Sequence Types

FEB 24TH, 2014

What we have not learned so far…

- How to store, organize, and access large amounts of data?
- **Examples:**
  - **Read a sequence of million numbers and output these in sorted order.**
  - **Read a text, correct all spelling errors in the text, and output the corrected text.**
- Programming languages typically provide tools and techniques to store and organize data.
- In Python we can use *sequence types* to do this.

Strings and *Lists* are examples of Sequence Types

- A *string* is a sequence of characters enclosed in quotes.
  Examples: "hello", "8.397", "7", '34'
  (The quotes can be single or double quotes)

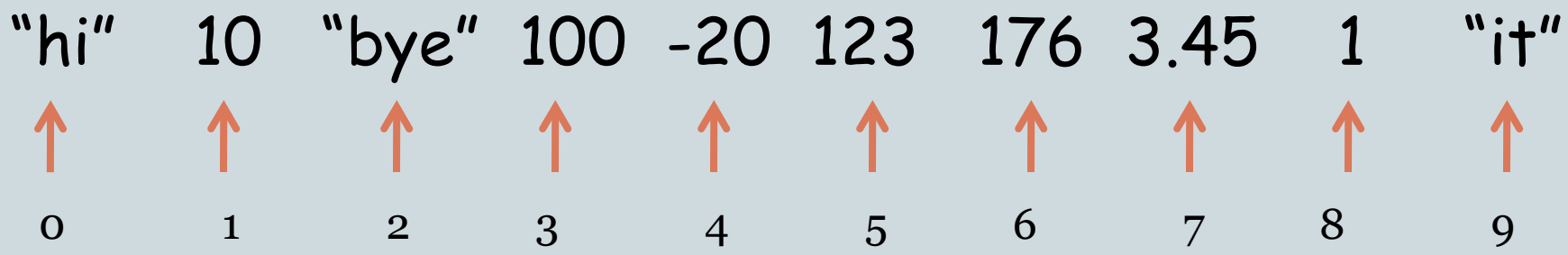
- A *list* is a sequence of objects enclosed in square brackets.
  Examples: [0, 1, 2, 3],
  ["Alice", "Bob", "Catherine"],
  ["hello", 4.567, -22, 87L, 'bye']

(Objects of different types can be part of the same list)

- Lists are more "general" than strings; strings can be viewed as special instances of lists.

Accessing items in lists and strings

L = ["hi", 10, "bye", 100, -20, 123, 176, 3.45, 1, "it"]



- One of the most useful features of sequence types is that elements in a sequence can be accessed efficiently and conveniently using their *position* in the sequence.
- This type of access is called *random access*. It refers to the fact that the amount of time to access an element via its index is independent of the value of the index or the size of the sequence.
- **Example:**

  L[0] is "hi", L[1] is 10, L[2] is "bye",..., L[9] is "it"

An example with lists and strings

- **Example:**

  L = ["hello, Pavan", [22, 0], 15]

  L[0][4] = "o"
  L[1][0] = 22
  L[0][1] = "e"
  L[2] = 15

The len function

- Python has a built-in function len(L) that returns the length, i.e., the number of elements, in list L. We already know that len(s) works for a string s.

Examples: len([]) is 0, len([34, 12, 45]) is 3, len("hello") = 5.

- Thus the elements of a list L are indexed from 0 through len (L)-1.

- This simple observation is quite useful in iterating through a list.

Example 1: Iterating through a list

- This program walks through the list, printing each element.
- The program uses the positions of the elements to index into the list.

```
L = ["hi", 109, "go", 111, 1.16, [122,30], "hello"]
i = 0
while i < len(L):
    print L[i]
    i = i + 1
```

Example 2: Testing membership in a list

```
# tests if a given element is a member of a given list.
# Returns True if element is a member; False otherwise.
def isMember(L, elem):
    i = 0 # i serves as the index into list L

    # Iterate through the elements of the list
    # comparing each of them with elem
    while i < len(L):
        if elem == L[i]:
            return True
        i = i + 1
    return False
```

The in operator

- The isMember function is rendered useless – by the Python in operator.
- The in operator is used as x in L, where x is an object and L is a list. This expression evaluates to True if x is an *element* in L; evaluates to False otherwise.

  Examples: 67 in [34, 12, 45] evaluates to False
  "hi" in [] evaluates to False, etc.

- This works on strings as well.

  Examples:
  "hi" in "history" evaluates to True
  "ei" in "piece" evaluates to False
  "ace" in "Wallace" evaluates to True

Example 3: Finding location of an element

```
# searches for a given element in a given list and
# returns the index of the first occurrence of the
# element, if it is present in the list. Otherwise,
# returns -1.

def search(L, elem):
    i = 0 # i serves as the index into list L

    # Iterate through the elements of the list
    # comparing each of them with elem
    while i < len(L):
        if elem == L[i]:
            return i
        i = i + 1

    return -1
```

Adding elements to a list

- The append and extend operations.
- **Examples:**

```
>>> L = [1, 25, "hello", -67]
>>> L.append(25)
>>> L
[1, 25, 'hello', -67, 25]
>>> L.extend([-1, -2])
>>> L
[1, 25, 'hello', -67, 25, -1, -2]
```

Programming Problem 4

- Read a file containing some number of nonnegative integers and output the number of *distinct* integers in the file.

- There is no specific format to the file – there could be several integers in a line or none, consecutive integers are separated by one or more white spaces (blanks, tabs, returns).

Example Input File (test.txt)

23 78

4567 123 789
230

1236765

78798 6768 678 678 78

Algorithm

1. `masterList = []`
2. Read a line of the file as a string.
3. "Parse" the line to extract a list `numbersInLine` of integers from the line.
4. Walk through list `numbersInLine` and for each element in `numbersInLine`, not in `masterList`, add it to `masterList`.
5. Go back to Line (2), if there are more lines to process.
6. Output the length of `masterList`.

Main Program

```
# Open a file called test.txt for read only and read the first line
f = open("test.txt", "r")
line = f.readline()
masterList = [] # keeps track of the list of distinct integers in the file

# Process each line, if line is non-empty
while line:
    # Parse the line to extract a list of numbers in the line
    numbersInLine = parse(line)

    # Extend the masterList by appending to it all the new
    # numbers in the line.
    masterList = uniqueExtend(masterList, numbersInLine)

    # Read the next line
    line = f.readline()

f.close()

print masterList
```

The function uniqueExtend

```
# Takes two lists L1 and L2 and returns the list obtained
# by appending to L1, all elements in L2 that are not in L1
def uniqueExtend(L1, L2):
    index = 0 # serves as index into list L2

    # Loop to walk through elements of L2
    while index < len(L2):
        # If current element of L2 is not in L1, then append it
        if not(L2[index] in L1):
            L1.append(L2[index])
        index = index + 1

    return L1
```

The function parse

```
# Takes a string consisting of non-negative integers and
# returns a list containing all the integers in the line.
# The integers in the line are separated by 1 or more blanks.
def parse(s):

    listOfNumbers = [] # maintains the list of numbers in strings s
    currentNumber = ""

    # The function oscillates between two states: in one state
    # it is processing the digits of an integer and the other state
    # it is processing the white spaces between consecutive integers.
    # The boolean variable numberBeingProcessed is used to keep track
    # of this state.
    numberBeingProcessed = False

    i = 0 # serves as an index into the string s
    while i < len(s):

        # if the current character is a digit
        if s[i] >= "0" and s[i] <= "9":
            numberBeingProcessed = True
            currentNumber = currentNumber + s[i]

        # else if the current character is a non-digit
        # immediately following a number
        elif numberBeingProcessed:
            listOfNumbers.append(int(currentNumber))
            numberBeingProcessed = False
            currentNumber = 0
        i = i + 1

    return listOfNumbers
```