Practical Assignment
Data Structures Applications

Assignment Description

In a bin-packing problem, we have `m` bins that have a capacity `c` and `n` objects with different sizes that need to be packed into these bins. A ***feasible*** packing is an assignment of objects to bins so that no bin's capacity is exceeded. A feasible packing that uses the fewest number of bins is an ***optimal packing***.

Example: Truck Loading

A freight company needs to pack parcels into trucks. Each parcel has a weight, and each truck has a load limit (assumed to be the same for all trucks). In the truck-loading problem, we are to pack the parcels into trucks using the fewest number of trucks. This problem may be modeled as a bin-packing problem with each truck being a bin and each parcel an object that needs to be packed.

Four popular approximation algorithms that generate solutions that use a number of bins that is close to minimum for this problem are:

1. ***First Fit (FF)***
   Objects are considered for packing in the order of arrival. We assume a large number of bins arranged from left to right. Each object is packed into the left-most bin into which it fits.

2. ***Best Fit (BF)***
   Let `cAvail[j]` denotes the capacity available in bin `j`. Initially, the available capacity is `c` for all bins. Each object is packed into the bin with the least `cAvail` that is at least object size.

3. ***First Fit Decreasing (FFD)***
   This method is the same as First Fit except that the objects are first reordered according to their size.

4. ***Best Fit Decreasing (BFD)***
   This method is the same as First Fit except that the objects are first reordered as for First Fit Decreasing.

Propose ***suitable data structures*** to store the information of bins and objects, and construct solutions in ***minimum TWO (2) different strategies*** (*FF*, *BF*, *FFD*, *BFD* and/or any other optimal algorithms) for the bin-packing problem. Compare the number of bins used by the strategies on randomly generated bin-packing instances.

Further information

Prepare the necessary data file(s) for building the data structure(s) needed in your application. You may give additional assumptions for your application.

To make your program more robust and avoid problems at run time, do as much status/error checking as you could in your program. And, good organization of the code and meaningful variable names would help readability, and liberal use of comments can help the marker understands what the program does and why.

In addition, provide UML diagram(s) to illustrate the design of your program and provide a flowchart for bin-packing algorithms.

Assessment and Submission

This is a group assignment. Form a group of 2 or 3 members, preferably from same programme as yours. Prepare a report (preferably using word processing software) to answer the questions given above.

Your **REPORT SHOULD CONTAIN** the following:

1. proposed solution – data structures and strategies for the bin-packing problem
2. flowchart for bin-packing algorithms
3. UML diagrams for illustrating the design of Java program
4. print out of the Java program
5. sample of input data and test cases
6. sample output(s) of your program
7. discussion/complexity analysis of the application
8. soft copy of the Java program (.java, .class and .bat files and upload to WBLE)

Do remember to print the assignment marking sheet and attach as the FIRST PAGE of your report.

The total mark of this practical assessment is 100. The 100 marks will contribute 20% of your final mark. The report will be marked for *correctness*, *completeness*, *presentation style*, and *relevant use of diagrams/tables/graphs*, etc. And the program implementation will be marked for *correctness, completeness*, *programming style*, *adequate testing* and *documentation/comments*. It's your responsibility to understand the requirements of the tasks and prepare well for your submission. You might be asked questions about the works you submit to ensure that you understand them.

Plagiarism

It is important that your solutions to the practical assignment be your own work. It is perfectly acceptable to seek help and advice when completing the practical assignment, but this must not be taken to the point where what is submitted is in part someone else's work.