CS 1110

Prelim 2 Review
Fall 2016

Exam Info

- Prelim 2: 7:30–9:00PM, Thursday, Nov. 10th
  - Last name **A – K** in Uris G01
  - Last name **L – O** in Phillips 101
  - Last name **P – W** in Ives 305
  - Last name **X – Z** in Ives 105
- To help you study:
  - Study guides, review slides are online
  - Review solution to prelim 1 (esp. call stack!)

What is on the Exam?

- Five questions from the following topics:
  - Recursion (Lab 8, A4)
  - Iteration and Lists (Lab 7, A4, A6)
  - Defining classes (Lab 9, Lab 10, A6)
  - Drawing folders (Lecture, A5)
  - Exceptions (Lectures 11 and 21)
  - Short Answer (Terminology, Potpourri)
- +2 points for name, netid **AND SECTION**

What is on the Exam?

- Recursion (Lab 8, A4)
  - Will be given a function specification
  - Implement it using recursion
  - May have an associated call stack question
- Iteration and Lists (Lab 7, A4, A6)
- Defining classes (Lab 9, Lab 10, A6)
- Drawing folders (Lecture, A5)
- Exceptions (Lectures 11 and 21)
- Short Answer (Terminology, Potpourri)

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 { }

    # We know left is { s[0]: 1 }.  No need to compute
    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

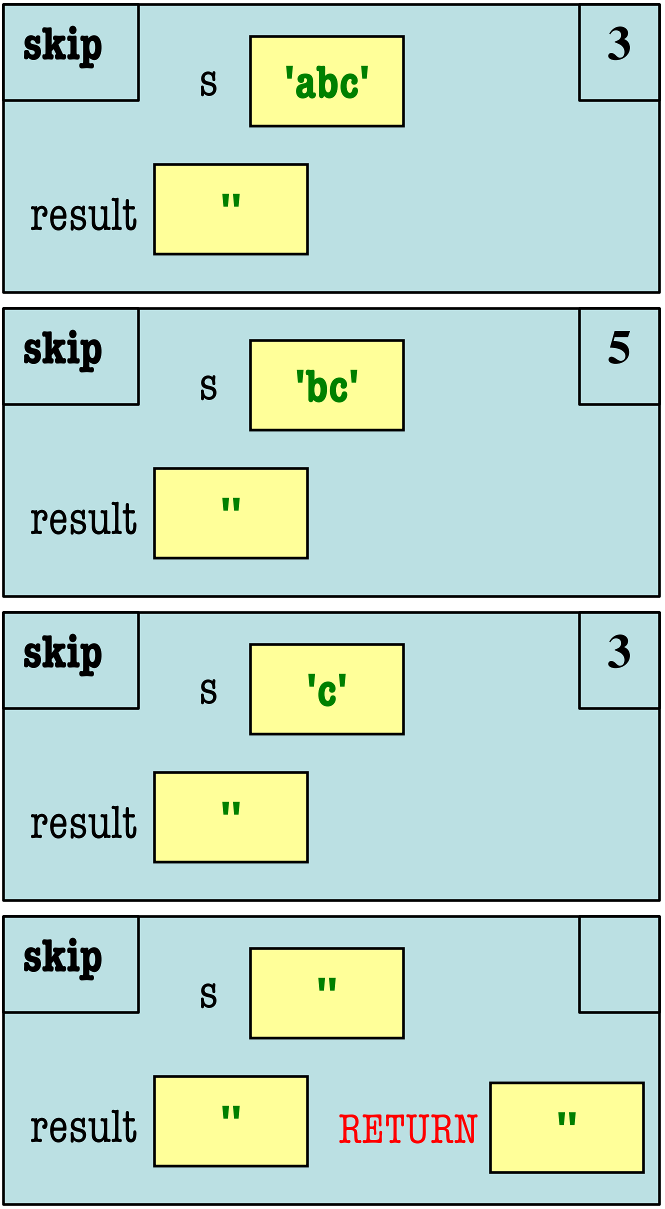
```
  def skip(s):
      """Returns: copy of s
      Odd (from end) skipped"""
1     result = ''
2     if (len(s) % 2 = 1):
3         result = skip(s[1:])
4     elif len(s) > 0:
5         result = s[0]+skip(s[1:])
6     return result
```

- **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')



skip | s 'abc' | 3 | result ''

skip | s 'bc' | 5 | result ''

skip | s 'c' | 3 | result ''

skip | s '' | result '' | RETURN ''

Call Stack Question

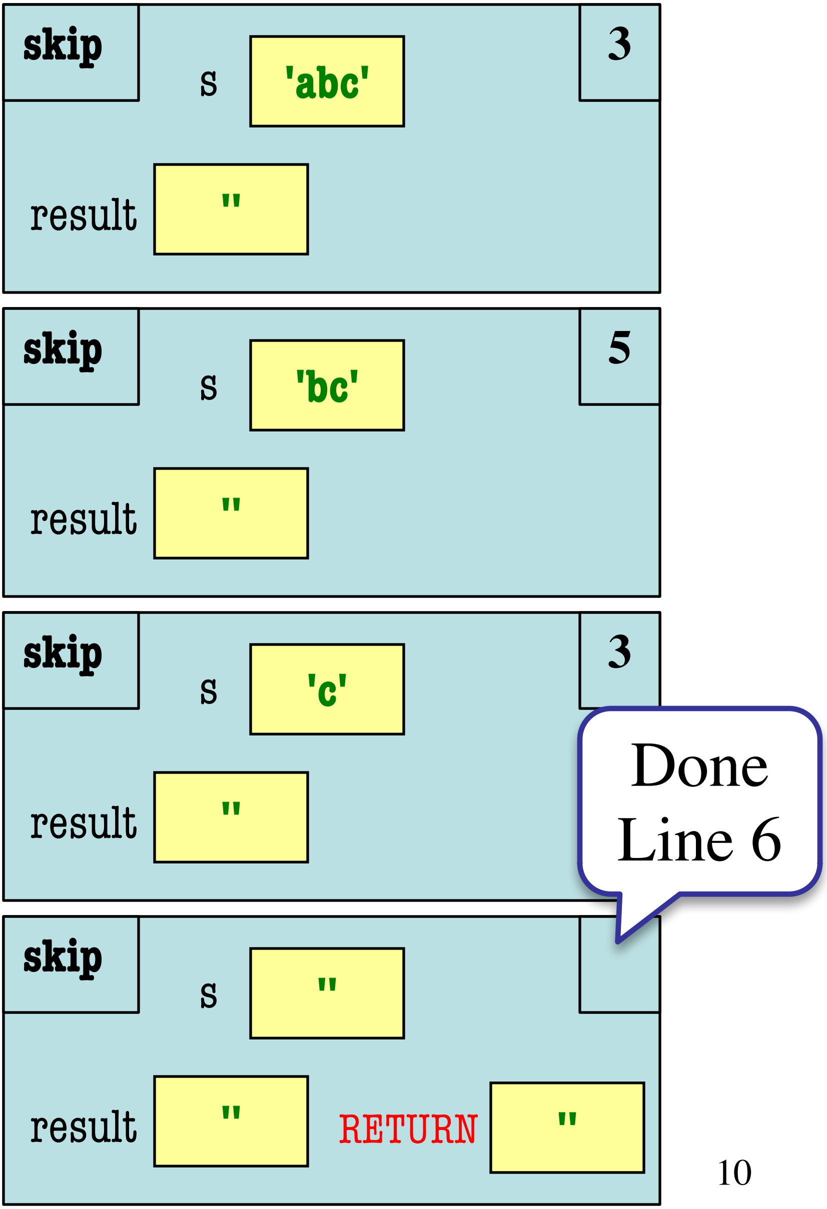
- **Call**: skip('abc')

```
  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 = ''



What is on the Exam?

- Recursion (Lab 8, A4)
- Iteration (Lab 7, A4, A6)
  - Again, given a function specification
  - Implement it using a for-loop
  - May involve 2-dimensional lists
- Defining classes (Lab 9, Lab 10, A6)
- Drawing folders (Lecture, A5)
- Exceptions (Lectures 11 and 21)
- 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 (Lab 8, A4)
- Iteration (Lab 7, A4, A6)
- Defining Classes (Lab 9, Lab 10, A6)
  - Given a specification for a class
  - Also given a specification for a subclass
  - Will “fill in blanks” for both
- Drawing folders (Lecture, A5)
- Exceptions (Lectures 11 and 21)
- Short Answer (Terminology, Potpourri)

```
class Customer(object):
    """Instance is a customer for our company
    Mutable attributes:
        _name: last name [string or None if unknown]
        _email: e-mail address [string or None if unknown]
    Immutable attributes:
        _born: birth year [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, b, 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: last name [string or None if unknown]
        _email: e-mail address [string or None if unknown]
    Immutable attributes:
        _born: birth year [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: last name [string or None if unknown]
        _email: e-mail address [string or None if unknown]
    Immutable attributes:
        _born: birth year [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: last name [string or None if unknown]
        _email: e-mail address [string or None if unknown]
    Immutable attributes:
        _born: birth year [int > 1900; -1 if unknown]"""

    # DEFINE GETTERS/SETTERS HERE
    ….
    def getBorn(self):
        return self._born
```

Getter

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

Immutable. No Setter!

```
class Customer(object):
    """Instance is a customer for our company
    Mutable attributes:
        _name: last name [string or None if unknown]
        _email: e-mail address [string or None if unknown]
    Immutable attributes:
        _born: birth year [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: last name [string or None if unknown]
        _email: e-mail address [string or None if unknown]
    Immutable attributes:
        _born: birth year [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: level of preference [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, b, 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: level of preference [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: level of preference [One of 'bronze', 'silver', 'gold'] """

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

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

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

explicit calls uses method in parent class as helper

What is on the Exam?

- Recursion (Lab 7, A4)
- Iteration and Lists (Lab 6, A4, A5)
- Defining classes (Lab 8, Lab 9, A5)
- Drawing class folders (Lecture, **A5**)
  - Given a skeleton for a class
  - Also given several assignment statements
  - Draw all folders and variables created
- Exceptions (Lectures 11 and 21)
- Short Answer (Terminology, Potpourri)

Two Example Classes

```
class CongressMember(object):
    """Instance is legislator in congress
    Instance attributes:
        _name: Member's name [str]"""

    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
```

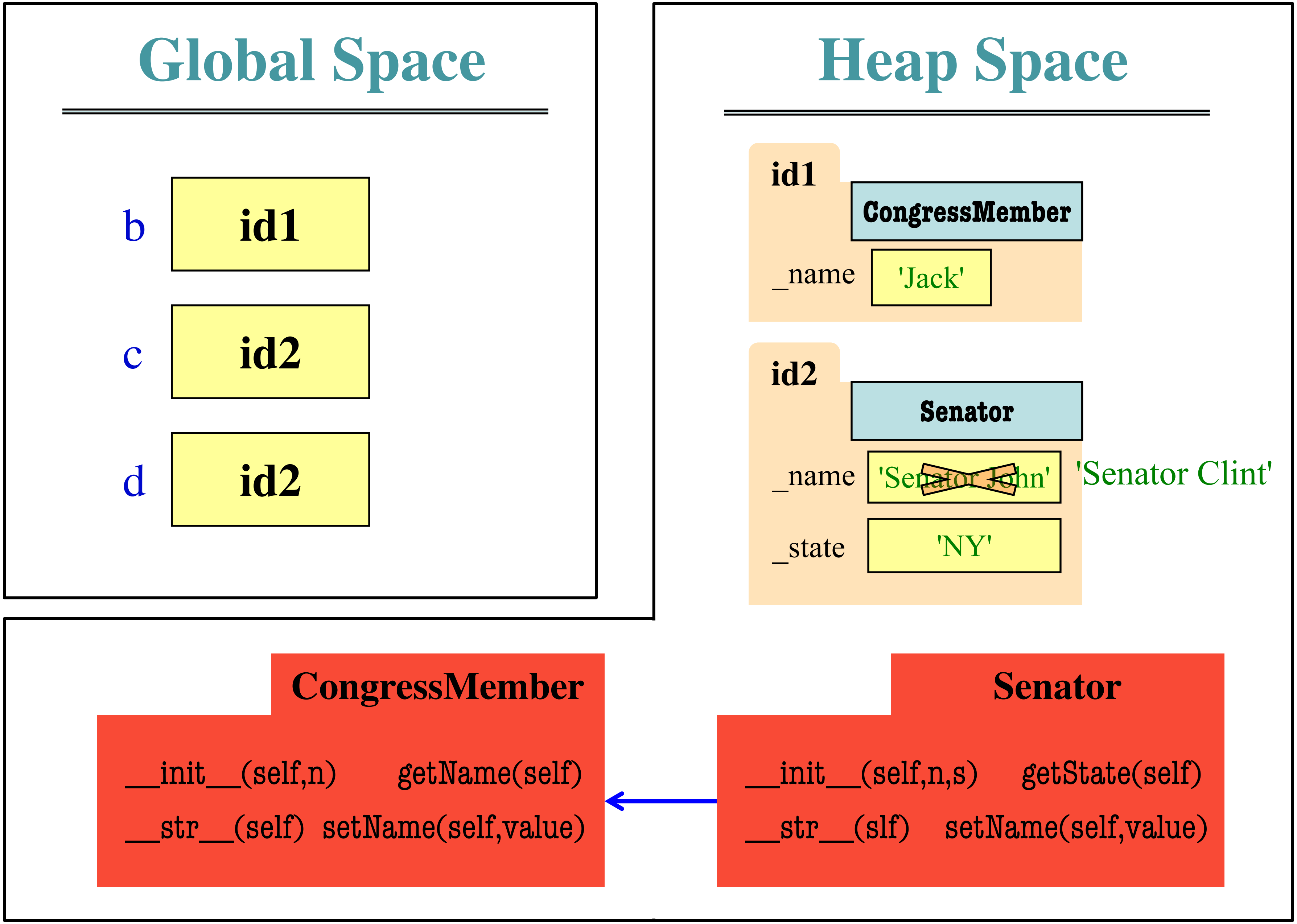
```
class Senator(CongressMember):
    """Instance is legislator in congress
    Instance attributes (plus inherited):
        _state: Senator's state [str]"""
    def getState(self):
        return self._state

    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
        CongressMember.__init__(self,n)
        self._state = s

    def __str__(self):
        return (CongressMember.__str__(self)+
                    ' 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

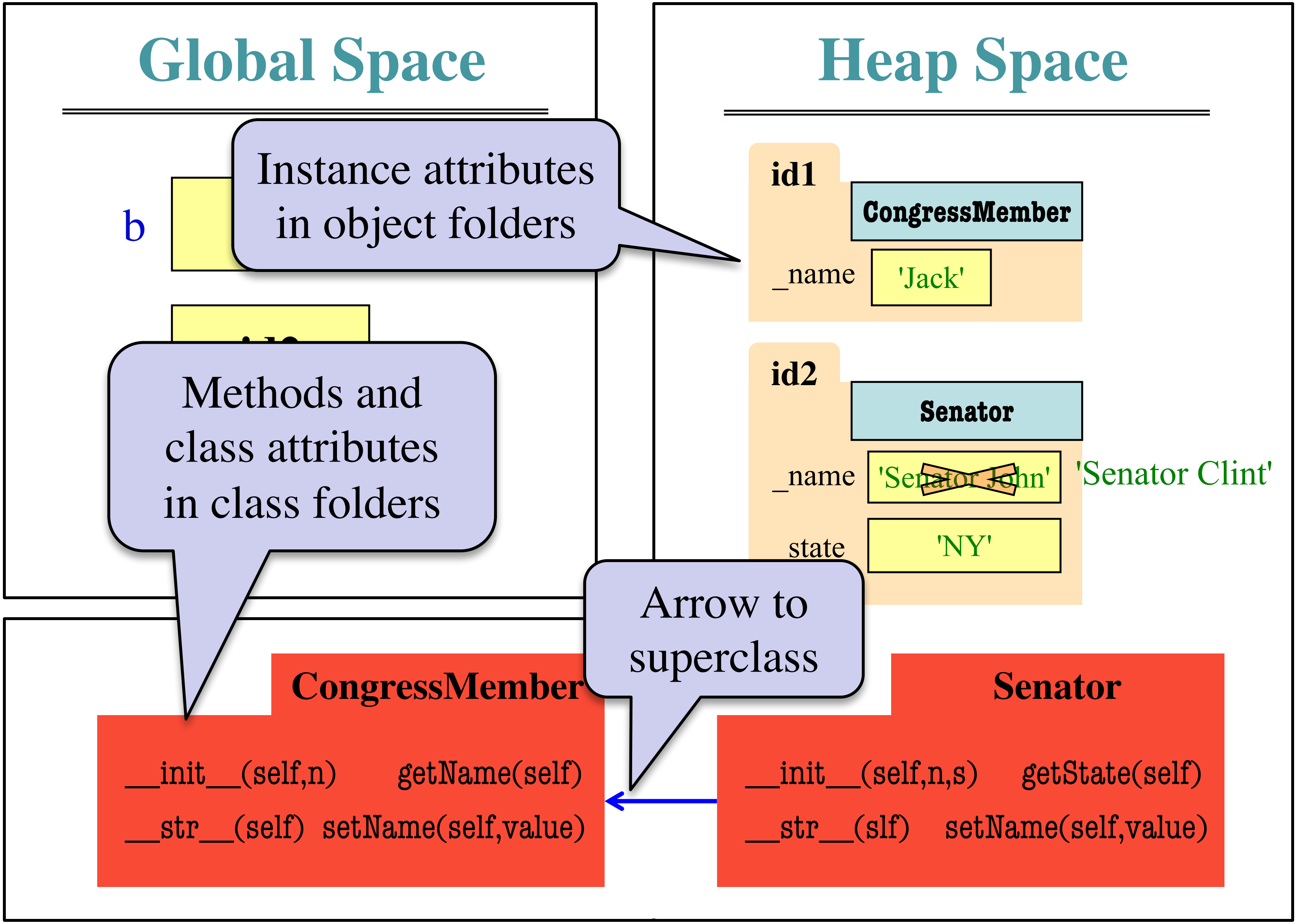
__init__(self,n) getName(self)

__str__(self) setName(self,value)

Senator

__init__(self,n,s) getState(self)

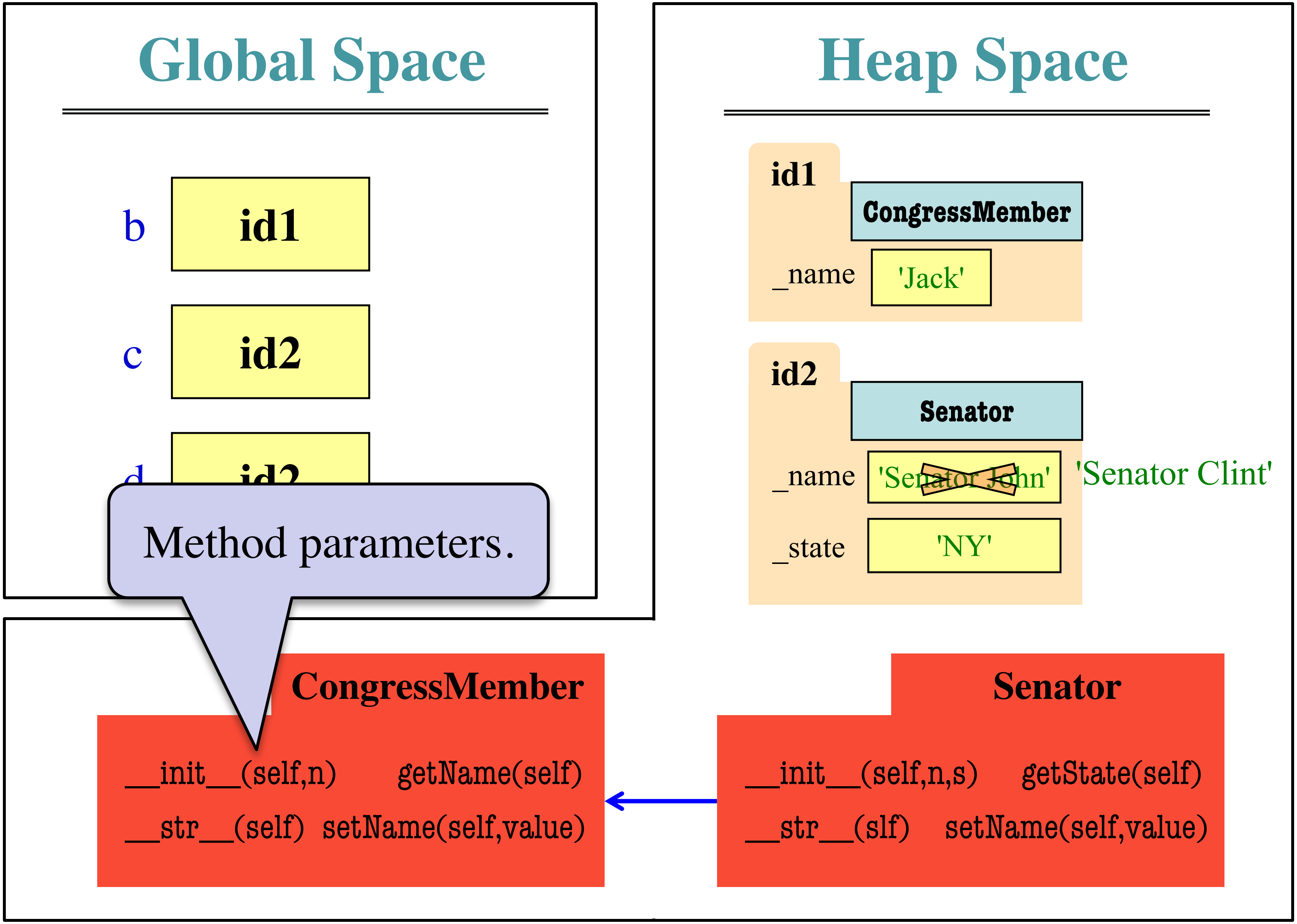
__str__(slf) setName(self,value)



Instance attributes in object folders

Methods and class attributes in class folders

Arrow to superclass



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

__init__(self,n,s) getState(self)

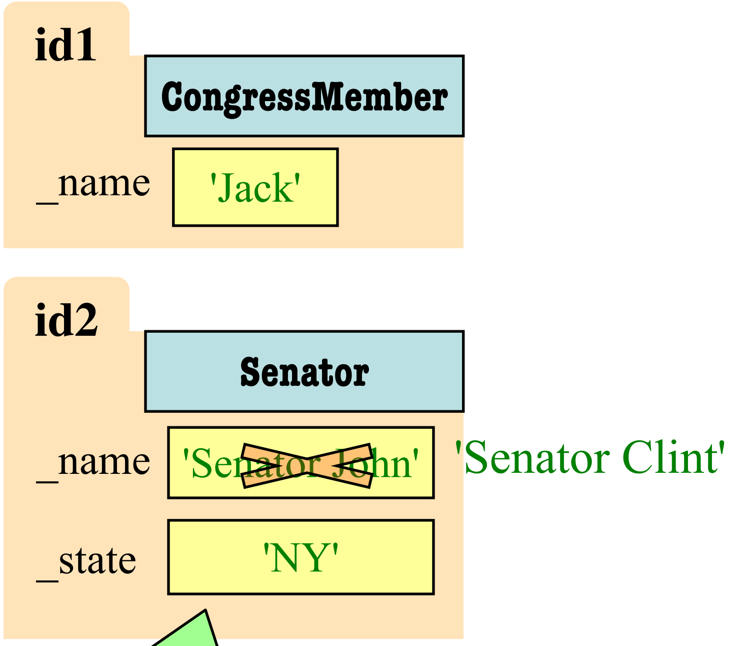
__str__(slf) setName(self,value)

Method parameters.

Method Overriding

```
class Senator(CongressMember):
    """Instance is legislator in congress
    Instance attributes (plus inherited):
        _state: Senator's state [str]"""

    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
        Senator.__init__(self,n)
        self._state = s

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

Heap Space



__init__ calls setter as a helper

What is on the Exam?

- Recursion (Lab 8, A4)
- Iteration and Lists (Lab 7, A4, A6)
- Defining classes (Lab 9, Lab 10, A6)
- Drawing class folders (Lecture, A5)
- Exceptions (Lectures 11 and 21)
  - Try-except tracing (skipped on Prelim 1)
  - But now with dispatch on type
  - Will give you exception hierarchy
- Short Answer (Terminology, Potpourri)

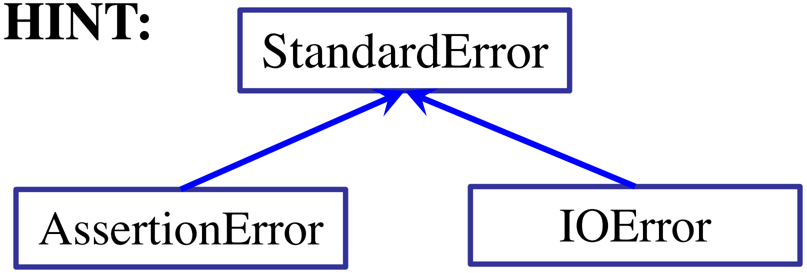
Exceptions and Dispatch-On-Type

```
def first(x):
    print 'Starting first.'
    try:
        second(x)
    except IOError:
        print 'Caught at first’
    print 'Ending first’


def second(x):
    print 'Starting second.'
    try:
         third(x)
    except AssertionError:
        print 'Caught at second’
    print 'Ending second’
```

```
def third(x):
    print 'Starting third.'
    if x < 0:
        raise IOError()
    elif x > 0:
        raise AssertionError()
    print ’Ending third.'
```

What is the output of first(-1)?

HINT:



Exceptions and Dispatch-On-Type

```
def first(x):
    print 'Starting first.'
    try:
        second(x)
    except IOError:
        print 'Caught at first’
    print 'Ending first’


def second(x):
    print 'Starting second.'
    try:
         third(x)
    except AssertionError:
        print 'Caught at second’
    print 'Ending second’
```

```
def third(x):
    print 'Starting third.'
    if x < 0:
        raise IOError()
    elif x > 0:
        raise AssertionError()
    print ’Ending third.'
```

What is the output of first(-1)?

```
Starting first.
Starting second.
Starting third.
Caught at first.
Ending first.
```

Exceptions and Dispatch-On-Type

```
def first(x):
    print 'Starting first.'
    try:
        second(x)
    except IOError:
        print 'Caught at first’
    print 'Ending first’


def second(x):
    print 'Starting second.'
    try:
        third(x)
    except AssertionError:
        print 'Caught at second’
    print 'Ending second’
```

```
def third(x):
    print 'Starting third.'
    if x < 0:
        raise IOError()
    elif x > 0:
        raise AssertionError()
    print ’Ending third.'
```

What is the output of first(1)?

Exceptions and Dispatch-On-Type

```
def first(x):
    print 'Starting first.'
    try:
        second(x)
    except IOError:
        print 'Caught at first’
    print 'Ending first’


def second(x):
    print 'Starting second.'
    try:
        third(x)
    except AssertionError:
        print 'Caught at second’
    print 'Ending second’
```

```
def third(x):
    print 'Starting third.'
    if x < 0:
        raise IOError()
    elif x > 0:
        raise AssertionError()
    print ’Ending third.'
```

What is the output of first(1)?

```
Starting first.
Starting second.
Starting third.
Caught at second.
Ending second.
Ending first.
```

What is on the Exam?

- Recursion (Lab 7, A4)
- Iteration and Lists (Lab 6, A4, A5)
- Defining classes (Lab 8, Lab 9, A5)
- Drawing class folders (Lecture, Study Guide)
- Exceptions (Lectures 11 and 21)
- Short Answer (Terminology, Potpourri)
    - See the study guide
    - Look at the lecture slides
    - Read relevant book chapters

In that order

Any More Questions?