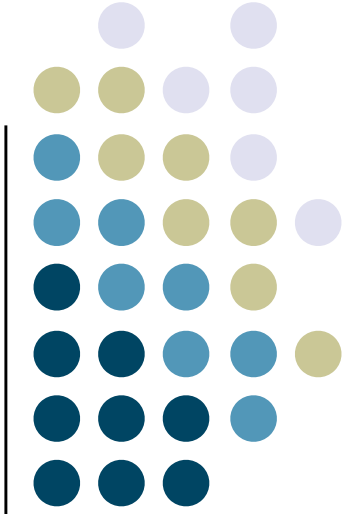
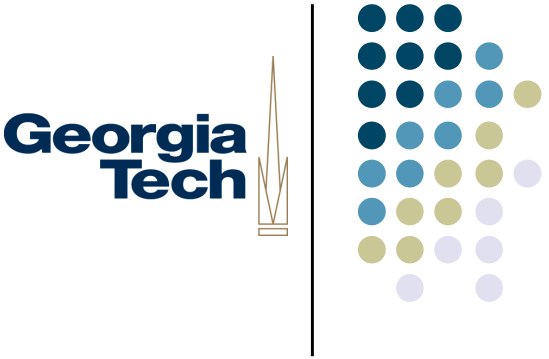
Python Strings and Data Structures



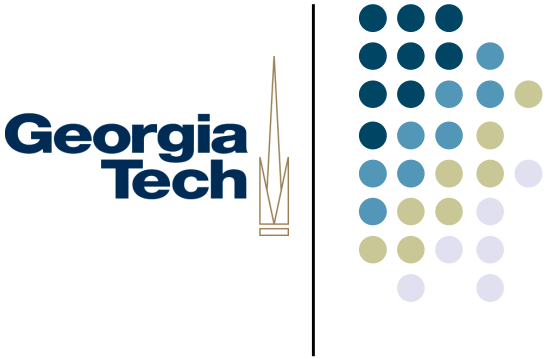
Georgia Tech

Learning Objectives



- Strings (more)
- Python data structures
  - Lists
  - Tuples
  - Dictionaries
- Get comfortable writing more code

Questions?

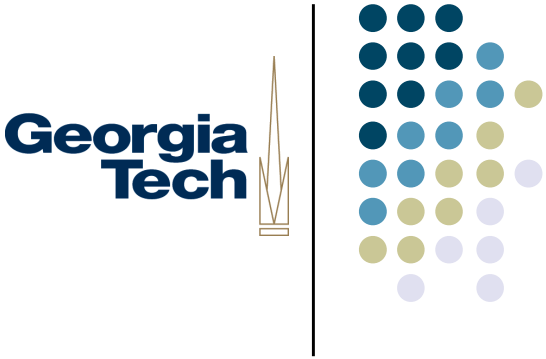


- Basic Python OK?
- How was the HW?

Strategies

- Don’t write up your entire program all at once
- Decompose it into pieces & get each piece working independently

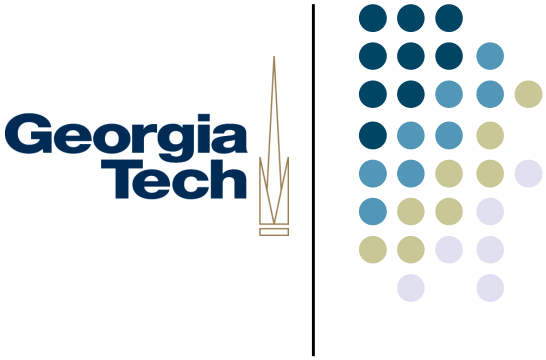
Multiple values



```
def mult3(a, b, c):
    return a+1, b+2, c+3

a, b, c = mult3(1, 1, 1)
```

Strings



- Used everywhere
  (Take out your laptops)

- ```
  >>> s = “Hey!”
  >>> print(s + “ You”)
  >>> print(len(s))
  >>> print(s * 3)
  ```
  ```

Printing Elements

Print all the letters in a string

```
for letter in "Hello":
    print(letter)
```

```
str = "run"
for ch in str:
    print(ch, end=' ')
```

Print only vowels?

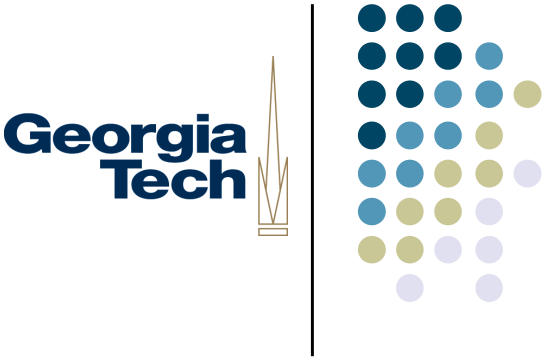
```
str = "dictionary"
for letter in str:
    if letter in "aeiouAEIOU":
        print(letter)
```

Reverse

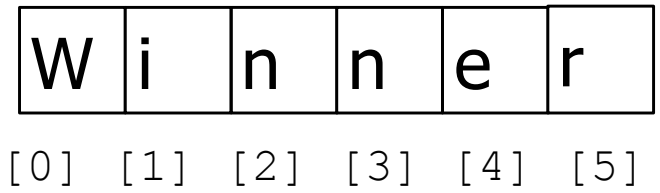
How to reverse a string?

```
def reverse(str):
    result = ""
    for letter in str:
        result = letter + result
    print result
```

Indices



Strings have indices




```
str = "Winner"
print(str[4])

print(str[-1])
print(str[-2])

print(str[6])

print(str[1:3])
```

Alt Traversal

Traverse, print, and reverse characters with while, not for

```
def reverse2(str):
    index = 0
    rev = ""
    while index < len(str)
        print(str[index])
        rev = rev + str[index]
    print(rev)
```

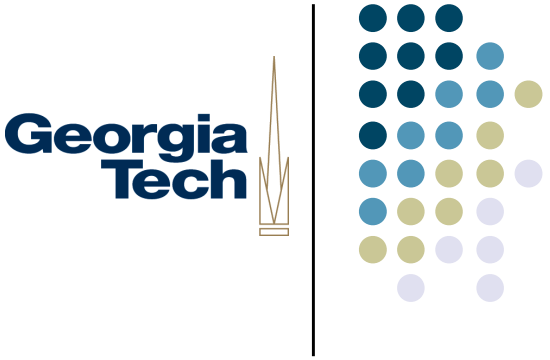
Wrong

Alt Traversal

Traverse, print, and reverse characters with while, not for

```
def reverse2(str):
    index = 0
    rev = ""
    while index < len(str)
        print(str[index])
        rev = str[index] + rev
        index = index + 1
    print(rev)
```

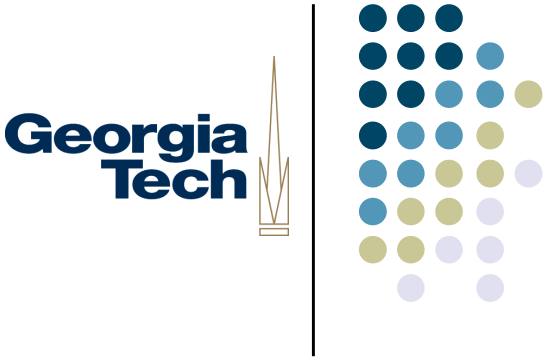
Modify a String?



- Strings are immutable
  - Once created, cannot be changed
- So how do you "modify" one?

- Always create a new one

String Operations



- Many functions on strings
  - `s.count(s1)` – count of how often s1 occurs in s
  - `s.find(s1)` – Returns first index of s1 in s (-1 if not there)
  - `s.lower()` – convert to lowercase
  - `s.upper()` – convert to uppercase
  - `s.replace(old, new)` – replaces all occurrences of old with new
  - `s.isalpha()` – true if only contains alphabetic characters
  - `s.isdigit()` – true if only numbers
  - `s.lstrip()` – removes leading whitespace from s
  - `s.rstrip()` – removes trailing whitespace from s
  - `s.strip()` – removes leading & trailing whitespace from s
  - `s.isupper()` – true if all uppercase
  - …

Remember: Some return a new string, don't modify existing one

Useful function

```
>>>str = “   John plays golf”
>>>l = str.split()
>>>print(l)

[‘John’, ‘plays’, ‘golf’]
```

A list (more to come soon)

```
>>> str.strip().lower().split()
???
```

Parsing a String

Want second half of email (after @ sign) in this

From: Bruckman, Amy S asb@cc.gatech.edu Date: Fri, 26 Aug 2016 20:32:17 +0000

```
str = "From: Bruckman, Amy S asb@cc.gatech.edu Date: Fri, 26 Aug 2016 20:32:17 +0000"
pos = str.fund('@')
space = str.find(' ',pos)
host = str[pos+1,space]
```

Exercise

- Create a palindrome tester

```
def palindrome(str):
    start = 0
    end = len(str) - 1
    while start < end:
        if str[start] != str[end]
            return False
        start = start + 1
        end = end - 1
    return True
```

Helpful Stuff I

- `dir` function – lists all methods on a type of object

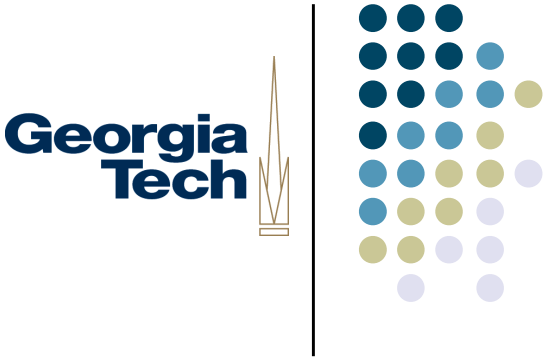
```
>>> stuff = 'Hello world'
>>> type(stuff) <type 'str'>
>>> dir(stuff) ['capitalize', 'center', 'count', 'decode', 'encode', 'endswith',
'expandtabs', 'find', 'format', 'index', 'isalnum', 'isalpha', 'isdigit', 'islower',
'isspace', 'istitle', 'isupper', 'join', 'ljust', 'lower', 'lstrip', 'partition',
'replace', 'rfind', 'rindex', 'rjust', 'rpartition', 'rsplit', 'rstrip', 'split',
'splitlines', 'startswith', 'strip', 'swapcase', 'title', 'translate', 'upper', 'zfill']
```

Helpful Stuff 2

- `help` function tells what a method does

```
>>> help(str.capitalize)
Help on method_descriptor:
capitalize(...)
S.capitalize() -> string
Return a copy of the string S with only its first character capitalized.
```

Admin Intermission



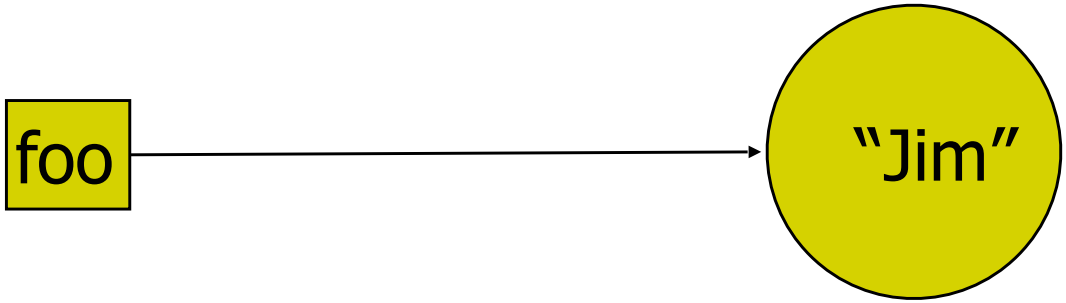
- Survey
- Piazza
- Office hours
- Slides
- Code in t-square

Data Structures

- Sometimes, you need more than a variable

Variables

- A variable is simply a name that contains a reference to some information
- foo = "Jim"



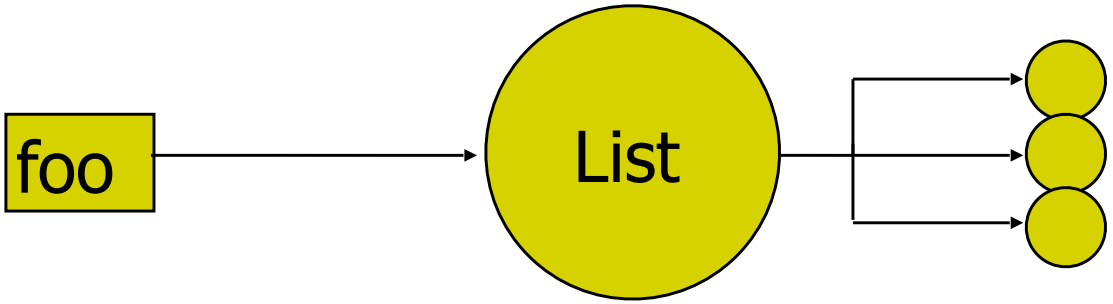
- Variables can be reassigned, and multiple variables can refer to the same thing
- Stashing a reference in a variable gives you a way to name it, and get at it later

Problem

- 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 built in way to do this: lists
- `foo = [ "one", "two", "three" ]`

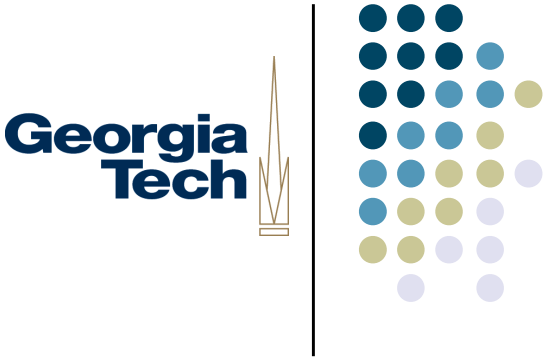


- Lists collect multiple references to data items into a single data structure
- These references are ordered
- The contents of the list can be altered (it is mutable)
- `currentChatUsers = [ "Amy", "Steven", ... ]`

List

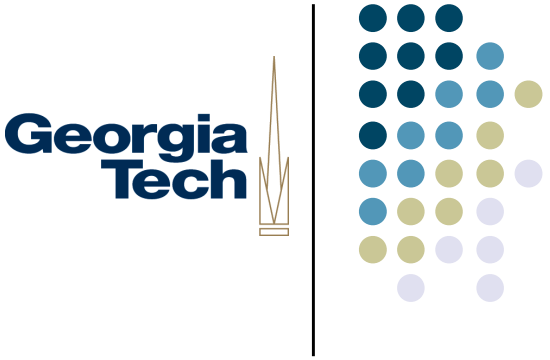
- Sequence of values
- Heterogeneous (not all same type of value)
- Mutable!
- Denoted with [ ]

```
[50, 40, 30, 'Mary', 'Fred']
```



```
evens = [2, 4, 6, 8]
names = [“Jim”, “Jane”, “Mike”, “Mary”]
vals = range(5)
# vals is  [0, 1, 2, 3, 4]
nums = range(1,10,3)
# ???
for i in nums:
     print(i)
```

Accessing Elements



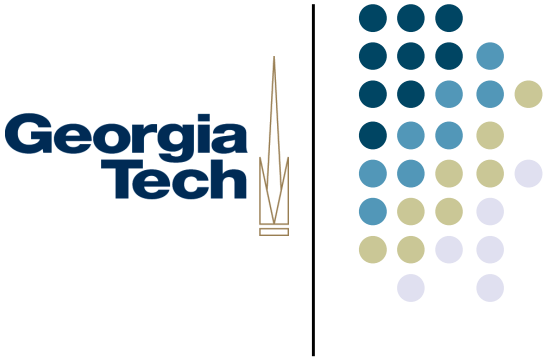
- [ ] used to get an index

```
days = [‘sun’, ‘mon’, ‘tue’, ‘wed’, ‘thu’, ‘fri’, ‘sat’]
c = days[3]
print(c)
print( days[-1] )
week = days[1:6]
print(week)
```

```
days[2] = ‘sleep’
# What happens?
```

Mutable

List Methods



`append(item)` – Adds item to end of list

`count(item)` – Returns count of how often item appears

`index(item)` – Returns index of first element with value item

`insert(index, item)` – Put item into list at position index and slide all others over one to the right

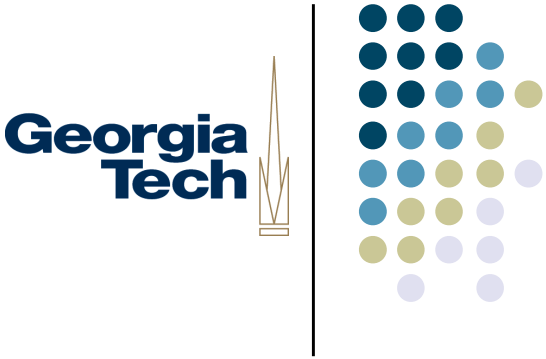
`sort()` – Sort items so they appear in ascending order

`remove(item)` – Remove first occurrence of item

`reverse()` – Reverses order of list

```
>>>l = [‘a’, ‘b’, ‘c’]
>>> del l[1]
>>> print(l)
```

Aliases

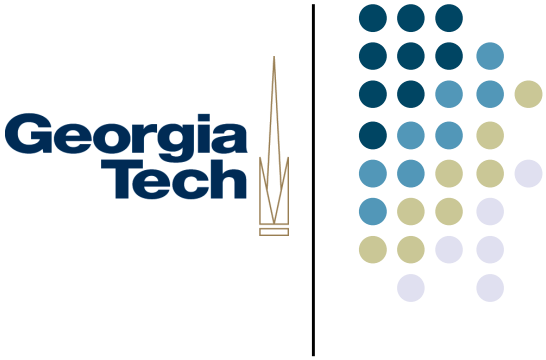


```
list1 = [1, 2, 3, 4]
list2 = list1
list1[2] = 12

print(list1)
print(list2)

list3 = [] + list2
list3.append(10)
```

Tuple



- 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” )
```

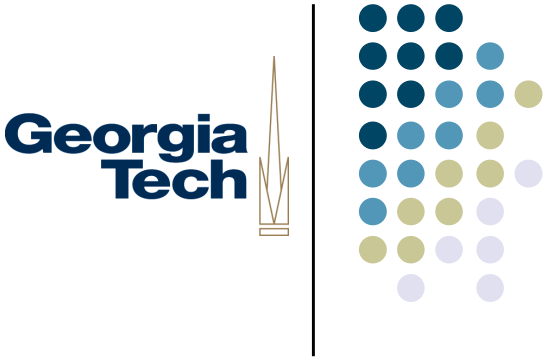
  - You need to group together a set of data whose structure is fixed:

    E.g., using tuples as quick-and-dirty records, such as address book entries:

```
myContactInfo = ( “John Stasko”, “TSRB355”, “stasko@cc.gatech.edu” )
```

- All list operations work on tuples, except ones that modify the set of references within the tuple
  - So, no append(), remove(), etc.

Tuple

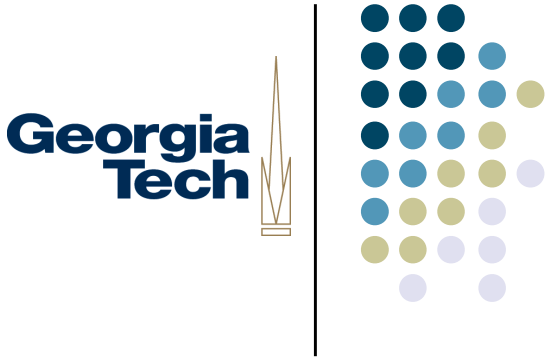


- Immutable!
- Lists of comma separated values

```
t1 = 'a', 'b', 'c'
t2 = ('a', 'b', 'c')
# equivalent

t3 = tuple('bobcat')
print(t3)
t4 = (10, 20, 30, 40)
print(t4[2])
print( t4[0:2])
```

Access



```
>>> m = [ 'go', 'fish' ]
>>> (x, y) = m
>>> x
'go'
>>> y
'fish'
>>>
```

```
>>> b,a = a,b
```

What does that do?

Multiple values

```
def mult3(a, b, c):
    return a+1, b+2, c+3

a, b, c = mult3(1, 1, 1)
```

Recall

Associating Data Items

- 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

- 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, Python has a built-in data structure for creating associations: the dictionary

Dictionary

- Like a list, but the index can be anything
  - You state what it is
  - Called a key
- Made up of key,value pairs
- Used to store and subsequently access data
- Similar to a hash table

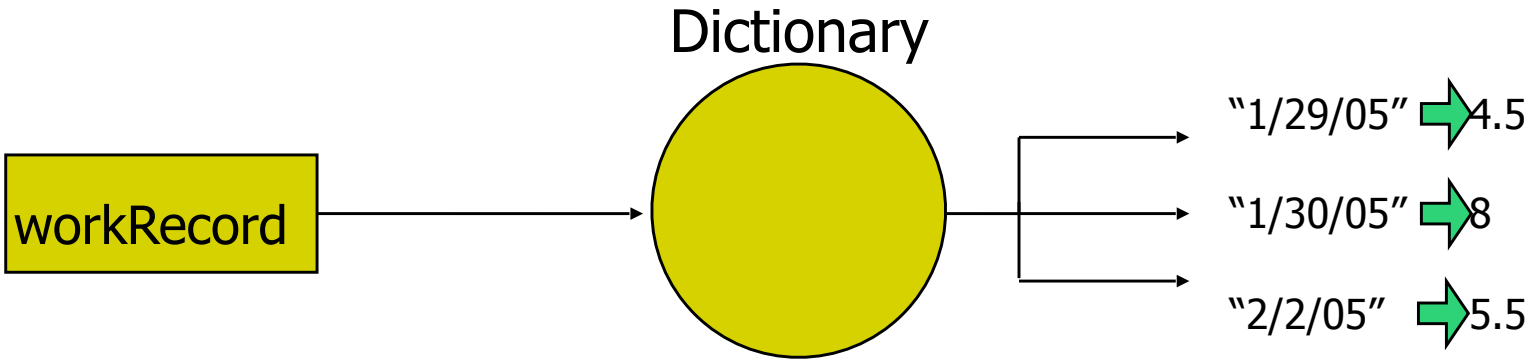
Example

902634854, “Sally Wilson”
917365643, “Lars Jonsson”
931967385, “Sakshi Gupta”
923438961, “Jiang Xiao”
…

Syntax: `{ key1:val1, key2:val2, … }`

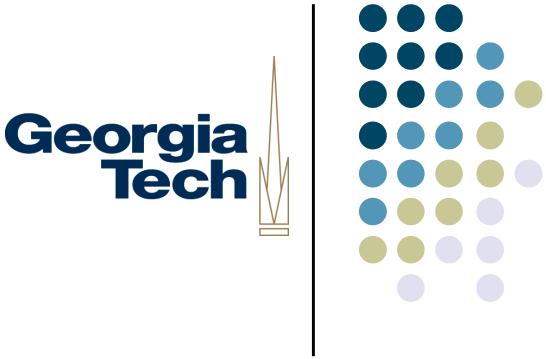
Dictionary Data Structure

- 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 Python data structure
- Virtually any Python data types can be used as a key or value

Code Example




```
months = {'Jan':1, 'Feb':2, 'Mar':3, 1:'Jan', 2:'Feb', 3:'Mar'}

print(months[2])
print(months['Jan'])

print(months.keys())
print(months.values())
```

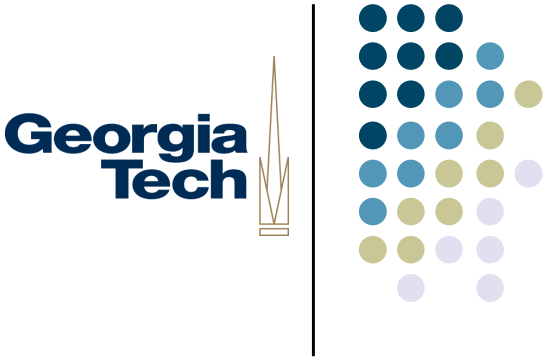
Important Note

- It is not ordered, ie, order is unpredictable

```
print(months)
```

- What happens?

Walking through



```
total = {'dave':83, 'sue':91, 'audrey':77}
for key in total:
    print(key, total[key])
```

How might you print them in sorted (alpha) order?

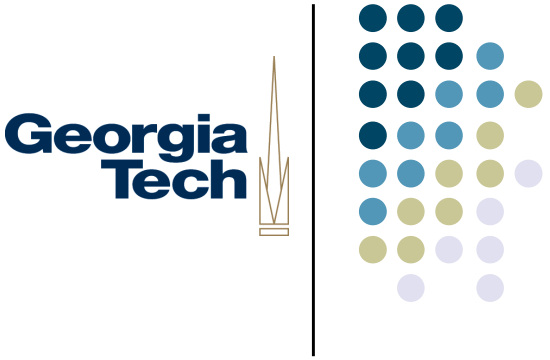
```
total = {'dave':83, 'sue':91, 'audrey':77}
print(total)
lst = list(total.keys())
lst.sort()
for key in lst:
    print(key, total[key])
```

Exercise

- Want to write a program that, given a big string, counts how often each letter appears

- How do it?

Solutions



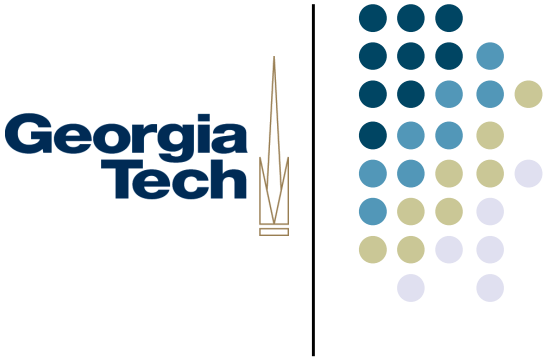
- 1. Make 26 variables
  - Yuk
- 2. Make a list
  - Need numeric index
- Take ordinal value of character as index

Solutions

- 3. Use dictionary

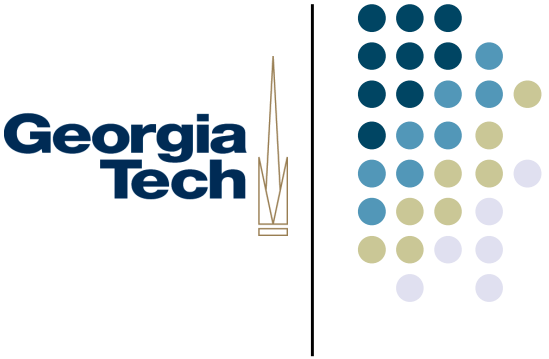
```
word = 'areallongword'
d = dict()
for c in word:
    if c not in d:
        d[c] = 1
    else:
        d[c] = d[c] + 1
print(d)
```

Operations Summary



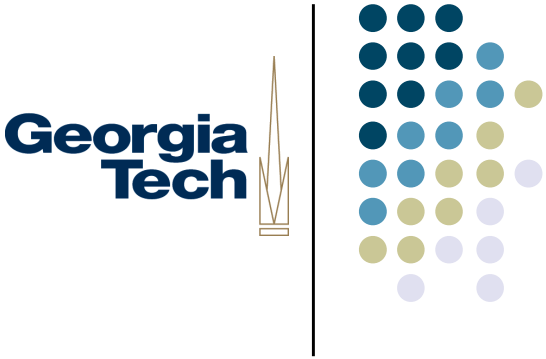
`d[k]` – returns item in d with key k
`len(d)` – returns number of items in d
`list(d.keys())` – returns a list containing the keys in d
`list(d.values())` – returns a list containing the values in d
`k in d` – returns true if key k is in d
`del d[k]` – removes the key k from d
`d.get(k,v)` – returns d[k] if k is in d, and v otherwise
`d[k] = v` – associates value v with key k in d
(replaces an existing value, if present)
`for k in d` – iterates over keys in d
`d.items()` – returns a list of (key,value) tuples
…

Learning Objectives



- Strings (more)
- Python data structures
  - Lists
  - Tuples
  - Dictionaries
- Get comfortable writing more code

Next Time



- Manipulating files
  - Reading and writing
- Starting to work with data