1 Functions on Lists

(a) The even-odd sort of a list that has even length permutes entries so that all the even-index entries come first followed by all the odd-indexed entries. To illustrate, suppose we have the following length-8 list:

```
'a' 'b' 'c' 'd' 'e' 'f' 'g' 'h'
```

Here are the length-4 lists of the even-indexed entries and the odd-indexed entries:

```
'a' 'c' 'e' 'g'  'b' 'd' 'f' 'h'
```

And here is the even-odd sort of the above length-8 list:

```
'a' 'c' 'e' 'g'  'b' 'd' 'f' 'h'
```

This operation could — but for this question you are not allowed to do so — can be carried out very simply using list slicing and list concatenation: indeed, if $x$ has length $n$ and $n$ is even, then the list $x[0:n:2] + x[1:n:2]$ is the even-odd sort of $x$. Implement the following procedure so that it performs as specified, using just for-loops and subscripting. No list slicing or list concatenation allowed.

```
def EvenOddSort(x):
    # Performs an even-odd sort of x
    # Precondition: x is a list with even length

    # Note that EvenOddSort does not return any values. Again, no list slicing or list concatenation allowed.

    # For a hint on important and potentially common errors, see this footnote.¹
```

(b) Assuming that the procedure EvenOddSort is available, implement the following function so that it performs as specified:

```
def MultipleSort(x,N):
    # Returns a list obtained by performing N even-odd sorts of the list x. The list x is not altered.

    # Precondition: x is a list with even length and N is a positive int.

    # Use a loop that calls EvenOddSort N times. (Don’t try to do some fancy “if N is even, I’ll get the same list back” type of reasoning.)

    # Some notes on potential errors in this footnote.²
```

¹ Don't change the list while constructing an even-odd-sorted version, and if $y$ is your even-odd sorted version, don't just do $x = y$! (Why?)

² EvenOddSort doesn't return anything. Don't operate on $x$ or you'll change it.
2 Farthest Point

Assume the existence of the following class, and that the command `import math` has been included beforehand.

```python
class Point(object):
    # Attributes:
    # x  the x-coordinate  [float]
    # y  the y-coordinate  [float]
    def __init__(self,x,y):
        self.x = x
        self.y = y
    def Dist(self,other):
        # Returns a float that is the distance from self to other.
        # Precondition: other is a Point
        return math.sqrt((self.x-other.x)**2+(self.y-other.y)**2)
```

Complete the following function so that it performs as specified

```python
def FarthestPt(L,idx,P):
    # Returns an integer j with the property that the distance from
    # L[j] to P is maximum among all the ***unvisited*** points.
    if idx[i] = 1, then we say that L[i] has been visited. If idx[i] = 0, then
    we say that L[i] is unvisited.
    Preconditions: L is a list of references to Point objects, P is a reference
to a point object, and idx is a list of ints that are either zero or 1. The
lists idx and L have the same length and idx has at least one zero entry.

3 Nested Loops

1. What is the output if the following is executed?

```python
s = "abcd"
for i in range(4):
    for j in range(i+1,4):
        print i, j, s[i]+s[j]
```

2. For each key in dictionary D, write down the key and corresponding value in D.

```python
D1 = {'a':'one', 'b':'two', 'c': 'three', 'd':'four'}
D2 = {'c':'five', 'd':'six', 'e': 'seven', 'f':'eight'}
D = {}
for d in D1:
    D[d] = D1[d]
```
for d in D2:
    D[d] = D2[d]

4 More work with lists, which are objects

(a) If the following is executed, then what are the first five lines of output?

```python
x = [10, 20, 30]
for k in range(1000):
    print "k: ", k, "x in the loop", x
    x.append(x[0])
    x = x[1:4]
```

(b) If the following is executed, then what is the output? For full credit you must also draw two state diagrams. The first should depict the situation just after the Q.x = 0 statement and the second should depict the situation just after the P = Point(7,8) statement.

```python
P = Point(3, 4)
Q = P
Q.x = 0
print Q.x, Q.y, P.x, P.y
P = Point(7, 8)
print Q.x, Q.y, P.x, P.y
```

(c) If the following is executed, then what is the output?

```python
x = [10, 20, 30, 40]
y = x
for k in range(4):
    print "x is", x
    print "y is", y
    print "...."
    x[k] = y[3-k]
print x
```

5 Dictionaries

(a) Complete the following function so that it performs as specified

```python
def F(s,D):
    """ Returns True if s is a key for D and every element in D[s] is also a key in D. Otherwise returns False.
    """

    Precondition: s is a nonempty string and D is a dictionary whose keys are strings and whose values are lists of strings.

    """
```
6 Methods and Lists of Objects

Assume the availability of the following class:

class City(object):
    
    attributes:
        name      the name of a city [str]
        high: the record high temperatures [length-12 list of int]
        low: the record low temperatures [length-12 list of int]

    def __init__(self,cityName,high,low):
        
        self.name = cityName
        self.high = high
        self.low = low

(a) Complete the following method for the class City so that it performs as specified.

    def HotMonths(self):
        
        Returns the number of months where the record high
        is strictly greater than 80.

(b) Complete the following method for the class City so that it performs as specified. Your implementation
    must make effective use of the method above.

    def Hotter(self,other):
        
        Returns True if the city encoded in self has strictly more
        hot months than the city encoded in other.

        A month is hot if the record high for that month is > 80

        PreC: other is a city object

(c) Complete the following method for the class City so that it performs as specified.

    def Variation(self):
        
        Returns a length 12 list of ints whose k-th entry
        is the record high for month k minus the record low for month k.

(d) Complete the following method for the class City so that it performs as specified.

    def Exaggerate(self):
        
        Modifies self.high so that each entry is increased by 1
        and modifies self.low so that each entry is decreased by 1.
(e) Complete the following function so that it performs as specified. Assume that the methods in parts (a) and (b) are available; your implementation must make effective use of them.

```python
def Hottest(C):
    """ Returns an item from C that represents the city that has the most hot months.
    PreC: C is a list of references to City objects
    """
```