CSC1103 Laboratory/Tutorial 6: Array

1. Sorting algorithm is one of the core engines in machine learning and the quick sort algorithm is one of them. This method is far more complicated than shell sort algorithm but is one of the fastest sorting algorithms. In quick sort algorithm, one element of the list is selected as the pivot element although it is usually the first element in the list. The elements are arranged in two partitions. If we sort the list in ascending order from left to right, then all elements in the list that are smaller than pivot element are moved into left partition. All elements that are larger than pivot element are moved into right partition. The pivot element is then placed in between the two partitions. Next the two partitions are further subdivided into two additional partitions and the quick sort algorithm is applied recursively to each partition. This process of subdivision is continued until all partitions have only one element each at which point the array is sorted.

   Design the quick sort algorithm and pseudocode with recursive function and array. Write a C program to realize it by inputting 10,000 uniform distributed random number. Compared the execution time with selection sort, shell sort and bubble sort.

2. Vector is an important concept in both engineering and computer science when we want to perform 3D field integral computation in engineering (such as stokes theorems) or video analytics/animation in 3D (such as deep learning) for computer science. Cross product property of two vectors are often used to perform Given that two vectors $\mathbf{A}$ and $\mathbf{B}$ are given as

$$\mathbf{A} = \mathrm{A}_x\boldsymbol{i} + \mathrm{A}_y\boldsymbol{j} + \mathrm{A}_z\boldsymbol{k}$$
$$\mathbf{B} = \mathrm{B}_x\boldsymbol{i} + \mathrm{B}_y\boldsymbol{j} + \mathrm{B}_z\boldsymbol{k}$$

   The cross product of two vector $\mathbf{A} \times \mathbf{B} = \mathbf{C}$

$$\mathbf{C} = (\mathrm{A}_y\mathrm{B}_z - \mathrm{A}_z\mathrm{B}_y)\boldsymbol{i} + (\mathrm{A}_z\mathrm{B}_x - \mathrm{A}_x\mathrm{B}_z)\boldsymbol{j} + (\mathrm{A}_x\mathrm{B}_y - \mathrm{A}_y\mathrm{B}_x)\boldsymbol{k}$$

   Design the algorithm and pseudocode with function and array to compute the cross product $\mathbf{C}$. Hence write a C program to evaluate it with user input of both $\mathbf{A}$ and $\mathbf{B}$ vectors. Use three arrays $a[], b[], c[]$ each containing three elements to represent the vectors. For example

$$\mathrm{B}_x = b[0], \mathrm{B}_y = b[1], \mathrm{B}_z = b[2]$$

   Write a main program to test your function.