CSC 108H: Introduction to Computer Programming

Summer 2012

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Administration

- Exercise 2 is posted.
  - Due one week from today.
- The first assignment will be posted by Monday.
  - Will be due Tuesday after the midterm.
  - Should be started before the midterm.
- Help Centre is still open.
  - BA 2270.

String Review

- Strings are a new type we use to represent text.
  - Denoted by `'` or “ or `'''`.
  - Can use escape characters to put in special characters into strings.
  - Other types can be inserted into a string using string formatting.
  - len, ord and char are useful functions.
  - `.strip, .replace, .lower, .upper, .count` are useful methods.

String Review Questions

- Write expression to:
- Determine if 'x' is in string s.

- Remove all instances of 'b' from a string.

  Remove leading and trailing instances of 'b' from a string.

- Write a function that takes a lower case letter, and returns the corresponding number assuming a=1, b=2,...

String Review Questions

- Write expression to:
- Determine if 'x' is in string s.

```
'x' in s
```

- Remove all instances of 'b' from a string.

```
s.replace('x','')
```

Remove leading and trailing instances of 'b' from a string.

```
s.strip('b')
```

- Write a function that takes a lower case letter, and returns the corresponding number assuming a=1, b=2,...

```
def foo(x):
    y = ord(x)
    y -= ord(a)
    y += 1
    return y
```

Modules Review

- A module is a single file that contains python code.
  - This code can be used in a program that's in the same directory by using `import` or `from module_name import *`
  - All of the code in a module is executed the first time it is imported.
  - To access imported functions one used `module_name.function_name()`
- Each module has a `__name__`.
  - This is either the filename if the module has been imported or `'__main__'` if the file is being run.

Module Review

- Assume we have a module named foo, that contains a function f, and a variable x.
- How can we get a block to execute only if foo is imported.

- If we import foo without using from, how can we call f or get the value of x?

Module Review

- Assume we have a module named foo, that contains a function f, and a variable x.
- How can we get a block to execute only if foo is imported.

```
if __name__ == 'foo':
    block
```

- If we import foo without using from, how can we call f or get the value of x?

```
foo.f, foo.x
```

Lists

- So far, every name we've seen has referred to a single object.
  - Variables names refer to a single int/bool/str/etc.
  - Function names refer to a single function.
- This is not always convenient.
  - Think of keep records for a club.
  - It might be useful to have one way to easily store the names of all the members.
- Can use a `list`.

Lists

- Lists are assigned with:

```
list_name = [list_elt0,
list_elt1, ..., list_eltn]
```

- To retrieve a list element indexed by i one does :

```
list_name[i]
```

- So the following are equivalent:

```
eg_list = [15]          foo(15)
foo(eg_list[0])
```

Lists

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```
list_name = [list_elt0,
list_elt1, ..., list_eltn]
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- To retrieve a list element indexed by i one does :

```
list_name[i]
```

- So the following are equivalent:

```
eg_list = [15]          foo(15)
foo(eg_list[0])
```

Lists

- Empty lists are allowed: `[]`.
- `list_name[-i]` returns the ith element from the back.
  - Note the difference between `l[0]` and `l[-1]`.
- Lists are heterogeneous:
  - That is, the elements in a list need not be the same type, can have ints and strings.
  - Can even have lists themselves.

Lists

- To get to the i-th element of a list we use:

  `list_name[i-1]`
- We use i-1 because lists are indexed from 0.
- This means to refer to the elements of a 4 element list named list_name we use `list_name[0], list_name[1], list_name[2], list_name[3]`

List Question.

- What is printed?

```
eg_list = [0, 'sgeg', True, 12,
'gg']
print eg_list[0]
print eg_list[-0]
print eg_list[-2] + eg_list[-5]
print eg_list[1] + eg_list[-1]
print eg_list[2]
```

List Question.

- What is printed?

```
eg_list = [0, 'sgeg', True, 12,
'gg']
print eg_list[0] 0
print eg_list[-0] 0
print eg_list[-2] + eg_list[-5]
12
print eg_list[1] + eg_list[-1]
sgeggg
print eg_list[2] True
```

Lists and the memory model.

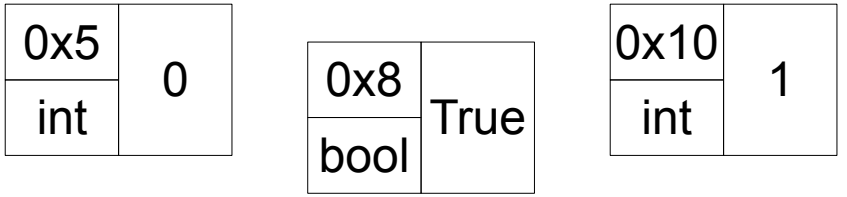
```
eg_list = [0,1,True]
```

Global
eg_list: 0x1

?

Lists and the memory model.

```
eg_list = [0,1,True]
```

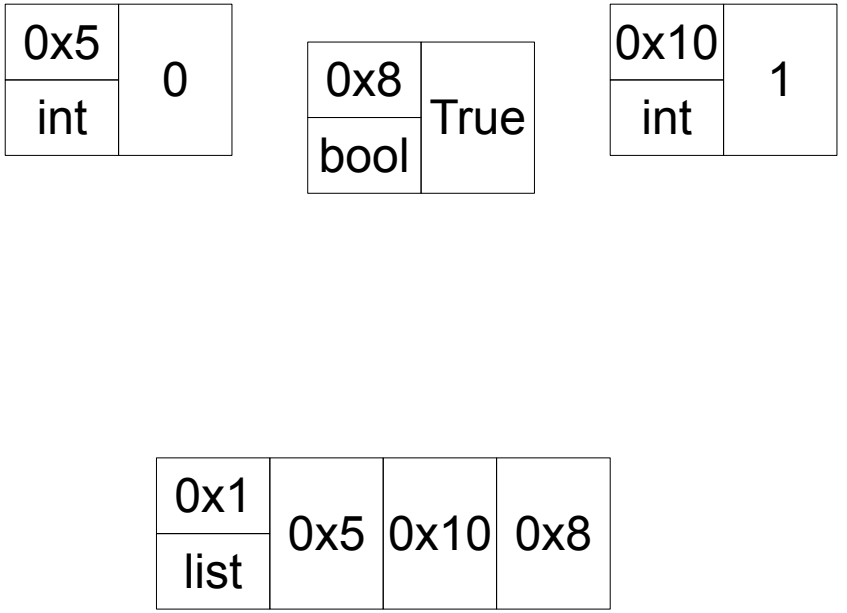


Global
eg_list: 0x1

?

Lists and the memory model.

```
eg_list = [0,1,True]
```



Changing a List

- A list is like a whole bunch of variables.
  - We've seen we can change the value of variables with assignment statements.
  - We can change the value of list elements with assignment statements as well.
- We just put the element on the left and the expression on the right:

```
list_name[i] = expression
```

- This assigned the value of the expression to `list_name[i]`.

Immutable objects

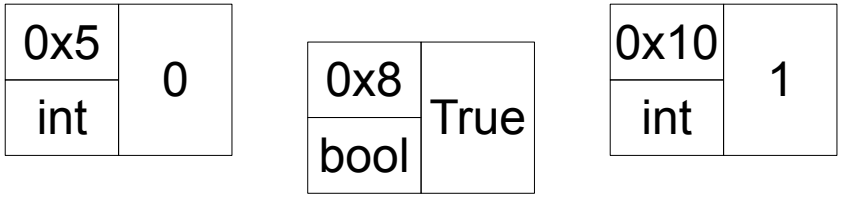
- Ints, floats, strings and booleans don't change.
- If we need to change the value of a variable that refers to one of these types, we need to create a new instance of the type in memory.
- That is, instead of making an old int into a new one, we make a new int, and throw the old one away.

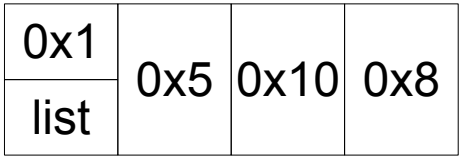
Mutability

- If we only want to change one element of a list, then it seems a waste to have to create all of the types that it points to again, even though only one of them has changed.
- So this isn't done. Instead we can change the individual elements of a list.
- Note that since we view these as memory locations, this means that we change the location in memory that the list points to.

Lists and the memory model.

```
eg_list = [0,1,True]
eg_list[0] = 10
```





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```
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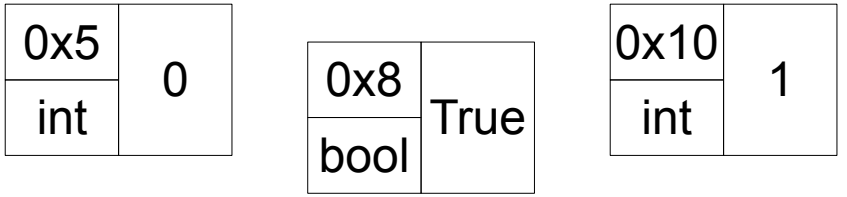
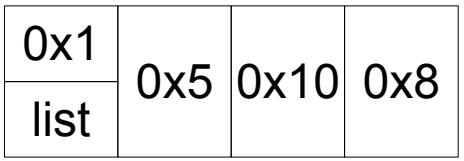
```





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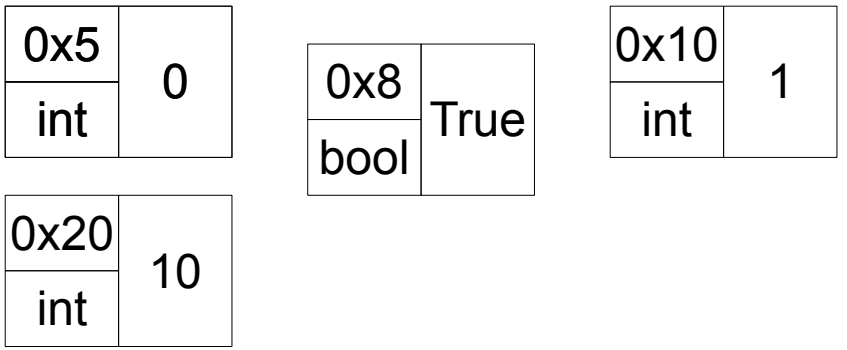

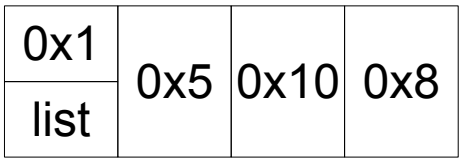

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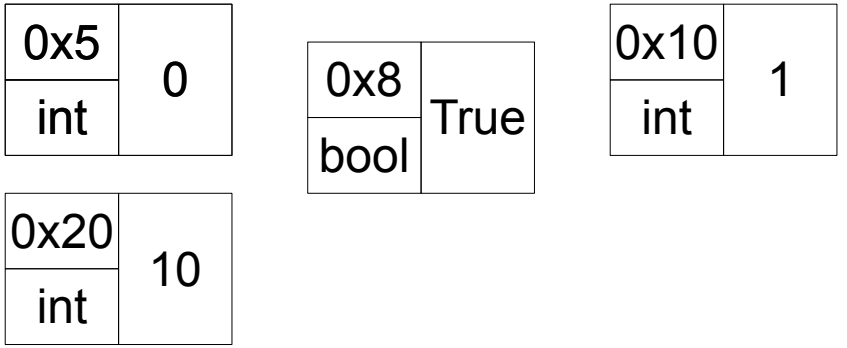

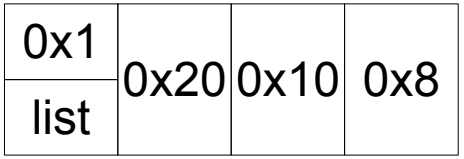

Lists and the memory model.

```
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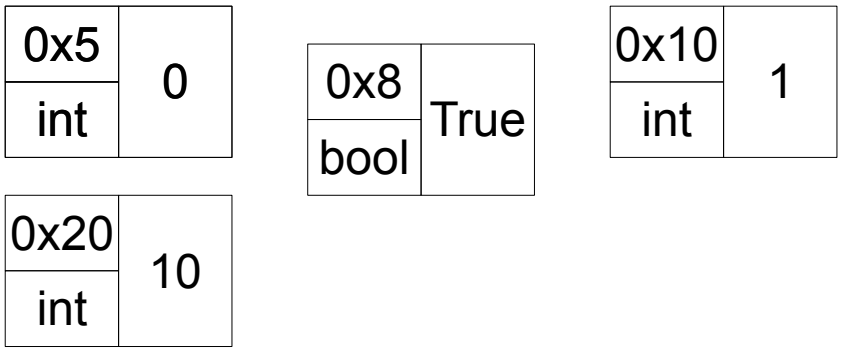
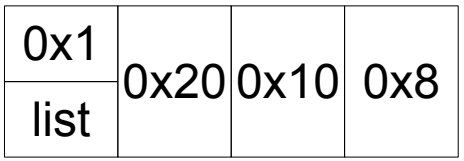
eg_list[0] = 10
```





Aliasing

- Consider:

```
x=10
y=x
x=5
print x, y
```

- We know this will print `5 10` to the screen, because ints are immutable.

Aliasing

- Let `eg_list` be an already initialised list and consider:

```
x = eg_list
y = x
x[0] = 15
print y[0]
```

- Lists are mutable, so this will print 15.

What gets printed?

```
l = [0,1,2]
print l
l[0] = 10
print l[0]
print l
```

```
l = [0,1,2]
print l
l = 10
print l
print l[0]
```

```
l = [0,1,2]
print l
l = 10
print l[0]
print l
```

What gets printed?

```
l = [0,1,2]
print l
l[0] = 10
print l[0]
print l
```

```
[0,1, 2]
10
[10, 1, 2]
```

```
l = [0,1,2]
print l
l = 10
print l
print l[0]
```

```
[0,1, 2]
10
Crash
```

```
l = [0,1,2]
print l
l = 10
print l[0]
print l
```

```
[0,1, 2]
Crash
```

Aliasing and functions.

- When one calls a function, one is effectively beginning with a bunch of assignment statements.
  - That is, the parameters are assigned to the local variables.
- But with mutable objects, these assignment statements mean that the local variable refers to a mutable object that it can change.
- This is why functions can change mutable objects, but not immutable ones.

Break, the first.

What gets printed?

```
def foo(l):
    l[0]=10
x = [15]
print x
foo(x)
print x
```

```
def foo(l):
    l[0]=10
    l = []
x = [15]
print x
foo(x)
print x
```

What gets printed?

```
def foo(l):
    l[0]=10
x = [15]
print x
foo(x)
print x
```

```
[15]
[10]
```

```
def foo(l):
    l[0]=10
    l = []
x = [15]
print x
foo(x)
print x
```

```
[15]
[10]
```

Why was x not empty?

```
def foo(l):
    l[0]=10
    l = []
x = [15]
print x
foo(x)
print x
```


Global
x: 0x1

0x5	15
int	

0x1	0x5
list	

Why was x not empty?

```
def foo(l):
    l[0]=10
    l = []
x = [15]
print x
foo(x)
print x
```

foo
l: 0x1
Global
x: 0x1

0x5	15
int	

0x1	0x5
list	

Why was x not empty?

```
def foo(l):
    l[0]=10
    l = []
x = [15]
print x
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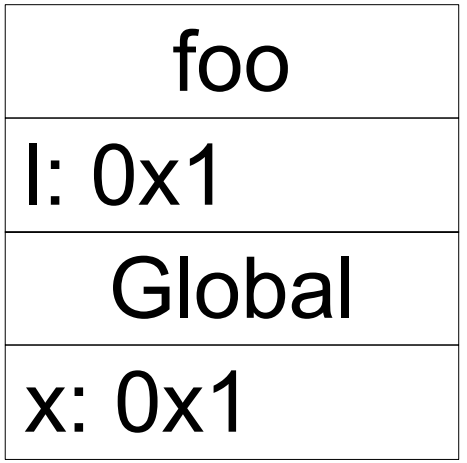
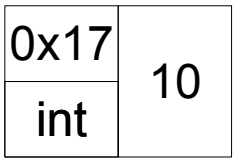
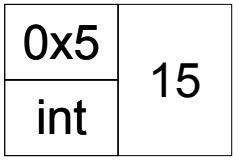
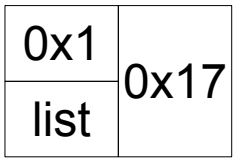
print x
```



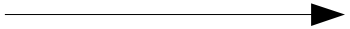


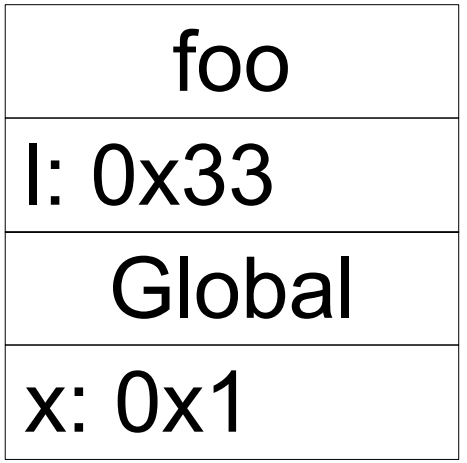


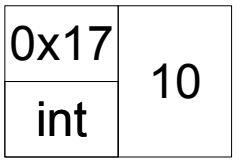


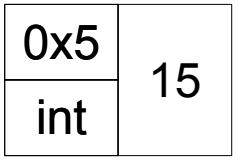
Why was x not empty?

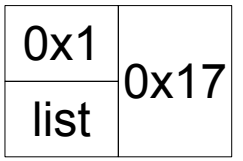
```
def foo(l):
    l[0]=10
    l = []
x = [15]
print x
foo(x)
print x
```











Repetition

- Often times in programs we want to do the same thing over and over again.
- For example, we may want to add every element of a list to some string.
- Or we may want to execute a block of code until some condition is true.
- Or we may want to change every element of a list.

Loops

- Python has two types of loops.
- The `for` loop.
  - This is a bit simpler.
  - This requires an object to loop over.
  - Some code is executed once for every element in the object.
- The `while` loop.
  - Some code is executed so long as a certain condition is true.

For Loops with Lists

- syntax:

```
for item in eg_list:
    block
```

- This is equivalent to:

```
item = eg_list[0]
block
item = eg_list[1]
block
...
```

For Loops with Strings

- `eg_str[i]` evaulates to the i-1st character of `eg_str`.
- syntax:

```
for item in eg_str:
    block
```

- This is equivalent to:

```
item = eg_str[0]
block
item = eg_str[1]
block
...
```

A useful Loop Template

- Often times we get something from every element of a list and use this to create a single value.
- Like the number of times some condition is true.
- Or the average of the elements of the list.

A useful Loop Template

- In this case we often use an accumulator_variable that accrues information each time the loop happens.
- This often looks like

```
accum_var = 0 #maybe [] or ''.
for elt in list_name:
    block #This will modify accum_var
#accum_var should hold the right #value here.
```

A useful Loop Template

- The average of the number of elements in the list. (`len(list_name)` is length of a list)

```
accum_var = 0 #maybe [] or ''.
for elt in list_name:
    block #This will modify accum_var
#accum_var should hold the right #value here.
```

A useful Loop Template

- The average of the number of elements in the list.(`len(list_name)` is length of a list)

```
accum_var = 0
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#accum_var should hold the right #value here.
```

A useful Loop Template

- The average of the number of elements in the list.(`len(list_name)` is length of a list)

```
accum_var = 0
for elt in list_name:
    accum_var += elt
#accum_var should hold the right
#value here.
```

A useful Loop Template

- The average of the number of elements in the list.(`len(list_name)` is length of a list)

```
accum_var = 0
for elt in list_name:
    accum_var += elt
accum_var = accum_var/len(list_name)
```

Write loops to

- Return the sum of the squares of all the list elements
- Return the number of elements divisible by 7.

Write loops to

- Return the sum of the squares of all the list elements

```
x = 0
for i in l:
    x += i * i
```

- Return the number of elements divisible by 7.

```
x = 0
for i in l:
    if i % 7 == 0:
        x+=1
```

For Loops with Lists

```
item = eg_list[0]
block
item = eg_list[1]
block
...
```

- Note that even if the block changes the value of item the value of `eg_list[i]` may not change.
  - Depends on whether `eg_list[i]` is mutable.

For Loops with Lists

- To guarantee our ability to change eg_list[i] we need the block to have eg_list[item] instead of item, and item to contain the indices.

```
item = 0
block
item = 1
block
...
```

Looping over Lists

- To do that, we use the range() function.
  - `range(i)` returns an ordered list of ints ranging from 0 to i-1.
  - `range(i,j)` returns an ordered list of ints ranging from i to j-1 inclusive.
  - `range(i,j,k)` returns a list of ints ranging from i to j-1 with a step of at least k between ints.
- So `range(i,k)==range(i,k,1)`
- To modify a list element by element we use:

```
for i in range(len(eg_list)):
    block
```

Break, the second.

Unravel the Loops

```
x = [0, 0, 0]
for i in x:
    i+=1
```

```
x = [0, 0, 0]
for i in range(len(x)):
    x[i]+=1
```

Unravel the Loops

```
x = [0, 0, 0]
for i in x:
    i+=1
```

```
x = [0, 0, 0]
for i in range(len(x)):
    x[i]+=1
```

```
i = x[0]
i+= 1
i = x[1]
i+= 1
i = x[2]
i+= 1
```

```
i = range(len(x))[0]
x[i]+= 1
i = range(len(x))[1]
x[i]+= 1
i = range(len(x))[2]
x[i]+= 1
```

Lists: Functions

- Lists come with lots of useful functions and methods.
- `len(list_name)`, as with strings, returns the length of the list.
- `min(list_name)` and `max(list_name)` return the min and max so long as this is well defined.
- `sum(list_name)` returns the sum of elements so long as they're numbered.
  - *Not* defined for lists of strings.

Lists: Methods

- `sort()` - sorts the list in-place so long as this is well defined. (need consistent notions of > and ==)
- `insert(index, value)` – inserts the element value at the index specified.
- `remove(value)` – removes the first instance of value.
- `count(value)` – counts the number of instances of value in the list.

List Methods

- `append(value)` – adds the value to the end of the list.
- `extend(eg_list)` - glues `eg_list` onto the end of the list.
- `pop()` - returns the last value of the list and removes it from the list.
- `pop(i)` - returns the value of the list in position i and removes it from the list.

Pitfalls

- Note that insert, remove, append, extend, and pop all change the length of a list.
- These methods can be called in the body of a for loop over the list that is being looped over.
- This can lead to all sorts of problems.
  - Infinite loops.
  - Skipped elements.

Pitfalls

- Note that append, extend, and pop all change the length of a list.
- These methods can be called in the body of a for loop over the list that is being looped over.
- This can lead to all sorts of problems.
  - Infinite loops.
  - Skipped elements.
- Don't Do This.

How Long are these lists at the end?

```
x = []
y = [0,1]
for i in y:
    x.append(i)
```

```
x = []
y = [0,1]
for i in y:
    x.extend(y)
```

```
x = []
y = [0,1]
for i in range(2):
    x.extend(y)
    y.pop()
```

How Long are these lists at the end?

```
x = []
y = [0,1]
for i in y:
    x.append(i)
```

```
len(x) == 2
len(y) == 2
```

```
x = []
y = [0,1]
for i in y:
    x.extend(y)
```

```
len(x) == 4
len(y) == 2
```

```
x = []
y = [0,1]
for i in range(2):
    x.extend(y)
    y.pop()
```

```
len(x) == 3
len(y) == 0
```

Copying a List

- We saw that as lists are mutable, we can't copy them by assigning another variable to them.
- Lists are copied in python by using `[:]`
- so the following will cause `x` to refer to a copy of `eg_list`

```
x = eg_list[:]
```

- Now we can modify `x` without modifying eg_list.

Copying List Question

- x and y are both lists.
- Write code so that one adds the values of y to the end of x, and the values of x to the end of y.

Copying List Question

- x and y are both lists.
- Write code so that one adds the values of y to the end of x, and the values of x to the end of y.

```
tmp_x = x[:]
x.extend(y)
y.extend(tmp_x)
```

List slicing.

- Sometimes we want to perform operations on a sublist.
- To refer to a sublist we use list slicing.
- `y=x[i:j]` gives us a list y with the elements from i to j-1 inclusive.
  - `x[:]` makes a list that contains all the elements of the original.
  - `x[i:]` makes a list that contains the elements from i to the end.
  - `x[:j]` makes a list that contains the elements from the beginning to j-1.
- y is a new list, so that it is not aliased with x.

Strings revisted.

- Strings can be considered tuples of individual characters. (since they are immutable).
- In particular, this means that we can use the list knowlege that we gained, an apply it to strings.
  - Can reference individual characters by string[+/-i].
  - Strings are not heterogenous, they can only contain characters.
  - min() and max() defined on strings, but sum() is not.
  - You can slice strings just as you can lists.

What is the result of the following slices?

```
s = “I am a string”
                        s[:10]
s[:]
                        s[-3:]
s[0:13]
                        s[:-3]
s[3:]
```

What is the result of the following slices?

```
s = “I am a string”

s[:]
“I am a string”
s[0:13]
“I am a string”
s[3:]
“m a string”

s[:10]
“I am a str”
s[-4:]
“ring”
s[:-4]
“I am a st”
```

String methods revisted.

- Now that we know that we can index into strings, we can look at some more string methods.
  - `find(substring)`: give the index of the first character in a matching the substring from the left or -1 if no such character exists.
  - `rfind(substring)`: same as above, but from the right.
  - `find(substring,i,j)`: same as find(), but looks only in `string[i:j]`.

Nested Lists

- Because lists are heterogeneous, we can have lists of lists.
- This is useful if we want matrices, or to represent a grid or higher dimenstional space.
- We then reference elements by list_name[i][j] if we want the jth element of the ith list.
- So then naturally, if we wish to loop over all the elements we need nested loops:

```
for item in list_name:
    for item2 in item:
        block
```

Lab Review

- Next weeks lab covers strings.
- You'll need to be comfortable with:
  - string methods.
  - writing for loops over strings.
  - string indexing.