CSc 110 Sample Final Exam #2

1. While Loop Simulation

For each call of the method below, write the value that is returned:

```
def mystery(i, j):
    k = 0
    while (i > j):
        i = i - j
        k = k + (i - 1)
    return k
```

Function Call	Value Returned
`mystery(2, 9)`	_____
`mystery(5, 1)`	_____
`mystery(38, 5)`	_____
`mystery(5, 5)`	_____
`mystery(40, 10)`	_____

2. Inheritance Mystery

Assume that the following classes have been defined:

```
class Pen(Sock):
    def method1(self):
        print("pen 1  ", end='')

class Lamp:
    def method1(self):
        print("lamp 1  ", end='')

    method2(self):
        print("lamp 2  ", end='')

    def __str__(self):
        return "lamp"
```

```
class Book(Sock):
    def method2(self):
        print("book 2  ", end='')
        super(Book, self).method2()

class Sock(Lamp):
    def method1(self):
        print("sock 1  ", end='')
        self.method2()

    def __str__(self):
        return "sock"
```

Given the classes above, what output is produced by the following code?

```
elements = [Book(), Pen(), Lamp(), Sock()]
for i in range(0, len(elements)):
    print(elements[i])
    elements[i].method1()
    print()
    elements[i].method2()
    print()
    print()
```

3. Dictionary/Set Mystery

Consider the following method:

```
def mystery(list1, list2):
    result = {}
    for i in range(0, len(list1)):
        result[list1[i]] = list2[i]
        result[list2[i]] = list1[i]
    return result
```

The three entries below specify values for the first and second parameters to method `mystery`. For each entry, indicate what values would be stored in the dictionary returned by function `mystery` if the given lists are passed as parameters. Dictionary elements should be listed with "key:value" elements, as in {`'b' :'z'`, `'d' :'b'`}.

list1: `['b', 'l', 'u', 'e']` list2: `['s', 'p', 'o', 't']`

dictionary returned:_____

list1: `['k', 'e', 'e', 'p']` list2: `['s', 'a', 'f', 'e']`

dictionary returned:_____

list1: `['s', 'o', 'b', 'e', 'r']` list2: `['b', 'o', 'o', 'k', 's']`

dictionary returned:_____

4. **Dictionary/Set Programming**.

Write a function `union(m1,m2)` that accepts two dictionaries (whose keys and values are both integers) as parameters, and returns a new dictionary that represents a merged union of the two original dictionaries. The "union" of two dictionaries *m1* and *m2* is a new dictionary that contains every key from *m1* and every key from *m2*. Each value stored in your "union" dictionary should be the sum of the corresponding value(s) for that key in *m1* and *m2*. If the key exists in only one of the two dictionaries, that dictionary's corresponding value should be used.

For example, consider the dictionaries `m1` and `m2` with the following key/value pairs:

```
m1 is {7:1, 18:5, 42:3, 76:10, 98:2, 234:50}
m2 is {7:2, 11:9, 42:-12, 98:4, 234:0, 9999:3}
```

The call of `union(m1, m2)` should return a dictionary that contains the following key/value pairs:

{**7:3**, 11:9, 18:5, **42:-9**, 76:10, **98:6**, **234:50**, 9999:3}

The key 98 exists in both dictionaries, so the new dictionary contains the sum of its values from the two dictionaries, (2 + 4 = 6). The key 9999 exists in only one of the two dictionaries, so its sole value of 3 is stored as its value in the resulting dictionary.

(Problem 4. description continues on next page.)

Either dictionary passed in (or both) could be empty. Though the pairs are shown in sorted order by key above, you should not assume that the dictionaries passed to you store their keys in sorted order.

You may create one collection (list, dictionary, set) of your choice as auxiliary storage to solve this problem. You can have as many simple variables as you like. You should not modify the contents of the dictionaries passed to your function.

5. String Programming

Write a function called `encode` that takes a string `s` and an integer `n` as parameters and that returns a new string that scrambles the order of the characters from `s` in a particular way. Taking the characters from `s` in order, imagine filling a grid of `n` rows column by column. When `s` is "abcdefghijklmnopqrstuvwxyz" and `n` is 3, you get:

```
row 1:  a d g j m p s v y
row 2:  b e h k n q t w z
row 3:  c f i l o r u x
```

The function should return the result of concatenating these characters together with row 1 first, then row 2, and then row 3. Notice that the final row will not necessarily be complete, as in the example above where the final row has two fewer characters. Consider the following call to `encode`:

```
encode("abcdefghijklmnopqrstuvwxyz", 3)
```

The resulting string should be "`adgjmpsvybehknqtwzcfilorux`". The string parameter might contain any characters, including spaces. For example, the call:

```
encode("four score and seven", 4)
```

returns "`f rneosedvuc eroasn`" because the following grid would be produced:

```
row 1:  f  r n e
row 2:  o s e d v
row 3:  u c   e
row 4:  r o a s n
```

You may assume that the string passed as a parameter is not empty and that the integer passed as a parameter is greater than or equal to 1 and less than the length of the string. You are not allowed to construct any structured objects other than strings to solve this problem (that is, no list, list of lists, etc).

6. List of Lists Programming

Write a function called `num_unique` that takes a list of lists as a parameter and returns the number of unique values stored in it. For example, if you have the following list of lists:

```
lis = [[1, 2, 3], [4, 3, 2, 1], [6, 7, 7], [8]]
```

a call to `num_unique(lis)` should return 7. You may create one other data structure to help you solve this problem.

7. List Programming

Write a function named `longest_sorted_sequence` that accepts a list of integers as a parameter and that returns the length of the longest sorted (nondecreasing) sequence of integers in the list. For example, consider a variable named `lis` set to the following values:

```
lis = [3, 8, 10, 1, 9, 14, -3, 0, 14, 207, 56, 98, 12]
```

Then the call of `longest_sorted_sequence(lis)` should return `4` because the longest sorted sequence in the list has four values in it (the sequence -3, 0, 14, 207). Notice that sorted means nondecreasing, which means that the sequence could contain duplicates. For example, consider a variable named `lis2` set to the following values:

```
lis2 = [17, 42, 3, 5, 5, 5, 8, 2, 4, 6, 1, 19]
```

Then the function would return `5` for the length of the longest sequence (the sequence 3, 5, 5, 5, 8). Your function should return 0 if passed an empty list. Your function should return 1 if passed a list that is entirely in decreasing order or contains only one element.

8. Critters

Write a class `Bumblebee` that extends the `Critter` class from the Critters assignment.
A `Bumblebee` object should move in a "spiral" pattern from W to S to E to N, lengthening each time:

- one step west
- two steps south
- three steps east
- four steps north
- five steps west
- six steps south
- seven steps east
- eight steps north
- nine steps west

  ...

All other `Bumblebee` behavior uses the `Critter` defaults. You may add anything needed, such as instance variables (attributes) or additional methods, to implement this behavior appropriately.

9. Classes and Objects

Suppose that you are provided with a pre-written class `Rectangle` as described at right. (The headings are shown, but not the method bodies, to save space.) Assume that the attributes, constructor, and methods shown are already implemented. You may refer to them or use them in solving this problem if necessary.

Write a method named **`union`** that will be placed inside the `Rectangle` class to become a part of each `Rectangle` object's behavior. The `union` method accepts another rectangle *r* as a parameter and turns this rectangle into the union of itself and *r* ; that is, modifies the attributes so that they represent the smallest rectangular region that completely contains both this rectangle and *r*.

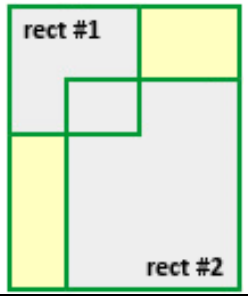
For example, if the following `Rectangle` objects are created as in the code below:

```
rect1 = Rectangle(5, 12, 4, 6)
rect2 = Rectangle(6,  8, 5, 7)

rect3 = Rectangle(14, 9, 3, 3)
rect4 = Rectangle(10, 3, 5, 8)
```

Then the following calls to the `union` method would modify the objects' state as indicated in the comments.

```
rect1.union(rect2)    # {(5, 8), 6x10}
rect4.union(rect3)    # {(10, 3), 7x9}
```

```
# A Rectangle stores an (x, y)
# coordinate of its top/left
# corner, a width and height.

class Rectangle:

    # Constructs a new Rectangle
    # with the given x,y,w,h.
    def __init__(self, x, y, w, h:
        self.__x = x
        self.__y = y
        self.__width = w
        self.__height = h

    # returns the attribute values
    def getx(self):
        return self.__x
    def gety(self):
        return self.__y
    def get_width(self):
        return self.__width
    def get_height(self):
        return self.__height

    # example: {(5, 12), 4x6}
    def  __str__(self):
      …


    # your method would go here
```



CSc 110 Sample Final Exam #2 Solutions

1. While Loop Simulation

Method Call	Value Returned
`mystery(2, 9)`	0
`mystery(5, 1)`	6
`mystery(38, 5)`	119
`mystery(5, 5)`	0
`mystery(40, 10)`	57

2. Inheritance Mystery

```
sock
sock 1  book 2  lamp 2
book 2  lamp 2

sock
pen 1
lamp 2

lamp
lamp 1
lamp 2

sock
sock 1  lamp 2
lamp 2
```

3. Dictionary/Set Mystery

```
list1 = ['b', 'l', 'u', 'e']
list2 = ['s', 'p', 'o', 't']

dictionary returned: {b=s, e=t, l=p, o=u, p=l, s=b, t=e, u=o}

list1: ['k', 'e', 'e', 'p']
list2: ['s', 'a', 'f', 'e']
dictionary returned: {a=e, e=p, f=e, k=s, p=e, s=k}

list1 = ['s', 'o', 'b', 'e', 'r']
list2 = ['b', 'o', 'o', 'k', 's']
dictionary returned: {b=o, e=k, k=e, o=b, r=s, s=r}
```

4. Dictionary/Set Programming

```
def union(m1, m2):
   result = {}
   for key, value in m1.items():
       result[key] = value
   for key, value in m2.items():
       if (key in result):
          result[key] = result[key] + value
      else:
          result[key] = value
   return result
```

5. String Programing

```
      def encode(s, n):
          result = ""
          for j in range(0, n):
              for i in range(0, len(s) - j, n):
                  result += s[i + j]
          return result
```

6. List of Lists Programming

```
def num_unique(lis):
    unique = set()
    for i in range(0, len(lis)):
        for j in range(0, len(lis[i])):
            unique.add(lis[i][j])
    return len(unique)
```

7. List Programming

```
   def longest_sorted_sequence(list):
       if (len(list) == 0):
           return 0

       max = 1
       count = 1
       for i in range(1, len(list)):
           if (list[i] >= list[i - 1]):
               count += 1
           else:
               count = 1

           if (count > max):
               max = count
       return max
```

8. Critters

```
class Bumblebee(Critter):
    def __init__(self):
        super(Bumblebee, self).__init__()
        self.__steps = 0
        self.__max = 1
        self.__direction = 0   # 0=west, 1=south, 2=east, 3=north

    def get_move(self):
        self.__steps += 1
        if (self.__steps > self.__max):
            # Pick a new direction and re-set the steps counter
            self.__steps = 1
            self.__max += 1
            self.__direction = (self.__direction + 1) % 4

        if (self.__direction == 0):
            return DIRECTION_WEST
        elif (self.__direction == 1):
            return DIRECTION_SOUTH
        elif (self.__direction == 2):
            return DIRECTION_EAST
        else:  # self.__direction == 3
            return DIRECTION_NORTH
```

9. Classes

```
def union(self,r):
        # find the union's bounds
        left = min(self.__x, r.getx())
        top = min(self.__y, r.gety())
        right = max(self.__x + self.__width, r.getx() + r.get_width())
        bottom = max(self.__y + self.__height, r.gety() + r.get_height())

        self.__x = left
        self.__y = top
        self.__width = right - left
        self.__height = bottom - top
```