CSc 110, Autumn 2016

Lecture 15: lists

Adapted from slides by Marty Stepp and Stuart Reges

"The machine learning algorithm wants to know if we’d like a dozen wireless mice to feed the Python book we just bought."
Can we solve this problem?

• Consider the following program (input underlined):

How many days' temperatures? 7
Day 1's high temp: 45
Day 2's high temp: 44
Day 3's high temp: 39
Day 4's high temp: 48
Day 5's high temp: 37
Day 6's high temp: 46
Day 7's high temp: 53
Average temp = 44.6
4 days were above average.
Why the problem is hard

• We need each input value twice:
  • to compute the average (a cumulative sum)
  • to count how many were above average

• We could read each value into a variable... but we:
  • don't know how many days are needed until the program runs
  • don't know how many variables to declare

• We need a way to declare many variables in one step.
Lists

- **list**: object that stores many values.
  - **element**: One value in a list.
  - **index**: A 0-based integer to access an element from a list.

<table>
<thead>
<tr>
<th>index</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>value</td>
<td>12</td>
<td>49</td>
<td>-2</td>
<td>26</td>
<td>5</td>
<td>17</td>
<td>-6</td>
<td>84</td>
<td>72</td>
<td>3</td>
</tr>
</tbody>
</table>

- element 0
- element 4
- element 9
List initialization

name = [value, value, ... value]

• Example:
numbers = [12, 49, -2, 26, 5, 17, -6]

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<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>value</td>
<td>12</td>
<td>49</td>
<td>-2</td>
<td>26</td>
<td>5</td>
<td>17</td>
<td>-6</td>
</tr>
</tbody>
</table>

• Useful when you know what the array's elements will be

name = [value] * count

• Example:
numbers = [0] * 4

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</tr>
</thead>
<tbody>
<tr>
<td>value</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Accessing elements

name[index] # access
name[index] = value # modify

• Example:
  numbers = [0] * 2
  numbers[0] = 27
  numbers[1] = -6

  print(numbers[0])
  if (numbers[1] < 0):
      print("Element 1 is negative.")
      index 0 1
  value 27 -6
Out-of-bounds

• Legal indexes to use [:]: between – list's length and the list's length - 1.
  • Reading or writing any index outside this range with [:] will cause an
    IndexError: list assignment index out of range

• Example:

  ```python
  data = [0] * 10
  print(data[0])         # okay
  print(data[9])         # okay
  print(data[-20])       # error
  print(data[10])        # error
  ```

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<tbody>
<tr>
<td>value</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>0</td>
</tr>
</tbody>
</table>
Lists and \texttt{for} loops

- It is common to use \texttt{for} loops to access list elements.

\begin{verbatim}
for i in range(0, 8):
    print(str(numbers[i]) + " ", end='')
print()  # output: 0 4 11 0 44 0 0 2
\end{verbatim}

- Sometimes we assign each element a value in a loop.

\begin{verbatim}
for i in range(0, 8):
    numbers[i] = 2 * i
\end{verbatim}

\begin{tabular}{cccccccc}
index & 0 & 1 & 2 & 3 & 4 & 5 & 6 & 7 \\
value  & 0 & 2 & 4 & 6 & 8 & 10 & 12 & 14
\end{tabular}
**len()**

- **Use `len()`** to find the number of elements in a list.

```python
for i in range(0, len(numbers)):
    print(numbers[i] + " ", end='')
# output: 0 2 4 6 8 10 12 14
```

- **What expressions refer to:**
  - The last element of any array?
  - The middle element?
Lists and for loops

• You can also loop directly over lists, just as with strings

```python
code_list = [1, 3, 6, 23, 43, 12]
for number in code_list:
    print(str(number + " ", end=''))
print()  # output: 1 3 6 23 43 12
```
Weather question

• Use a list to solve the weather problem:

  How many days' temperatures? 7
  Day 1's high temp: 45
  Day 2's high temp: 44
  Day 3's high temp: 39
  Day 4's high temp: 48
  Day 5's high temp: 37
  Day 6's high temp: 46
  Day 7's high temp: 53
  Average temp = 44.6
  4 days were above average.
Weather answer

# Reads temperatures from the user, computes average and # days above average.

def main():
    days = int(input("How many days' temperatures? "))

    temps = [0] * days  # list to store days' temperatures
    sum = 0

    for i in range(0, days):  # read/store each day's temperature
        temps[i] = int(input("Day " + (i + 1) + "'s high temp: "))
        sum += temps[i]
    average = sum / days

    count = 0  # see if each day is above average
    for i in range(0, days):
        if (temps[i] > average):
            count += 1

    # report results
    print("Average temp = " + str(average))
    print(str(count) + " days above average")
Weather question 2

• Modify the weather program to print the following output:

  Type in a temperature or "done" to finish
  Day 1's high temp: 45
  Day 2's high temp: 44
  Day 3's high temp: 39
  Day 4's high temp: 48
  Day 5's high temp: 37
  Day 6's high temp: 46
  Day 7's high temp: 53
  Day 7's high temp: done
  Average temp = 44.6
  4 days were above average.
List declaration

\texttt{name} = []

- Example:
  \texttt{numbers} = []

Creates an empty list

\textit{index}

\textit{value}
List functions

<table>
<thead>
<tr>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>append(x)</td>
<td>Add an item to the end of the list. Equivalent to $a[len(a):] = [x]$.</td>
</tr>
<tr>
<td>extend(L)</td>
<td>Extend the list by appending all the items in the given list. Equivalent to $a[len(a):] = L$</td>
</tr>
<tr>
<td>insert(i, x)</td>
<td>Inserts an item at a given position. $i$ is the index of the element before which to insert, so $a.insert(0, x)$ inserts at the front of the list.</td>
</tr>
<tr>
<td>remove(x)</td>
<td>Removes the first item from the list whose value is $x$. Errs if there is no such item.</td>
</tr>
<tr>
<td>pop(i)</td>
<td>Removes the item at the given position in the list, and returns it. $a.pop()$ removes and returns the last item in the list.</td>
</tr>
<tr>
<td>clear()</td>
<td>Remove all items from the list.</td>
</tr>
<tr>
<td>index(x)</td>
<td>Returns the index in the list of the first item whose value is $x$. Errs if there is no such item.</td>
</tr>
<tr>
<td>count(x)</td>
<td>Returns the number of times $x$ appears in the list.</td>
</tr>
<tr>
<td>sort()</td>
<td>Sort the items of the list</td>
</tr>
<tr>
<td>reverse()</td>
<td>Reverses the elements of the list</td>
</tr>
<tr>
<td>copy()</td>
<td>Return a copy of the list</td>
</tr>
</tbody>
</table>
Weather 2 answer

# Reads temperatures from the user, computes average and # days above average.

def main():
    print("Type in a temperature or "'done" to finish")

    temps = []  # list to store days' temperatures
    sum = 0
done = input("Day 1's high temp: ")
day = 1

while(done != "done"):
    done = int(done)
    sum += done
    temps.append(done)
done = input("Day " + str(day + 1) + "'s high temp: ")
day += 1
average = sum / day

    count = 0  # see if each day is above average
for i in range(0, day - 1):
    if (temps[i] > average):
        count += 1
# report results
print("Average temp = " + str(average))
print(str(count) + " days above average")
Weather question 3

• Modify the weather program to print the following output:

How many days’ temperatures?  7
Day 1's high temp: 45
Day 2's high temp: 44
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Day 7's high temp: 53
Average temp = 44.6
4 days were above average.

Temperatures: [45, 44, 39, 48, 37, 46, 53]
Two coldest days: 37, 39
Two hottest days: 53, 48
# Reads temperatures from the user, computes average and # days above average.
def main():
    days = int(input("How many days' temperatures? "))

    temps = [0] * days  # list to store days' temperatures
    sum = 0

    for i in range(0, days):  # read/store each day's temperature
        temps[i] = int(input("Day " + (i + 1) + "'s high temp: "))
        sum += temps[i]
    average = sum / days

    count = 0  # see if each day is above average
    for i in range(0, days):
        if (temps[i] > average):
            count += 1

    # report results
    print("Average temp = " + str(average))
    print(str(count) + " days above average")

    print("Temperatures: " + str(temps))
    temps.sort()
    print("Two coldest days: " + str(temps[0]) + ", " + str(temps[1]))
    print("Two hottest days: " + str(temps[-1]) + ", " + str(temps[-2]))
"list mystery" problem

- **traversal**: An examination of each element of a list.

- What element values are stored in the following list?

  ```python
  a = [1, 7, 5, 6, 4, 14, 11]
  for i in range(0, len(a) - 1):
      if (a[i] > a[i + 1]):
          a[i + 1] = a[i + 1] * 2
  ```

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