1. While Loop Simulation

For each call of the function below, write the output that is printed:

```python
def mystery(i, j):
    while (i != 0 and j != 0):
        i = i // j
        j = (j - 1) // 2
        print(str(i) + " " + str(j) + " ", end='')
    print(i)
```

<table>
<thead>
<tr>
<th>Function Call</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>mystery(5, 0)</td>
<td></td>
</tr>
<tr>
<td>mystery(3, 2)</td>
<td></td>
</tr>
<tr>
<td>mystery(16, 5)</td>
<td></td>
</tr>
<tr>
<td>mystery(80, 9)</td>
<td></td>
</tr>
<tr>
<td>mystery(1600, 40)</td>
<td></td>
</tr>
</tbody>
</table>
2. Inheritance Mystery
Assume that the following classes have been defined:

```python
class A(B):
    def method2(self):
        print("a 2 ", end='')
        self.method1()

class B(C):
    def __str__(self):
        return "b"
    def method2(self):
        print("b 2 ", end='')
        super(B, self).method2()

class C:
    def __str__(self):
        return "c"
    def method1(self):
        print("c 1 ", end='")
    def method2(self):
        print("c 2 ", end='')

class D(B):
    def method1(self):
        print("d 1 ", end='')
    def method2(self)
```

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

```python
elements = [A(), B(), C(), D()]
for i in range(0, len(elements)):
    print(elements[i])
    elements[i].method1()
    print()
    elements[i].method2()
    print()
```

3. Collections Mystery
Consider the following method:

```python
def mystery(data, pos, n):
    result = set()
    for i in range(0, n):
        for j in range(0, n):
            result.add(data[i + pos][j + pos])
    return result
```

Suppose that a variable called grid has been declared as follows:

```python
grid = [[8, 2, 7, 8, 2, 1], [1, 5, 1, 7, 4, 7],
        [5, 9, 6, 7, 3, 2], [7, 8, 7, 7, 9],
        [4, 2, 6, 9, 2, 3], [2, 2, 8, 1, 1, 3]]
```

which means it will store the following 6-by-6 grid of values:

```
8 2 7 8 2 1
1 5 1 7 4 7
5 9 6 7 3 2
7 8 7 7 7 9
4 2 6 9 2 3
2 2 8 1 1 3
```

For each call below, indicate what value is returned. If the function call results in an error, write "error" instead.

<table>
<thead>
<tr>
<th>Function Call</th>
<th>Contents of Set Returned</th>
</tr>
</thead>
<tbody>
<tr>
<td>mystery(grid, 2, 2)</td>
<td>__________________________</td>
</tr>
<tr>
<td>mystery(grid, 0, 2)</td>
<td>__________________________</td>
</tr>
<tr>
<td>mystery(grid, 3, 3)</td>
<td>__________________________</td>
</tr>
</tbody>
</table>
4. List Programming

Write a function named `is_unique` that takes a list of integers as a parameter and that returns a boolean value indicating whether or not the values in the list are unique (True for yes, False for no). The values in the list are considered unique if there is no pair of values that are equal. For example, if a variable called `list` stores the following values:

```python
list = [3, 8, 12, 2, 9, 17, 43, -8, 46, 203, 14, 97, 10, 4]
```

Then the call of `is_unique(list)` should return `True` because there are no duplicated values in this list.

If instead the list stored these values:

```python
list = [4, 7, 2, 3, 9, 12, -47, -19, 308, 3, 74]
```

Then the call should return `False` because the value 3 appears twice in this list. Notice that given this definition, a list of 0 or 1 elements would be considered unique.

5. Dictionary/Set Programming

Write a function called `count_in_area_code` that accepts two parameters, a dictionary from names (strings) to phone numbers (strings) and an area code (as a string), and returns how many unique phone numbers in the map use that area code. For example, if a map `m` contains these pairs:

```python
{Marty=206-685-2181, Rick=520-206-6126, Beekto=206-685-2181,
 Jenny=253-867-5309, Stuart=206-685-9138, DirecTV=800-494-4388,
 Bob=206-685-9138, Benson=206-616-1246, Hottline=900-520-2767}
```

The call of `count_in_area_code(m, "206")` should return 3, because there are 3 unique phone numbers that use the 206 area code: Marty/Beekto's number of "206-685-2181", Stuart/Bob's number of "206-685-9138", and Benson's number of "206-616-1246".

You may assume that every phone number value string in the dictionary will begin with a 3-digit numeric area code, and that the area code string passed will be a numeric string exactly 3 characters in length. If the dictionary is empty or contains no phone numbers with the given area code, your function should return 0.

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 dictionary passed to your function.
6. Programming
Write a function called \texttt{same\_pattern} that returns true or false depending upon whether two strings have the same pattern of characters. More precisely, two strings have the same pattern if they are of the same length and if two characters in the first string are equal if and only if the characters in the corresponding positions in the second string are also equal. Below are some examples of patterns that are the same and patterns that differ (keep in mind that the method should return the same value no matter what order the two strings are passed).

<table>
<thead>
<tr>
<th>1st String</th>
<th>2nd String</th>
<th>Same Pattern?</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;&quot;</td>
<td>&quot;&quot;</td>
<td>True</td>
</tr>
<tr>
<td>&quot;a&quot;</td>
<td>&quot;x&quot;</td>
<td>True</td>
</tr>
<tr>
<td>&quot;a&quot;</td>
<td>&quot;ab&quot;</td>
<td>False</td>
</tr>
<tr>
<td>&quot;ab&quot;</td>
<td>&quot;ab&quot;</td>
<td>True</td>
</tr>
<tr>
<td>&quot;aa&quot;</td>
<td>&quot;xy&quot;</td>
<td>False</td>
</tr>
<tr>
<td>&quot;aba&quot;</td>
<td>&quot;+-+&quot;</td>
<td>True</td>
</tr>
<tr>
<td>&quot;---&quot;</td>
<td>&quot;aba&quot;</td>
<td>False</td>
</tr>
<tr>
<td>&quot;abcabc&quot;</td>
<td>&quot;zodzod&quot;</td>
<td>True</td>
</tr>
<tr>
<td>&quot;abcabd&quot;</td>
<td>&quot;zodzoe&quot;</td>
<td>True</td>
</tr>
<tr>
<td>&quot;abcabc&quot;</td>
<td>&quot;xxxxxx&quot;</td>
<td>False</td>
</tr>
<tr>
<td>&quot;aaasscccnn&quot;</td>
<td>&quot;aaabbbcccd&quot;</td>
<td>True</td>
</tr>
<tr>
<td>&quot;asasasasas&quot;</td>
<td>&quot;xyxyxyxyxy&quot;</td>
<td>True</td>
</tr>
<tr>
<td>&quot;ascneencsa&quot;</td>
<td>&quot;aeiouuoiea&quot;</td>
<td>True</td>
</tr>
<tr>
<td>&quot;aaasscccnn&quot;</td>
<td>&quot;aaabbbcccd&quot;</td>
<td>True</td>
</tr>
<tr>
<td>&quot;asasasasas&quot;</td>
<td>&quot;xxxxxyyyyy&quot;</td>
<td>False</td>
</tr>
<tr>
<td>&quot;ascneencsa&quot;</td>
<td>&quot;aeiouaeiou&quot;</td>
<td>False</td>
</tr>
<tr>
<td>&quot;aaasscccnn&quot;</td>
<td>&quot;xxxxyyzzzz&quot;</td>
<td>False</td>
</tr>
<tr>
<td>&quot;aaassiiii&quot;</td>
<td>&quot;gggdddfhh&quot;</td>
<td>False</td>
</tr>
</tbody>
</table>

Your function should take two parameters: the two strings to compare. You are allowed to create new strings, but otherwise you are not allowed to construct extra data structures to solve this problem (no list, set, dictionary, etc). You are limited to the string functions on the cheat sheet.

7. 2-d Lists
Write a function called \texttt{find\_max} that takes a two dimensional list as a parameter and returns the number of the row that sums to the greatest value. For example if you had the following list of lists:
\begin{verbatim}
list = [[[1, 2, 3], [2, 3, 3], [1, 3, 3]]
\end{verbatim}
The first row would be 6, the second 8 and the third 7. The function would therefore return 1. You can assume the passed in list of lists has at least one row and one column. You cannot assume that it is square.

8. Critters
Write a class \texttt{Ostrich} that extends the \texttt{Critter} class from the Critters assignment, including its \texttt{get\_move} and \texttt{get\_color} methods. An \texttt{Ostrich} object first stays in the same place for 10 moves, then moves 10 steps to either the WEST or the EAST, then repeats. In other words, after sitting still for 10 moves, the ostrich randomly picks to go west or east, then walks 10 steps in that same direction. Then it stops and sits still for 10 moves and repeats. Whenever an \texttt{Ostrich} is moving (that is, whenever its last call to \texttt{get\_move} returned a direction other than \texttt{DIRECTION\_CENTER}), its color should be white ("white"). As soon as it stops moving, and initially when it first appears in the critter world, its color should be cyan ("cyan"). When randomly choosing west vs. east, the two directions should be equally likely.

You may add anything needed (fields, other methods) to implement the above behavior appropriately. All other critter behavior not discussed here uses the default values.
9. Classes and Objects

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

Write an instance method named `compare` that will be placed inside the `Date` class to become a part of each `Date` object's behavior. The `compare` method accepts another `Date` as a parameter and compares the two dates to see which comes first in chronological order. It returns an integer with one of the following values:

- a negative integer (such as -1) if the date represented by this `Date` comes before that of the parameter
- 0 if the two `Date` objects represent the same month and day
- a positive integer (such as 1) if the date represented by this `Date` comes after that of the parameter

For example, if these `Date` objects are declared in client code:

```
sep19 = Date(9, 19)
dec15 = Date(12, 15)
temp = Date(9, 19)
sep11 = Date(9, 11)
```

The following `boolean` expressions should have `True` results.

```
sep19.compare(sep11) > 0
sep11.compare(sep19) < 0
temp.compare(sep19) == 0
dec15.compare(sep11) > 0
```

Your method should not modify the state of either `Date` object (such as by changing their `day` or `month` field values).
Solutions

1. While Loop Simulation

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>mystery(5, 0)</td>
<td>5</td>
</tr>
<tr>
<td>mystery(3, 2)</td>
<td>1 0 1</td>
</tr>
<tr>
<td>mystery(16, 5)</td>
<td>3 2 1 0 1</td>
</tr>
<tr>
<td>mystery(80, 9)</td>
<td>8 4 2 1 2 0 2</td>
</tr>
<tr>
<td>mystery(1600, 40)</td>
<td>40 19 2 9 0 4 0</td>
</tr>
</tbody>
</table>

2. Inheritance Mystery

```
    b
c 1
a 2  c 1
    b
c 1
b 2  c 2
    c
c 1
c 2
    b
d 1  b 2  c 2
b 2  c 2
```

3. Collections Mystery

<table>
<thead>
<tr>
<th>Function Call</th>
<th>Contents of Set Returned</th>
</tr>
</thead>
<tbody>
<tr>
<td>mystery(grid, 2, 2)</td>
<td>[6, 7]</td>
</tr>
<tr>
<td>mystery(grid, 0, 2)</td>
<td>[1, 2, 5, 8]</td>
</tr>
<tr>
<td>mystery(grid, 3, 3)</td>
<td>[1, 2, 3, 7, 9]</td>
</tr>
</tbody>
</table>

4. List Programming

```python
def is_unique(list):
    for i in range(1, len(list)):
        for j in range(i, len(list)):
            if list[i - 1] == list[j]:
                return False
    return True
```

5. Collections Programming

```python
def count_in_area_code(numbers, area_code):
    unique_numbers = set()
    for name, phone in numbers.items():
        if (phone[0:3] == area_code):
            unique_numbers.add(phone)
    return len(unique_numbers)
```
6. Programming

```python
def same_pattern(s1, s2):
    if (len(s1) != len(s2)):
        return False
    for i in range(0, len(s1)):
        for j in range(i + 1, len(s1)):
            if (s1[i] == s1[j] and s2[i] != s2[j]):
                return False
            if (s2[i] == s2[j] and s1[i] != s1[j]):
                return False
    return True
```

7. 2d Lists

```python
def find_max(lis):
    max_sum = 0
    max_row = 0
    for i in range(0, len(lis)):
        cur_sum = 0
        cur_row = i
        for j in range(0, len(lis[i])):
            cur_sum += lis[i][j]
            if cur_sum > max_sum:
                max_sum = cur_sum
                max_row = cur_row
    return max_row
```

8. Critters

```python
class Ostrich(Critter):
    def __init__(self):
        super(Ostrich, self).__init__()
        self.__hiding = True
        self.__steps = 0
        self.__west = randint(0, 1) == 0

    def get_color(self):
        if (self.__hiding):
            return "cyan"
        else:
            return "white"

    def get_move(self):
        if (self.__steps == 10):
            self.__steps = 0  # Pick a new direction and re-set the steps counter
            self.__hiding = not self.__hiding
            self.__west = randint(0, 1) == 0

            self.__steps += 1
            if (self.__hiding):
                return DIRECTION_CENTER
            elif (self.__west):
                return DIRECTION_WEST
            else:
                return DIRECTION_EAST
```

9. Classes

```python
def compare(other):
    if (self.__month < other.__month or (self.__month == other.__month and self.__day < other.__day)):
        return -1
    elif (self.__month == other.__month and self.__day == other.__day):
        return 0
    else:
        return 1
```