1995 Paper 3 Question 5

Data Structures and Algorithms

For each of the following situations identify one data structure or algorithm that it would be sensible to use, and another that would in principle achieve the desired result but which would have significant disadvantages. You may identify standard methods by name and need not describe in detail how they work, but should make it clear what properties the schemes that you identify have that make some of them more appropriate than others.

(a) You need to represent some (directed) graphs where when a graph has N vertices it will have around $N \log N$ edges. The number of vertices, N, may become quite large. [4 marks]

(b) In the process of rendering a graphical image you have already sorted all the objects that have to be drawn with an ordering based on their distance from the viewpoint. Now the image has been changed slightly so that you can start to display the next frame of the video sequence, so all the distances have changed, and you need to sort the objects again. [4 marks]

(c) You need to build a table. It will be possible to insert objects into the table or retrieve previously stored ones. The only operation you are permitted to perform on objects is a pair-wise comparison that can tell if two objects are equal and if not indicates an ordering between them. There will be both plenty of insertion operations and plenty of lookups. [4 marks]

(d) You need to find the shortest distance (through a directed graph that has lengths associated with each edge) from a nominated source point A to each of a collection of destinations $\{B_i\}$. [4 marks]

(e) Blocks of material, each identified by a key, are to be stored on a large disc. From time to time new blocks (and associated keys) will need to be added, but mostly you need to service requests where a user submits a key and wants the corresponding information recovered. There is so much data that the disc is fairly full. [4 marks]