

# OTE: Ohjelmointitekniikka

## Programming Techniques

course homepage: <http://www.cs.uku.fi/~mnykanen/OTE/>

Week 04/2009

**Exercise 1.** The *Dutch Flag problem* is as follows: There is some function  $colour(x)$  which tells the colour of the given element  $x$ : RED, WHITE or BLUE. The task is to permute the given input array  $a$  so that its RED elements come before its WHITE elements, which in turn come before its BLUE elements<sup>1</sup>.

- (a) Give a GCL algorithm for this problem.
- (b) Argue the correctness of your algorithm.

**Exercise 2.**

- (a) How is the solution to the Dutch flag problem of Exercise 1 related to the *partition* procedure within the *quicksort* algorithm?
- (b) Give a GCL *quicksort* algorithm which uses the solution to that problem.

**Exercise 3.**

- (a) Rewrite the *quicksort* algorithm so that the array part sorted by the first recursive call is no longer than the part handled by the second call.
- (b) Explain how this version of the *quicksort* algorithm can be optimized further to use only logarithmic recursion depth.

**Exercise 4.** The *median* of an unsorted input array  $a[0 \dots 2 \cdot N]$  is the element which would appear at the middle position  $a[N]$  after sorting  $a$ .

- (a) Explain how you can simplify the *quicksort* algorithm into one which finds this median element faster than fully sorting the array  $a$ .  
(HINT: After *partitioning*, just decide in which part  $a[N]$  would be.)
- (b) Give an iterative version of this algorithm via tail recursion elimination.

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<sup>1</sup>This problem was one of many posed by the late Edsger W. Dijkstra, who was of Dutch origin. The colours come from the Dutch flag.