayed by Program 13-7



The info dialog box displayed by Program 13-7



Thanks for clicking the button.

Creating a Quit Button

- Quit button: closes the program when the user clicks it
- To create a quit button in Python:
  - Create a `Button` widget
  - Set the root widget's `destroy` method as the callback function
    - When the user clicks the button the `destroy` method is called and the program ends

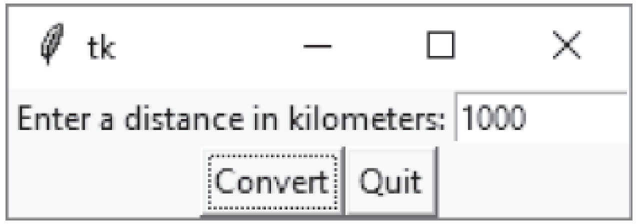
Getting Input with the `Entry` Widget

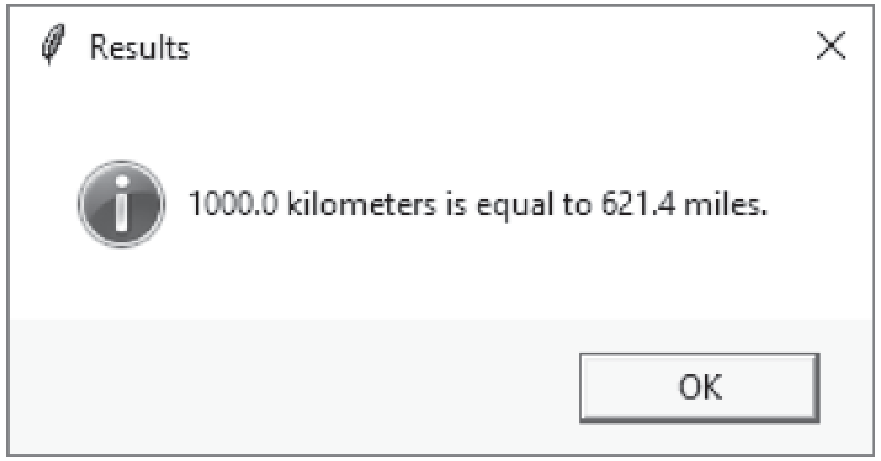
- `Entry` widget: rectangular area that the user can type text into
  - Used to gather input in a GUI program
  - Typically followed by a button for submitting the data
    - The button's callback function retrieves the data from the `Entry` widgets and processes it
  - `Entry` widget's `get` method: used to retrieve the data from an `Entry` widget
    - Returns a string

Getting Input with the `Entry` Widget (cont'd.)

1 The user enters 1000 into the `Entry` widget and clicks the `Convert` button.

2 This info dialog box is displayed.





1000.0 kilometers is equal to 621.4 miles.

Using Labels as Output Fields

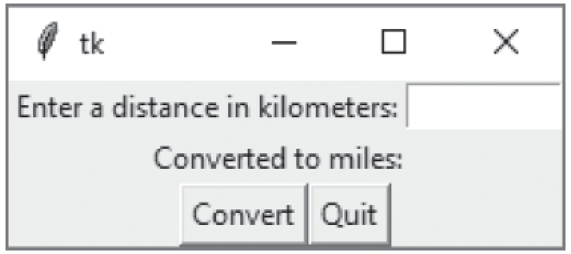
- Can use `Label` widgets to dynamically display output
  - Used to replace info dialog box
  - Create empty `Label` widget in main window, and write code that displays desired data in the label when a button is clicked

Using Labels as Output Fields (cont'd.)

- `StringVar` class: `tkinter` module class that can be used along with `Label` widget to display data
  - Create `StringVar` object and then create `Label` widget and associate it with the `StringVar` object
  - Subsequently, any value stored in the `StringVar` object with automatically be displayed in the `Label` widget

Using Labels as Output Fields (cont'd.)

The window initially displayed



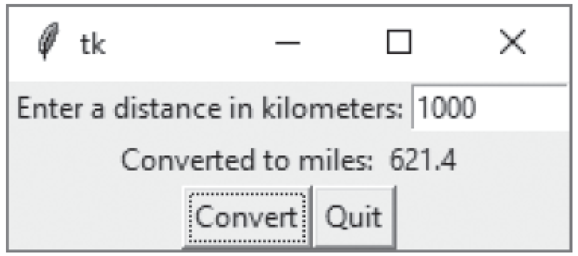
tk

Enter a distance in kilometers:

Converted to miles:

Convert Quit

The window showing 1000 kilometers converted to miles



tk

Enter a distance in kilometers: 1000

Converted to miles: 621.4

Convert Quit

Radio Buttons and Check Buttons

- Radio button: small circle that appears filled when it is selected and appears empty when it is deselected
  - Useful when you want the user to select one choice from several possible options
- `Radiobutton` widgets: created using `tkinter` module's `Radiobutton` class
  - `Radiobutton` widgets are mutually exclusive
    - Only one radio button in a container may be selected at any given time

Radio Buttons and Check Buttons (cont'd)

- `IntVar` class: a `tkinter` module class that can be used along with `Radiobutton` widgets
  - Steps for use:
    - Associate group of `Radiobutton` widgets with the same `IntVar` object
    - Assign unique integer to each `Radiobutton`
    - When a `Radiobutton` widgets is selected, its unique integer is stored in the `IntVar` object
  - Can be used to select a default radio button

Using Callback Functions with `Radiobuttons`

- You can specify a callback function with `Radiobutton` widgets
    - Provide an argument `command=self.my_method` when creating the `Radiobutton` widget
    - The command will execute immediately when the radio button is selected
    - Replaces the need for a user to click OK or submit before determining which `Radiobutton` is selected

Check Buttons

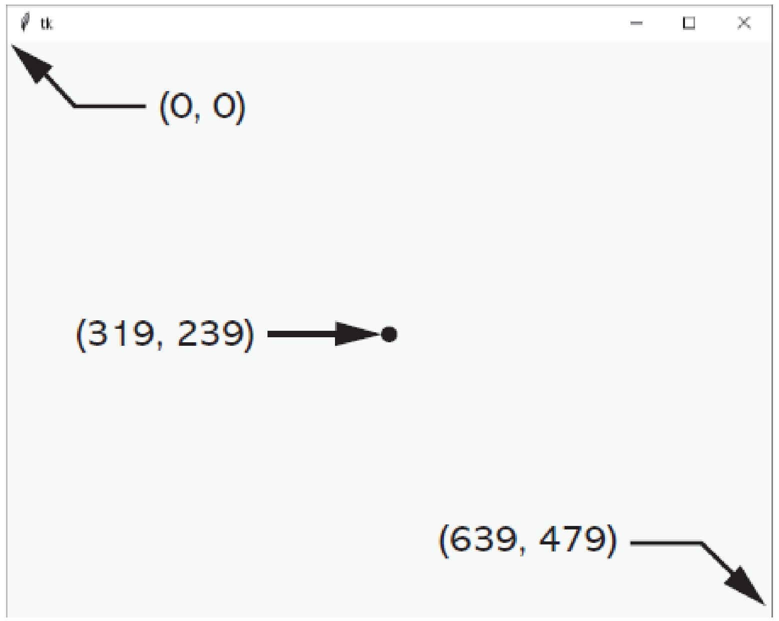
- Check button: small box with a label appearing next to it; check mark indicates when it is selected
  - User is allowed to select any or all of the check buttons that are displayed in a group
    - Not mutually exclusive
- `Checkbutton` widgets: created using `tkinter` module's `Checkbutton` class
  - Associate different `IntVar` object with each `Checkbutton` widget

Drawing Shapes with the `Canvas` Widget

- The `Canvas` widget is a blank, rectangular area that allows you to draw simple 2D shapes.
- You use the `Canvas` widget's *screen coordinate system* to specify the location of your graphics.
- The coordinates of the pixel in the upper-left corner of the screen are (0, 0).
  - The *X* coordinates increase from left to right
  - The *Y* coordinates increase from top to bottom.

Drawing Shapes with the `Canvas` Widget

Various pixel locations in a 640 by 480 window



Drawing Shapes with the `Canvas` Widget

- Creating a `Canvas` widget:

```
# Create the main window.
self.main_window = tkinter.Tk()

# Create the Canvas widget.
self.canvas = tkinter.Canvas(self.main_window, width=200, height=200)
```

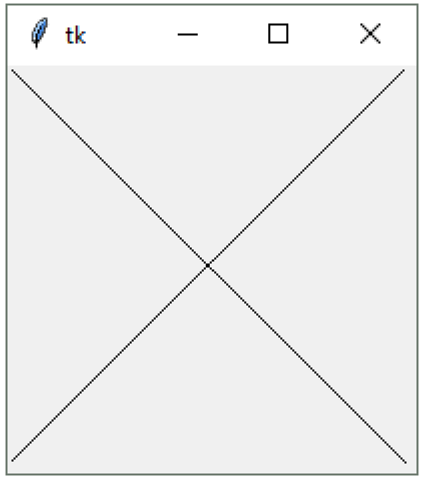
Drawing Shapes with the `Canvas` Widget

- The `Canvas` widget has numerous methods for drawing graphical shapes on the surface of the widget.
- The methods that we will discuss are:
  - `create_line`
  - `create_rectangle`
  - `create_oval`
  - `create_arc`
  - `create_polygon`
  - `create_text`

Drawing a Line

$$\textit{canvas\_name}\texttt{.create\_line(}\underbrace{\texttt{x1, y1,}}_{\text{Coordinates of the line's starting point}}\ \overbrace{\texttt{x2, y2,}}^{\text{Coordinates of the line's ending point}}\ \underset{\text{Optional arguments (See Table 13-2)}}{\textit{options}\ldots}\texttt{)}$$

```
# This program demonstrates the Canvas widget.
import tkinter

class MyGUI:
    def __init__(self):
        # Create the main window.
        self.main_window = tkinter.Tk()

        # Create the Canvas widget.
        self.canvas = tkinter.Canvas(self.main_window, width=200,height=200)

        # Draw two lines.
        self.canvas.create_line(0, 0, 199, 199)
        self.canvas.create_line(199, 0, 0, 199)

        # Pack the canvas.
        self.canvas.pack()

        # Start the mainloop.
        tkinter.mainloop()

# Create an instance of the MyGUI class.
my_gui = MyGUI()
```



Drawing a Rectangle

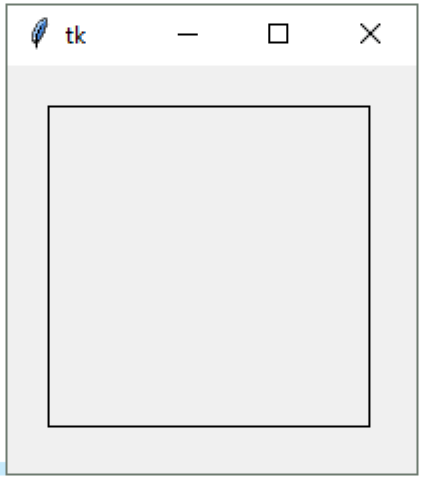
Coordinates of
the lower-right
corner

```
canvas_name.create_rectangle(x1, y1, x2, y2, options…)
```

Coordinates of
the upper-left
corner

Optional arguments
(See Table 13-3)

```python
# This program draws a rectangle on a Canvas.
import tkinter

class MyGUI:
    def __init__(self):
        # Create the main window.
        self.main_window = tkinter.Tk()

        # Create the Canvas widget.
        self.canvas = tkinter.Canvas(self.main_window, width=200, height=200)

        # Draw a rectangle.
        self.canvas.create_rectangle(20, 20, 180, 180)

        # Pack the canvas.
        self.canvas.pack()

        # Start the mainloop.
        tkinter.mainloop()

# Create an instance of the MyGUI class.
my_gui = MyGUI()
```



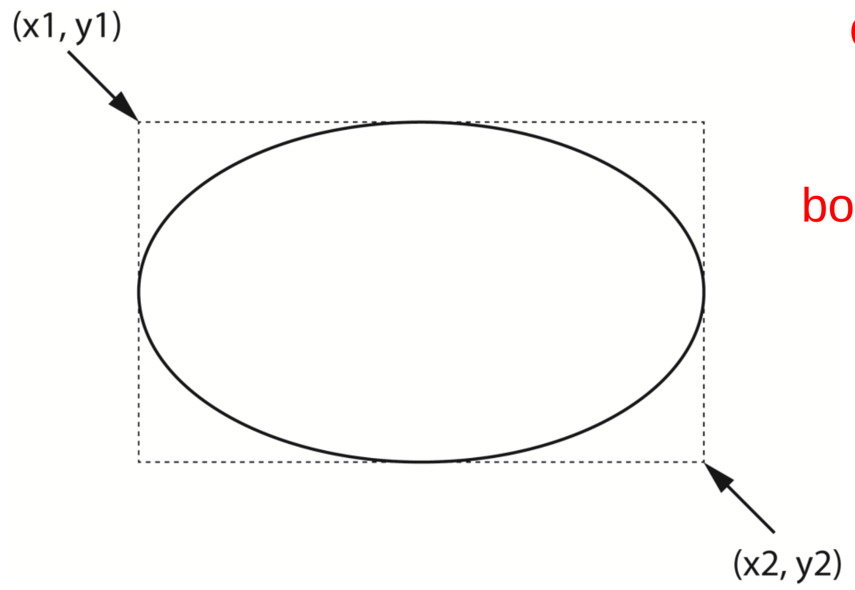
Drawing an Oval

Coordinates of the lower-right corner of bounding rectangle

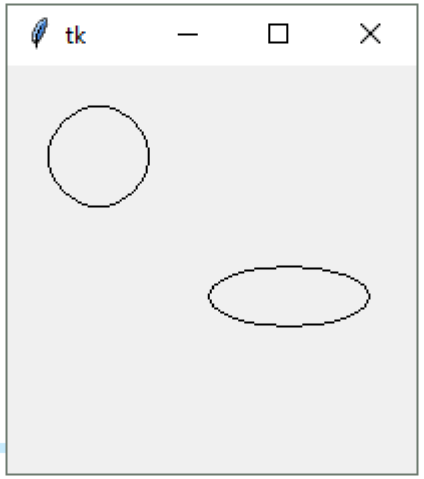
```
canvas_name.create_oval(x1, y1, x2, y2, options…)
```

Coordinates of the upper-left corner of bounding rectangle

Optional arguments (See Table 13-4)



```python
# This program draws two ovals on a Canvas.
import tkinter

class MyGUI:
    def __init__(self):
        # Create the main window.
        self.main_window = tkinter.Tk()

        # Create the Canvas widget.
        self.canvas = tkinter.Canvas(self.main_window, width=200, height=200)

        # Draw two ovals.
        self.canvas.create_oval(20, 20, 70, 70)
        self.canvas.create_oval(100, 100, 180, 130)

        # Pack the canvas.
        self.canvas.pack()

        # Start the mainloop.
        tkinter.mainloop()

# Create an instance of the MyGUI class.
my_gui = MyGUI()
```



Drawing an Arc

Coordinates of the upper-left corner of bounding rectangle

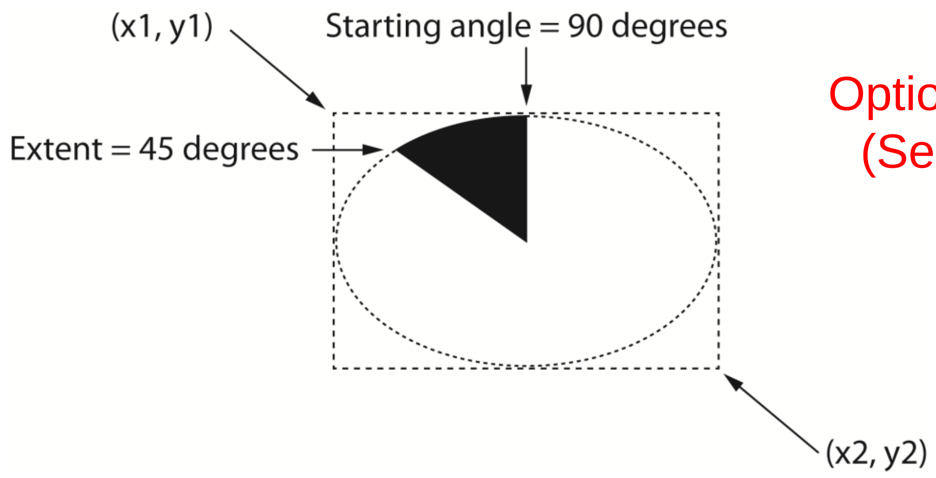
Coordinates of the lower-right corner of bounding rectangle

```
canvas_name.create_arc(x1, y1, x2, y2,
                       start=angle, extent=width,
                       options...)
```

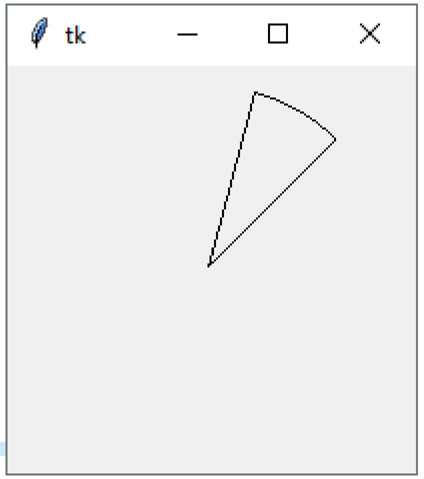
Starting angle

Counter clockwise extent of the arc

Optional arguments (See Table 13-5)



```
# This program draws an arc on a Canvas.
import tkinter

class MyGUI:
    def __init__(self):
        # Create the main window.
        self.main_window = tkinter.Tk()

        # Create the Canvas widget.
        self.canvas = tkinter.Canvas(self.main_window, width=200, height=200)

        # Draw an arc.
        self.canvas.create_arc(10, 10, 190, 190, start=45, extent=30)

        # Pack the canvas.
        self.canvas.pack()

        # Start the mainloop.
        tkinter.mainloop()

# Create an instance of the MyGUI class.
my_gui = MyGUI()
```

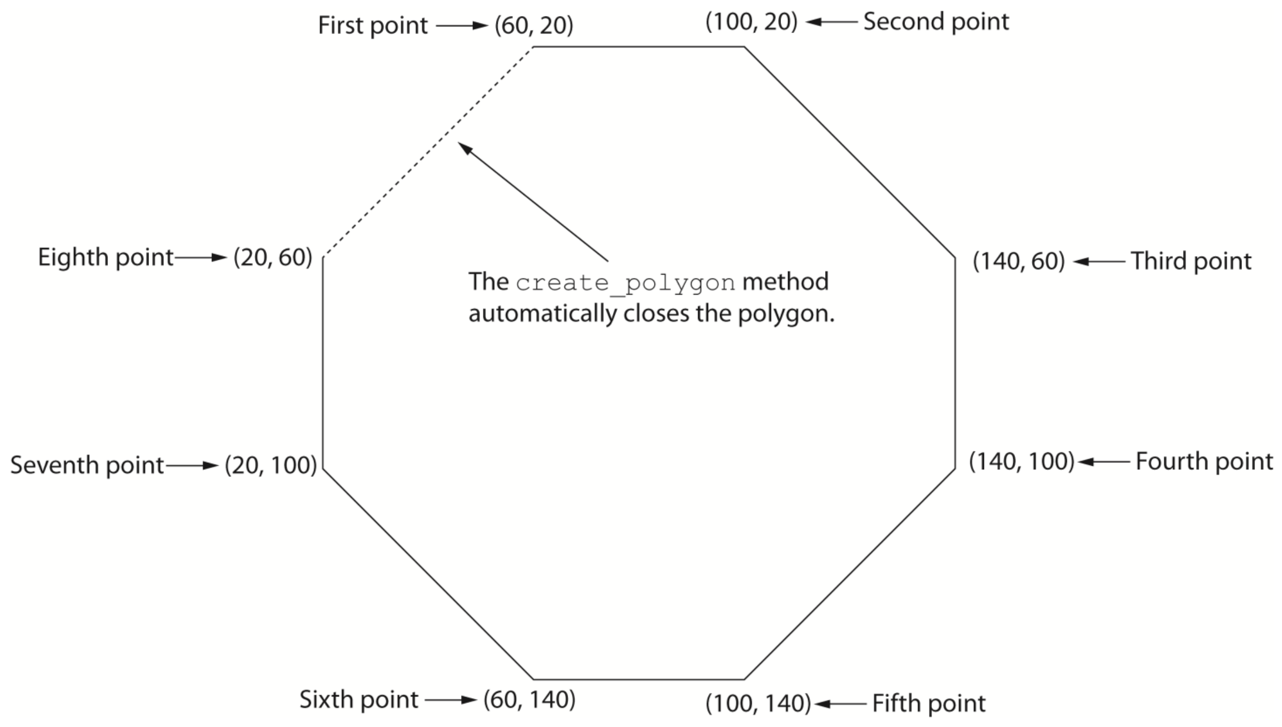


Drawing a Polygon

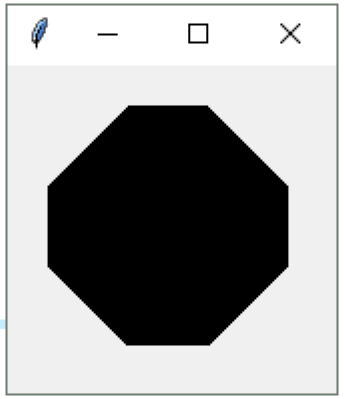
$$\texttt{\textit{canvas\_name}.create\_polygon(}\underbrace{\texttt{x1, y1,}}_{\substack{\text{Coordinates of}\\ \text{the first vertex}}}\ \overbrace{\texttt{x2, y2,}}^{\substack{\text{Coordinates of}\\ \text{the second vertex}}}\ \texttt{…,}\underset{\substack{\text{Optional arguments}\\ \text{(See Table 13-7)}}}{\texttt{\textit{options}…}}\texttt{)}$$

Drawing a Polygon

```
self.canvas.create_polygon(60, 20, 100, 20, 140, 60, 140, 100,
                           100, 140, 60, 140, 20, 100, 20, 60)
```



```
# This program draws a polygon on a Canvas.
import tkinter

class MyGUI:
    def __init__(self):
        # Create the main window.
        self.main_window = tkinter.Tk()

        # Create the Canvas widget.
        self.canvas = tkinter.Canvas(self.main_window, width=160, height=160)

        # Draw a polygon.
        self.canvas.create_polygon(60, 20, 100, 20, 140, 60, 140, 100,
                                   100, 140, 60, 140, 20, 100, 20, 60)

        # Pack the canvas.
        self.canvas.pack()

        # Start the mainloop.
        tkinter.mainloop()

# Create an instance of the MyGUI class.
my_gui = MyGUI()
```



Displaying Text on the Canvas

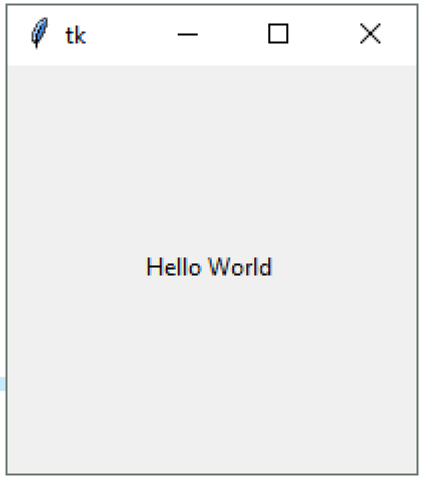
Text to display

```
canvas_name.create_text(x, y, text=text, options…)
```

Coordinates of the text's insertion point

Optional arguments (See Table 13-8)

```
# This program draws text on a Canvas.
import tkinter

class MyGUI:
    def __init__(self):
        # Create the main window.
        self.main_window = tkinter.Tk()

        # Create the Canvas widget.
        self.canvas = tkinter.Canvas(self.main_window, width=200, height=200)

        # Display text in the center of the window.
        self.canvas.create_text(100, 100, text='Hello World')

        # Pack the canvas.
        self.canvas.pack()

        # Start the mainloop.
        tkinter.mainloop()

# Create an instance of the MyGUI class.
my_gui = MyGUI()
```



Hello World

Summary

- This chapter covered:
  - Graphical user interfaces and their role as event-driven programs
  - The `tkinter` module, including:
    - Creating a GUI window
    - Adding widgets to a GUI window
    - Organizing widgets in frames
    - Receiving input and providing output using widgets
    - Creating buttons, check buttons, and radio buttons
    - Drawing simple shapes with the `Canvas` widget

Thank You