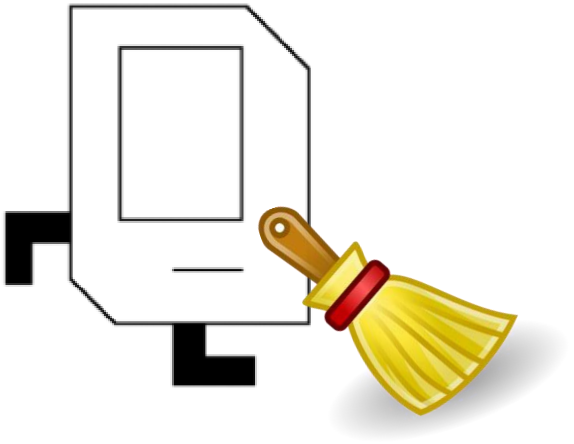
Housekeeping



- Assignment #2 due today
- Assignment #3 goes out today
  - Can do Part 1 after today's class
  - Can do Part 2 after next class

Reviewing Parameters and Good Programming Style

Global Variables: Bad Style

```
# Constant - visible to all functions
NUM_DAYS_IN_WEEK = 7

# Global variable - visible to all functions
balance = 0


def main():
    balance = int(input("Initial balance: "))
    while True:
        amount = int(input("Deposit (0 to quit): "))
        if amount == 0:
            break
        deposit(amount)


def deposit(amount):
    balance += amount
```

Different variables with the same name!
Super confusing!

- **Also, really BAD style**
  - So bad, that Python won't even let you do it unless you basically add a command that says "I want to have bad style"
  - I'm not going to show you that command in Python
    - But, if you know it already, DON'T use it!
    - We're in polite company

Using Parameters: Good Style

Don't want using your toaster
to impact your refrigerator!

```
def main():
    balance = int(input("Initial balance: "))
    while True:
        amount = int(input("Deposit (0 to quit): "))
        if amount == 0:
            break
        balance = deposit(balance, amount)


def deposit(balance, amount):
    balance += amount
    return balance
```

<u>Encapsulation Principle</u>:
Data used by a function
should be a parameter or
encapsulated in function

The Python Console

- Can run Python interactively using the "console"
  - In PyCharm click "Python Console" tab at bottom of window
  - In Terminal, run Python (e.g., typing "py" or "python3" or "python", depending on your platform) to get console
- Console has prompt: >>>
  - Can type and execute Python statements (and see results)
  - Example:

```
>>> x = 5
>>> x
5
```

  - Easy way to try things out to answer questions you may have
  - Console prompt looks like doctest indicator
  - Use `exit()` to leave console

Let’s Take the Console Out For a Spin…

And Then There Were None

- The term **`None`** is used in Python to describe "no value"
  - For example, it is the value you would get from a function that doesn't return anything
  - WHAT?!
  - Example:

```
>>> x = print("hi")
>>> print(x)
None
```

  - Comparing anything to **`None`** (except **`None`**) is False
- Why does **`None`** exist?
  - Denotes when the suitcase for a variable has "nothing" in it

Learning Goals

1. Learning about lists in Python
2. Writing code to use lists
3. Understand how lists work as parameters

Lists

What is a List?

- A **list** is way to keep track of an *ordered collection* of items
  - Items in the list are called "elements"
  - <u>Ordered</u>: can refer to elements by their position
  - <u>Collection</u>: list can contain multiple items
- The list dynamically adjusts its size as elements are added or removed
- Lists have a lot of built-in functionality to make using them more straightforward

Show Me the Lists!

- Creating lists
  - Lists start/end with brackets. Elements separated by commas.

```
my_list = [1, 2, 3]
reals = [4.7, -6.0, 0.22, 1.6]
strs = ['lots', 'of', 'strings', 'in', 'list']
mix = [4, 'hello', -3.2, True, 6]
empty_list = []
```

- List with one element is **not** the same as the element
  - Could try this out on the console:

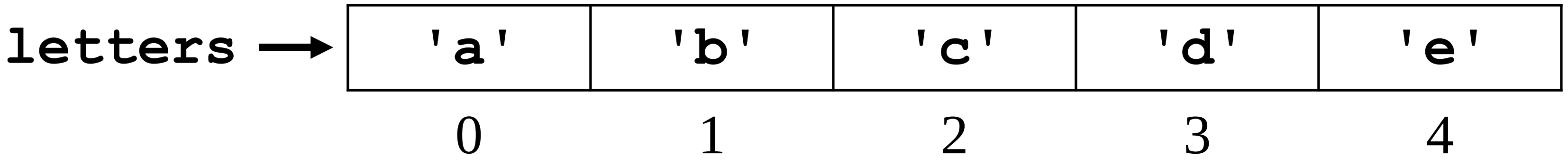
```
>>> list_one = [1]
>>> one = 1
>>> list_one == one
False
```

Accessing Elements of List

- Consider the following list:

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

- Can think of it like a series of variables that are indexed
  - Indexes start from 0



- Access individual elements:

`letters[0]` is `'a'`

`letters[4]` is `'e'`

Accessing Elements of List

- Consider the following list:

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

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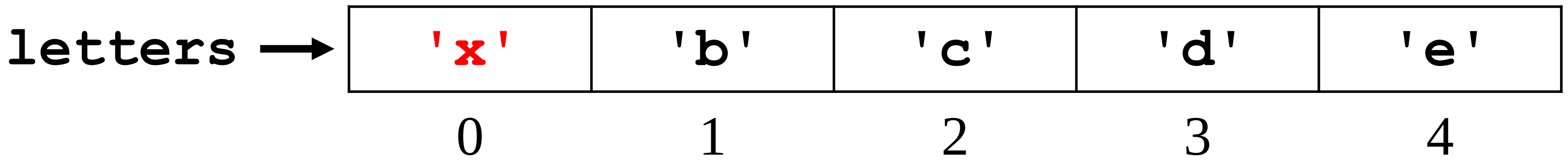


- Access individual elements:

  `letters[0]` is `'a'`

  `letters[4]` is `'e'`

- Can set individual elements like regular variable:

```
letters[0] = 'x'
```

Getting Length of a List

- Consider the following list:

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

- Can get length of list with **`len`** function:

  `len(letters)` is **5**

  – Elements of list are indexed from 0 to length – 1

- Example:

```
for i in range(len(letters)):
    print(i, "->", letters[i])
```

```
0 -> a
1 -> b
2 -> c
3 -> d
4 -> e
```

List Length: The Advanced Course

- Recall our old friends:

```
my_list = [1, 2, 3]
reals = [4.7, -6.0, 0.22, 1.6]
strs = ['lots', 'of', 'strings', 'in', 'list']
mix = [4, 'hello', -3.2, True, 6]
empty_list = []
```

- Pop quiz!

`len(my_list)`	= 3
`len(reals)`	= 4
`len(strs)`	= 5
`len(mix)`	= 5
`len(empty_list)`	= 0

The Strangeness of Indexing

- Can use negative index to work back from end of list
  - What?!

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

- Bring me the strangeness!

  `letters[-1]` is `'e'`

  `letters[-2]` is `'d'`

  `letters[-5]` is `'a'`

  - For indexes, think of `-x` as same as `len(list)-x`

  `letters[-1]` is same as `letters[len(letters)-1]`

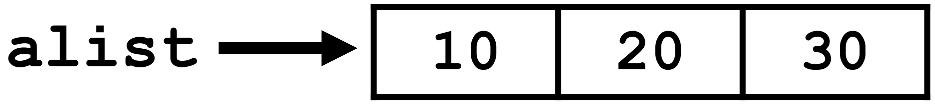
- How about this?

```
letters[6]
IndexError: list index out of range
```

Building Up Lists

- Can add elements to end of list with **`.append`**

```
alist = [10, 20, 30]
```

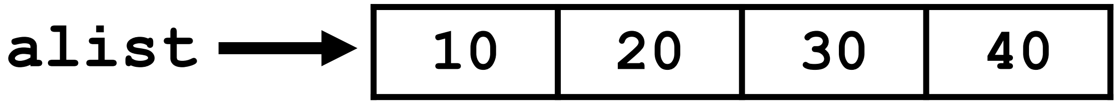


```
[10, 20, 30]
```

Building Up Lists

- Can add elements to end of list with `.append`

```
alist = [10, 20, 30]
alist.append(40)
```

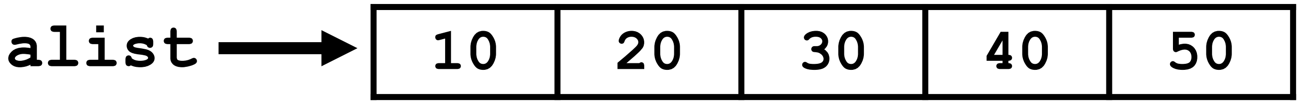


```
[10, 20, 30, 40]
```

Building Up Lists

- Can add elements to end of list with **`.append`**

```
alist = [10, 20, 30]
alist.append(40)
alist.append(50)
```

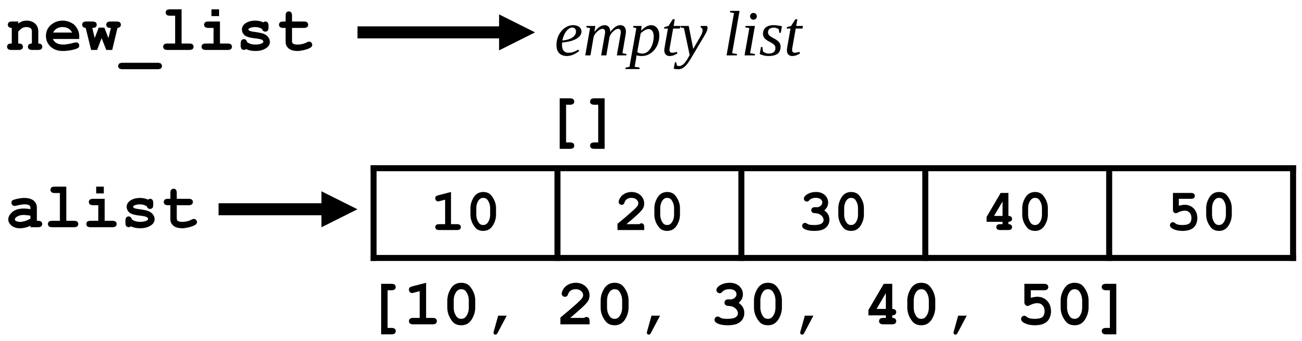


`[10, 20, 30, 40, 50]`

Building Up Lists

- Can add elements to end of list with **`.append`**

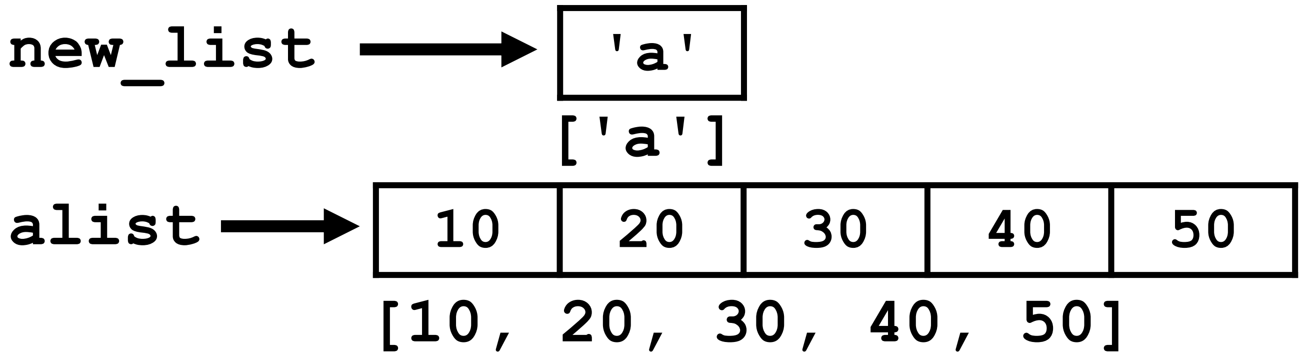
```
alist = [10, 20, 30]
alist.append(40)
alist.append(50)
new_list = []
```



Building Up Lists

- Can add elements to end of list with `.append`

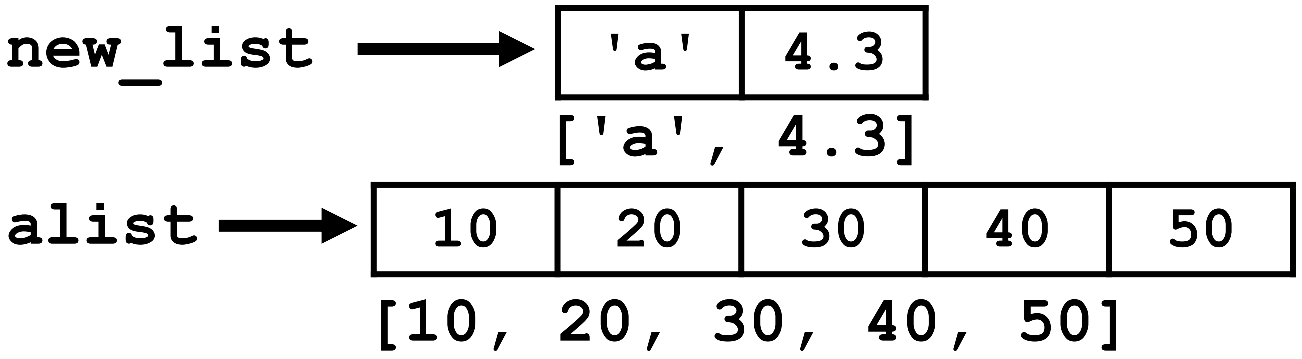
```
alist = [10, 20, 30]
alist.append(40)
alist.append(50)
new_list = []
new_list.append('a')
```



Building Up Lists

- Can add elements to end of list with `.append`

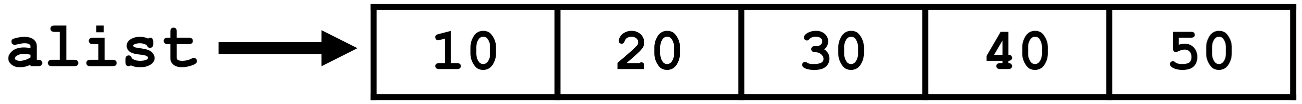
```
alist = [10, 20, 30]
alist.append(40)
alist.append(50)
new_list = []
new_list.append('a')
new_list.append(4.3)
```



Removing Elements from Lists

- Can remove elements from end of list with **`.pop`**
  - Removes the last element of the list and <u>returns it</u>

```
alist = [10, 20, 30, 40, 50]
```

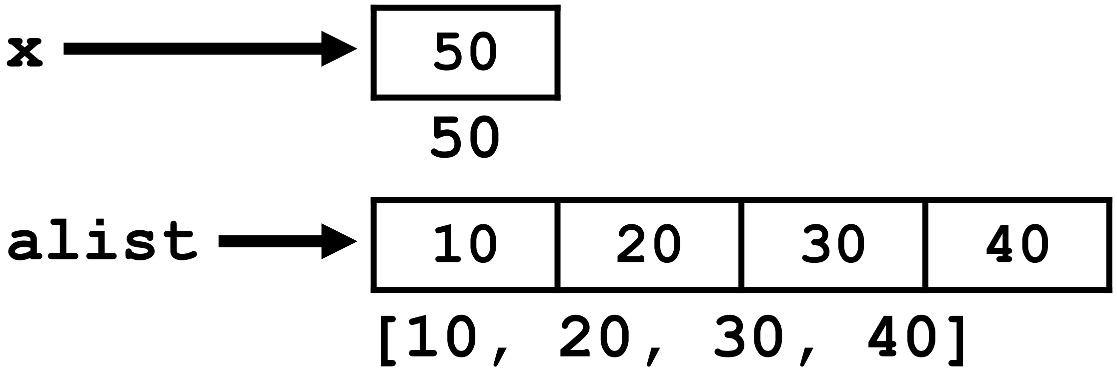


```
[10, 20, 30, 40, 50]
```

Removing Elements from Lists

- Can remove elements from end of list with **`.pop`**
  - Removes the last element of the list and returns it

```
alist = [10, 20, 30, 40, 50]
x = alist.pop()
```



Removing Elements from Lists

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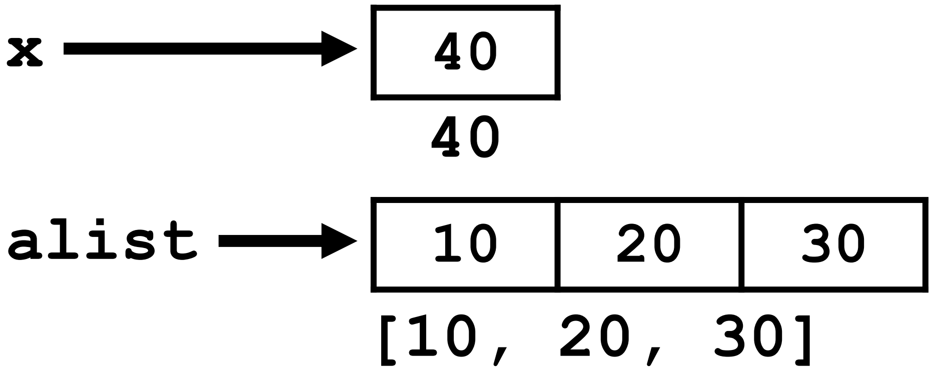
alist = [10, 20, 30, 40, 50]
x = alist.pop()
x = alist.pop()
```



Removing Elements from Lists

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alist = [10, 20, 30, 40, 50]
x = alist.pop()
x = alist.pop()
x = alist.pop()
```
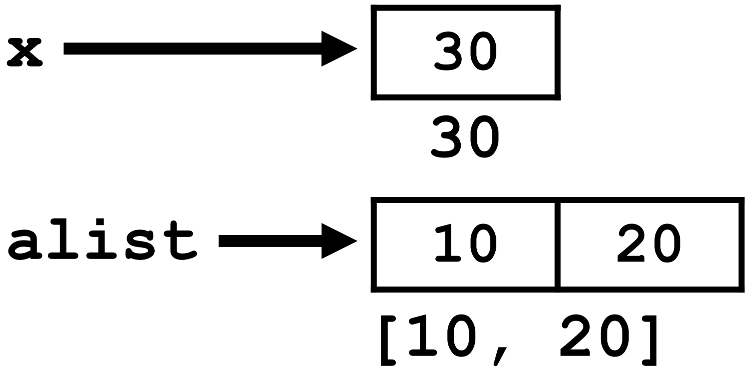
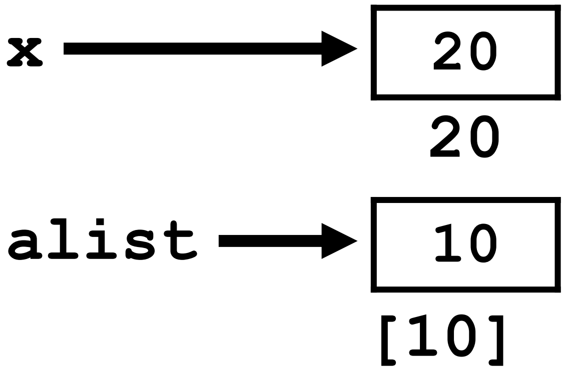



Removing Elements from Lists

- Can remove elements from end of list with **`.pop`**
  - Removes the last element of the list and returns it

```
alist = [10, 20, 30, 40, 50]
x = alist.pop()
x = alist.pop()
x = alist.pop()
x = alist.pop()
```



Removing Elements from Lists

- Can remove elements from end of list with **`.pop`**
  - Removes the last element of the list and <u>returns it</u>

```
alist = [10, 20, 30, 40, 50]
x = alist.pop()
x = alist.pop()
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x = alist.pop()
```
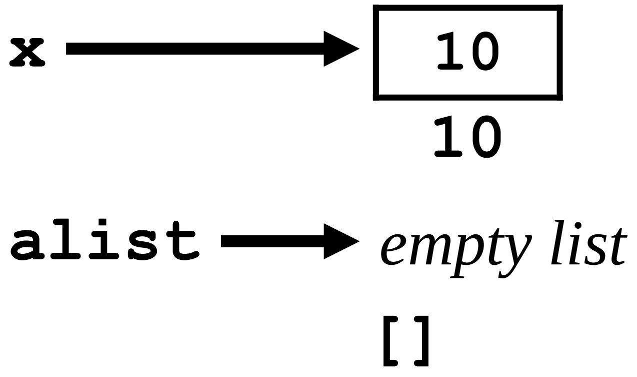



Removing Elements from Lists

- Can remove elements from end of list with `.pop`
  - Removes the last element of the list and returns it

```
alist = [10, 20, 30, 40, 50]
x = alist.pop()
x = alist.pop()
x = alist.pop()
x = alist.pop()
x = alist.pop()
```

$$\texttt{x} \longrightarrow \boxed{10}$$

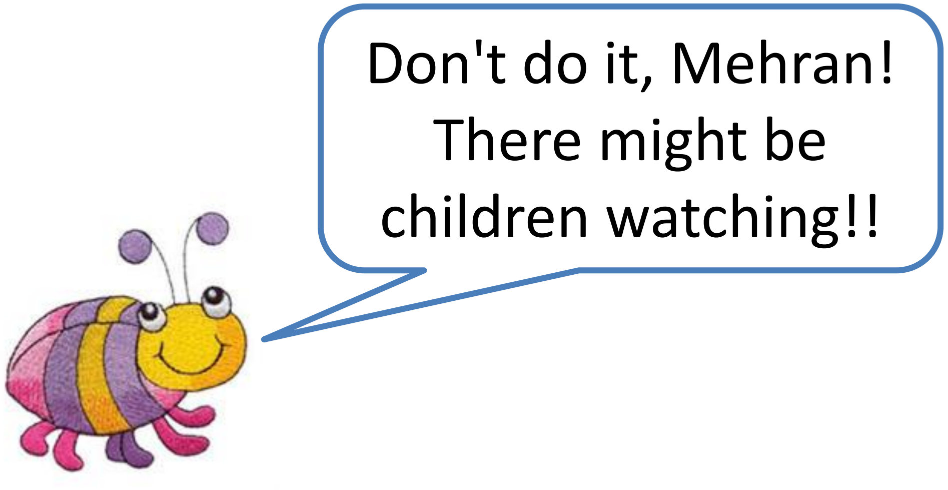
10

$$\texttt{alist} \longrightarrow \textit{empty list}$$

[]

What is we did one more?

```
x = alist.pop()
IndexError: pop from empty list
```



More Fun With Lists

- Can I get a couple new lists, please?

```
num_list = [1, 2, 3, 4]
str_list = ['Ruth', 'John', 'Sonia']
```

- Printing lists (here, we show using the console):

```
>>> print(num_list)
[1, 2, 3, 4]
>>> print(str_list)
['Ruth', 'John', 'Sonia']
```

- Check to see if list is empty (empty list is like "False")

```
if num_list:
    print('num_list is not empty')
else:
    print('num_list is empty')
```

Even More Fun With Lists

- Can I get a couple new lists, please?

```
num_list = [1, 2, 3, 4]
str_list = ['Ruth', 'John', 'Sonia']
```

- Check to see if a list contains an element:

```
x = 1
if x in num_list:
   # do something
```

- General form of test (evaluates to a Boolean):

  element **`in`** ***list***

  – Returns **`True`** if ***element*** is a value in ***list***, **`False`** otherwise

  – Could use as test in a **`while`** loop too

List Function Extravaganza (part 1)!

- Function: ***list***`.pop(index)  # pop can take parameter`
  - Removes (and returns) an element at specified index

```
>>> fun_list = ['a', 'b', 'c', 'd']
>>> fun_list.pop(2)
'c'
>>> fun_list
['a', 'b', 'd']
```

- Function: ***list***`.remove(elem)`
  - Removes (and returns) first occurrence of element in list

```
>>> another_list = ['a', 'b', 'b', 'c']
>>> another_list.remove('b')
>>> another_list
['a', 'b', 'c']
```

  - ValueError if you try to remove an element that isn't in list

List Function Extravaganza (part 2)!

- Function: ***list*****`.extend(other_list)`**
  - Adds all element from other list to list that function is called on

```
>>> list1 = [1, 2, 3]
>>> list2 = [4, 5]
>>> list1.extend(list2)
>>> list1
[1, 2, 3, 4, 5]
```

- **`append`** is not the same as **`extend`**
  - Append adds a single element, extends merges a list onto another

```
>>> list1 = [1, 2, 3]
>>> list2 = [4, 5]
>>> list1.append(list2)
>>> list1
[1, 2, 3, [4, 5]]
```

List Function Extravaganza (part 3)!

- Using **+** operator on lists works like **`extend`**, but creates a new list. Original lists are unchanged.

```
>>> list1 = [1, 2, 3]
>>> list2 = [4, 5]
>>> list3 = list1 + list2
>>> list3
[1, 2, 3, 4, 5]
```

- Can use **+=** operator just like **`extend`**

```
>>> list1 = [1, 2, 3]
>>> list2 = [4, 5]
>>> list1 += list2
>>> list1
[1, 2, 3, 4, 5]
```

List Function Extravaganza (part 4)!

- Function: ***list***`.index(elem)`
  - Returns index of first element in list that matches parameter elem

```
>>> alist = ['a', 'b', 'b', 'c']
>>> i = alist.index('b')
>>> i
1
```

  - ValueError if you ask for index of an element that isn't in list
- Function: ***list***`.insert(index, elem)`
  - Inserts elem at the given index. Shifts all other elements down.

```
>>> jedi = ['luke', 'rey', 'obiwan']
>>> jedi.insert(1, 'mehran')
>>> jedi
['luke', 'mehran', 'rey', 'obiwan']
```

  - Don't give up on your dreams…

List Function Extravaganza (part 5)!

- Function: ***list*.copy()**
  - Returns a copy of the list

```
>>> actual_jedi = ['luke', 'rey', 'obiwan']
>>> fantasy = actual_jedi.copy()
>>> fantasy
['luke', 'rey', 'obiwan']
>>> fantasy.insert(1, 'mehran')
>>> fantasy
['luke', 'mehran', 'rey', 'obiwan']
>>> actual_jedi
['luke', 'rey', 'obiwan']
```

List Function Extravaganza (part 6)!

```
reals = [3.6, 2.9, 8.0, -3.2, 0.5]
```

- Function: `max(list)`
  - Returns maximal value in the list

```
>>> max(reals)
8.0
```

- Function: `min(list)`
  - Returns minimal value in the list

```
>>> min(reals)
-3.2
```

- Function: `sum(list)`
  - Returns sum of the values in the list

```
>>> sum(reals)
11.8
```

Looping Through List Elements

```
str_list = ['Ruth', 'John', 'Sonia']
```

- For loop using **`range`**:

```
for i in range(len(str_list)):
    elem = str_list[i]
    print(elem)
```

Output:

```
Ruth
John
Sonia
```

- We can use a new kind of loop called a "for-each" loop

```
for elem in str_list:
    print(elem)
```

- These loops both iterate over all elements of the list
  - Variable **`elem`** is set to each value in list (in order)

For-Each Loop Over Lists

```
str_list = ['Ruth', 'John', 'Sonia']

for elem in str_list:
    # Body of loop
    # Do something with elem
```

This code gets repeated once for <u>each</u> element in list

- Like variable **`i`** in **`for`** loop using **`range()`**, **`elem`** is a variable that gets updated with each loop iteration.
- **`elem`** gets assigned to each element in the list in turn.

Looping Through List Elements

- General form of for-each loop:

  for ***element*** **in** ***collection*****:**

  # do something with ***element***

- ***element*** can be any variable you want to use to refer to items in the ***collection***
  - On each iteration through the loop, ***element*** will be set to be the next item (in order) in the ***collection***
  - Recall, example:

    ```
    for elem in str_list:
        print(elem)
    ```
  - Lists are collections
  - We'll see other kinds of collections later in course

We'll continue with lists next class!