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Algorithms & Data Structures Programming task 7 HS 19

The solutions for this sheet need to be submitted to the judge by Sunday, 10 November, 23:59:59.

Exercise 7.1 *Heap and Heap sort* **(2 bonus point)**.

Your task is to implement some operations for the data structure maxheap. Those are `isMaxHeap` and `heapSort`. To realise them, you also need to implement the auxiliary functions `heapify`, and `siftDown`. If you wish, you can also implement `siftUp`. All auxiliary functions are tested in the Eclipse project, but not by Judge. For debugging, the tests visualize the heap in Graphviz format, to render it, you can use offline `dot`, or online `http://www.webgraphviz.com/` tools.

`isMaxHeap` checks if an array is a maxheap, i.e., if it satisfies the maxheap condition everywhere.

`heapSort` sorts the array via the heapsort algorithm.

`heapify` builds a maxheap from the input array.

`siftDown` checks whether the element with a given index has a too high index to satisfy the heap property. If not, then it restores the heap property for this element.

`siftUp` checks whether the element with a given index has a too low index to satisfy the heap property. If not, then it restores the heap property for this element.

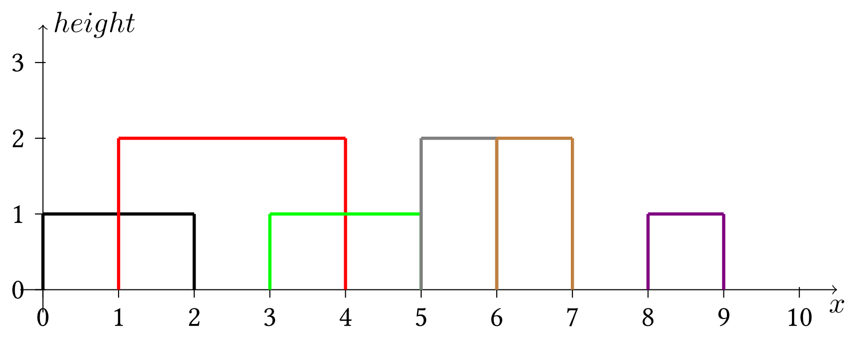
Please find a more detailed description of the task in the `Main.java` file. The methods that you have to implement are denoted by `TODO` and description of the task. The data format is described by the method `Main.read`. The Eclipse project also contains a set of basic tests, execute them by running `JUnitTest.java`.

You get one point for each passing test set. The test set `basic` is smaller, so it does not test time complexity. That is doing test set `complex`.

Submission: Submit your `Main.java` at `https://judge.inf.ethz.ch/team/websubmit.php?cid=28784&problem=AD19H7P1`. The enrollment password is "`asymptotic`".

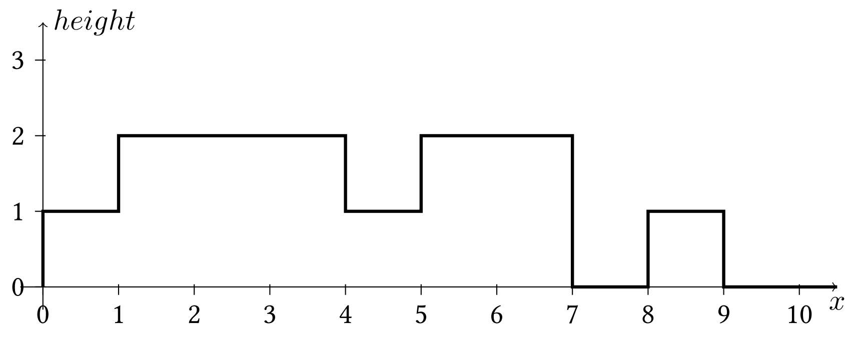
Exercise 7.2 *Computing overlapping buildings silhouette* (**2 bonus point**).

In this exercise, you are going to develop an algorithm to compute the silhouette of a given set of rectangular buildings. Every building is determined by its beginning and end on the x axis, and its height. The input has the form of a set of triples of (beginning, height, end) $\in \mathbb{N}^3$. A city is a set of buildings. For example,



is represented by input: `0, 1, 2, 1, 2, 4, 3, 1, 5, 5, 2, 6, 6, 2, 7, 8, 1, 9`. Note that the order of buildings does not have to satisfy any order.

For a given set of buildings, your goal is to compute the overall silhouette of the whole city. Graphically, it is:



which we represent as silhouette $\underline{0}, \overline{1}, \underline{1}, \overline{2}, \underline{4}, \overline{1}, \underline{5}, \overline{2}, \underline{7}, \overline{0}, \underline{8}, \overline{1}, \underline{9}, \overline{0}$. This array consists of pairs of x axis positions where the height of silhouette changes (underscored) and the height itself (overscored). Every silhouette is therefore terminated by height 0.

Please find more detailed description in the `Main.java` file. The task is to implement methods `Main.evaluate`. The data format is described by method `Main.read`. The Eclipse project also contains a set of basic tests, run them by running `JUnitTest.java`.

The judge is again testing two test sets. To pass `simple`, it is fine if your solution works for all buildings of height 1. But you have to do so in $\mathcal{O}(n \log(n))$. The test set `generic` requires you to evaluate an arbitrary silhouette in $\mathcal{O}(n \log(n))$. Hint (in white text):

Submission: Submit your `Main.java` at `https://judge.inf.ethz.ch/team/websubmit.php?cid=28784&problem=AD19H7P2`. The enrollment password is "`asymptotic`".