CSC1103 Laboratory/Tutorial 11: Structures and Unions

1. Global Positioning System (GPS) is a pervasive localization system that provides real time information about the 3D position of the GPS chip device such as those install in the mobile device. Assuming the mobile application (apps) such as Google Maps make use of the 2D/3D position given by the GPS chip installed in the mobile device and calculated the two-points distance using Euclidean distance for mapping as shown below

$$d(p,q) = \sqrt{\sum_{i=1}^{N}(p_i - q_i)^2}$$

where $d(p,q)$ is the distance between two points p and q and N is the number of dimension such as 2 or 3 in 2D and 3D space respectively

Assuming that the mobile apps requires to store 10,000 points and calculate 9999 distance among each neighboring point. Write a C program for the following
   a. create a 3D GPS coordinates structure data type to define 3D points(x, y, z)
   b. create both structure data types for 2D and 3D Euclidean distance with the 3D GPS coordinates data type. Hence, create a union structure variable to store both to minimize memory usage on the mobile apps
   c. Use pointer to union/structure to create following functions
      a. a function to read the 10,000 GPS data
      b. a function to calculate the 2D and 3D Euclidean distance based on user (mobile apps) request on the dimension
      c. a function to print out the 9999 2D or 3D Euclidean distance on the screen.
   d. Determine total distance travelled

Thus design the algorithm and pseudocode before write the C program. Calculate the memory required for the union structure variable.

2. Vectors are commonly used in physics, engineering and computing science to represent direction and magnitude such as representation of forces, air/heat flow or line in computer graphics/video respectively. We can represent vector in one

dimensional array having three elements to represent 3D line, forces ,air/heat flow having three components in space namely (x, y, z) coordinates. Create a structure template and hence structure variable to represent a vector in three-dimensional space. Write a C program that uses structure and pointer to structure to perform vector operation. Your program should have separate function for

a. Reading a vector
b. Printing a vector
c. Computing the resultant of two vectors (a , b) which is the Euclidean distance in Question1
d. Computing the dot product of two vectors given as

$$\boldsymbol{a}.\boldsymbol{b} = \sum_{i=1}^{3}(a_x b_x + a_y b_y + a_z b_z)$$

where $vector\boldsymbol{a} = \begin{bmatrix} a_x \\ a_y \\ a_z \end{bmatrix}$ and $vector\boldsymbol{b} = \begin{bmatrix} b_x \\ b_y \\ b_z \end{bmatrix}$

e. The angle between two $vector$ $\boldsymbol{a}$ and $\mathbf{vector}$ $\boldsymbol{b}$ given as

$$cos\theta = \frac{a.b}{|a||b|}$$

where $|\boldsymbol{a}| = \sqrt{a_x^2 + a_y^2 + a_z^2}$ and $|\boldsymbol{b}| = \sqrt{b_x^2 + b_y^2 + b_z^2}$

Thus design the algorithm and pseudocode before write the C program.