

Bin-Packing Algorithms (3 pages; 7/8/18)

(1) Example: Some books in a library are being stored (to make way for more computers). They are to be placed in 'bins' containing 60 books (all books are assumed to be the same size). The contents of each shelf must be packed in a single bin.

The shelves contain the following numbers of books:

30, 10, 45, 45, 30, 15 (total = 175)

A **lower bound** for the number of bins needed is obtained from:

$\frac{175}{60} = 2 \frac{55}{60}$; so at least 3 bins will be needed.

First fit algorithm

The contents of each shelf are placed in the first available bin:

30

30+10

30+10 | 45

30+10 | 45 | 45

30+10 | 45 | 45 | 30

30+10 +15 | 45 | 45 | 30 (requiring 4 bins)

First fit decreasing algorithm

The contents of the shelves are first arranged in decreasing order, and then the First fit algorithm is applied:

Re-ordered: 45, 45, 30, 30, 15, 10

45

45 | 45

45 | 45 | 30

45 | 45 | 30+30

45+15 | 45 | 30+30

45+15 | 45+10 | 30+30 (requiring 3 bins)

This generally gives a better solution because the smaller, more flexible items are saved until last.

Full bins method

We look to see if any combinations of shelves can completely fill any bins. Then the First fit algorithm is applied. The Full bins method doesn't normally count as a algorithm, as it will usually involve human intervention.

[Note: It is usual to apply only the First fit algorithm, but the First fit decreasing algorithm might give a better solution in some cases.]

30, 10, 45, 45, 30, 15

Filling bins, we get: 30+30 | 45+15; 10, 45

giving 30+30 | 45+15 | 10+45

(2) In some cases First fit decreasing will produce a worse solution than First fit.

For example, if a good solution is unpacked (keeping the same order), then the First fit algorithm will restore that solution, whereas the First fit decreasing algorithm may spoil it by re-ordering the items.

Example: 30, 20, 15, 30, 20, 15 (bins of size 65)

First fit produces: 30 + 20 + 15 | 30 + 20 + 15

First fit decreasing:

Re-ordered: 30, 30, 20, 20, 15, 15

30

30+30

30+30 | 20

30+30 | 20 + 20

30+30 | 20 + 20 + 15

30+30 | 20 + 20 + 15 | 15

(3) Notes

(i) Other examples:

- cars being loaded onto a ferry (with lanes of the same length)
- Amazon goods being allocated to parcels (of the same size)
- music tracks being placed on a set of CDs

(ii) The First fit and First fit decreasing algorithms are examples of **heuristic** algorithms; meaning that they usually produce a reasonably good solution (though less so in the case of the First fit algorithm) , but not necessarily the best one.