CS 134: Aliasing and While Loops
Announcements & Logistics

- **HW 5** due Mon at 11 pm
- **Lab 4 Part 2** due next Wed/Thur at 11 pm
  - We’ll send automated feedback about Part 1 later today
- **Midterm reminder**: Thur Mar 17: 6 - 7:30 pm or 8 - 9:30 pm
- **Midterm review**: Tue, Mar 15: 7 - 8:30 pm

Do You Have Any Questions?
Last Time

• Learned about writing and appending to files (and `.format()`)

• Reviewed useful list methods:
  • All of these methods modify/mutate the list:
    • `.append()`, `.extend()`, `.insert()`, `.remove()`, `.pop()`, `.sort()`

• Started discussion on **mutability** and **aliasing** in Python
Today’s Plan

• Continue discussing **aliasing** and **mutability** in Python
• Discuss while loops
  • Needed for ranked-choice voting on Lab 4 Part 2
Mutability and Aliasing
Recap: Value vs Identity

- An **object’s identity** never changes in Python once it has been created; think of it as the object’s **address** in memory
  - The `id()` function returns an integer representing an object's identity (or address)
- An **object’s value** is the value assigned to the object when it is created
  - Objects whose values can change are called **mutable**; objects whose values cannot change are called **immutable**

In [1]: `num = 5`

In [2]: `id(num)`

Out[2]: `4486937008`

**identity**: mem address where 5 is stored

**value**: 5
Comparing Value vs Identity

- The `==` operator compares the value of an object (i.e., are the contents of the objects the same?)

- The `is` operator compares the identity of two objects (i.e., do they have the same memory address?)

  - `var1 is var2` is equivalent to `id(var1) == id(var2)`

```python
In [1]: num = 5
In [2]: id(num)
Out[2]: 4486937008
```

Variable names like `num` point to memory addresses of stored value.
Strings are Immutable

Attempts to change an immutable object creates a new object
Strings are Immutable

In [1]: word = "Williams"

In [2]: college = word

In [3]: word == college
Out[3]: True

In [4]: print(id(word), id(college))
4518582576 4518582576

In [5]: word is college
Out[5]: True

In [6]: word = "Wellesley"

In [7]: print(id(word), id(college))
4518871920 4518582576

In [8]: word is college
Out[8]: False

Attempts to change an immutable object creates a new object
Mutability in Python

Strings, Ints, Floats are Immutable

- Once you create them, their value **cannot** be changed!
- All functions and methods that manipulate these objects return a **new object** and **do not modify** the original object

Lists are Mutable

- List values **can** be changed
- We reviewed how we can mutate/change what’s in a list using methods
- **Aliasing** happens when the value of one variable is assigned to another variable
  - Can have multiple names for the same object
- The mutability of lists has many implications with respect to **aliasing**
Lists are Mutable

Value of list objects can change, keeping identity the same

In [1]: myList = [1, 2, 3]

In [2]: id(myList)
Out[2]: 4418551104

In [3]: myList.append(4)

In [4]: id(myList)
Out[4]: 4418551104

Note: Value changes, identity stays the same
List Aliasing

• Any assignment or operation that creates a new name for an existing object implicitly creates an alias (a new name)

• Because list objects can change, this leads to some unusual aliasing side effects

In [1]:
list1 = [1, 2, 3]
list2 = list1

In [2]:
list1 is list2

Out[2]: True

We are not creating a separate copy, but rather creating a second name for the original list; list2 is an alias of list1
List Aliasing

- Unlike immutable objects (recall our string example with `word` and `college`), changing the value of `list1` will also change the value of `list2`:
- They are two names for the same list!

```
In [1]: list1 = [1, 2, 3]
    list2 = list1

In [2]: list1 is list2
Out[2]: True

In [3]: list1.append(4)

In [4]: list2
Out[4]: [1, 2, 3, 4]
```
List Aliasing

- An assignment to a new variable creates a new list

```python
In [1]: list1 = [1, 2, 3]
    list2 = list1
    myList = [1, 2, 3]

In [2]: # same values?
    myList == list1 == list2

Out[2]: True

In [3]: # same identities?
    myList is list1

Out[3]: False
```
(Crazy) Aliasing Examples

```python
In [1]:
    nums = [23, 19]
    words = ['hello', 'world']
    mixed = [12, nums, 'nice', words]

In [2]:
    words.append('sky')

In [3]:
mixed

Out[3]: [12, [23, 19], 'nice', ['hello', 'world', 'sky']]
```
(Crazy) Aliasing Examples

In [1]:
nums = [23, 19]
words = ['hello', 'world']
mixed = [12, nums, 'nice', words]
(Crazy) Aliasing Examples

In [2]: words.append('sky')
(Crazy) Aliasing Examples

```python
In [1]:
nums = [23, 19]
words = ['hello', 'world']
mixed = [12, nums, 'nice', words]

In [2]:
words.append('sky')

In [3]:
mixed

Out[3]:
[12, [23, 19], 'nice', ['hello', 'world', 'sky']]

In [4]:
mixed[1].append(27)
```
(Crazy) Aliasing Examples

In [4]: mixed[1].append(27)
(Crazy) Aliasing Examples

In [1]:
   nums = [23, 19]
   words = ['hello', 'world']
   mixed = [12, nums, 'nice', words]

In [2]:
   words.append('sky')

In [3]:
mixed

Out[3]:
[12, [23, 19], 'nice', ['hello', 'world', 'sky']]

In [4]:
mixed[1].append(27)

In [5]:
nums

Out[5]:
[23, 19, 27]

In [6]:
mixed

Out[6]:
[12, [23, 19, 27], 'nice', ['hello', 'world', 'sky']]
Conclusion

• We **cannot change** the value of **immutable** objects such as strings
  • Attempts to modify the object creates a new object
• We **can change** the value of **mutable** objects such as lists
  • Need to be mindful of aliasing; be careful to avoid unintended aliases
  • You can create a “true” copy of a list using slicing or a list comprehension
    ```python
    newList = myList[:]
    newList = [ele for ele in myList]
    ```
  • A (confusing) aside: When using the `+=` operator with lists, it actually calls `append()`! (Always use `myList = myList + [element]` if you want to avoid mutation.)
Moving on…
While Loops
For loops in Python

• **For loops** in Python are meant to iterate directly over a **fixed sequence** of items
  
  • No need to know the sequence's length ahead of time

• Interpretation of for loops in Python:
  
  ```python
  for each item in given sequence:
  (do something with item)
  ```

• Other programming languages (like Java) have for loops that require you to explicitly specify the length of the sequence or a stopping condition

• Thus Python for loops are sometimes called “for each” loops

• **Takeaway:** For loops in Python are meant to iterate directly over each item of a given **iterable** object (such as a sequence)
What If We Don’t Know When to Stop?

• Stopping condition of for loop: **no more elements in sequence**

  ["A", "cold", "winter", "day"]

• What if we don’t know when to stop?
  • Suppose you had to write a program to ask a user to enter a name, repeatedly, until the user enters “quit”, in which case you stop asking for input and print “Goodbye"
While Loops

• For loops iterate over a pre-determined sequence and stop at the end of the sequence

• On the other hand, while loops are useful when we don't know in advance when to stop

• while loop syntax:
  while (boolean expression evaluates to true):
    # keep repeating the following statements in loop body
    # as long as the loop condition is true

• A while loop will keep iterating as long as the condition in the parentheses is satisfied (is true) and will halt when the condition fails to hold (becomes false)
While Loop Example

- Example of a while loop that depends on user input

```python
prompt = 'Please enter a name (type quit to exit): '
name = input(prompt)

while (name.lower() != 'quit'):
    print('Hi,', name)
    name = input(prompt)
print('Goodbye')
```

- See notebook for example tests of this piece of code
While Loop to Print Halves

- Given a number, keep dividing it until it becomes smaller than 0 and print all the “halves”

```python
def printHalves(n):
    while n > 0:
        print(n)
        n = n // 2

printHalves(100)
```

Infinite loop! Indentation matters!
Infinite Loops

- Most of the time, you want to avoid an unintentional infinite loop
- Infinite loops occur when the loop condition never turns false
- Occasionally, as in Lab 4, you create an intentional infinite loop
  - This is ok (and sometimes desirable!) as long as there is a way to exit the loop
- A return statement will force the loop to exit

```python
def computeSum():
    sum = 0
    while True:
        prompt = 'Please enter a positive number: '
        num = int(input(prompt))
        if num < 0:
            return sum
        sum += num

if __name__ == "__main__":
    print("The sum is", computeSum())
```

Be careful with infinite loops!

Return if a negative value is provided