

Structures: Lists: Basics

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What is a List?

- A collection of values
 - Values
 - May all have the same type, or
 - May have different types
 - Each item is referred to as an element
 - Each element has an index
 - Unique integer identifying its position in the list
 - A list is one type of data structure
 - A mechanism for organizing related data

Creating a List

- Format:

```
<list name> = [<value 1>, ..., <value n>]
```

- Examples:

```
names = [] → defines an empty list
```

```
nums = [10.0, 9.0, 8.5, 5.0, 7.5]
```

```
letters = ['a', 'b', 'c', 'd', 'e', 'f', 'g']
```

```
names = ['Marc', 'Jim', 'Ken']
```

```
mixed = [1.0, 1, "this", True]
```

- By defining the list memory is allocated for it

*** Works on Lists?**

Repetition Operator (*)

- Just like strings, you can use asterisk to repeat a list

```
>list = [0]*5
```

← Produces a list of size 5 with all elements = 0

```
>newList = list*5
```

← Produces a new list of size 25 with all elements = 0

Indices

Accessing Elements

- Each list element has two unique indices, a positive one and a negative one:
 - Positive indices range from 0 to the length of the list minus one ($len(list)-1$)
 - Negative indices range from $-len(list)$ to -1

0	1	2	3	4	5	6	7
A	B	C	D	E	F	G	H
-8	-7	-6	-5	-4	-3	-2	-1

Accessing Elements - Accessing a Single Element

- To access one element, use the name of the list, followed by the index of that element in square brackets
 - Use this one element just like any other variable

names[**index**] →
returns the value stored
at location **index**.

names [0]	Marc
names [1]	Ken
names [2]	Jim
names [3]	Tony

- names refers to the whole list
- len(names) → 4
- names.index('Ken') → 1

Loop on List

Accessing Elements - Iterating Over List Items

- A for loop can be used iterates over the list values:

```
stuff = [1, "ICT", 3.14]
for item in stuff:
    print(item)
```

Accessing Elements - Iterating Over List Indices

- Sometimes we need a loop where the control variable varies over the indices rather than the values

```
stuff = [1, "ICT", 3.14]
for i in range(0, len(stuff))
    print(stuff[i])
```

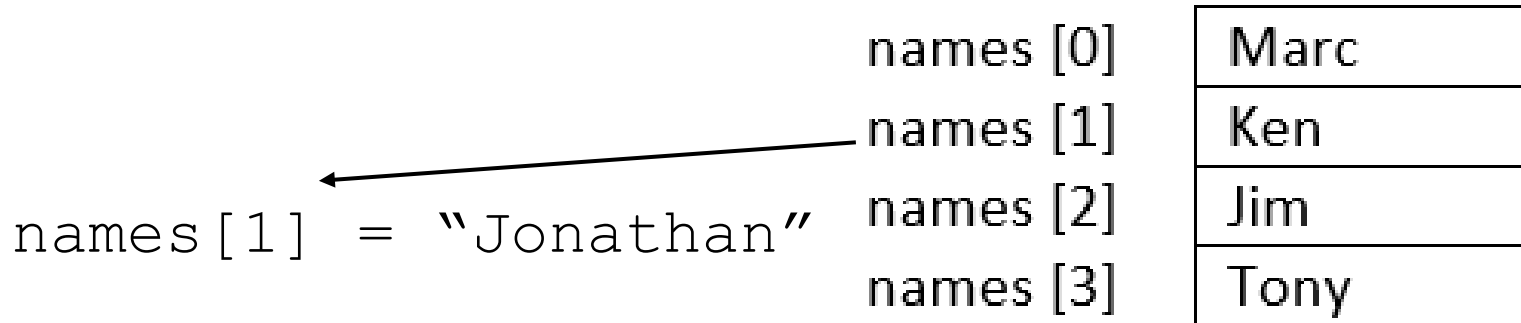
List length changes as elements are added/removed.
So, use *len()* function to determine the length of list.

Modifying List

Modifying Elements

- Lists are mutable, so their elements can be changed as follows:

```
names[index] = new_data
```



names [0]	Marc
names [1]	Jonathan
names [2]	Jim
names [3]	Tony

Adding Elements

- Lists are mutable, so we can add more elements to them.
- There are three ways to add elements to a list
 - `append(x)` : adds a single element to the end of the list
`names.append('Daniel')`
 - `insert(i, x)` : inserts a single element into a list at index `i`, shifts elements at index 3+ up
`names.insert(3, 'Chris')`
 - `extend(L)` : extends the list by appending the given second list to it
`names.extend(['Eric', 'Frank'])`

Adding Elements

- Example:

```
names = []
```

```
name = input("Enter a name:")  
names.append(name)
```

```
names_str = ["Joe", "James"]  
names.extend(names_str)
```

```
print(names)
```

Printing List

Printing List

- There are many ways to print the content of a list.
- Two common ways are:
 - using `print()`

```
print('names = %s' , (names))
```

- Using a loop → allows us to print the list in a customized format:

```
for i in range(0, len(names), 1):  
    print("names[%d] = %s" % (i, names[i]))
```

2D Lists

2D Lists

- A list of lists (images,movies,tables,matrices -> all 2D data)
- [does not have to be rectangular]

A matrix

1	2	3
4	5	6
7	8	9

A table

T01	Sandeep Zechariah
T02	<u>Hooman Khosravi</u>
T03	<u>Kanishka Singh</u>
T04	<u>Khobaib Zaamout</u>

2D Lists

- Format:

`<list name> = [[<value 1>, <value 2>, ... , <value n>],
 [<value 1>, <value 2>, ... , <value n>],
 ...
 [<value 1>, <value 2>, ... , <value n>]]`

rows

columns

Accessing 2D Lists

```
matrix1 = [[1, 2, 3], [4, 5, 6], [7, 8, 9]]
```

```
print(matrix1) → [[1, 2, 3], [4, 5, 6], [7, 8, 9]]
```

```
print(matrix1[0]) → [1, 2, 3]
```

```
print(matrix1[1]) → [4, 5, 6]
```

```
print(matrix1[2]) → [7, 8, 9]
```

```
row = matrix1[0]
```

```
print(row[0]) → 1
```

```
print(row[1]) → 2
```

```
print(row[2]) → 3
```

Accessing 2D Lists

```
matrix1 = [[1, 2, 3], [4, 5, 6], [7, 8, 9]]
```

```
print(matrix1[0][0])
```



1

```
print(matrix1[0][1])
```



2

```
print(matrix1[0][2])
```



3

2D List: Example

Example: Boggle

- Generate a random board for Boggle
 - 4x4 board
 - Store the board in a 2D list
 - Each space on the board contains one randomly selected letter
 - Display the board
 - Sample Board:

S	N	K	O
V	R	E	R
I	D	I	N
N	E	G	U

Example: Boggle

```
from pprint import pprint
from random import choice
```

```
NUM_ROWS = 4
```

```
NUM_COLS = 4
```

```
board = [] # Create a new, empty board
```

```
for row in range(NUM_ROWS): # Add the correct number of rows to the board
    board.append([""] * NUM_COLS) # Append a row of size NUM_COLS
```

```
pprint(board) #pretty print the board
```

```
# Set each element in the board to a random letter
```

```
for row in range(NUM_ROWS):
```

```
    for col in range(NUM_COLS):
```

```
        board[row][col] = choice("ABCDEFGHIJKLMNOPQRSTUVWXYZ")
```

```
pprint(board) # Pretty print the board
```

2D-List Creation

- Creating the following matrix programmatically:

```
matrix1 = [[1, 2, 3], [4, 5, 6], [7, 8, 9]]
```

2D-List Creation

- Creating the following matrix programmatically:

```
matrix1 = [[1, 2, 3], [4, 5, 6], [7, 8, 9]]
```


```
matrix1 = []  
for i in range (1, 10, 3):  
    row = [i , i + 1, i + 2]  
    matrix1.append(row)  
  
print(matrix1)
```

```
matrix2=[]  
  
ROWS=3  
COLS=3  
counter = 1  
  
for row in range(ROWS):  
    matrix2.append([])  
    for col in range(COLS):  
        matrix2[row].append(counter)  
        counter += 1  
  
print(matrix2)
```

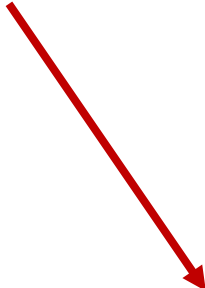
2D-List Printing

- Using *print (matrix)*
- Using loops:

```
for row in matrix:  
    print (row)
```



```
[1, 2, 3]  
[4, 5, 6]  
[7, 8, 9]
```



Print one row per iteration

```
for row in matrix:  
    output = ''  
    for num in row:  
        output += str(num) + ' '  
    print (output)
```



```
1 2 3  
4 5 6  
7 8 9
```

Print one row per iteration

Onward to ... more complicated lists.

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