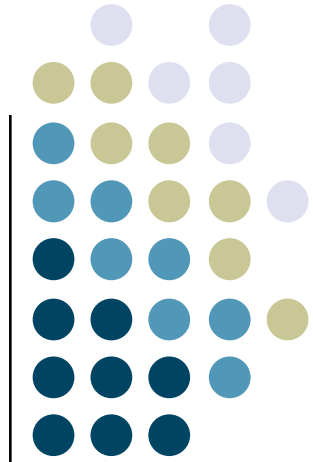
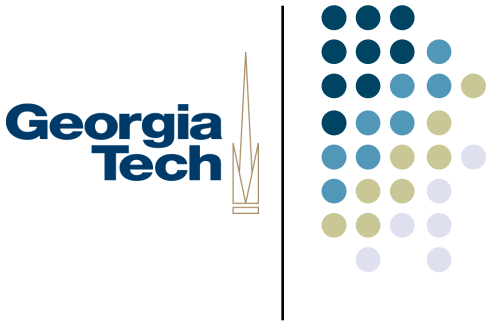
Week 2:
Quick and Dirty Jython Refresher

(Prelude to Asynchronous Programming)



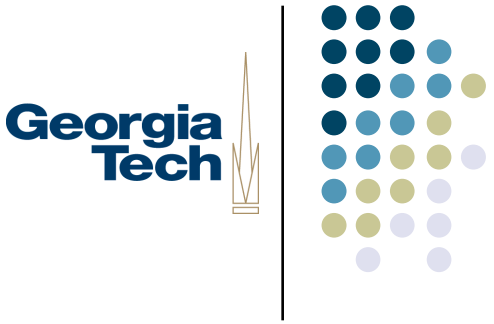
CS6452

Connecting the Lo-Fi Prototype with the Project

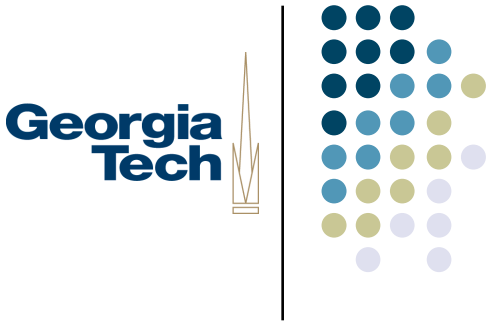


- A few points about the IM assignment
  - The IM protocol we'll be using doesn't support
    - Authentication/login
    - Sending messages to a user *before* that user joins the chat
    - Named, persistent chat rooms
    - Status changes ("available", "away")
    - Buddies
    - Adding people to existing chats
  - Some of these you can implement in your own client, even without server support
    - E.g., buffer messages sent to a user before he/she joins

A Bit More Administrivia...



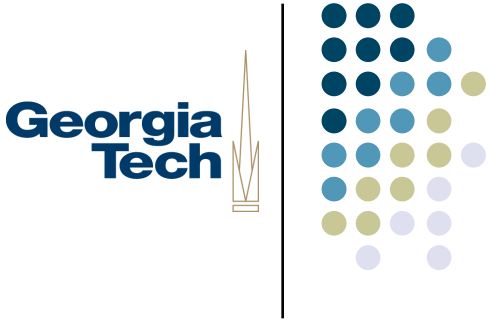
- Late policy for assignments:
  - Clear with me *first* if you have a valid excuse for missing a due date
    - Examples: medical or family emergency
  - My policy is -10% per late day, maximum 3 days late
- Grading criteria will be posted on the web for each assignment
- Readings will be posted ~1 week in advance
  - So, readings we'll discuss next week are already up
  - **Reminder:** 1-page summaries are due one in class one week after readings are assigned!
- In-class presentations
  - For each module we'll do a set of short in-class presentations
  - Drop me a note if you want to present on the GUI project (9/18)



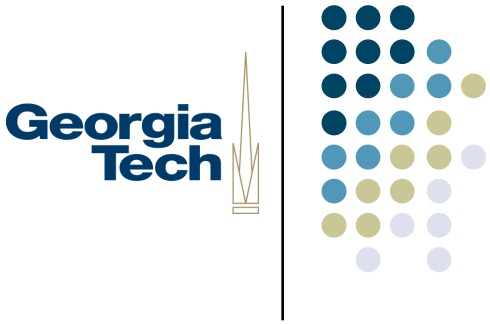
Today's Menu

- Jython Refresher
  - Collection Classes
  - Scoping and Modules
  - Classes and Objects
  - GUI Programming
- Useful odds-and-ends that may come in handy for the next assignment

Jython Collection Classes



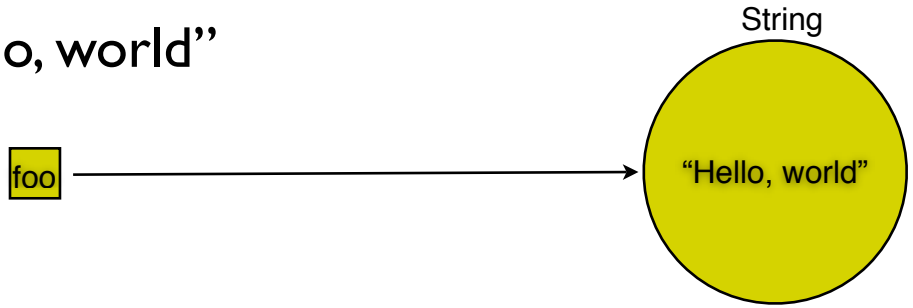
Collections



- One of the strongest features of Jython: powerful built-in data structures
- Let you organize and retrieve collections of data in ways that would be impractical if you had to stash every item in a variable
- Sequences
  - Lists
  - Tuples
- Dictionaries

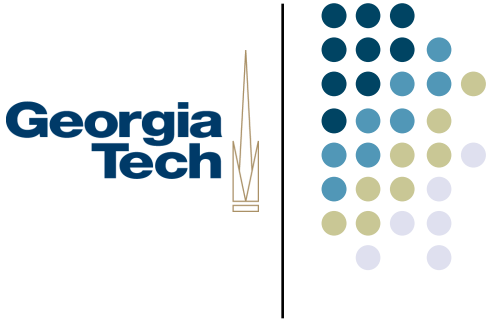
Variables and References

- A variable is simply a name that contains a reference to some information
- foo = “Hello, world”



- Variables can be reassigned, and multiple variables can refer to the same thing.
- Stashing a reference in a variable gives you a way to name it, and get at it later.

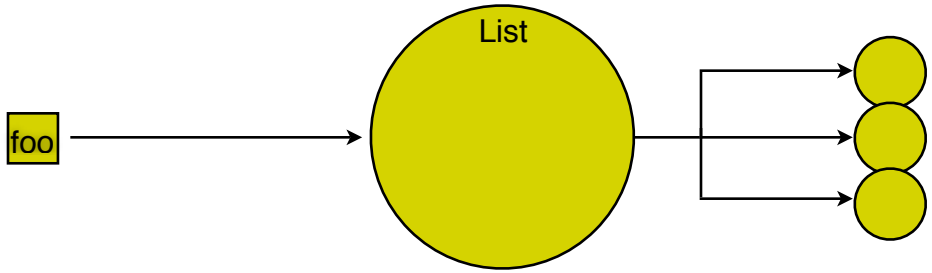
The Need for More Complex Data Structures



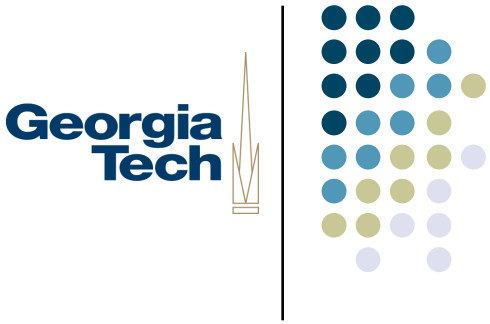
- Some more complex structures are hard to represent by just a named variable though.
- Example: you want to keep track of all of the users in a chat.
  - user1 = "Steven"
  - user2 = "Amy"
  - ...
- This is too *static*. Would you just create 1000 variables in case you ever had that many users? How would you do something to each one (can't easily iterate)

Lists to the Rescue

- Fortunately, Jython has a build in way to do this: *lists*
- foo = [“one”, “two”, “three”]



- Lists collect multiple references to data items into a single data structure
- These references are *ordered*
- The contents of the list can be altered (it is *mutable*)
- currentChatUsers = [“Amy”, “Steven”, ...]



A Quick Jython List Refresher

- Lists are *ordered* collections of items

```
>>> L=[0,'zero','one', 1]
```

- Selecting items from a list (note indices start at 0!)

```
>>> print L[1]
'zero'
```

- Getting the length of a list

```
>>> len(L)
4
```

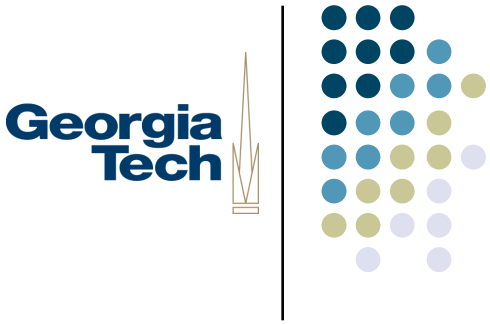
- Modifying lists

```
>>> L.append('two')
>>> L.remove('zero')
>>> print L
[0,'one', 1,'two']
```

- Iteration

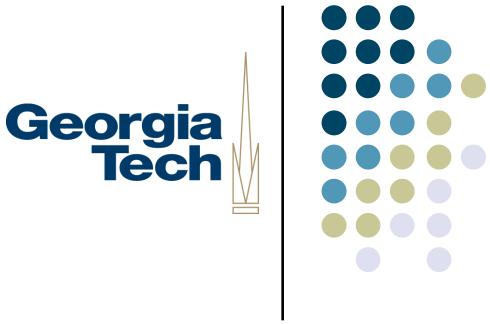
```
for item in L:
    print item
```

Tuples: Fixed Sequences



- Like lists, only *immutable*
  - The set of references in a tuple is **fixed**
- Generally used either when:
  - You need a constant list
    - daysOfWeek = ("Monday," "Tuesday", "Wednesday", "Thursday", "Friday", "Saturday", "Sunday")
  - You need to group together a set of data whose *structure* is fixed:
    - E.g., using tuples as quick-and-dirty records, such as address book entries:
    - myContactInfo = ("Keith Edwards", "TSRB348", "keith@cc")
- All list operations work on tuples, except ones that modify the set of references within the tuple
  - So, no append(), remove(), etc.

Associating Data Items With Each Other

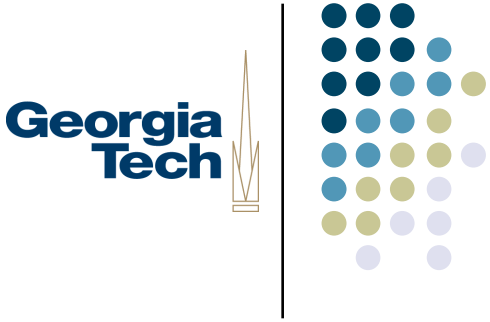


- Sometimes, you need to associate one item with another one
  - Example: hours worked on each day of the week:

“Sunday”	4.5
“Monday”	8
...	...

- You could do this with variables, as long as there’s a fixed set of them:
  - sunday=4.5
  - monday=8

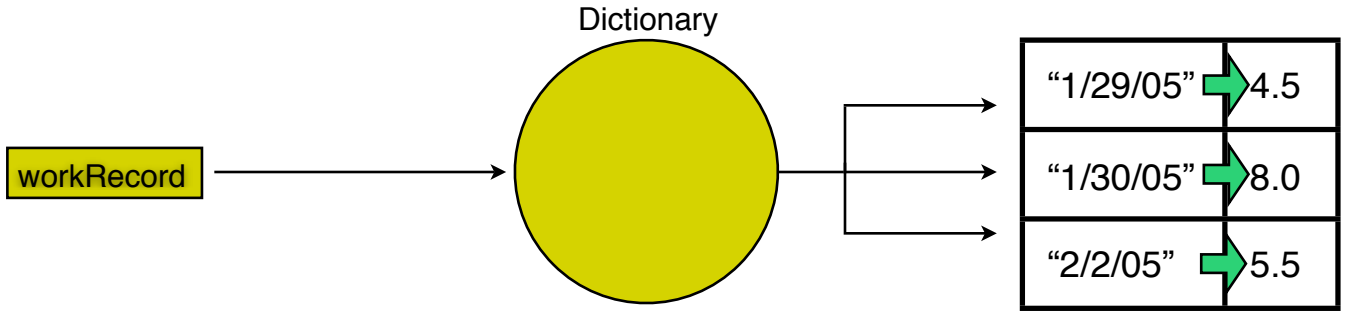
Associating Data Items With Each Other (cont'd)



- If you don't know the associations you might have up front, you could use parallel lists:
  - workDates = ["1/29/05", "1/30/05", "2/1/05", ...]
  - workHours = [4.5, 8, 5.5, ...]
- Then, iterate through the first list to find the date you're looking for, then look for the item with the corresponding index in the second list
- Too much work! Too error prone!
- Fortunately, Jython has a built-in data structure for creating associations: the *dictionary*

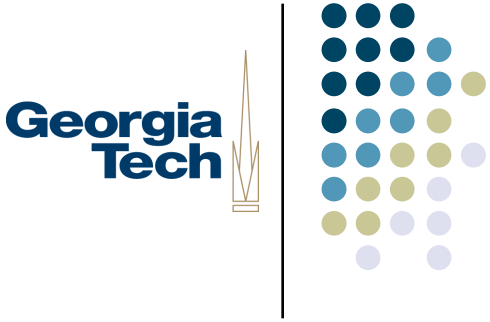
The Dictionary Data Structure

- Dictionaries associate *values* with *keys* (you *lookup* a value given its key)
- Both are references to data items
- workRecord = { "1/29/05": 4.5, "1/30/05": 8, "2/2/05": 5.5 }



- *Dictionaries are the most commonly used Jython data type*
- *Virtually any Jython data type can be used as a key or as a value*

A Quick Jython Dictionary Refresher



- Initializing a dictionary:

  >>> dict = {'one': 1, 'two': 2, 'three': 3}

- Looking up values:

  >>> dict["two"]

  2

- Inserting and changing values:

  >>> dict["four"] = 4

  >>> dict["two"] = 2222

  >>> dict

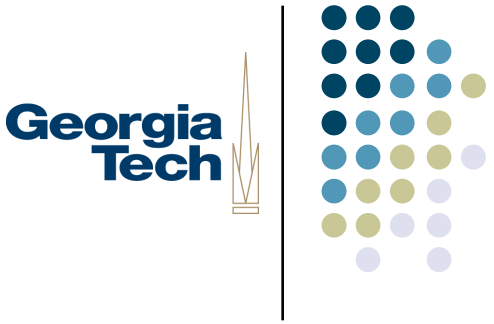
  {'one': 1, 'two': 2222, 'three': 3, 'four': 4}

- Other operations:

  >>> del dict["one"]

  >>> len(dict)

  3



More Dictionary Goodness

- Testing whether or not a dictionary has a given key

  >> dict.has_key("two")

  1

  >> dict.has_key("five")

  0

- Getting keys, values, and entire items

  >> dict.keys()

  ["two", "three", "four"]

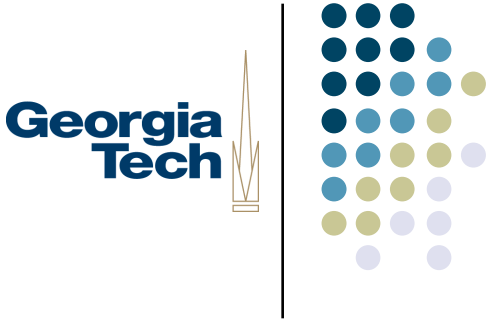
  >> dict.values()

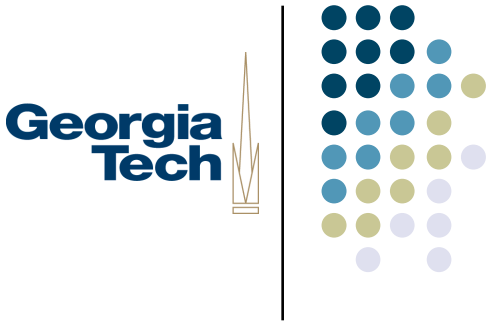
  [2222, 3, 4]

  >> dict.items()

  [("two", 2222), ("three", 3), ("four", 4)]

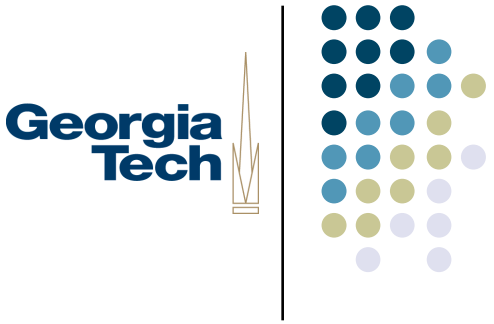
Scoping and Modules





Scoping

- What is scoping?
- Scoping is a fancy word that just means "the rules about what you can see from where" in a program
- The *namespace* is the collection of stuff that you can see from any given point in a program



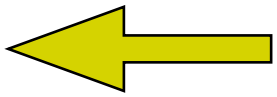
An Example: Scoping Error

- welcomeMsg = “Hello!”
- def changeWelcomeMsg():
  - welcomeMsg = “Bonjour!”
  - print “New welcome message is”, welcomeMsg

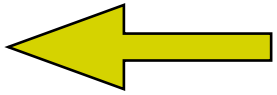
- changeWelcomeMsg()
- >>> New welcome message is Bonjour!
- print welcomeMsg
- “Hello!”

An Example: Scoping Error

- welcomeMsg = “Hello!”
- def changeWelcomeMsg():
  - welcomeMsg = “Bonjour!”
  - print “New welcome message is”, welcomeMsg

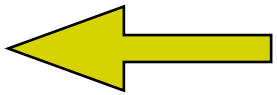


welcomeMsg is defined in the **global scope**



This lines defines a *new* variable with the same name, in the **local scope!**

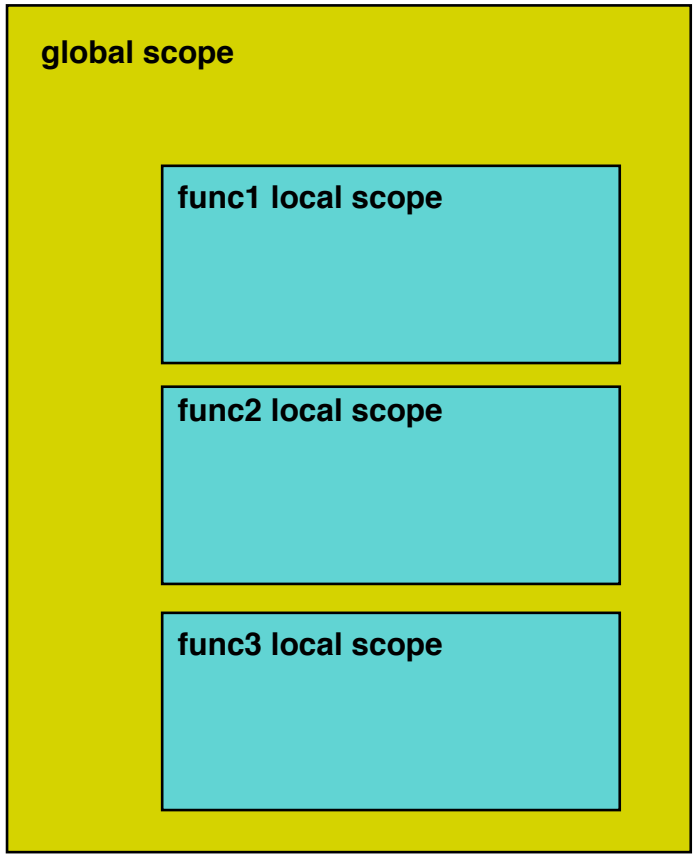
- changeWelcomeMsg()
- >>> New welcome message is Bonjour!
- print welcomeMsg
- “Hello!”

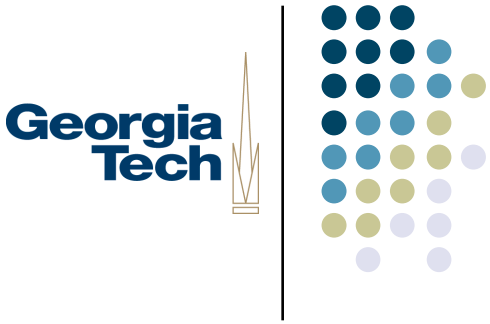


Since this call to *print* is outside the function changeWelcomeMsg(), it refers to the welcomeMsg variable in the global scope.

Thinking About Scopes

- Variables named in **the** global scope are available to statements in **any** scope
  - Unless they have been "hidden" by a local variable with the same name, as in the error example
- Variables named in **a** local scope are only available to statements in that scope
- The first **assignment** to a variable determines the scope it is in

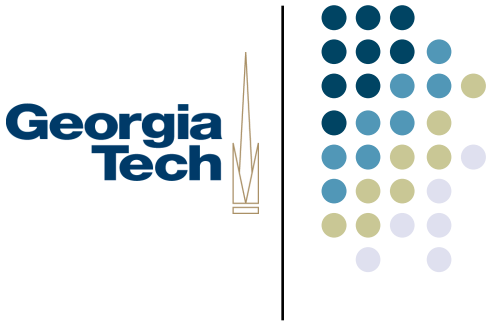




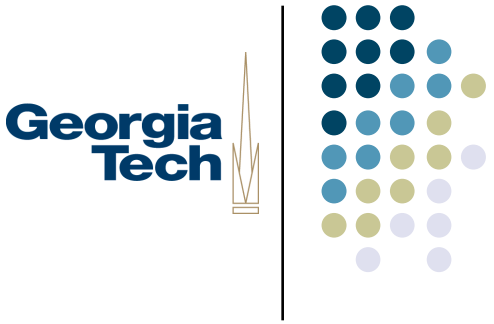
More on Scopes

- "Global" really means the file the variable is in
  - When you start developing with multiple files, each file defines its own scope that is "global" for that file
- Each call to a function creates a new local scope
  - Thus if a variable foo is defined in function func(), each call to func() has its own new "namespace" and its own separate foo
- By default, *all* assignments that you make in a function create names in the local scope
  - Advanced: you can use the *global* statement if you want to change a global variable from within a function
  - Dangerous, but useful. We'll talk about it in a later lecture
- Names not assigned to in a function are assumed to be globals

Still More on Scopes



- What all this boils down to is...
  - Local variables (those first assigned to within a function) serve as temporary names you need only when a function is running
  - This helps modularity of your program ("hide" details within a function)
- But:
  - You need to be careful when using a name within a function that's defined outside
  - Subtle and hard to track bugs...

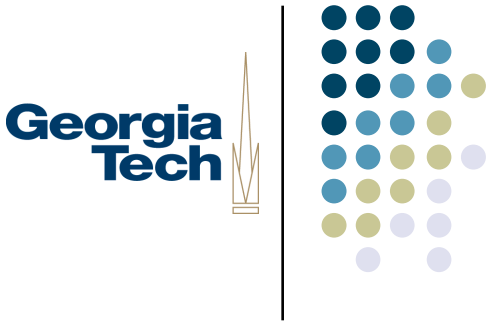


Scoping Gotchas

- Subtly different than some other languages
- 1. Local scopes don't nest

```
def outerfunc(x, y):
    def innerfunc(z):
        if z > 0:
            print x, y
    innerfunc(x)
```

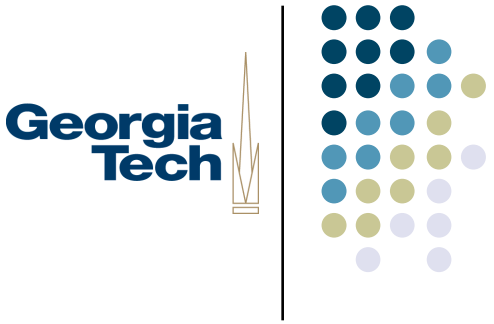
  - x and y aren't available inside the local scope for innerfunc
- 2. There are actually *thr*ee scopes: global, local, and __builtin__
  - First, the local scope is checked
  - Then, the global scope
  - Finally, the scope defined by the module called __builtin__
    - len, abs, max, min, ...



Modules

- *Modules* are the highest level building blocks in a Jython program
- Usually correspond to a single file of code
- Let you organize your code more creatively:
  - Reuse code by storing it in files, callable by other files
  - Partition the variable and function namespace (so that not everything has to be at the "top level")
  - Create functionality or data that can be shared across programs
- You *import* a module to gain access to its functionality

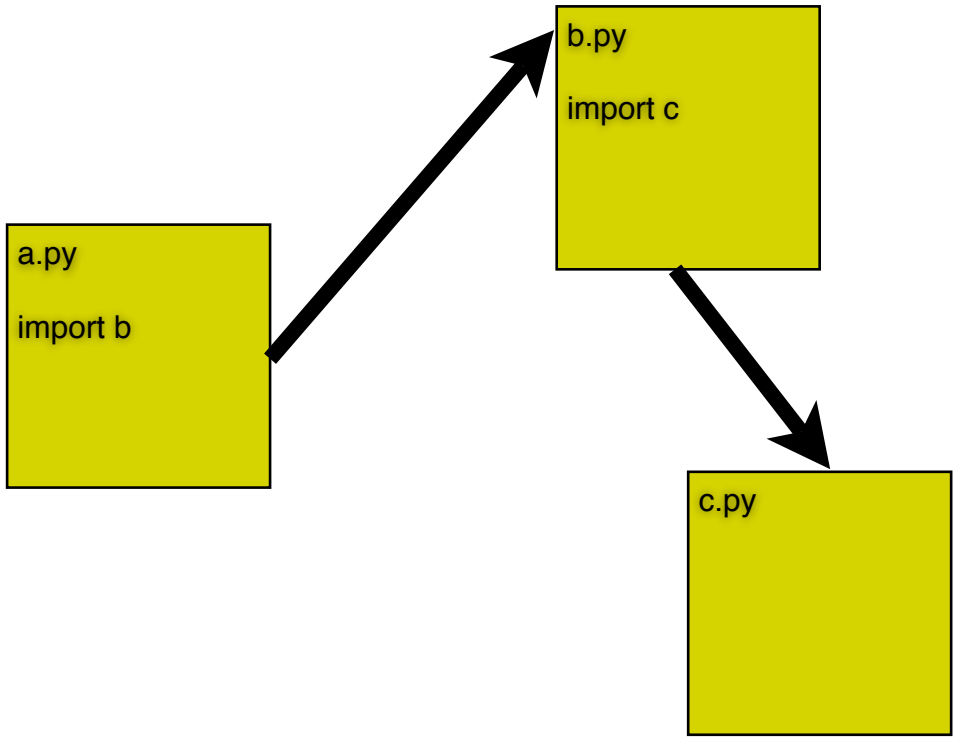
Modules and Scoping

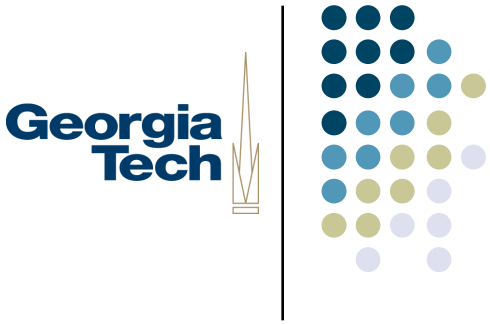


- Each module actually defines its own global scope
- Within a module, you can refer to names without using any extra qualification
- To refer to names outside a module, you first import the module to make it available to you
- Then refer to the name using dot notation
- Example:

```
import os
os.listdir("/Users/keith/Desktop")
```

Breaking Your Program into Separate Files

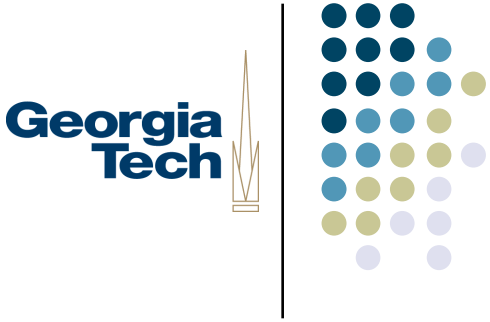


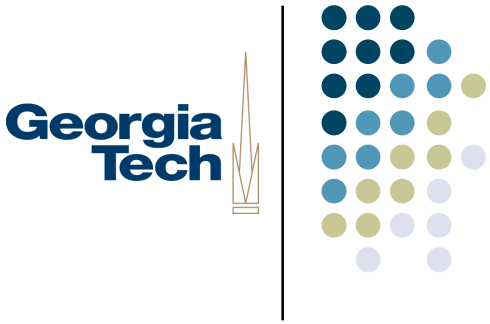


Imports

- Each *import* statement defines a new namespace
  - Imagine a file *networking.py*, containing a function *broadcast()*
  - In your code:
    - import networking
    - networking.broadcast()
- You can assign more convenient names at the time of import
  - Example: *networking* is too long to type repeatedly, or collides with another name in you program
  - In your code:
    - import networking as net
    - net.broadcast()
  - Or:
    - import javax.swing as swing
    - list = swing.JList()

Classes and Objects





Objects

- Objects are simply a way to group together a set of functions with the data that they operate on
- The built-in Jython types are *already* objects!
  - Strings, integers, lists, dictionaries, etc.
- You can also create your own
  - You first have to write a "blueprint" for what the object will do
  - This is called the object's *class*
  - Defines what operations are available on it, what data it contains, etc
  - You can use the blueprint to make *instances* of the class

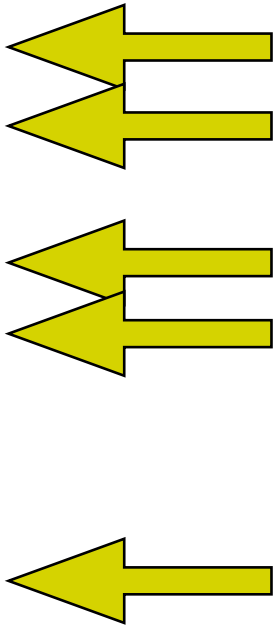
- Terminology:
  - Instances are the actual objects
  - Classes are just the blueprints for making instances

Defining a New Class

```
class Counter:
    def __init__(self):
        self.count = 0

    def increment(self):
        self.count = self.count+1
        return self.count

>>> c = Counter()
>>> c.increment()
1
>>> c.increment()
2
```



You define a new class via the *class* keyword

__init__() is a special function that is called when an instance of the class is created

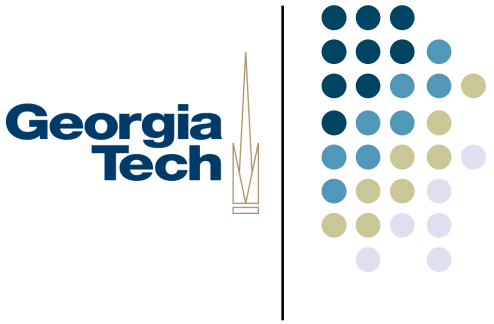
Classes can contain functions

Every function in a class takes an additional argument, called *self*, which refers to the object on which the function is being called.

Within a class, you must refer to data in the class explicitly by scope: self.count

Creating an instance of a class looks like using the class name as a function call

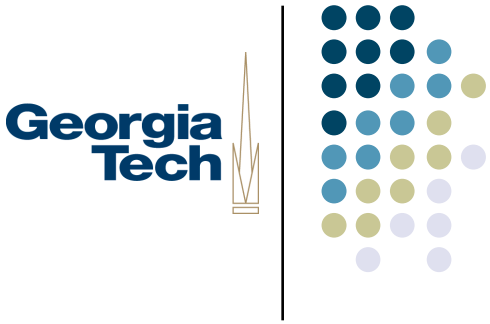
Each Instance is Separate



- Each instance has its own copy of the data, and its own namespace:

```
>>> c1 = Counter()
>>> c2 = Counter()
>>> c1.increment()
1
>>> c1.increment()
2
>>> c2.increment()
1
```

- Object-oriented programming lets you create reusable chunks of code and data
- Each copy is separate from the others
- Advanced: there are ways to have instances of a class share data

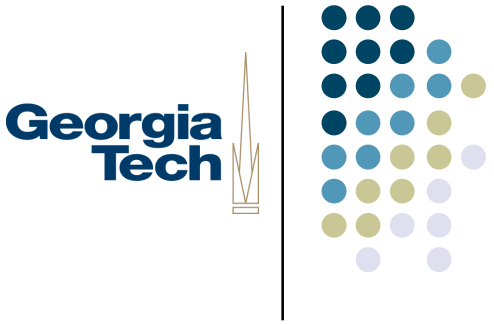


Classes and Scoping

- Classes add a few more scoping rules to Jython
  - Each *instance* is its own scope
  - Within a class, methods define local scopes just like functions
  - Example:

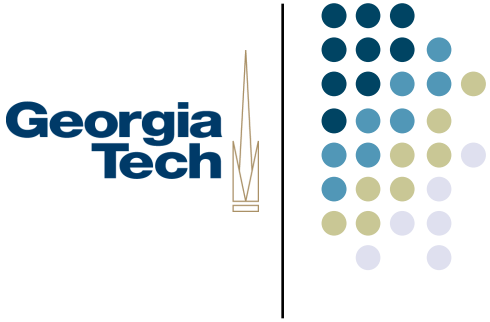
```
class Test:
    def someMethod(self):
        self.daysOfWeek = [”Sun”,“Mon”,“Tue”,“Wed”,“Thu”,“Fri”,“Sat”]
        length = len(self.daysOfWeek)
        for i in range(0, length):
            print self.daysOfWeek[i]
```

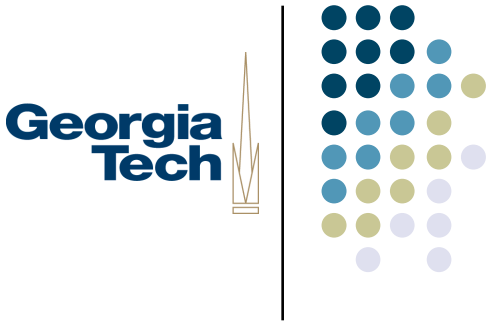
Coming Full Circle...



- In Jython, everything makes use of the same simple mechanisms:
  - Modules are really *dictionaries* that map from names (of variables and functions) to the data and code in those modules
    - import os
    - print os.__dict__
    - {'listdir': <function at 15905785>, ...}
    - dir(os) -- shows values in dictionary
    - print os.__doc__
  - Classes use the same mechanisms under the cover
    - print Counter.__dict__
    - {'__module__': '__main__', 'increment': <function increment at 8963605>, '__doc__': None, 'count': 0}
  - These dictionaries just define the names that are valid within the module or class

GUI Programming

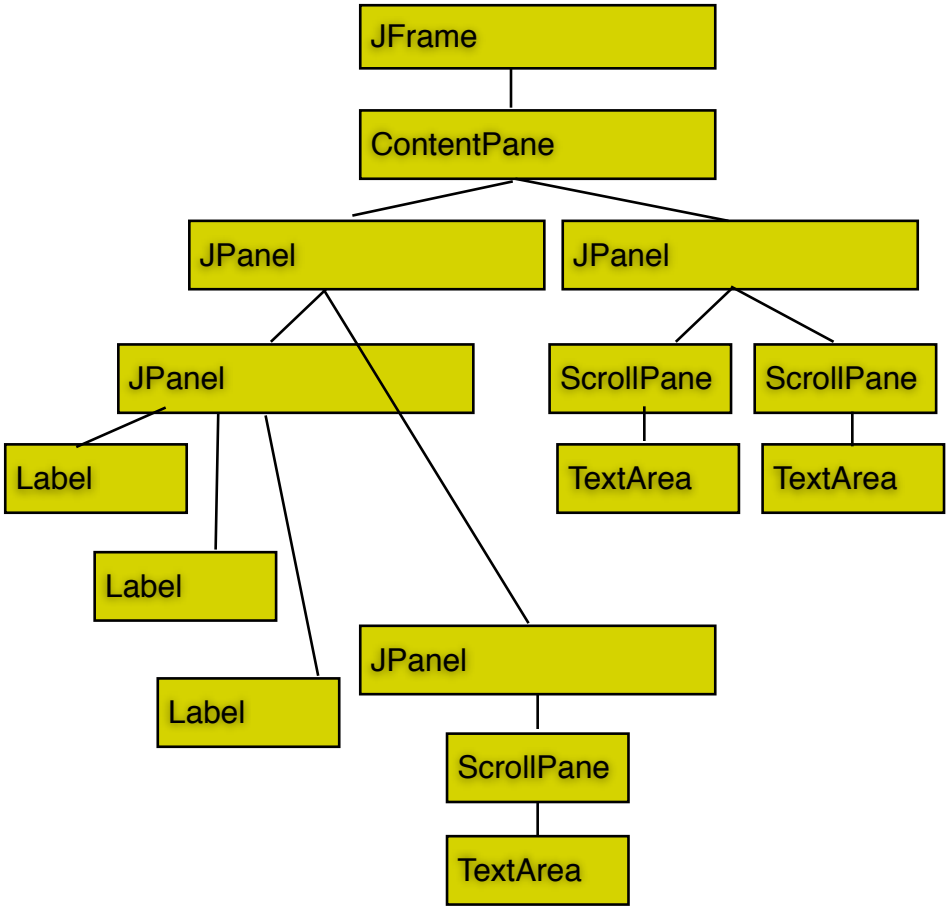


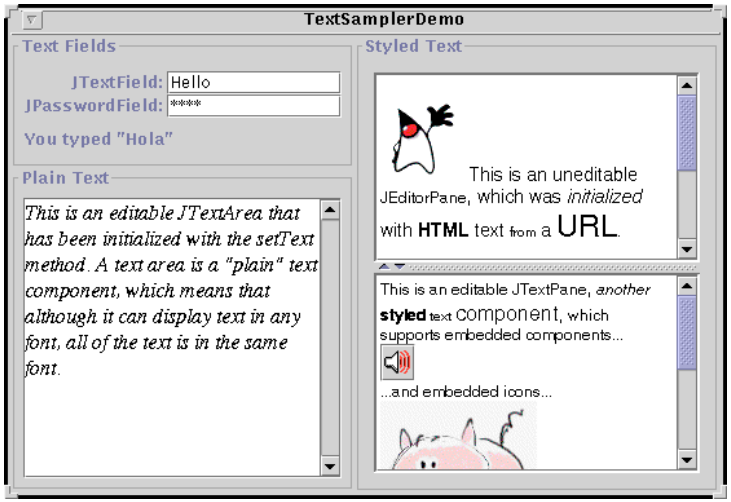


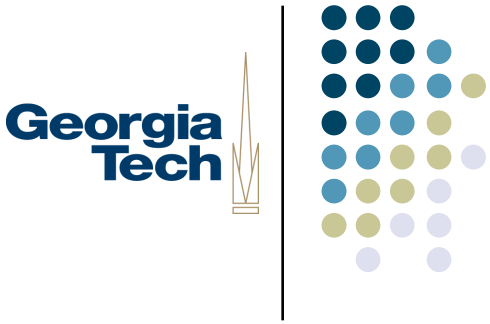
GUI Programming 101

- The most important thing:
  - GUIs are layed out as *trees*
- There is a toplevel container, usually a window
- Inside this are multiple panels (often invisible), used to control layout
- For page layout people, think of the grid
  - Decompose interface into rectangular regions
  - May need many (invisible) sublevels to get it all right

An Example


JFrame
ContentPane
JPanel
JPanel
JPanel
ScrollPane
ScrollPane
Label
TextArea
TextArea
Label
Label
JPanel
ScrollPane
TextArea

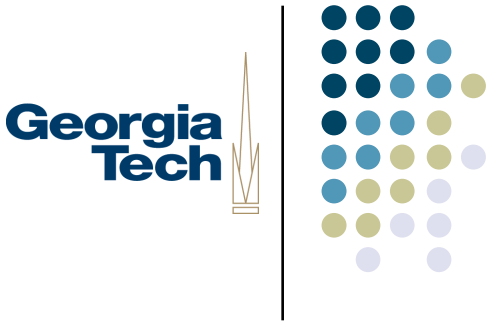

TextSamplerDemo
Text Fields
JTextField: Hello
JPasswordField: ****
You typed "Hola"
Plain Text
This is an editable JTextArea that has been initialized with the setText method. A text area is a "plain" text component, which means that although it can display text in any font, all of the text is in the same font.
Styled Text
This is an uneditable JEditorPane, which was initialized with HTML text from a URL.
This is an editable JTextPane, another styled text component, which supports embedded components...
...and embedded icons...



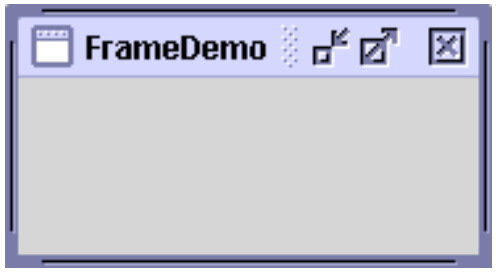
Some Common Swing Widgets

- *Swing*: Java's GUI programming toolkit, callable in Jython
- On today's menu:
  - JFrames, JPanels
  - Layout Managers
  - JLists
  - JButtons
  - JLabels, JTextFields, JTextAreas
- This is an overview *only*
- You can do much more than I've shown here with each of these widgets, plus there are many more widgets than these

Swing Widgets in Jython: JFrames and JPanels



- JFrames are top-level windows
- JPanels allow grouping of other widgets

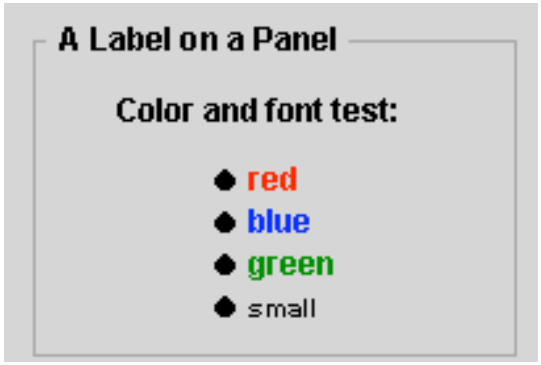


- Each JFrame has a panel into which the frame's contents must go: the *contentPane*

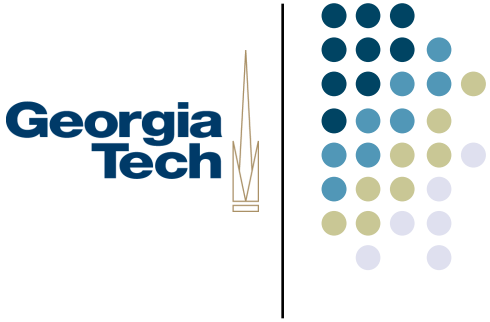
```
window = swing.JFrame("FrameDemo")
window.contentPane.add(new JButton())
```

- You must *pack* and *show* a JFrame to display it

```
window.pack()
window.show()
```



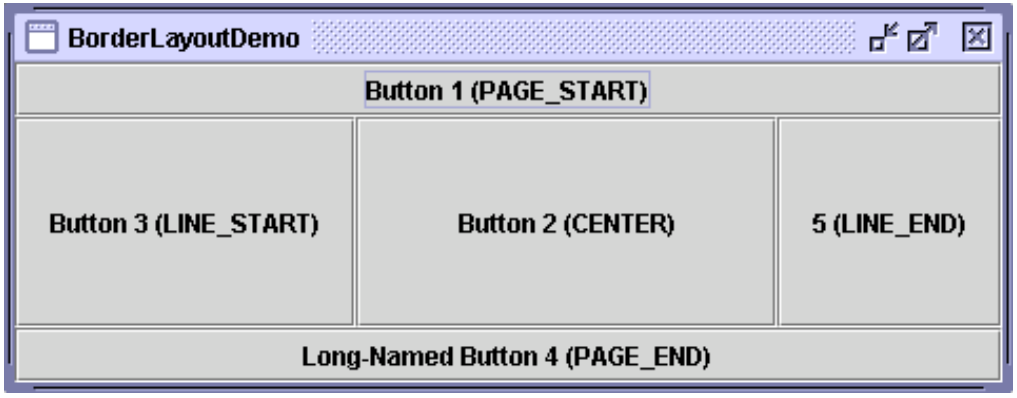
Swing Widgets in Jython: Layout Managers



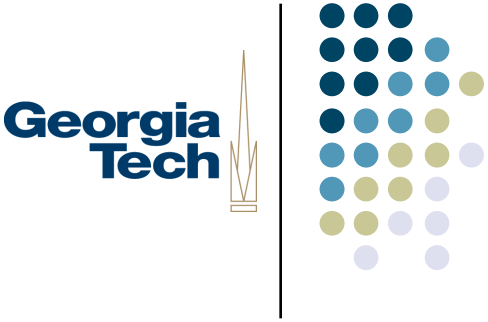
- Layout Managers control the placement of widgets in a JPanel
- Simplest by far: awt.BorderLayout

  window.contentPane.layout = awt.BorderLayout()

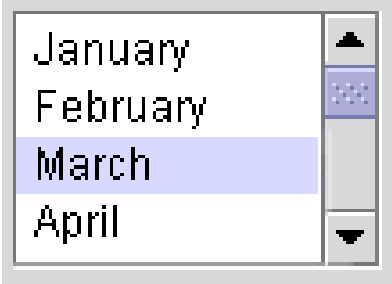
  window.contentPane.add("Center", swing.JButton("Button 2 (CENTER)"))
- Five regions:
  - North, South: expand horizontally
  - East, West: expand vertically
  - Center: expands in both directions



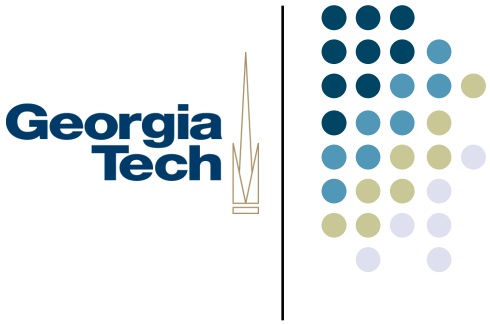
Swing Widgets in Jython: JLists

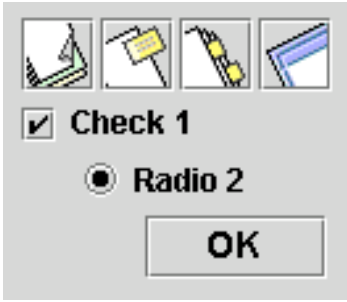


- JLists are collections of widgets
  - list = swing.JList()
- Put JLists in a JScrollPane to make them scrollable
  - window.contentPane.add(swing.JScrollPane(list))
- JLists contain a *listData* member with the contents
  - list.listData = ['January', 'February', 'March', ...]
- *selectedValue* contains the selected item!
  - >>> print list.selectedValue
  - 'March'



Swing Widgets in Jython: JButtons





- JButtons have many fancy features...
  - Images, labels, tooltips, etc.
- Basic use is very simple:
  - Supply a label when you construct the button
    - button = swing.JButton("This is my label!")
  - Provide a function to use as a callback
    - def callbackFunction(event):
      - print "button pressed!"
    - button.actionPerformed = someCallback
  - NOTE: when the function is a *method*, you must handle it slightly differently!
    - def callbackMethod(self, event):
      - print "button pressed!"
    - button.actionPerformed = self.someCallback

Swing Widgets in Jython: JTextFields, JTextAreas, and JLabels

- JLabels are the world's simplest widgets

  years = swing.JLabel("Years")

- JTextFields are used for single-line text entry

  yearValue = swing.JTextField()

  print yearValue.text

  30

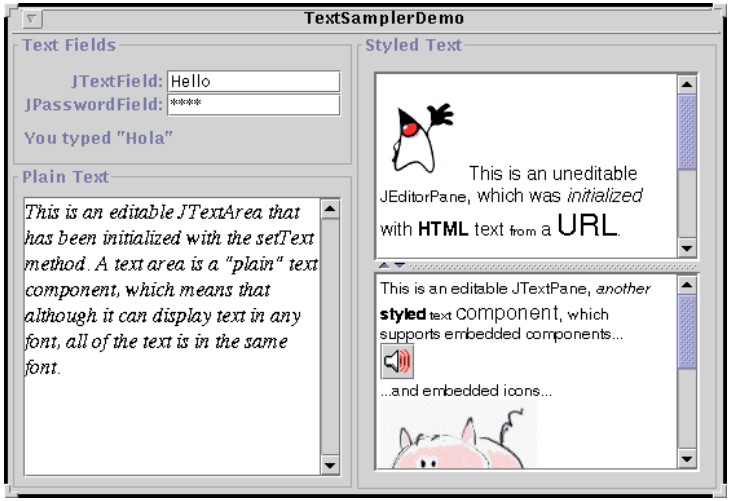
- JTextAreas are used for longer pieces of text

  area = swing.JTextArea(24, 80)

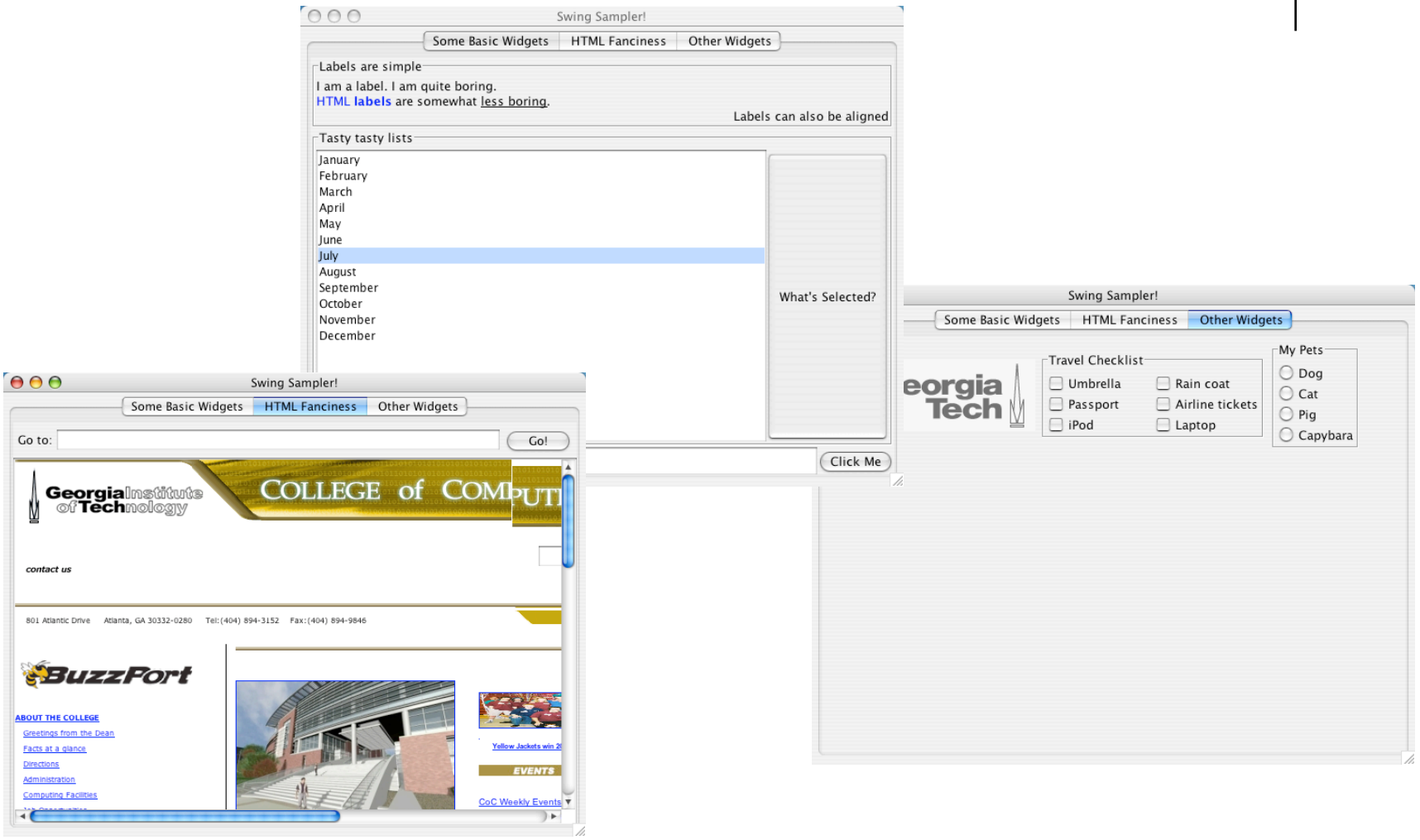
  area.editable = 0

  print area.text

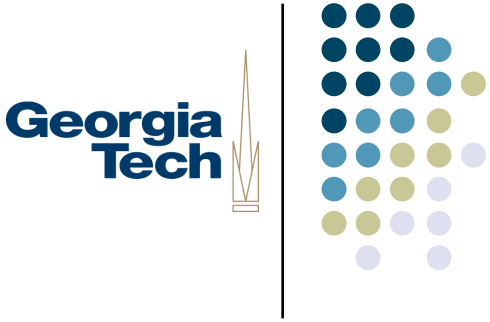
  area.text = area.text + "One more string"

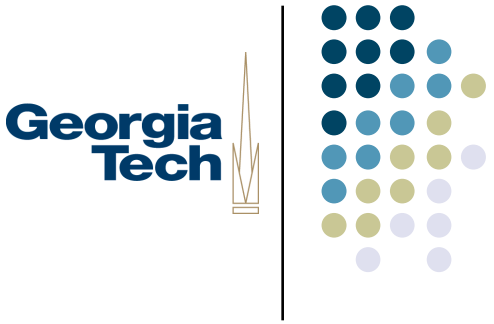


Putting it All Together



Code Walkthrough and Demo

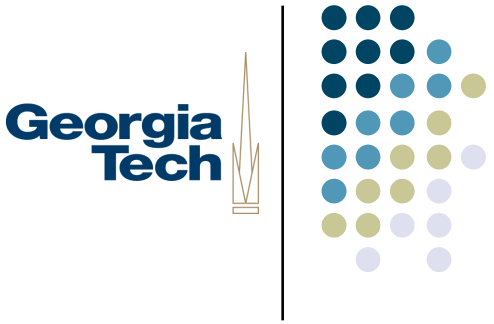




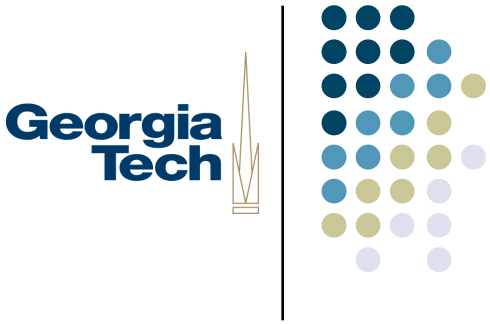
Useful Odds-and-Ends #1

- How do you make a "main" program?
  - Analog to void main() in C, public static void main() in Java
- In Jython, the system variable __name__ will be set to the string "__main__" in any file passed directly on the command line to Jython
- Example:
  - if __name__ == "__main__":
    - sampler = SwingSampler()
  - On command line:
    - jython swing-sampler.py

Useful Odds-and-Ends #2

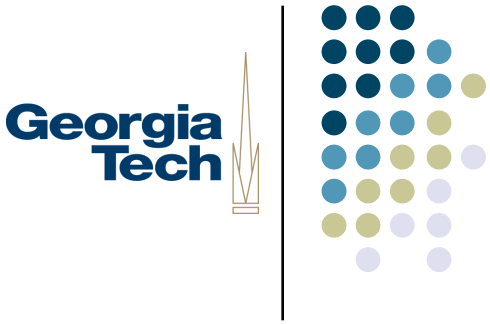


- How do you get the name of the user running your program?
- Useful in, e.g., a Chat program if you don't want to require users to log in explicitly
- *Note: for testing, you probably want some way to override this, so that you can simulate multiple users on the same machine*
  - import java.lang as lang
  - me = lang.System.getProperty("user.name")
- Returns login name



Useful Odds-and-Ends #3

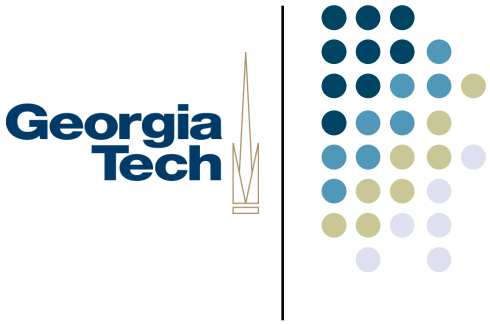
- How do you pass arguments on the command line?
- Useful, for example, to override the user name or set other parameters explicitly
- The variable *sys.argv* is the "argument vector"--the list of arguments passed on the command line
- The first element (sys.argv[0]) is *always* the name of the Jython file
- Example:
  - import sys
  - if __name__ == "__main__":
    - if len(sys.argv) > 1:
      - print "Got an argument", sys.argv[1]
    - else:
      - print "Got no arguments"



Useful Odds-and-Ends #4

- Wacky Python syntax
- Multi-line string constants
  - """this is a multi-line
    string constant"""
- Multiple assignment
  - a, b, c = 1, 2, 3
  - for key, value in dict.items():
- Default parameters
  - def func(a, b=0, c="Fred", *d, **e):
    - *d is a "catch-all" -- captures in a tuple any excess arguments
    - **e is a second-level catch-all -- captures in a dictionary any keyword arguments not already specified in the argument list
- And, of course, indentation denotes blocks...

Useful Odds-and-Ends #5



- Easy bridging between Java and Jython
- Can import and use arbitrary Java classes from within Jython
  - import java.util.Date as Date
  - d = Date()
  - print d
- Can subclass Java classes from Jython
  - class MyUI(swing.JFrame):
- Automatic type conversion between many Java and Jython types
  - e.g., Jython lists to and from Java arrays
- Detection and conversion of common code patterns

setFoo(); getFoo()	foo = 12; print foo

JButton close = new JButton("Close Me")
close.addActionListener(new ActionListener() {
  public void actionPerformed(ActionEvent ev) {
  java.lang.System.exit(0);
  }
});
	close = swing.JButton("Close Me")
	close.actionPerformed = self.terminateProgram
	
	def terminateProgram(self, event):
	  java.lang.System.exit(0)