CSE101 – Midterm 2 Review

1. Assume a list is defined with this statement:
   >>> halogens = ['F', 'Cl', 'Br', 'I', 'At']

   Explain how the list would be sorted by a call to isort. The easiest way to do this is to show the lines that would be displayed by the print statement that displays the sorted and unsorted regions. Here are the first two lines, to get you started:

   > >>> isort(halogens)
   >
   > ['F'] ['Cl', 'Br', 'I', 'At']
   >
   > ['Cl', 'F'] ['Br', 'I', 'At']
   >
   > ['Br', 'Cl', 'F'] ['I', 'At']
   >
   > ['Br', 'Cl', 'F', 'I'] ['At']
   >
   > ['At', 'Br', 'Cl', 'F', 'I']

2. Below is a test list with 16 numbers. Show how this list would be sorted by a call to msort. The easiest way to do this is to show the groups before each round of merges.
   1 99 3 47 50 37 79 71 15 51 87 28 19 93 91 70

   > The initial groups are given as below:
   >
   > [1] [99] [3] [47] [50] [37] [79] [71] [15] [51] [87] [28] [19] [93] [91] [70]
   >
   > After calling merge_groups with size 1
   >
   > _[1 99] [3 47] [37 50] [71 79] [15 51] [28 87] [19 93] [70 91] _____
   >
   > After calling merge_groups with size 2
   >
   > _[1 3 47 99] [37 50 71 79] [15 28 51 87] [19 70 91 93]_____
   >
   > After calling merge_groups with size 4
   >
   > _[1 3 37 47 50 71 79 99] [15 19 28 51 70 87 91 93]_____
   >
   > After calling merge_groups with size 8
   >
   > _[1 3 15 19 28 37 47 50 51 70 71 79 87 91 93 99] _____

3. Write assignment statements that create dictionaries for the following sets of data:
   • The months of the year, using first three letters of month names as the keys and numbers from 1 to 12 as values.

   • The colors of the rainbow are VIOLET, INDIGO, BLUE, GREEN, YELLOW, ORANGE, and RED. Using the letters in the acronym VIBGYOR as keys and these colors as values, place them in the *colors* dictionary. (4 pts)

months = { 'jan': 1, 'feb': 2, 'mar': 3, 'apr': 4, 'may': 5, 'jun': 6, 'jul': 7, 'aug': 8, 'sep': 9, 'oct': 10, 'nov': 11, 'dec': 12}

colors = ___{'V': 'Violet', 'I': 'Indigo', 'B': 'Blue', 'G': 'Green', 'Y': 'Yellow', 'O': 'Orange', 'R': 'Red'}_____

_____

4. Complete the following function with recursion to convert the integer n to a string of binary representation. E.g. dec2bin(15) = 1111

```
def dec2bin(n):
    if n < 0:
        _return 'Must be a positive integer'_____
    elif n == 0:
        __return ''_____
    else:
        ___return dec2bin(n//2) + str(n%2) _____
```

5. Write iterative and recursive functions to reverse a list of elements.

```
def reverse(a):
            newlist = []
            for item in a:
                newlist = [item] + newlist
                print ("item = ", item, " newlist = ", newlist)
            return newlist


def recursiveReverse(a):

    #base
    if len(a) == 0:
        return []
    else:
        return [a[-1]] + recReverse(a[:-1])
```

6. Write a recursive function to sum elements in a list of numbers.

```
def sumList(a):
    # base
    if len(a) == 0:
        return 0
    return a[0] + sumList(a[1:])
```

7. **Output analysis: For the following sub-questions, write the output of python code lines in the space provided.**

A) Suppose a list a is defined with this statement:

>>> a = [11, 0, 6, 12, 7, 8, 3, 15, 4, 10]

How many comparisons will be made by the following searches using the linear search method? (4 pts)

> a. isearch(a, 0) __-> 2_____
>
> b. isearch(a, 3) __-> 7_____
>
> c. isearch(a, 9) __-> 10_____
>
> d. isearch(a, 10) __-> 10_____

B) Suppose a variable s has been defined with this assignment statement:

>>> s = "To be, or not to be, that is the Question:"

What will Python print for each of the following statements?

> a. >>> print(s) _____->To be, or not to be, that is the Question:_____
>
> b. >>> print(len(s)) _____->42_____
>
> c. >>> print(s.split()) _____->['To', 'be,', 'or', 'not', 'to', 'be,', 'that', 'is', 'the', 'Question:']_____
>
> d. >>> import string
>
>   >>> print(s.strip(string.punctuation)) _____->'To be, or not to be, that is the Question'_____

C) Suppose a dictionary object is defined with the following statement:

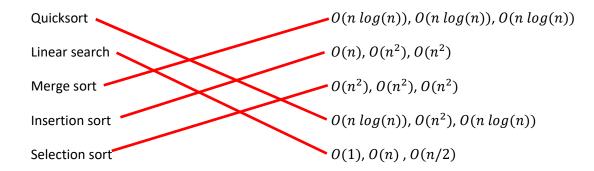>>> d = {'M':1000, 'D':500, 'C':100, 'L':50, 'X':10, 'V':5, 'I':1}

What will Python print as the value of the following expressions?

> a. >>> len(d) _____-> 7_____
>
> b. >>> d['X'] _____-> 10_____
>
> c. >>> d['Z'] _____-> KeyError: 'Z'_____
>
> d. >>> 'Q' in d _____-> False_____
>
> e. >>> 5 in d _____-> False_____
>
> f. >>> list(d.keys()) _____-> ['M', 'D', 'C', 'L', 'X', 'V', 'I']_____

7. **Objective questions:**

A) Suppose somelist = [1, 2, 0]. Which of the following will change somelist to [2, 1, 0]?

> a. somelist.insert(somelist.pop(2), 0)
>
> b. somelist.insert(somelist.pop(1), 0)
>
> c. somelist.insert(0, somelist.pop(2))
>
> d. somelist.insert(0, somelist.pop(1))

B) Which of the following algorithms uses the strategy divide and conquer?
   a. Linear Search Algorithm
   b. Luhn Algorithm
   c. **Binary Search Algorithm**
   d. Insertion Sort Algorithm

C) Which of the following statements is false?
   a. The strategy for the linear search and insertion sort algorithms is the same: iterate over every location in the list and perform some operation.
   b. **For any list containing n items, binary search requires roughly n comparisons to find the target element.**
   c. A successful search in a binary search algorithm might return after the first comparison.
   d. Merge Sort and Quicksort are two divide-and-conquer sorting algorithms.

D) Given a list a = [1,3,5,7,9,11] and target element to be 9; what are the mid values (corresponding array elements) in the binary search iterations?
   a. **5 and 9**
   b. 7 and 10
   c. 8 and 9
   d. 8 and 10

E) Given a list a = [1, 2, 3, 5, 8, 13, 21, 34]. How many iterations required to find 2 using the binary search algorithm?
   a. 1
   b. 2
   c. **3**
   d. 4

F) Match the searching/sorting algorithm and its best, worst and average complexity.

Quicksort $O(n\ log(n)), O(n\ log(n)), O(n\ log(n))$

Linear search $O(n), O(n^2), O(n^2)$

Merge sort $O(n^2), O(n^2), O(n^2)$

Insertion sort $O(n\ log(n)), O(n^2), O(n\ log(n))$

Selection sort $O(1), O(n), O(n/2)$

8. Use Caeser Cipher technique with right shift of 3 letters (e.g. A is shifted to D) for encrypting the following message:

'The pen is mightier than the sword.'

9. Use Caeser Cipher technique with right shift of 3 letters (e.g. A is shifted to D) for decrypting the following message:

'Wkh shq lv pljkwlhu wkdq wkh vzrug.'

10. An encryption formula for multiplicative cipher is E(x) = kx mod 26 where x is the position of letter in English alphabet and k is a key. E.g. suppose the key is 7.
    - The letter A (0) is mapped to (0x7) mod 26 = 0, which is also A.
    - The letter J (9) is mapped to (9x7) mod 26 = 11, which is L.

    Encrypt the following message using above strategy:
    YELLOW SEA

11. An affine cipher combines ideas from the shift cipher and multiplicative cipher, performing both a multiplication and an addition.
    - The value x of some letter is encrypted using the formula (ax+b) mod 26 where a is the multiplier and b is the shift amount
    - a and b together from the encryption key.

    E.g. if a = 7 and b = 3, then
    - The letter A(0) is mapped to (0x7 + 3) mod 26 = 3, which is D.
    - The letter J (9) is mapped to (9x7 + 3) mod 26 = 14, which is O.

    Encrypt the following message using affine cipher:
    SUMMER IS LOVELY.

12. The rail fence cipher rearranges the characters in a zigzag pattern.
    - The key is the number of rows used to create the zigzag
    - For example, the message STONYBROOKUNIV written over two rows would look like this:

    S   O   Y   R   O   U   I

       T   N   B   O   K   N   V

    - To produce the final encrypted message read off the characters row-by-row:

    SOYROUITNBOKNV

    Use rail fence cipher with key = 2 to encrypt the following message:
    MISSISSIPI RIVER (Consider " " as a separate character).
    Use rail fence cipher with key = 2 to decrypt the following message:
    MSISP IEISSIIRVR

Cryptography Objective questions:

Input message in Cryptography is called;

(a)   Plain text

(c)   Plain and cipher

(b)   Cipher Text

(d)   None of the above

Asymmetric key is also called:

(a)   Secret key   (b)   Public key

(c)   Private key   (d)   None of the above

A digital signature need a :

    (a)   Public key system

    (b)   Private key system

    (c)   Public and private key system

    (d)   None of the above

Encryption protects against:

    (a)   Attacks (b)   Viruses

    (c)   Manipulation of data   (d)   All of the above

Block cipher processes:

    (a)   1000 bits at a time

    (b)   One block of data at a time

    (c)   Both a and b

    (d)   None of the above

Decryption algorithm:

(a)   Encrypts input data

(b)   Decrypts the encrypted data

(c)   Both a and b

(d)   None of the above

Encryption strength is based on:

    (a)   Strength of algorithm

    (b)   Secrecy of key

    (c)   Length of key

    (d)   All of the above

Transposition cipher involves:

(a)   Replacement of blocks of text with other blocks

(b)   Replacement of characters of text with other character

(c)   Strict row to column replacement

(d)   Some permutation on the input text to produce cipher text

In the digital signature technique, the sender of the message uses.................to create cipher text:

(a)   Own symmetric key

(b)   Own private key

(c)   The receiver's private key

(d)   Receiver's public key