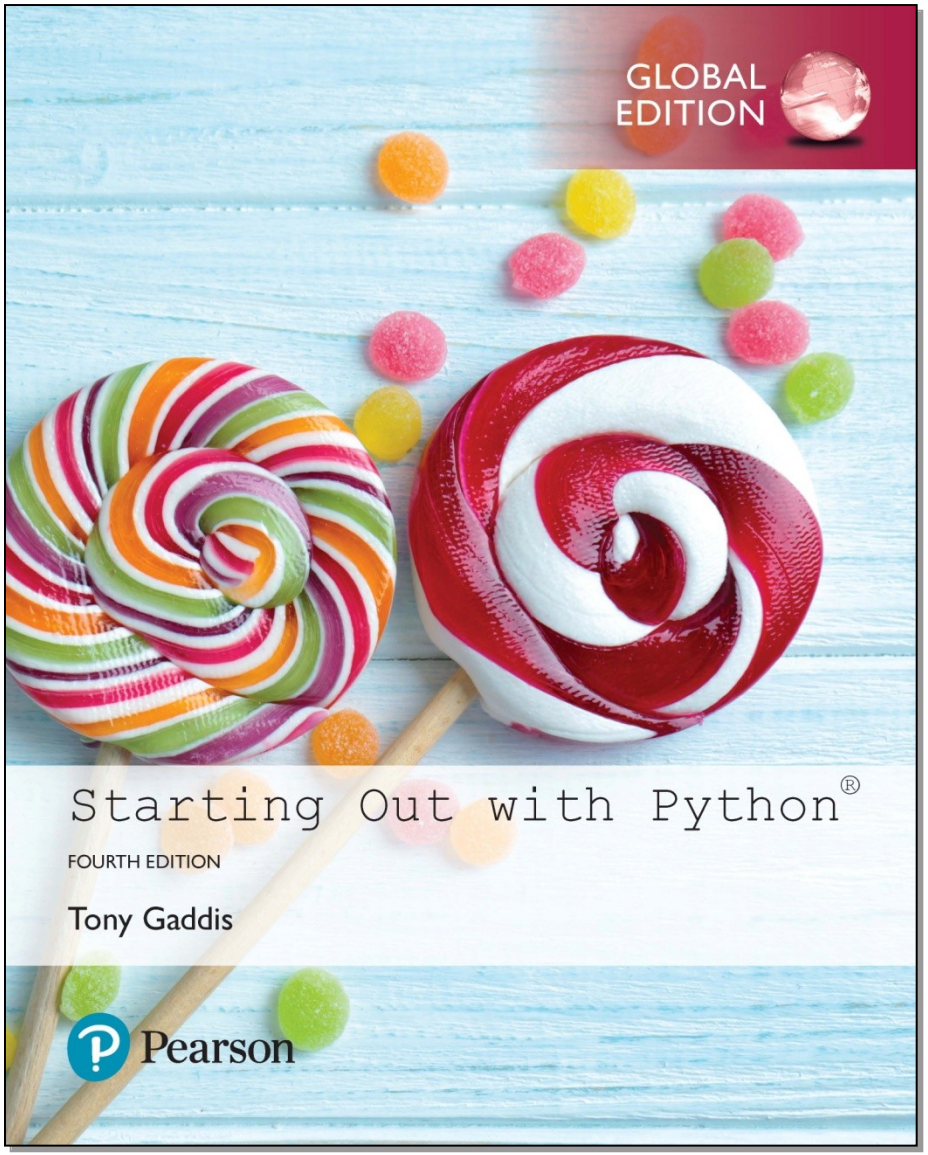
CHAPTER 13

GUI Programming



Topics

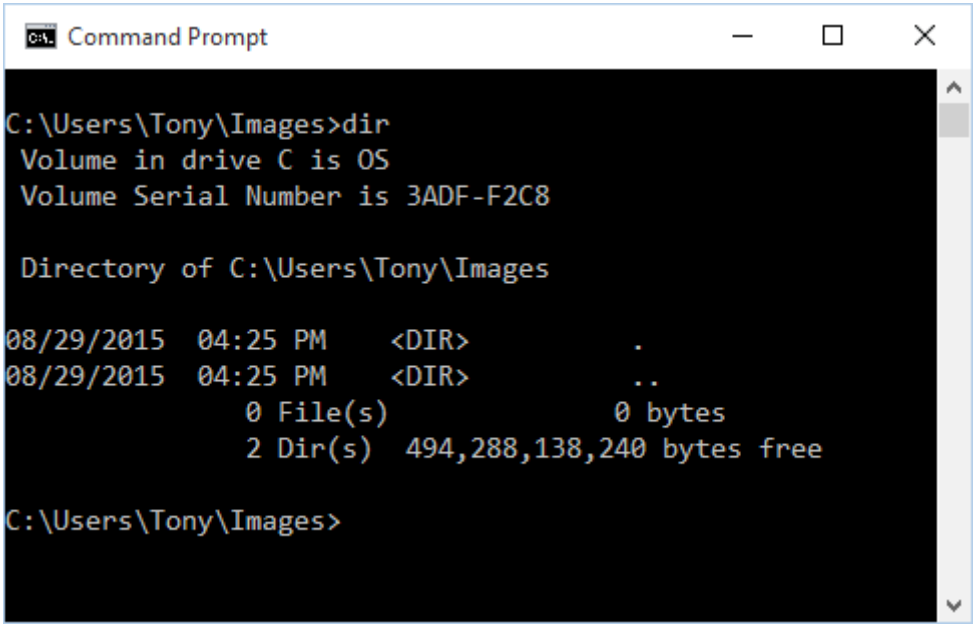
- Graphical User Interfaces
- Using the `tkinter` Module
- Display Text with `Label` Widgets
- Organizing Widgets with Frames
- `Button` Widgets and Info Dialog Boxes
- Getting Input with the `Entry` Widget
- Using Labels as Output Fields
- Radio Buttons and Check Buttons
- Drawing Shapes with the `Canvas`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

Graphical User Interfaces

- User Interface: the part of the computer with which the user interacts
- Command line interface: displays a prompt and the user types a command that is then executed
- Graphical User Interface (GUI): allows users to interact with a program through graphical elements on the screen

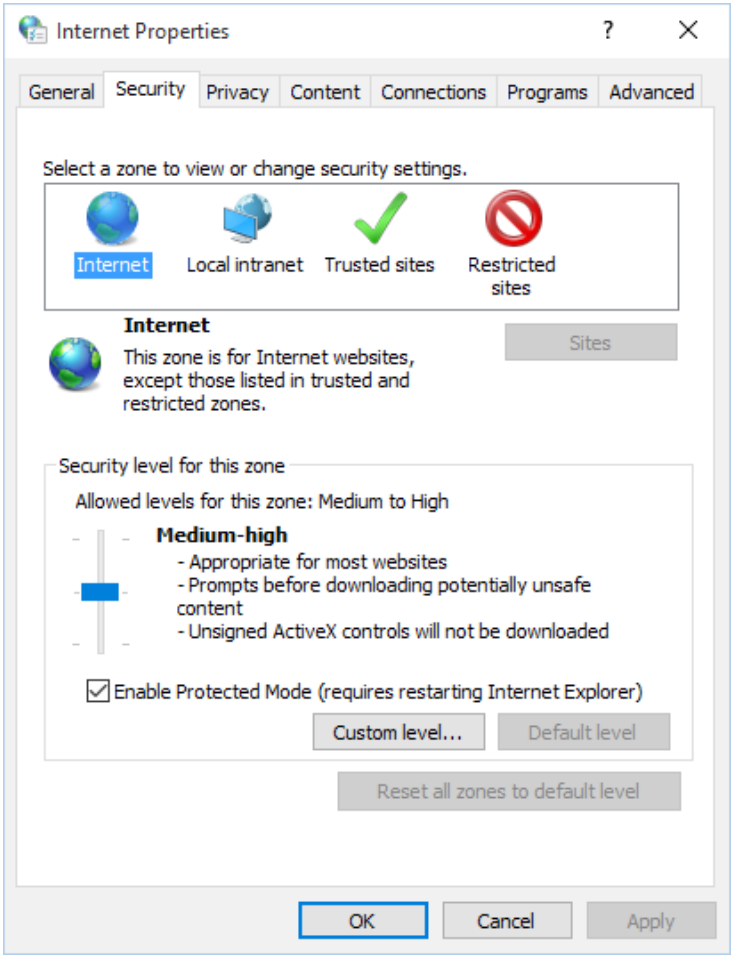
Graphical User Interfaces (cont'd.)

- **A command line interface**



Graphical User Interfaces (cont'd.)

- **<u>Dialog boxes</u>: small windows that display information and allow the user to perform actions**
  - Responsible for most of the interaction through GUI
  - User interacts with graphical elements such as icons, buttons, and slider bars



GUI Programs Are Event-Driven

- **In text-based environments, programs determine the order in which things happen**
  - The user can only enter data in the order requested by the program
- **GUI environment is event-driven**
  - The user determines the order in which things happen
    - User causes events to take place and the program responds to the events

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

Table 13-1 `tkinter` Widgets

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

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.)

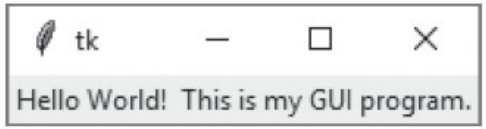
- **`pack` method: determines where a widget should be positioned and makes it visible when the main window is displayed**
  - Called for each widget in a window
  - Receives an argument to specify positioning
    - Positioning depends on the order in which widgets were added to the main window
    -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

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

Figure 13-5 Window displayed by Program 13-3

Figure 13-6 Window displayed by Program 13-4

Figure 13-7 Window displayed by Program 13-5



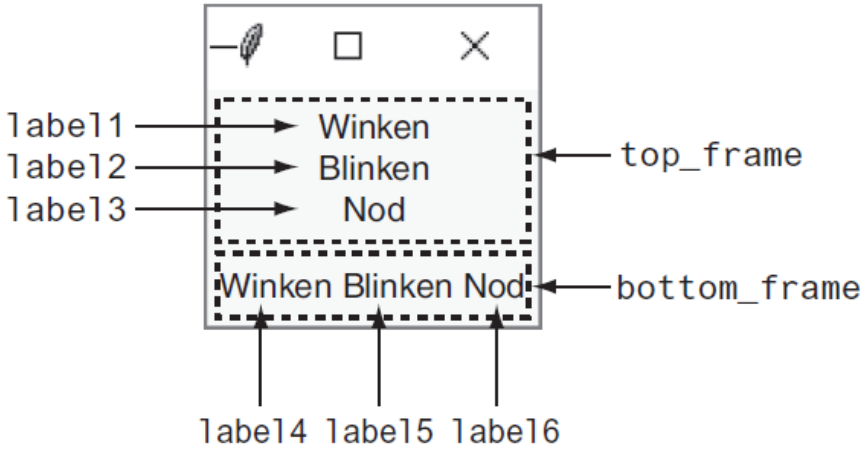
Organizing Widgets with Frames

- **`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')
```

Organizing Widgets with Frames (cont'd.)

Figure 13-9 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

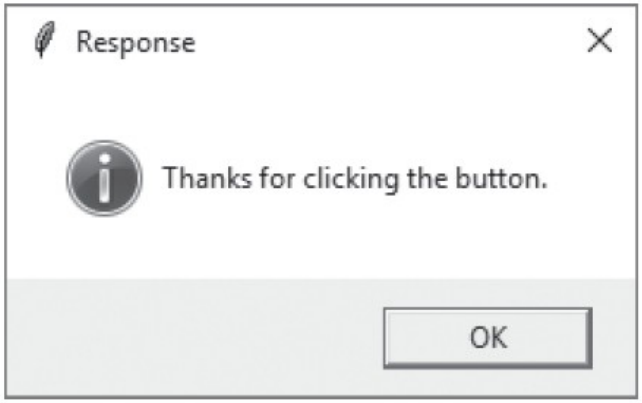
`Button` Widgets and Info Dialog Boxes (cont'd.)

- **<u>Info dialog box</u>: 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.)

Figure 13-10 The main window displayed by Program 13-7

Figure 13-11 The info dialog box displayed by Program 13-7



Creating a Quit Button

- **<u>Quit button</u>: 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

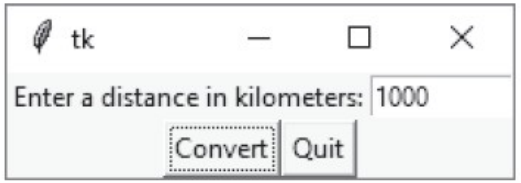
Getting Input with the `Entry` Widget

- **`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

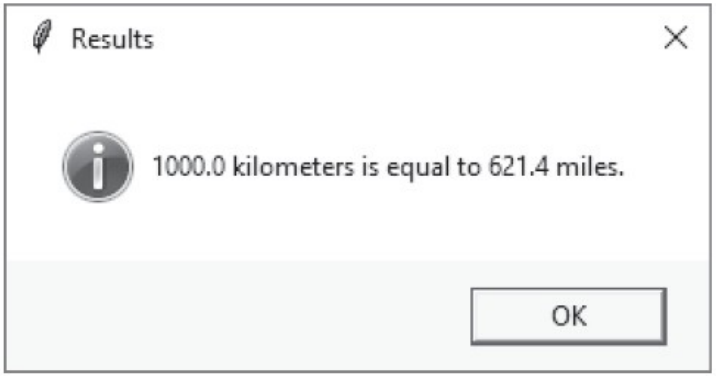
Getting Input with the `Entry` Widget (cont'd.)

Figure 13-15 The info dialog box

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



2. This info dialog box is displayed.



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.)

Figure 13-16 The window initially displayed

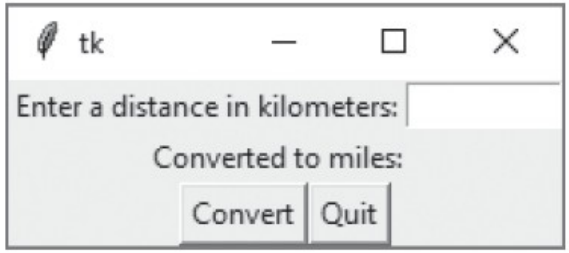
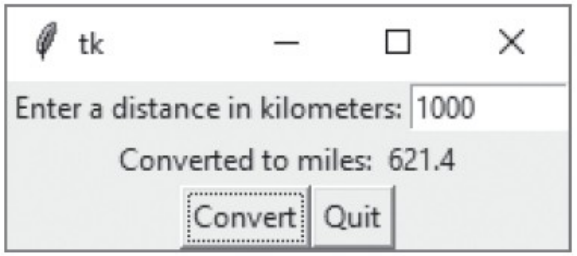


Figure 13-17 The window showing 1000 kilometers converted to miles



Radio Buttons and Check Buttons

- **<u>Radio button</u>: 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
- **<u>`Radiobutton` widgets</u>: 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

- **<u>Check button</u>: 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
- **<u>`Checkbutton` widgets</u>: created using `tkinter` module's `Checkbutton` class**
  - Associate different `IntVar` object with each `Checkbutton` widget

Drawing Shapes with the `Canvas` Widget

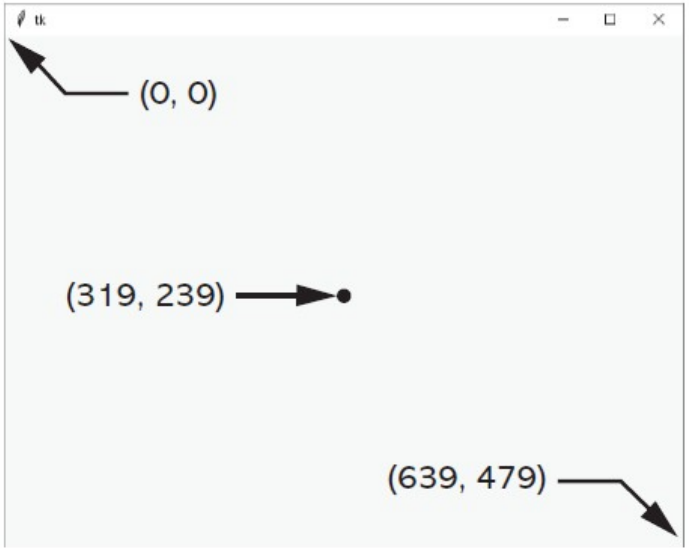
- **The `Canvas` widget is a blank, rectangular area that allows you to draw simple 2D shapes.**

- **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

Figure 13-26 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

Coordinates of the line's ending point

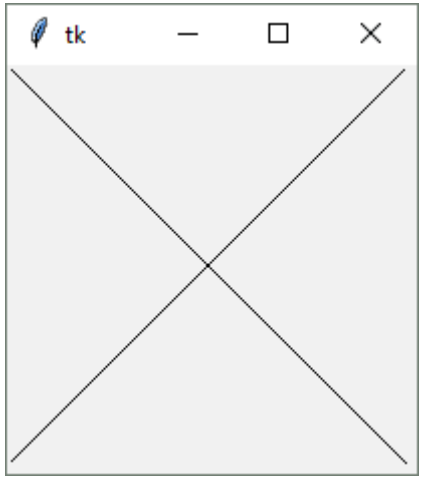
```
canvas_name.create_line(x1, y1, x2, y2, options…)
```

Coordinates of the line's starting point

Optional arguments (See Table 13-2)

Program 13-14 (draw_line.py)

```
# 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

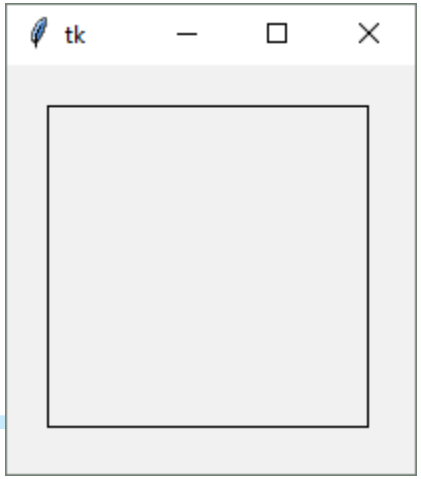
```
canvas_name.create_rectangle(x1, y1, x2, y2, options…)
```

Coordinates of the upper-left corner

Optional arguments (See Table 13-3)

Program 13-16 (draw_square.py)

```
# 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()
```



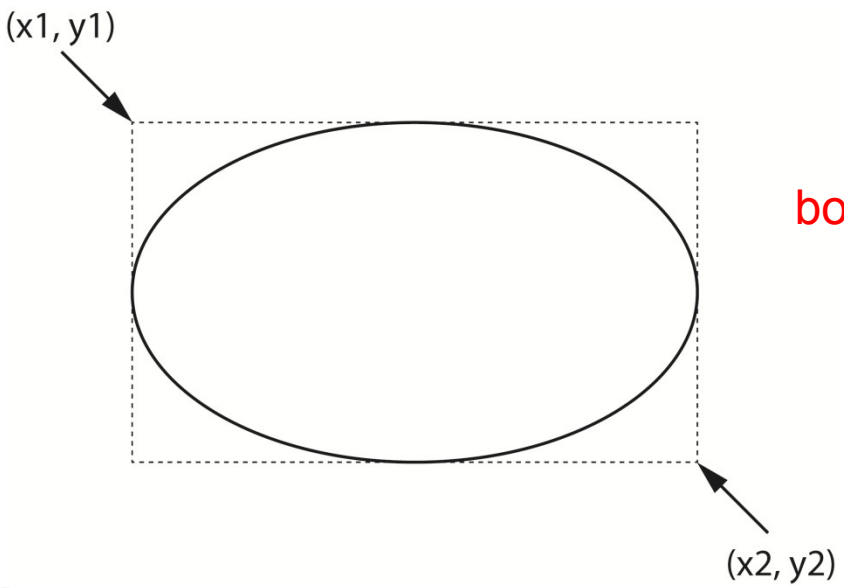
Drawing an Oval

Coordinates of the lower-right corner of bounding rectangle

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

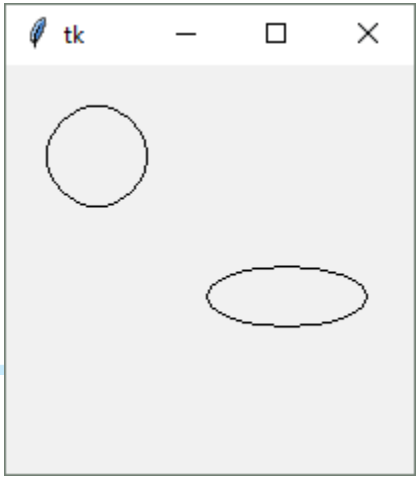
Coordinates of the upper-left corner of bounding rectangle

Optional arguments (See Table 13-4)



Program 13-17 (draw_ovals.py)

```
# 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

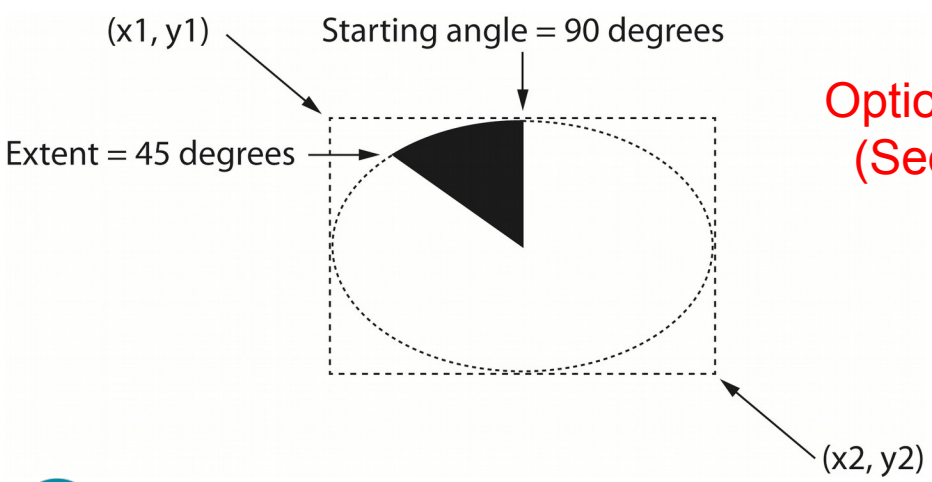
Coordinates of the lower-right corner of bounding rectangle

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

Starting angle

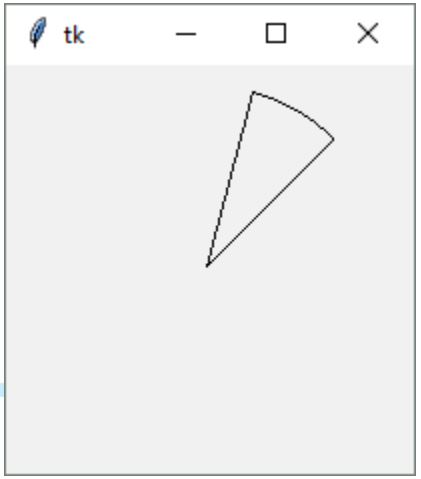
Counter clockwise extent of the arc

Optional arguments (See Table 13-5)



Program 13-18 (draw_arc.py)

```
# 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

Coordinates of the second vertex

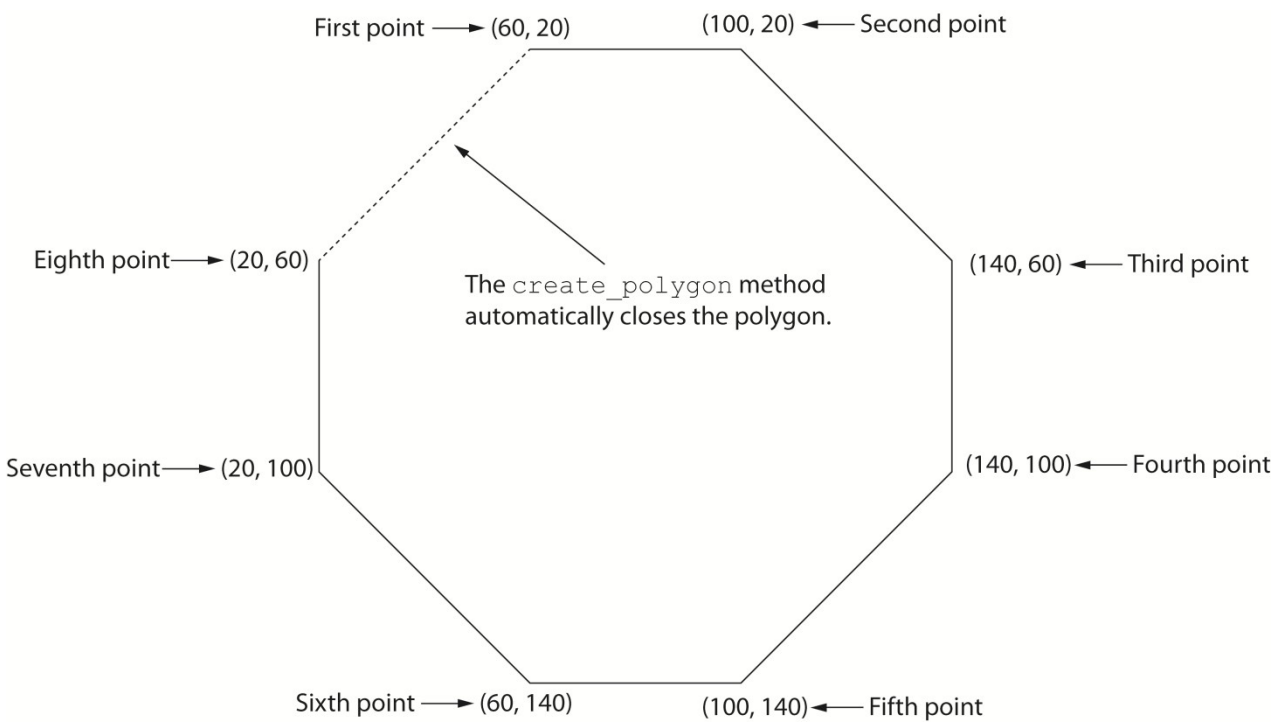
```
canvas_name.create_polygon(x1, y1, x2, y2, …,options…)
```

Coordinates of the first vertex

Optional arguments (See Table 13-7)

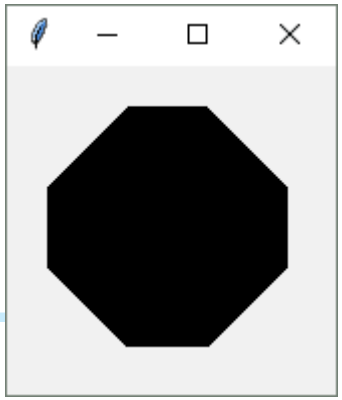
Drawing a Polygon

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



Program 13-20 (draw_polygon.py)

```
# 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

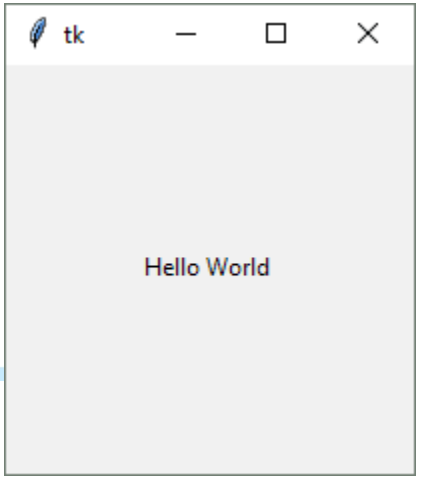
```
canvas_name.create_text(x, y, text=text, options…)
```

Coordinates of the text's insertion point

Optional arguments (See Table 13-8)

Program 13-21 (draw_text.py)

```
# 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()
```



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