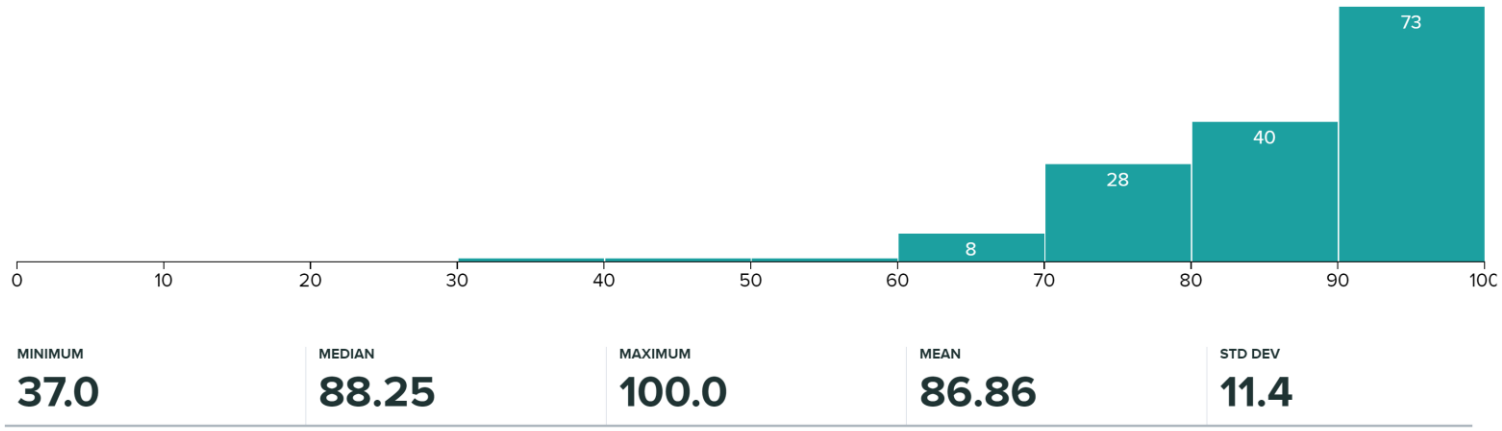
Lists

15-110 – Friday 02/26

Announcements

- **Quiz1 scores & feedback have been released**
  - Median: 88.25. Well done!
  - View your submission and feedback on **Gradescope**, not Canvas



- Hw2 due Monday at noon. There's a lot of coding. **Start early!**

- Opportunity to change breakout room groups – fill out the form if you have an opinion. Link: https://forms.gle/XM4cHqDGqaKYo5Fx8

Learning Goals

- Read and write code using **1D** and **2D lists**
- Use **list methods** to change lists without variable assignment

Lists

Lists are Containers for Data

A **list** is a data structure that holds an ordered collection of data values.

Example: a sign-in sheet for a class.

Sign In Here
0. Elena
1. Max
2. Eduardo
3. Iyla
4. Ayaan

Lists make it possible for us to assemble and analyze a collection of data **using only one variable**.

List Syntax

We use **square brackets** to set up a list in Python.

```
a = [ ] # empty list
b = [ "uno", "dos", "tres" ] # list with three strings
c = [ 1, "dance", 4.5 ] # lists can have mixed types
```

Basic List Operations

Lists share most of their basic operations with strings.

```
a = [ 1, 2 ] + [ 3, 4 ] # concatenation – [ 1, 2, 3, 4]
b = [ "a", "b" ] * 3 # repetition – [ "a", "b", "a", "b", "a", "b" ]
c = [ 1, 5 ] < [ 2, 4 ] # comparison/equality – True
d = 4 in [ "a", "b", 1, 2 ] # membership – False
```

This includes **indexing** and **slicing**.

```
lst = [ "a", "b", "c", "d" ]
print(lst[1]) # indexing – prints "b"
print(lst[2:]) # slicing – prints [ "c", "d" ]
```

List Functions and Methods

There are a few useful built-in functions that work directly on lists.

```
len(lst) # the number of elements in lst
min(lst)/max(lst) # the smallest/largest element in lst
sum(lst) # the sum of the elements in lst
```

There are also some list methods which are called directly on the list, like string methods.

```
lst.count(element) # the number of times element occurs in lst
lst.index(element) # the first index of element in lst
```

Looping Over Lists

Looping over lists works the same way as with strings. We can use a for loop over the indexes of the list to access each item. For example, the following loop sums all the values in `prices`.

```
total = 0
for i in range(len(prices)):
    total = total + prices[i]
print(total)
```

Use `s.split(c)` to Turn Strings Into Lists

We'll also use a new string method, `s.split(c)`, to split up a string into a new list based on a separator character, `c`. This is highly useful for working with text data (books, scripts, chat logs...).

```
def findName(sentence, name):
    words = sentence.split(" ")
    for i in range(len(words)):
        if words[i] == name:
            return True
    return False

findName("Ask Tom to phone Nina", "Tom")
# words holds ["Ask", "Tom", "to", "phone", "Nina"]
```

Activity: Predict the Result

What will be printed after each of the following code snippets?

```
lst = ["a", "b", 1, 2]

print(lst[1]) # Q1

s = ""
for i in range(len(a)):
    s = s + str(a[i])
print(s) # Q2
```

Example: `findMax(nums)`

Let's write a function that finds the maximum value in a list of integers (without using the built-in `max` function).

```
def findMax(nums):
    biggest = nums[0] # why not 0? Negative numbers!
    for i in range(len(nums)):
        if nums[i] > biggest:
            biggest = nums[i]
    return biggest
```

We'll often use this algorithmic structure to find the biggest/best item in a structure.

2D Lists

2D Lists are Lists of Lists

We often need to work with data that is **two-dimensional**, such as the coordinates on a grid, values in a spreadsheet, or pixels on a screen. We can store this type of data in a **2D list**, which is just a list that contains other lists.

For example, the 2D list to the right holds population data, where each population datapoint itself contains multiple data values (city, county, and population).

Population List

0.
- 0. "Pittsburgh"
- 1. "Allegheny"
- 2. 302407

1.
- 0. "Philadelphia"
- 1. "Philadelphia"
- 2. 1584981

2.
- 0. "Allentown"
- 1. "Lehigh"
- 2. 123838

3.
- 0. "Erie"
- 1. "Erie"
- 2. 97639

4.
- 0. "Scranton"
- 1. "Lackawanna"
- 2. 77182

Syntax of 2D Lists

Setting up a 2D list is no different than setting up a 1D list; each inner list is one data value.

```
cities = [ ["Pittsburgh", "Allegheny", 302407],
           ["Philadelphia", "Philadelphia", 1584981],
           ["Allentown", "Lehigh", 123838],
           ["Erie", "Erie", 97639],
           ["Scranton", "Lackawanna", 77182] ]
```

When indexing into a 2D list, the first square brackets index into a row and the second index into a column. The length of a 2D list is the number of lists in the outer list.

```
cities[2]    # [ "Allentown", "Lehigh", 123838 ]
cities[2][1] # "Lehigh"
len(cities)  # 5
```

Looping Over 2D Lists

We can loop over a 2D list the same way we loop over a list. Indexing into a list once will produce an **inner list**. We'll need to index a second time to get a value.

```
def getCounty(cities, cityName):
    for i in range(len(cities)):
        entry = cities[i] # entry is a list
        if entry[0] == cityName:
            return entry[1]
    return None # city not found
```

Looping Over All 2D List Elements

When you loop over a 2D list and want to access *every* element, you need to use **nested for loops**. Often, the outer loop iterates over the indexes of the outer list (**rows**) and the inner loop iterates over the indexes of the inner list (**columns**).

```
gameBoard = [ ["X", " ", "O"], [" ", "X", " "], [" ", " ", "O"] ]
for row in range(len(gameBoard)): # each row is a list
    boardString = ""
    for col in range(len(gameBoard[row])): # each col is a string
        boardString = boardString + gameBoard[row][col]
    print(boardString) # separate rows on separate lines
```

Activity: `getTotalPopulation(cities)`

Write the function `getTotalPopulation(cities)` that takes the city-information 2D list from before and finds the total population of all cities in the list:

```
cities = [ ["Pittsburgh", "Allegheny", 302407],
           ["Philadelphia", "Philadelphia", 1584981],
           ["Allentown", "Lehigh", 123838],
           ["Erie", "Erie", 97639],
           ["Scranton", "Lackawanna", 77182] ]
```

Hint: note that the population is in the third column. What index corresponds to that?

List Methods

Some List Methods Change the List

Sometimes we want to modify a list directly, to add or remove elements from it. There are a set of list methods that can do this **without using variable assignment at all**.

```
lst = [ 1, 2, "a" ]
lst.append("b") # adds the element to the end of the list
```

Note that we do not set `lst = lst.append`; the list is changed **in place**. In fact, the `append` method returns `None`, not a list. We'll talk more about how this works next time.

Example: `getFactors(n)`

Let's write a function that takes an integer and returns a list of all the factors of that integer.

```
def getFactors(n):
    factors = [ ]
    for num in range(1, n+1): # num is a possible factor
        if n % num == 0:
            factors.append(num)
    return factors
```

Additional List Methods

Here are a few other useful list methods that change the list in place:

```
lst = [ 1, 2, "a" ]
lst.insert(1, "foo") # inserts 2nd param into 1st param index
lst.remove("a") # removes the given element from the list once
lst.pop(0) # removes the element at given index from the list
```

Learning Goals

- Read and write code using **1D** and **2D lists**
- Use **list methods** to change lists without variable assignment
- **Feedback: http://bit.ly/110-s21-feedback**