

CS 1110

Prelim 2 Review
Fall 2024

Exam Info

- **Prelim 2:** Thursday, December 5th at 7:30 pm
 - Last name **A – C** in Ives 305
 - Last name **D – E** in Ives 105
 - Last name **F – Q** in Statler Aud.
 - Last name **R – Z** in Uris G01
 - SDS Students received an e-mail
- Exceptions **ONLY** if you filed a conflict
 - We expect you at time and room assigned

Studying for the Exam

- Read study guides, review slides online
 - Solution to review posted after review
- Review all labs and assignments
 - Solutions to Assignment 5 are in CMS
 - No solutions to code, but talk to TAs
- Look at exams from past years
 - Exams with solutions on course web page
 - Only look at fall exams; spring is **VERY** different

What is on the Exam?

- **Four or Five** questions on these topics :
 - Recursion (Labs 15 and 16; A4)
 - Iteration (Labs 13, 17, and 22; A4; A6)
 - Defining classes (Labs 18, 19, 20, & 21; A6)
 - Drawing folders (Lecture; A5)
 - Short Answer (Terminology, Potpourri)
- + 2 pts for writing your name and net-id
- Exact number depends on question length

What is on the Exam?

- **Four or Five** questions on these topics :
 - Recursion (Labs 15 and 16; A4)
 - Iteration (Labs 13, 17, and 22; A4; A6)
 - Defining classes (Labs 18, 19, 20, & 21; A6)
 - Drawing folders (Lecture; A5)
 - Short Answer (Te **Not Happening** i)
- + 2 pts for writing your name and net-id
- Exact number depends on question length

What is on the Exam?

- Recursion (Labs 15 and 16; A4)
 - Will be given a function specification
 - Implement it using recursion
 - May have an associated call stack question
- Iteration (Labs 13, 17, and 22; A4; A6)
- Defining classes (Labs 18, 19, 20, and 21; A6)
- Drawing folders (Lecture; A5)
- Short Answer (Terminology, Potpourri)

Recursive Function (Fall 2017)

```
def filter(nlist):
```

```
    """Return: a copy of nlist (in order) with negative numbers.
```

```
    The order of the original list is preserved
```

```
    Example: filter([1,-1,2,-3,-4,0]) returns [1,2,0]
```

```
    Precondition: nlist is a (possibly empty) list of numbers."""
```

Recursive Function (Fall 2017)

```
def filter(nlist):
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    """Return: a copy of nlist (in order) with negative numbers.
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```
    The order of the original list is preserved
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```
    Example: filter([1,-1,2,-3,-4,0]) returns [1,2,0]
```

```
    Precondition: nlist is a (possibly empty) list of numbers."""
```

Hint:

- Use divide-and-conquer to break up the list
- Filter each half and put back together

Recursive Function (Fall 2017)

```
def filter(nlist):
```

```
    """Return: a copy of nlist (in order) with negative numbers."""
```

```
    if len(nlist) == 0:
```

```
        return []
```

```
    elif len(nlist) == 1:
```

```
        return nlist[:] if nlist[0] >= 0 else [] # THIS does the work
```

```
    # Break it up into halves
```

```
    left = filter(nlist[:1])
```

```
    right = filter(nlist[1:])
```

```
    # Combine
```

```
    return left+right
```

Recursive Function (Fall 2017)

```
def filter(nlist):
```

```
    """Return: a copy of nlist (in order) with negative numbers."""
```

```
    if len(nlist) == 0:
```

```
        return []
```

```
    # Do the work by removing one element
```

```
    left = nlist[:1]
```

```
    if left[0] < 0:
```

```
        left = []
```

```
    right = filter(nlist[1:])
```

```
    # Combine
```

```
    return left+right
```

Either
approach
works.
Do what
is easiest.

Recursive Function (Fall 2014)

```
def histogram(s):
```

```
    """Return: a histogram (dictionary) of the # of letters in string s.
```

```
    The letters in s are keys, and the count of each letter is the value. If  
    the letter is not in s, then there is NO KEY for it in the histogram.
```

```
    Example: histogram('') returns { },
```

```
            histogram('abracadabra') returns {'a':5,'b':2,'c':1,'d':1,'r':2 }
```

```
    Precondition: s is a string (possibly empty) of just letters."""
```

Recursive Function (Fall 2014)

```
def histogram(s):
```

```
    """Return: a histogram (dictionary) of the # of letters in string s.
```

```
    The letters in s are keys, and the count of each letter is the value. If  
    the letter is not in s, then there is NO KEY for it in the histogram.
```

```
    Precondition: s is a string (possibly empty) of just letters."""
```

Hint:

- Use divide-and-conquer to break up the string
- Get two dictionaries back when you do
- Pick one and insert the results of the other

Recursive Function

```
def histogram(s):
```

```
    """Return: a histogram (dictionary) of the # of letters in string s."""
```

```
    if s == "": # Small data
```

```
        | return {}
```

```
    # left = { s[0]: 1 }. No need to compute this
```

```
    right = histogram(s[1:])
```

```
    if s[0] in right: # Combine the answer
```

```
        | right[s[0]] = right[s[0]]+1
```

```
    else:
```

```
        | right[s[0]] = 1
```

```
    return right
```

Call Stack Question

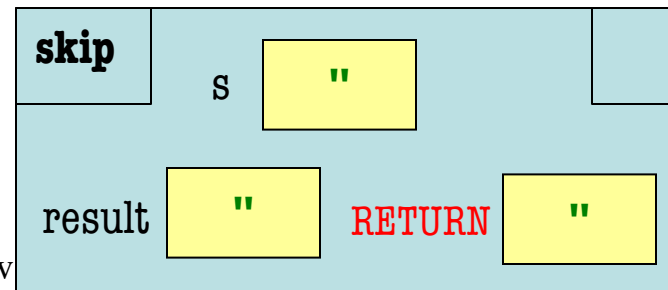
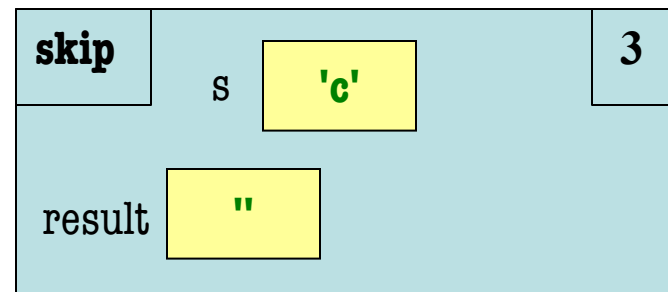
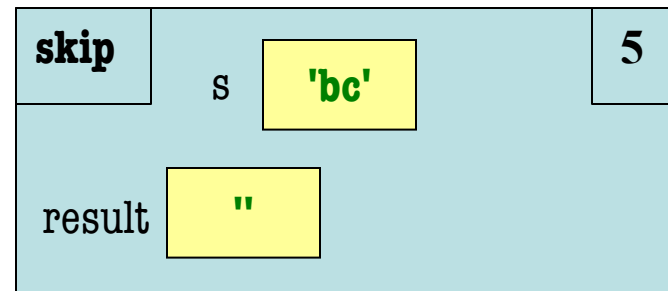
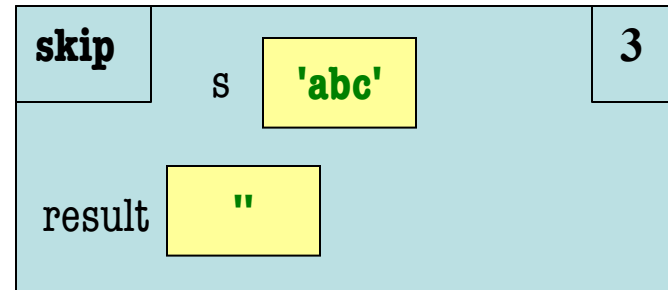
```
def skip(s):  
    """Returns: copy of s  
    Odd (from end) skipped"""  
1   result = ""  
2   if (len(s) % 2 == 1):  
3       |   result = skip(s[1:])  
4   elif len(s) > 0:  
5       |   result = s[0]+skip(s[1:])  
6   return result
```

- **Call:** skip('abc')
- Recursive call results in four frames (why?)
 - Consider when 4th frame completes line 6
 - Draw the entire call stack at that time
- Do not draw more than four frames!

Call Stack Question

- **Call:** skip('abc')

```
def skip(s):  
    """Returns: copy of s  
    Odd (from end) skipped"""  
1  result = ""  
2  if (len(s) % 2 == 1):  
3      result = skip(s[1:])  
4  elif len(s) > 0:  
5      result = s[0]+skip(s[1:])  
6  return result
```



Call Stack Question

- **Call:** skip('abc')

```
def skip(s):
```

```
    """Returns: copy of s
```

```
    Odd (from end) skipped"""
```

```
1 result = ""
```

```
2 if (len(s) % 2 == 1):
```

```
3     result = skip(s[1:])
```

```
4 elif len(s) > 0:
```

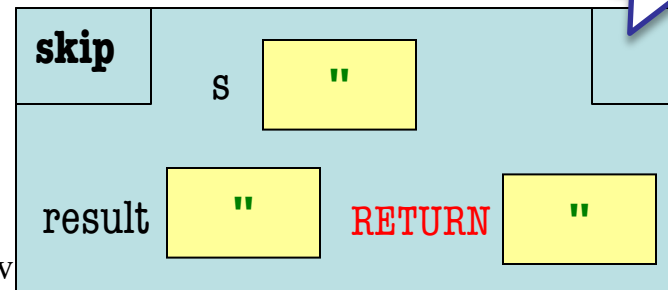
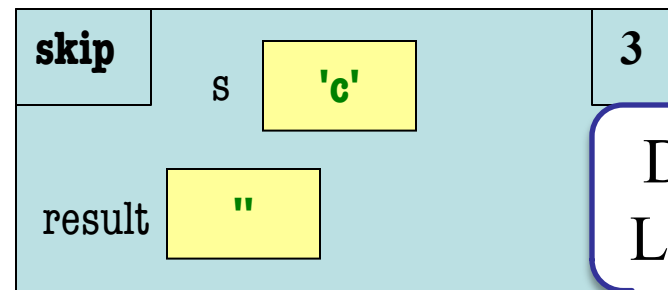
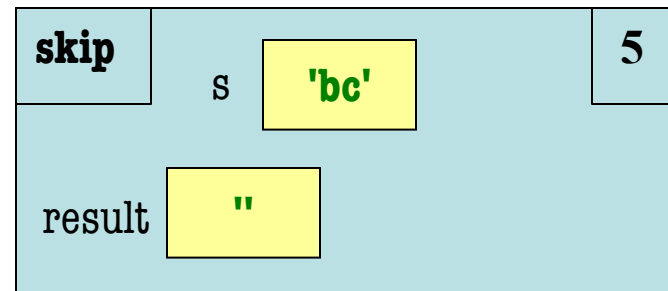
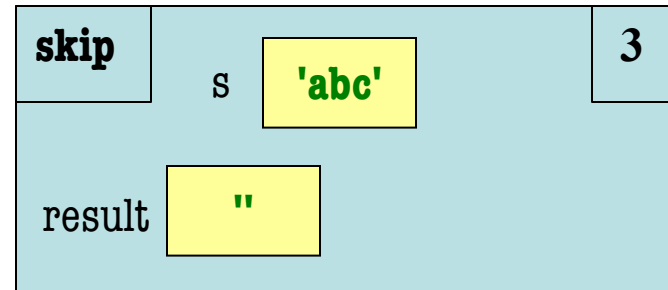
```
5     result = s[0]+skip(s[1:])
```

```
6 return result
```

s = 'abc'
s = 'c'

s = 'bc'

s = ""



Done
Line 6

What is on the Exam?

- Recursion (Labs 15 and 16; A4)
- Iteration (Labs 13, 17, and 22; A4; A6)
 - Again, given a function specification
 - Implement it using a for-loop
 - May involve 2-dimensional lists
- Defining classes (Labs 18, 19, 20, and 21; A6)
- Drawing folders (Lecture; A5)
- Short Answer (Terminology, Potpourri)

Implement Using Iteration

```
def evaluate(p, x):
```

```
    """Returns: The evaluated polynomial p(x)
```

```
    We represent polynomials as a list of floats. In other words
```

```
    [1.5, -2.2, 3.1, 0, -1.0] is  $1.5 - 2.2x + 3.1x^2 + 0x^3 - x^4$ 
```

```
    We evaluate by substituting in for the value x. For example
```

```
    evaluate([1.5, -2.2, 3.1, 0, -1.0], 2) is  $1.5 - 2.2(2) + 3.1(4) - 1(16) = -6.5$ 
```

```
    evaluate([2], 4) is 2
```

```
    Precondition: p is a list (len > 0) of floats, x is a float"""
```

Implement Using Iteration

```
def evaluate(p, x):
```

```
    """Returns: The evaluated polynomial p(x)
```

```
    Precondition: p is a list (len > 0) of floats, x is a float"""
```

```
    sum = 0
```

```
    xval = 1
```

```
    for c in p:
```

```
        sum = sum + c*xval    # coefficient * (x**n)
```

```
        xval = xval * x
```

```
    return sum
```

Example with 2D Lists (Like A6)

```
def max_cols(table):
```

```
    """Returns: Row with max value of each column
```

```
    We assume that table is a 2D list of floats (so it is a list of rows and
    each row has the same number of columns. This function returns
    a new list that stores the maximum value of each column.
```

```
    Examples:
```

```
        max_cols([ [1,2,3], [2,0,4], [0,5,2] ]) is [2,5,4]
```

```
        max_cols([ [1,2,3] ]) is [1,2,3]
```

```
    Precondition: table is a NONEMPTY 2D list of floats"""
```

Example with 2D Lists (Like A6)

```
def max_cols(table):
```

```
    """Returns: Row with max value of each column
```

```
    Precondition: table is a NONEMPTY 2D list of floats"""
```

```
    # Use the fact that table is not empty
```

```
    result = table[0][:] # Make a copy, do not modify table.
```

```
    # Loop through rows, then loop through columns
```

```
    for row in table:
```

```
        for k in range(len(row)):
```

```
            if row[k] > result[k]:
```

```
                result[k] = row[k]
```

```
    return result
```

While-Loop Example

```
def dupevens(nums):
```

```
    """MODIFIES nums so that all even numbers are duplicated
```

```
    The duplicate value should appear immediately after the original.
```

```
    Example: If a = [1,2,3,4], dupevens(a) modifies a to [1,2,2,3,4,4]
```

```
    Precondition: nums is a list of integers"""
```

While-Loop Example

```
def dupevens(nums):
```

```
    """MODIFIES nums so that all even numbers are duplicated
```

```
    Precondition: nums is a list of integers"""
```

```
    k = 0 # Loop variable
```

```
    while k < len(nums):
```

```
        if nums[k] % 2 == 0:
```

```
            nums.insert(k,nums[k])
```

```
            k = k+2 # Skip over number AND duplicate
```

```
        else:
```

```
            k = k+1
```

What is on the Exam?

- Recursion (Labs 15 and 16; A4)
- Iteration (Labs 13, 17 and 22; A4, A6)
- Defining Classes (Labs 18, 19, 20, and 21; A6)
 - Given a specification for a class
 - Also given a specification for a subclass
 - Will “fill in blanks” for both
- Drawing folders (Lecture; A5)
- Short Answer (Terminology, Potpourri)


```
class Customer(object):
```

```
    """Instance is a customer for our company"""
```

```
    # MUTABLE ATTRIBUTES:
```

```
    # _name: string or None if unknown
```

```
    # _email: string or None if unknown
```

```
    # IMMUTABLE ATTRIBUTES:
```

```
    # _born: int > 1900; -1 if unknown
```

```
    # DEFINE GETTERS/SETTERS HERE
```

```
    # Enforce all invariants and enforce immutable/mutable restrictions
```

```
    # DEFINE INITIALIZER HERE
```

```
    # Initializer: Make a Customer with last name n, birth year y, e-mail address e.
```

```
    # E-mail is None by default
```

```
    # Precondition: parameters n, y, e satisfy the appropriate invariants
```

```
    # OVERLOAD STR() OPERATOR HERE
```

```
    # Return: String representation of customer
```

```
    # If e-mail is a string, format is 'name (email)'
```

```
    # If e-mail is not a string, just returns name
```

```
class Customer(object):
    """Instance is a customer for our company"""
    # MUTABLE ATTRIBUTES:
    # _name: string or None if unknown
    # _email: string or None if unknown
    # IMMUTABLE ATTRIBUTES:
    # _born: int > 1900; -1 if unknown
```

```
# DEFINE GETTERS/SETTERS HERE
```

```
def getName(self):
    | return self._name
```

Getter

```
def setName(self,value):
    | assert value is None or type(value) == str
    | self._name = value
```

Setter

Actual Exam Question
probably not this long.
Just for this practice.

```
class Customer(object):
    """Instance is a customer for our company"""
    # MUTABLE ATTRIBUTES:
    # _name: string or None if unknown
    # _email: string or None if unknown
    # IMMUTABLE ATTRIBUTES:
    # _born: int > 1900; -1 if unknown

    # DEFINE GETTERS/SETTERS HERE

    ....
    def getEmail(self):
        | return self._email

    def setEmail(self,value):
        | assert value is None or type(value) == str
        | self._email = value
```

Getter

Setter

Actual Exam Question probably not this long. Just for this practice.

```
class Customer(object):
    """Instance is a customer for our company"""
    # MUTABLE ATTRIBUTES:
    # _name: string or None if unknown
    # _email: string or None if unknown
    # IMMUTABLE ATTRIBUTES:
    # _born: int > 1900; -1 if unknown

    # DEFINE GETTERS/SETTERS HERE

    ....
    def getBorn(self):
        | return self._born
```

Getter

Immutable.
No Setter!

Actual Exam Question probably not this long. Just for this practice.

```
class Customer(object):
    """Instance is a customer for our company"""
    # MUTABLE ATTRIBUTES:
    # _name: string or None if unknown
    # _email: string or None if unknown
    # IMMUTABLE ATTRIBUTES:
    # _born: int > 1900; -1 if unknown

    # DEFINE GETTERS/SETTERS HERE

    ...
    # DEFINE INITIALIZER HERE
    def __init__(self, n, y, e=None):
        assert type(y) == int and (y > 1900 or y == -1)
        self.setName(n) # Setter handles asserts
        self.setEmail(e) # Setter handles asserts
        self._born = y # No setter
```

Actual Exam Question
probably not this long.
Just for this practice.

```

class Customer(object):
    """Instance is a customer for our company"""
    # MUTABLE ATTRIBUTES:
    # _name: string or None if unknown
    # _email: string or None if unknown
    # IMMUTABLE ATTRIBUTES:
    # _born: int > 1900; -1 if unknown

    # DEFINE GETTERS/SETTERS HERE
    ...
    # DEFINE INITIALIZER HERE
    ...
    # OVERLOAD STR() OPERATOR HERE
    def __str__(self):
        if self._email is None:
            return " if self._name is None else self._name
        else:
            s = " if self._name is None else self._name
            return s+'('+self._email+')'

```

Actual Exam Question
probably not this long.
Just for this practice.

None or str

If not None,
always a str

```

class PrefCustomer(Customer):
    """An instance is a 'preferred' customer"""
    # MUTABLE ATTRIBUTES (in addition to Customer):
    # _level: One of 'bronze', 'silver', 'gold'

    # DEFINE GETTERS/SETTERS HERE
    # Enforce all invariants and enforce immutable/mutable restrictions

    # DEFINE INITIALIZER HERE
    # Initializer: Make a new Customer with last name n, birth year y,
    # e-mail address e, and level l
    # E-mail is None by default
    # Level is 'bronze' by default
    # Precondition: parameters n, y, e, l satisfy the appropriate invariants

    # OVERLOAD STR() OPERATOR HERE
    # Return: String representation of customer
    # Format is customer string (from parent class) +', level'
    # Use __str__ from Customer in your definition

```

```
class PrefCustomer(Customer):
```

```
    """An instance is a 'preferred' customer"""
```

```
    # MUTABLE ATTRIBUTES (in addition to Customer):
```

```
    # _level: One of 'bronze', 'silver', 'gold'
```

```
    # DEFINE GETTERS/SETTERS HERE
```

```
    def getLevel(self):
```

```
        return self._level
```

Getter

```
    def setLevel(self,value):
```

```
        assert type(value) == str
```

```
        assert (value == 'bronze' or value == 'silver' or value == 'gold')
```

```
        self._level = value
```

Setter

Actual Exam Question
will not be this long.
Just for this practice.


```

class PrefCustomer(Customer):
    """An instance is a 'preferred' customer"""
    # MUTABLE ATTRIBUTES (in addition to Customer):
    # _level: One of 'bronze', 'silver', 'gold'

    # DEFINE GETTERS/SETTERS HERE

    ...
    # DEFINE INITIALIZER HERE
    def __init__(self, n, y, e=None, l='bronze'):
        super().__init__(n,y,e)
        self.setLevel(l) # Setter handles asserts

    # OVERLOAD STR() OPERATOR HERE
    def __str__(self):
        return super().__str__()+' '+self._level

```

Actual Exam Question
will not be this long.
Just for this practice.

Using super() in place of
self uses parent __str__

What is on the Exam?

- Recursion (Labs 15 and 16; A4)
- Iteration (Labs 13, 17, and 22; A4, A6)
- Defining classes (Labs 18, 19, 20, and 21; A6)
- Drawing class folders (Lecture; A5)
 - Given a skeleton for a class
 - Also given several assignment statements
 - Draw all folders and variables created
- Short Answer (Terminology, Potpourri)

Two Example Classes

```
class Congressman(object):
    """Instance is legislator in congress"""
    # INSTANCE ATTRIBUTES:
    # _name: a string

    def getName(self):
        | return self._name

    def setName(self,value):
        | assert type(value) == str
        | self._name = value

    def __init__(self,n):
        | self.setName(n) # Use the setter

    def __str__(self):
        | return 'Honorable '+self.name
```

```
class Senator(CongressMember):
    """Instance is legislator in congress"""
    # INSTANCE ATTRIBUTES (additional):
    # _state: a string

    def getState(self):
        | return self._state

    def setName(self,value):
        | assert type(value) == str
        | self._name = 'Senator '+value

    def __init__(self,n,s):
        | assert type(s) == str and len(s) == 2
        | super().__init__(n)
        | self._state = s

    def __str__(self):
        | return (super().__str__() +
        |         ' of '+self.state)
```

'Execute' the Following Code

```
>>> b = CongressMember('Jack')
>>> c = Senator('John', 'NY')
>>> d = c
>>> d.setName('Clint')
```

Remember:

Commands outside of
a function definition
happen in global space

- Draw two columns:
 - **Global space**
 - **Heap space**
- Draw both the
 - Variables created
 - Object folders created
 - Class folders created
- If an attribute changes
 - Mark out the old value
 - Write in the new value

Global Space

b

id1

c

id2

d

id2

Heap Space

id1

CongressMember

_name

'Jack'

id2

Senator

_name

~~'Senator John'~~ 'Senator Clint'

_state

'NY'

CongressMember

```
__init__(self,n)    getName(self)
__str__(self)      setName(self,value)
```

Senator(ConMember)

```
__init__(self,n,s)  getState(self)
__str__(slf)        setName(self,value)
```



Global Space

b

Instance attributes
in object folders

Methods and
class attributes
in class folders

CongressMember

```
__init__(self,n)    getName(self)  
__str__(self)    setName(self,value)
```

Heap Space

id1

CongressMember

_name 'Jack'

id2

Senator

_name ~~'Senator John'~~ 'Senator Clint'

state 'NY'

Arrow is
optional

Senator(ConMember)

```
__init__(self,n,s)    getState(self)  
__str__(slf)    setName(self,value)
```

Method Overriding

```
class Senator(CongressMember):
    """Instance is legislator in congress"""
    # INSTANCE ATTRIBUTES (additional):
    # _state: a string

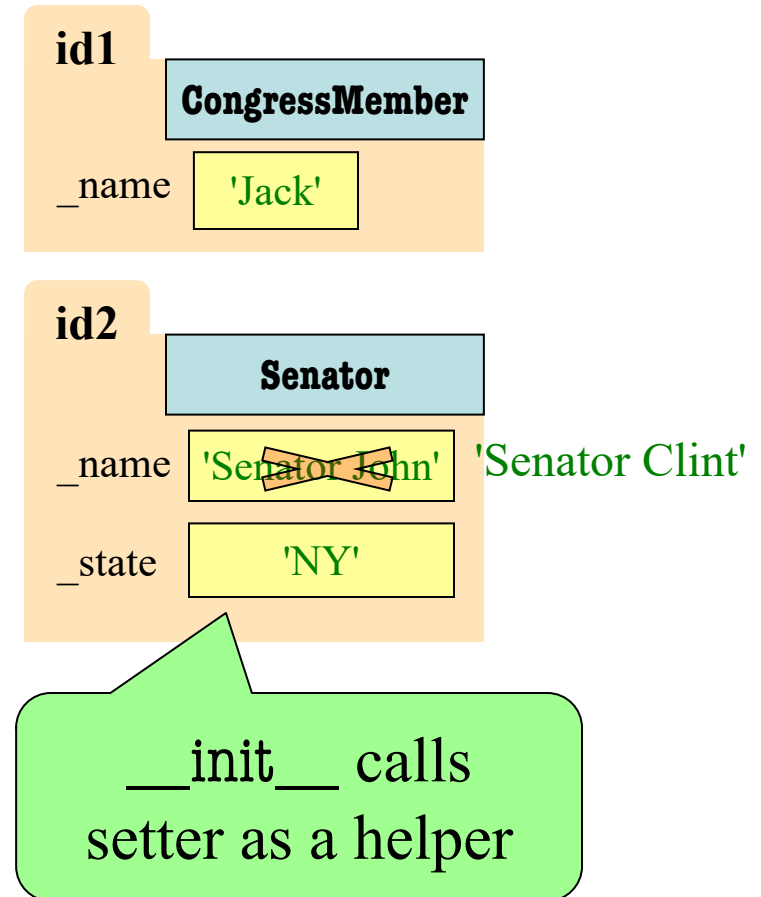
    def getState(self):
        | return self._state

    def setName(self,value):
        | assert type(value) == str
        | self._name = 'Senator '+value

    def __init__(self,n,s):
        | assert type(s) == str and len(s) == 2
        | super().__init__(n)
        | self._state = s

    def __str__(self):
        | return (super().__str__()+
        |         ' of '+self.state)
```

Heap Space



What is on the Exam?

- Recursion (Labs 15 and 16; A4)
 - Iteration (Labs 13, 17, and 22; A4; A6)
 - Defining classes (Labs 18, 19, 20, and 21; A6)
 - Drawing class folders (Lecture; A5)
 - **Short Answer (Terminology, Potpourri)**
 - See the study guide
 - Look at the lecture slides
 - Look at the lecture demo code
- In that order

What is on the Exam?

- Recursion (Labs 15 and 16; A4)
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- Defining classes (Labs 18, 19, 20, and 21; A6)
- Drawing class folders (Lecture; A5)
- Short Answer (Terminology, Potpourri)
 - See the s
 - Look at t
 - Look at the lecture demo code

Saved for the Final

In that order

Any More Questions?

