CS 1110

Prelim 2 Review
Fall 2020

Exam Info

- **Prelim 2**: Thursday, November 19th at 9:30 am
  - In-person students in Barton Hall
  - SDS students in 114 and 122 Gates
  - **Exam Seating** contains room, time AND **entrance!**
- Online students will work in Gradescope
  - **Exam Seating** contains your proctor information
  - Proctor will contact you directly
  - There are no plans hold mock exam unless you ask

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Do not come to Barton early!

Do not crowd the entrance!

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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 13 & 14, A4)
  - Iteration and Lists (Labs 12 & 15, A4, A6)
  - Defining classes (Labs 16-18, A6)
  - Drawing folders (In class, A5)
  - Short Answer (Terminology, Potpourri)
- + 2 pts for writing your name and net-id
- Exact number depends on question length

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- + 2 pts for writing your name and net-id
- Exact number depends on question length

What is on the Exam?

- Recursion (Labs 13 & 14, A4)
  - Will be given a function specification
  - Implement it using recursion
  - May have an associated call stack question
- Iteration and Lists (Labs 12 & 15, A4, A6)
- Defining classes (Labs 16-18, A6)
- Drawing folders (In class, 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)

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def filter(nlist):
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    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."""
```

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

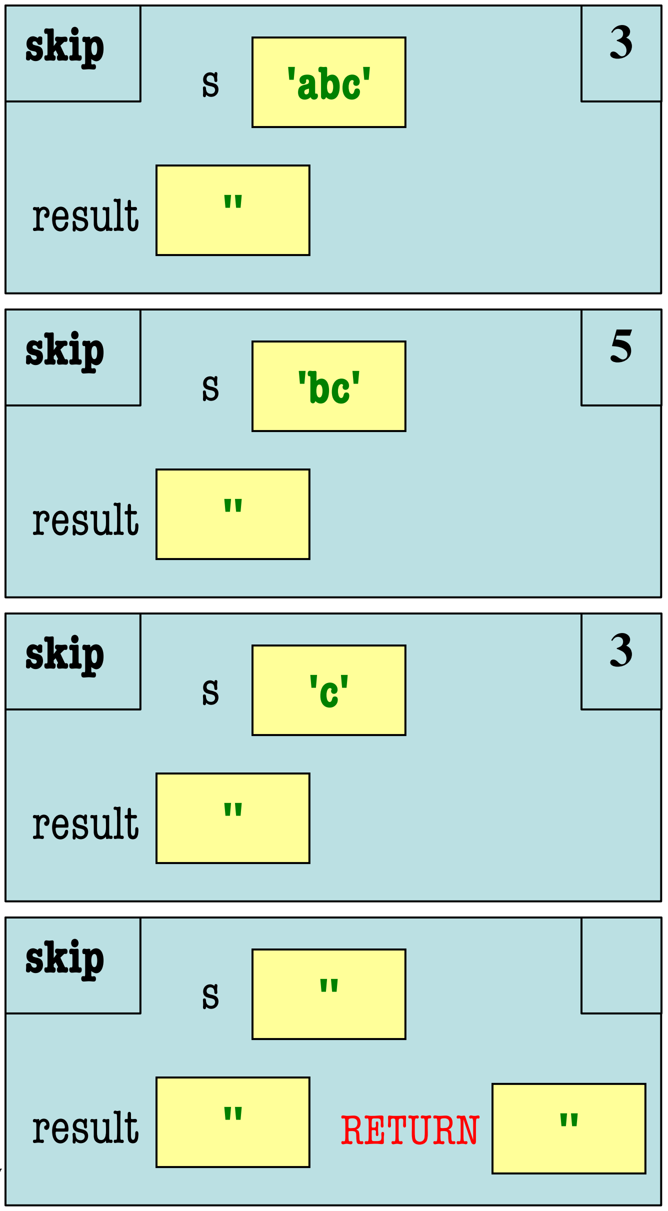
```
  def skip(s):
      """Returns: copy of s
      Odd (from end) skipped"""
1     result = ''
2     if (len(s) % 2 == 1):
3         result = skip(s[1:])
4     elif len(s) > 0:
5         result = s[0]+skip(s[1:])
6     return result
```

- **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

```
  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')



Call Stack Question

```
    def skip(s):
        """Returns: copy of s
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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
```

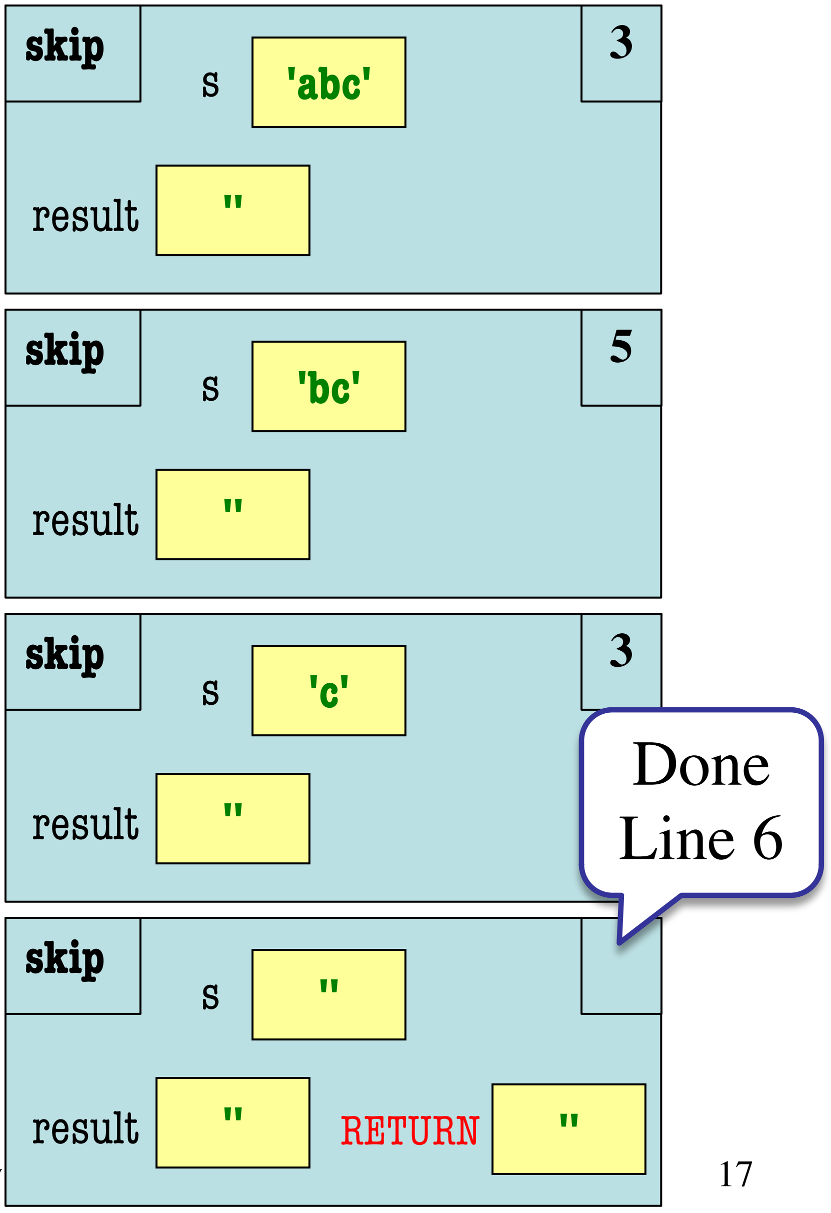
s = 'abc'

s = 'c'

s = 'bc'

s = ''

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



What is on the Exam?

- Recursion (Labs 13 & 14, A4)
- Iteration and Lists (Labs 12 & 15, A4, A6)
  - Again, given a function specification
  - Implement it using a for-loop
  - May involve 2-dimensional lists
- Defining classes (Labs 16-18, A6)
- Drawing folders (In class, 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
```

What is on the Exam?

- Recursion (Labs 13 & 14, A4)
- Iteration and Lists (Labs 12 & 15, A4, A6)
- Defining Classes (Labs 16-18, 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

    def setName(self,value):
        assert value is None or type(value) == str
        self._name = 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 getEmail(self):
        return self._email

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

Getter

Setter

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```
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
```

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```
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

```python
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

    def setLevel(self,value):
        assert type(value) == str
        assert (value == 'bronze' or value == 'silver' or value == 'gold')
        self._level = value
```

Getter

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 13 & 14, A4)
- Iteration and Lists (Labs 12 & 15, A4, A6)
- Defining Classes (Labs 16-18, 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 CongressMember(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
```

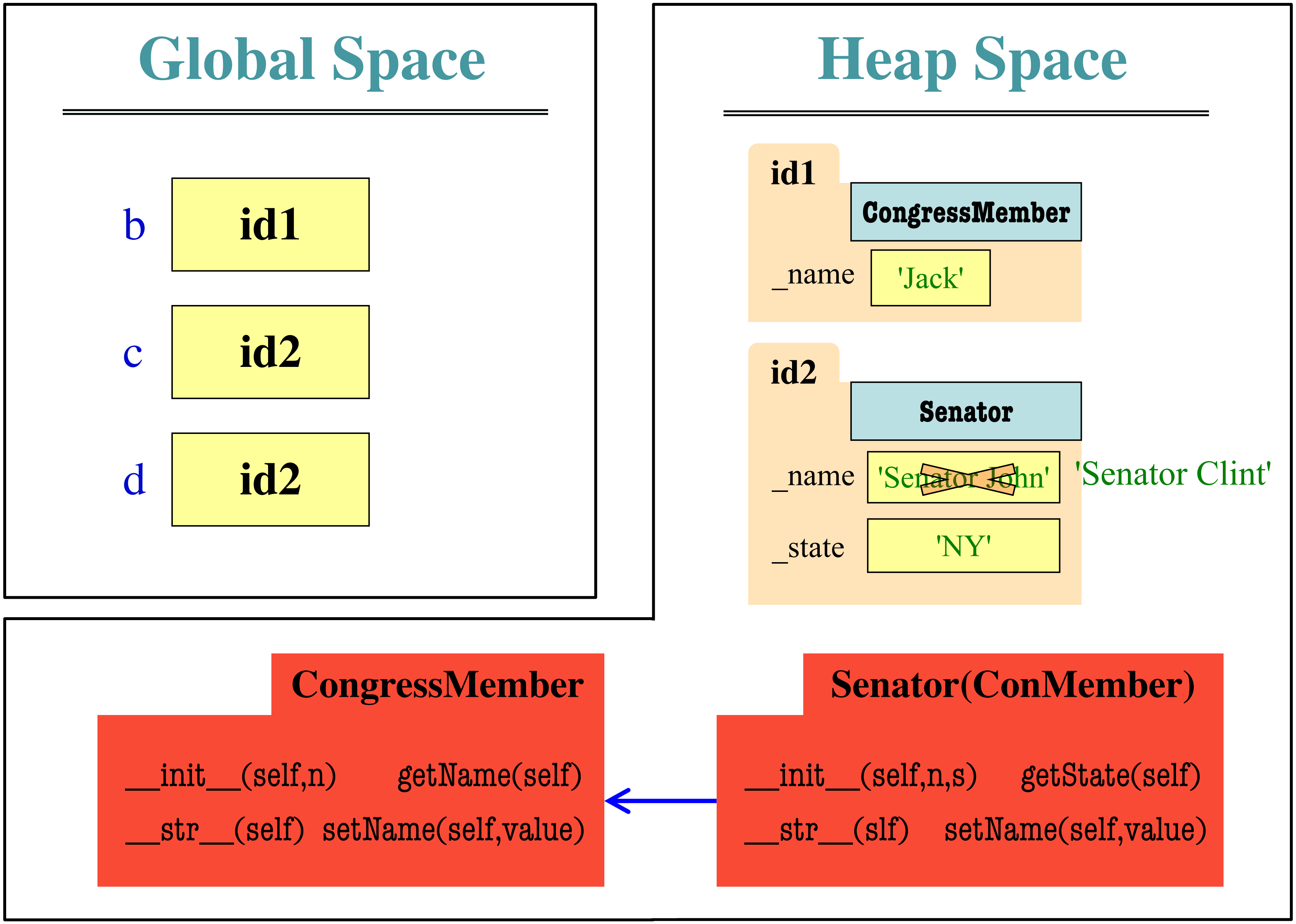
```
class Senator(CongressMember):
    """Instance is legislator in congress"""
    # INSTANCE ATTRIBUTES (additional):
    # _state: a string
    def getState(self):
        return self._state

    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)
```

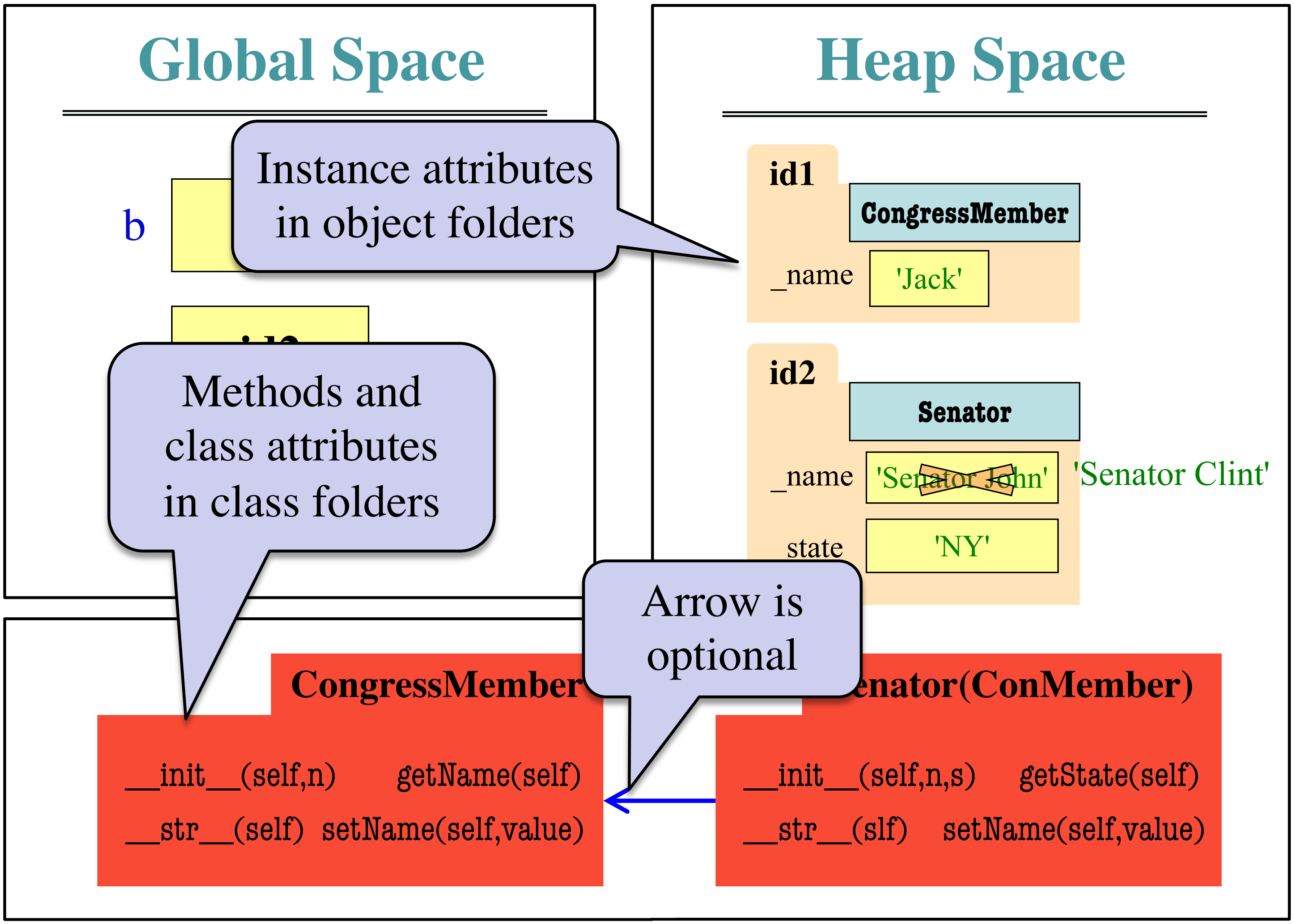
‘Execute’ the Following Code

```
>>> 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

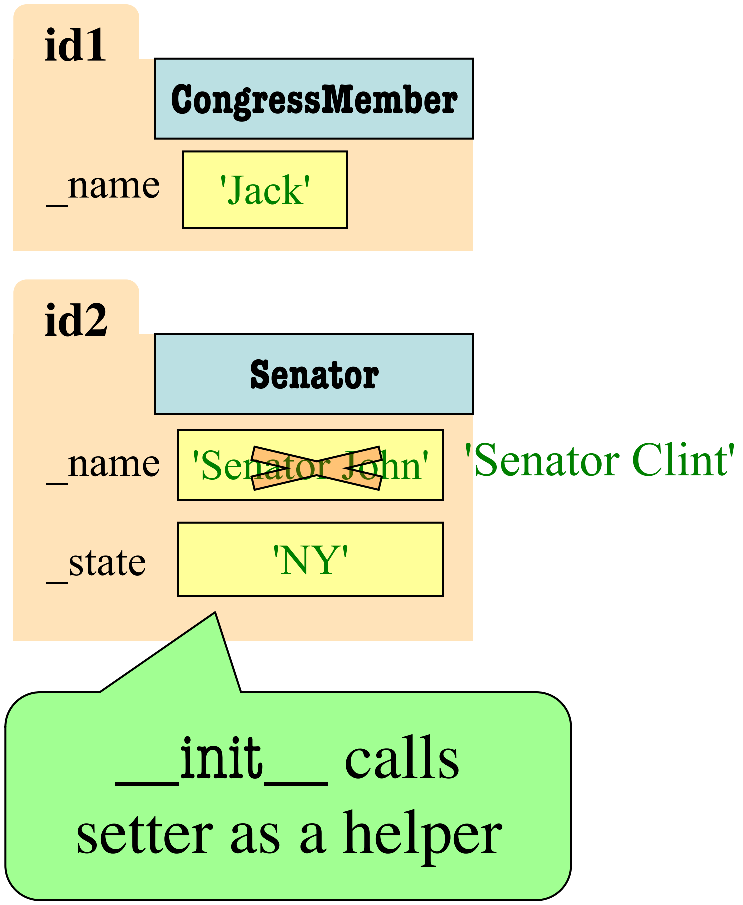

Global Space
b id1
c id2
d id2
Heap Space
id1
CongressMember
_name 'Jack'
id2
Senator
_name ~~'Senator John'~~ 'Senator Clint'
_state 'NY'
CongressMember
__init__(self,n) getName(self)
__str__(self) setName(self,value)
Senator(ConMember)
__init__(self,n,s) getState(self)
__str__(slf) setName(self,value)


Global Space
Heap Space
b
id2
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)
Instance attributes in object folders
Methods and class attributes in class folders
Arrow is optional

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 (Lab 7, A4)
- Iteration and Lists (Lab 8, A4, A6)
- Defining classes (Lab 9, A6)
- Drawing class folders (Lecture, A5)
- Short Answer (Terminology, Potpourri)
  - See the study guide
  - Look at the lecture slides
  - Read relevant book chapters

} In that order

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- Recursion (Lab 7, A4)
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- Short Answer (Terminology, Potpourri)
  - See the s
  - Look at t
  - Read relevant book chapters

Unlikely to happen

In that order

Any More Questions?