Alexandria University
Faculty of Engineering
Computer and Systems Engineering Department

CS122: Data Structures I
Assigned: Tues, Mar. 1st , 2022
Due: Monday, Feb. 7th , 2022

Sheet 1
Primitive Data Types and Arrays

1. **(Floating Points)** Floating-point numbers in a certain hexadecimal computer are to be represented using 48-bits: One for the sign, seven for the characteristic part, and forty for the mantissa.

1. What is the precision in such representation?
2. What is the largest and least positive numbers that can be represented in such system?
3. What is the limit of the relative chopping error that may be introduced in representation of a real data item?
4. How is the zero represented?

2. **(Relative Error)** Which of the following floating-point systems has the least bound of relative error in the representation of real values :

1. A system with 6 Hexadecimal digits
2. A system with 7 Decimal digits
3. A system with 8 Octal digits

3. **(Array Mapping)** Given the array `X[L1..U1, L2..U2, L3..U3, L4..U4, L5..U5];` each element in the array occupies 2 memory cells. Derive the appropriate addressing equation for an element that has the indexes `s1,s2,s3,s4,s5` and can be accessed as `X[s1][s2][s3][s4][s5],` if X is stored:

1. in a row-major order
2. in a column-major order

4. **(Sparse Matrices)** If ”S” is a pxq matrix with ”k” nonzero elements, for what values of ”k” does the coordinates-method use less storage space than ”S”? (Assume that each of the coordinates occupy the same amount of space as an element of ”S”).

5. **(Sparse Matrices)** Assume a sparse matrix X of size m x n is to be saved. The array X is estimated to have a maximum of p% nonzero elements. Each array element takes c memory cells. The number of bits required per cell is b.

1. Find the ratio between the memory spaces required to save X as a 2D-array and using the Coordinate method.
2. For what values of p does the coordinate method use less storage than the 2D-array

representation?

6. **(Triangular Matrices)** Derive the mapping function required to map between the indexes I and j of a lower triangular matrix (represented as 2D array) and the index k of the more efficient linear row-major representation of this matrix. State the range of k. Repeat for the column-major representation for symmetric matrices.

7. **(Triangular Matrices)** Write an algorithm to calculate the sum of two triangular matrices A and B.