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CS 577 - Homework 6
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1 Graded written problem

Input: In a library, there are n books that must be stored in alphabetical order in adjustable height shelves. Each book b_i has height h_i and a thickness t_i. Each shelf has width w. The next shelf will be placed on top of $\max(h_i)$ on the given shelf.

Output: Minimize the total height of the shelves to store all the books.

1.1 Algorithm

We have to place books on shelves alphabetically and so the intuition to minimize the height is that we will place a book on a new shelf only if the current shelf does not have any space for the book or if the placing of this book on a new shelf will minimize the overall height in the future. To find if placing a book on new shelf reduces the height of the shelves we need to consider all books which need to be placed after it as well, to achieve this we will start from the last book and calculate the least possible height when that book is kept on a new shelf.

Algorithm 1 Algorithm to minimize the height of shelves to store all books

```
1:  procedure ARRANGE-BOOKS(B[n], W[n], h[j])
2:      LeastHeight[n] ← ∞
3:      i ← n
4:      while i ≠ 1 do
5:          if i = n then
6:              LeastHeight[i] = h[i]          ▷ if Last book is on new shelf the min height is the books height
7:              i ← i − 1
8:              continue
9:          AllBooksWidth ← 0
10:         j ← i
11:         h_shelf ← 0
12:         while j ≠ n + 1 do
13:             if AllBooksWidth>ShelfWidth then
14:                 break
15:             h_shelf ← max(h_shelf, h[j])
16:             totalHeight ← h_shelf + LeastHeight[j + 1]
17:             if totalHeight<LeastHeight[j] then
18:                 LeastHeight[j] ← totalHeight
19:             j ← j + 1
20:         i ← i − 1
21:     return LeastHeight
```