ISE 101 – Introduction to Information Systems

- Lecture 7 Objectives:
  - Dictionaries
  - Graphical user interface (GUI)

DICTIONARIES

Nonsequential Data Collections

- Lists allows us to store and retrieve items from sequential data collections.
- When we need to access an item of the collection, we call it using its index (position of the item) which is an integer
- In Python, there are more flexible ways of storing data using key-value pair
- These collections are called dictionary
- Instead of using index→value as in lists, key → value pairs are used in dictionaries
- keys can be of any immutable type

Nonsequential Data Collections

- A dictionary in Python can be created using key-value pairs with curly brakets {}

  {<key>:<value>,<key>:<value>,...}
- The function `dict` creates a new dictionary with no items.

```
>>> x=dict()
```

Dictionaries

```
>>>
   myPasswords={"sis":"pass1","bankA":"pass2","bankB"
   :"pass3"}
>>> myPasswords
{'sis': 'pass1', 'bankB': 'pass3', 'bankA': 'pass2'}
```

- Once the dictionary is created, we can use the keys to access the corresponding value

<dictionary>[<key>]

```
>>> myPasswords["bankA"]
'pass2'
```

Dictionaries

- Dictionaries are **mutable** collections that implement mapping from keys to values
- Keys can be of any **immutable** type
  - strings
  - tuples
- Values can be of any type
- Dictionaries are very efficient and can store large amounts of items
- Python provides built-in functions for dictionaries

Dictionaries

- Dictionaries can be extended dynamically

```
>>> myPasswords
{'sis': 'pass1', 'bankB': 'pass3', 'bankA': 'pass2'}
>>> myPasswords["bankC"]='pass3'
>>> myPasswords
{'sis': 'pass1', 'bankB': 'pass3', 'bankA': 'pass2', 'bankC':
   'pass3'}
>>>
```

- There is no order (sequence) in the dictionary. Mapping is based on the key values
- The len function works on dictionaries; it returns the number of key-value pairs:

```
>>> len(myPasswords)
4
```

Dictionaries

Method	Meaning
<dict>.has_key(<key>)	Returns true if dictionary contains the specified key, false if it does not
<key> in <dict>	Same as has_key function
<dict>.keys()	Returns a list of keys
<dict>.values()	Returns a list of the values
<dict>.items()	Returns a list of tuples (key,value) representing the key-value pairs
<dict>.get(<key>,<default>)	If dictionary has key returns its value; otherwise returns default
del <dict>[<key>]	Deletes the specified entry
<dict>.clear()	Deletes all entries

Dictionaries

```
>>> myPasswords
{'sis': 'pass1', 'bankB': 'pass3', 'bankA': 'pass2', 'bankC': 'pass3'}
>>> myPasswords.keys()
['sis', 'bankB', 'bankA', 'bankC']
>>> myPasswords.values()
['pass1', 'pass3', 'pass2', 'pass3']
>>> "BankA" in myPasswords
False
>>> "sis" in myPasswords
True
>>> del myPasswords["sis"]
>>> myPasswords
{'bankB': 'pass3', 'bankA': 'pass2', 'bankC': 'pass3'}
>>> myPasswords.get("bankA","nothing")
'pass2'
>>> myPasswords.get("bank","nothing")
'nothing'
```

Example

- Write a function

  countWords(filename)

  that takes a filename as argument, counts the occurance of each word in that file and displays them.

Example

```
def countWords(filename):
    try:
        fp=open(filename)
        fc=fp.read()
    except:
        print('File IO problem')
        return
    fp.close()

    #empty dictionary to store word counts
    word_count=dict()

    #split into words
    word_list=fc.split()
    for word in word_list:
        if word in word_count:
            word_count[word]=word_count[word]+1
        else:
            word_count[word]=1

    for key in word_count:
        print(key+'-->'+str(word_count[key]))
```

Dictionaries and Tuples

- Dictionaries have a method called items that returns a list of tuples, where each tuple is a key-value pair.

```
>>> d = {'a':0, 'b':1, 'c':2}
>>> t = d.items()
>>> print t
[('a', 0), ('c', 2), ('b', 1)]
```

- As you should expect from a dictionary, the items are in no particular order.
- Conversely, you can use a list of tuples to initialize a new dictionary:

```
>>> t = [('a', 0), ('c', 2), ('b', 1)]
>>> d = dict(t)
>>> print d
{'a': 0, 'c': 2, 'b': 1}
```

Dictionaries and Tuples

- Combining this feature with zip yields a concise way to create a dictionary:

```
>>> d = dict(zip('abc', range(3)))
>>> print d
{'a': 0, 'c': 2, 'b': 1}
```

- The dictionary method update also takes a list of tuples and adds them, as key-value pairs, to an existing dictionary.
- Combining items, tuple assignment and for, you get the idiom for traversing the keys and values of a dictionary:

```
for key, value in d.items():
        print(value, key)
```

The output of this loop is:

```
0 a
2 c
1 b
```

Dictionaries and Tuples

- It is common to use tuples as keys in dictionaries
- For example, a telephone directory might map from last-name, firstname pairs to telephone numbers.
- Assuming that we have defined last, first and number, we could write:

```
directory[last,first] = number
```

- The expression in brackets is a tuple. We could use tuple assignment to traverse this dictionary.

```
for last, first in directory:
  print (first, last, directory[last,first])
```

Example

- Write a Python function named countPairs that takes a numeric list and count the number of pair occurances
- Consider the list [1,2,3,2,1,3,2,1,2]
- In this list
  - (1, 2) → 2
  - (3, 2) → 2
  - (1, 3) → 1
  - (2, 3) → 1
  - (2, 1) → 2

Example

```
def countPairs(nlist):
    pair_counts=dict()

    for i in range(0,len(nlist)-1):
        if (nlist[i],nlist[i+1]) in pair_counts:
          pair_counts[nlist[i],nlist[i+1]]=
                              pair_counts[nlist[i],nlist[i+1]]+1
        else:
            pair_counts[nlist[i],nlist[i+1]]=1

    for pair in pair_counts:
        print(pair,'-->',str(pair_counts[pair]))
```

GRAPHICAL USER INTERFACE (GUI)

Graphical User Interface (GUI) design

- Modern software uses GUI to interface users
- GUI includes
  - Windows, dialogs
  - UI controls (button, textbox etc)
  - Events (mouse, keyboard, time etc.)
- Frameworks are used for GUI design
  - Tkinter
  - wxWidgets
  - Qt
  - GTK+
  - ...

GUI Design

- Although there are many frameworks, their concepts are very similar
  - Standard controls (ie. Button, textbox, menu etc.) exist in all frameworks
  - Events associated with each control (ie. Mouse click, resize, content changed etc.) exist in all frameworks
  - (Nearly) all frameworks come with a layout design utility (ie. QtDesigner). These utilities make it easier to design the screen layouts.
  - Some of the frameworks are OS dependent (ie. .NET), works only with a specific OS.
  - Works as event-driven

GUI Design

- OS independent frameworks can work on any OS → more portable code
- Once the concept of GUI is grasped, learning different frameworks does not take too much time
- In this course, we are going to learn a very simple GUI framework (graphics.py by Zelle)
- This framework supplies thin wrapper classes to Tkinter framework which is quite complicated.

Event-based Programming

- Programming techniques we have seen in this class so far
  - Procedural
  - Object oriented
- In these techniques, commands are executed in a sequential manner. Functions are called whenever they are in the execution flow
- Difference of procedural and object oriented techniques lies in how we arrange data and functions.
- When UI is employed, the code executes depending of events happening
- Events may be coming from a user or the system. Eg. when the user clicks on a button, or when the duration of a timer ends an event is created

Event Handler Functions

- A function (called event-handler) should be written to handle each possible event. When an event occurs, the corresponding handler function is executed by the system.
- This way of programming is called event-based programming
- When the program is started, it is initialized (show the dialogs etc.) and starts to wait for events
- Most of the programs with UI works like this.

Graphics Library

- Graphics library is a simple UI framework designed (by John Zelle) for teaching purpose
- It can be downloaded from

  http://mcsp.wartburg.edu/zelle/python/graphics.py
- A reference can also be downloaded from

  http://mcsp.wartburg.edu/zelle/python/graphics/graphics.pdf

Graphics Library

- Copy graphics.py into

  C:\Python32\Lib
- To use this library, it should be imported using

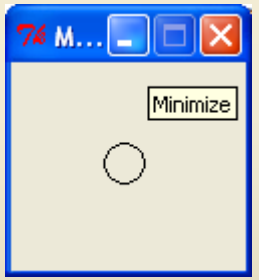
  >>> from graphics import *
- Then you can start using functions within this library
- There are two kinds of objects in the library.
  - The GraphWin class implements a window where drawing can be done,
  - GraphicsObjects are provided that can be drawn into a GraphWin.

Simple Example

```
from graphics import *


def main():
    win = GraphWin("My Circle",100,100)
    c=Circle(Point(50,50),10)
    c.draw(win)
    win.getMouse()
    win.close()


main()
```



Graphics Library

- Graphic library includes the following objects:
  - Point,
  - Line,
  - Circle,
  - Oval,
  - Rectangle,
  - Polygon,
  - Text,
  - Entry (for text-based input),
  - Image

GraphWin Object

- A GraphWin object represents a window on the screen where graphical images may be drawn. A program may define any number of GraphWins.
- A GraphWin understands the following methods:
  - GraphWin(title, width, height, autoflush) Constructs a new graphics window for drawing on the screen. The parameters are optional, the default title is “Graphics Window,” and the default size is 200 x 200. The autoflush parameter, if True causes the window to be immediately updated after every drawing operation. The default value is False, allowing operations to “batch up” for better efficiency.
  - plot(x, y, color) Draws the pixel at (x, y) in the window. Color is optional, black is the default. Note: pixel-level operations are very inefficient and this method should be avoided.

GraphWin Object

- A GraphWin understands the following methods:
  - plotPixel(x, y, Color) Draws the pixel at the “raw” position (x, y) ignoring any coordinate transformations set up by setCoords. Note: pixel-level operations are very inefficient and this method should be avoided.
  - setBackground(color) Sets the window background to the given color. The initial background is gray.
  - close() Closes the on-screen window. Once a window is closed, further operations on the window will raise a GraphicsError exception.

GraphWin Object

- isClosed() Returns a Boolean indicating if the window has been closed either by an explicit call to close or a click on its close box.
- getMouse() Pauses for the user to click in the window and returns where the mouse was clicked as a Point object. Raises GraphicsError if the window is closed while getMouse is in progress.
- setCoords(xll, yll, xur, yur) Sets the coordinate system of the window. The lower left corner is (xll, yll) and the upper right corner is (xur, yur). All subsequent drawing will be done with respect to the altered coordinate system (except for plotPixel).
- update() Causes any pending window operations to be performed. Normally, this will happen automatically during idle periods. Explicit update() calls may be useful for animations.

GraphWin Examples

```
>>> win=GraphWin("This title will appear on the top of the
    window",30,100)
```


```
>>> win.setBackground('red')
```


```
>>> p=win.getMouse()
>>> p.x
662
>>> p.y
9
```

GraphWin Examples

```
>>> win=GraphWin("This title will appear on the top of the
    window",300,300)
>>> win.plotPixel(150,150,'red')
```

Graphic Objects

- The module provides the following classes of drawable objects:
  - Point,
  - Line,
  - Circle,
  - Oval,
  - Rectangle,
  - Polygon,
  - Text.
- All objects are initially created unfilled with a black outline. All graphics objects support the following generic set of methods:
  - setFill(color) Sets the interior of the object to the given color.
  - setOutline(color) Sets the outline of the object to the given color.

Graphic Objects

- setWidth(pixels) Sets the width of the outline of the object to this many pixels. (Does not work for Point.)
- draw(aGraphWin) Draws the object into the given GraphWin. An object may only be drawn in one window at a time.
- undraw() Undraws the object from a graphics window. Returns silently if object is not drawn.
- move(dx,dy) Moves the object dx units in the x direction and dy units in the y direction. If the object is currently drawn, its image is adjusted to the new position.
- clone() Returns a duplicate of the object. Clones are always created in an undrawn state. Other than that, they are identical to the cloned object.

Point Object

- Point(x,y) Constructs a point having the given coordinates.
- getX() Returns the x coordinate of a point.
- getY() Returns the y coordinate of a point.

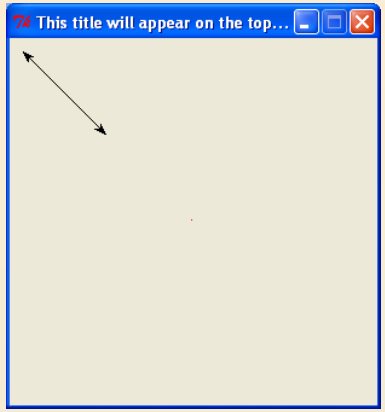
Line Object

- Line(point1, point2) Constructs a line segment from point1 to point2.
- setArrow(string) Sets the arrowhead status of a line. Arrows may be drawn at either the first point, the last point, or both. Possible values of string are 'first', 'last', 'both', and 'none'. The default setting is 'none'.

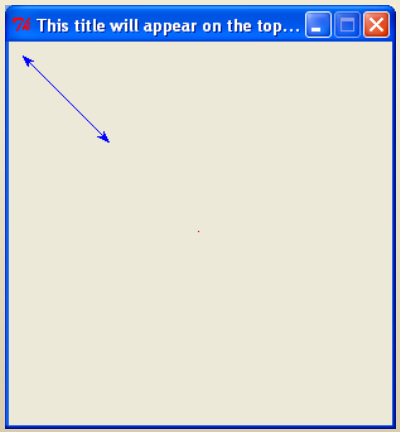
```
>>> l1=Line(Point(10,10),Point(80,80))
>>> l1.draw(win)
```

Line Object

>>> l1.setArrow('both')



>>> l1.setOutline('blue')



>>> l1.setWidth(5)

Circle Objects

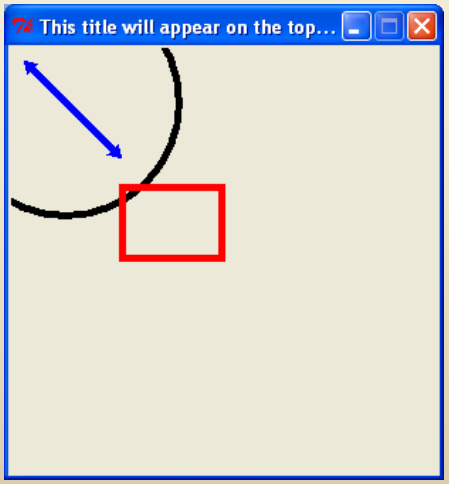
- Circle(centerPoint, radius) Constructs a circle with given center point and radius.
- getCenter() Returns a clone of the center point of the circle.
- getRadius() Returns the radius of the circle.

```
>>> c1=Circle(Point(40,40),80)
>>> c1.draw(win)
>>> c1.setWidth(5)
```

Rectangle Object

- Rectangle(point1, point2) Constructs a rectangle having opposite corners at point1 and point2.
- getCenter() Returns a clone of the center point of the rectangle.

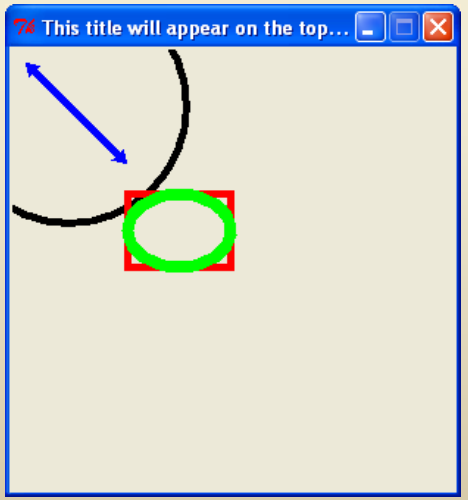
```
>>> r1=Rectangle(Point(80,100),Point(150,150))
>>> r1.setWidth(5)
>>> r1.draw(win)
>>> r1.setOutline('red')
```



Oval Object

- Oval(point1, point2) Constructs an oval in the bounding box determined by point1 and point2.
- getCenter() Returns a clone of the point at the center of the oval.

```
>>> o1=Oval(Point(80,100),Point(150,150))
>>> o1.setOutline('green')
>>> o1.draw(win)
>>> o1.setWidth(8)
```

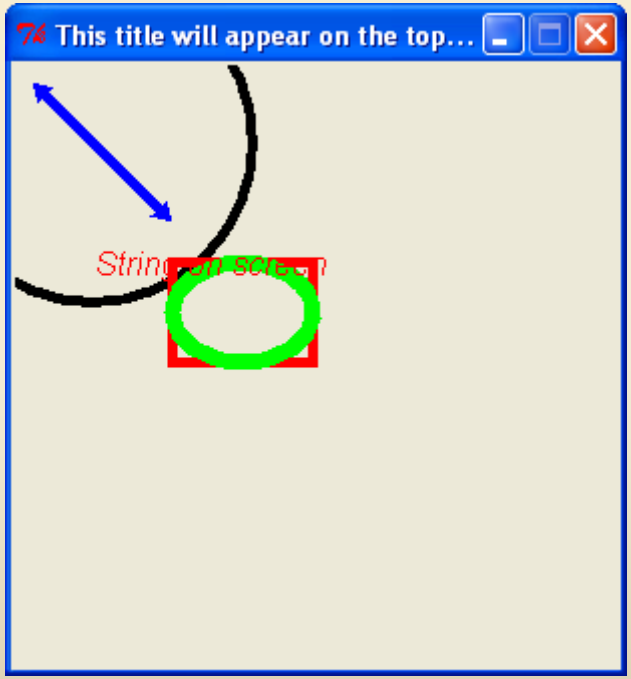


Text Object

- Text(anchorPoint, string) Constructs a text object that displays the given string centered at anchorPoint. The text is displayed horizontally.
- setText(string) Sets the text of the object to string.
- getText() Returns the current string.
- getAnchor() Returns a clone of the anchor point.
- setFace(family) Changes the font face to the given family. Possible values are: 'helvetica', 'courier', 'times roman', and 'arial'.
- setSize(point) Changes the font size to the given point size. Sizes from 5 to 36 points are legal.
- setStyle(style) Changes font to the given style. Possible values are 'normal', 'bold', 'italic', and 'bold italic'.
- setTextColor(color) Sets the color of the text to color. Note: setFill has the same effect.

Text Example

```
>>> t1=Text(Point(100,100),'String on screen')
>>> t1.setTextColor('red')
>>> t1.setStyle('italic')
>>> t1.draw(win)
```



Pixmap Object

- Simple image manipulation is done through the Pixmap class. A Pixmap object allows pixel-level access to an image. Pixmaps allow for saving to a file and may be displayed using an Image object.
- Pixmap(filename) Constructs a Pixmap from the image file, filename.
- Pixmap(width, height) Constructs a Pixmap of the given height and width. Initially, all pixels will be transparent.
- getWidth() Returns the width of the image in pixels.
- getHeight() Returns the height of the image in pixels.
- getPixel(x,y) Returns a triple (r,g,b) of the red, green, and blue intensities of the pixel at (x,y). Intensity values are in range(256).
- setPixel(x,y,color) Color is a triple (r,g,b) representing a color for the pixel. Sets pixel at (x,y) to the given color.
- save(filename) Saves the image in a file having the given name. The format for the file is determined by the extension on the filename (e.g. .ppm or .gif).
- clone() Returns a copy of the Pixmap.

Images

- The graphics module also provides minimal support for displaying certain image formats into a GraphWin.
- Most platforms will support bitmap, PPM, and GIF images. Display is done with an Image object.
- Images support the generic methods
  - move(dx,dy),
  - draw(graphwin),
  - undraw(), and clone().
- Image specific methods are:
  - Image(centerPoint, image) image is either the name of an image file, or a Pixmap object. Constructs an image from contents of the given file or pixmap, centered at the given center point.

Reversi with GUI

- Write reversi or othello on a 8x8 board
- For game rules see
  http://en.wikipedia.org/wiki/Reversi

- Game will be played between 2 players, NOT against computer
- For a simple GUI see the simpleGUI.py