**Algorithm Engineering**

**12 September 2013**

**Exercise [rank 5]**

Construct a perfect hash table for the set of keys {1, 4, 6, 8, 2, 9, 11, 16, 18}, by assuming a first-level table of size 5 and by defining hash functions of the form

h(x) = a \* x + b mod m, where m is a number (possibly not prime, in order to manage the functions of the second level).

**Exercise [rank 3+2]**

1. Indicate the optimal upper bounds for the two problems Permuting and Sorting in the RAM and in the External-memory models of computation.
2. Indicate whether it would be preferable to have a larger B or a larger M in order to improve the performance of an algorithm, and comment this answer in the light of point 1.

**Exercise [rank 3+4+3+4]**

Given the string T = babac,

1. construct its suffix tree ST (*hint*: you do not need to add $ at the end)
2. show how to derive from ST, the Suffix Array and the LCP array of T in linear O(|T|) time. Depict the algorithm and show its execution on ST of point 1.
3. describe an algorithm which, given a suffix SA[i], returns the suffix SA[j] of T which shares the LCP with SA[i] (*hint*: it can be solved in O(1) time)
4. construct the Cartesian Tree of the LCP array of point 2 (*hint*: it was used in class for supporting the RMQ-query over LCP)

**Exercise [rank 3+3]**

Given the undirected and weighted graph G={(A,B, 4), (A,F, 5), (A,E, 6), (B,C, 6), (B,F, 8), (C,D, 7), (C,F, 5), (D,F, 3), (D,E, 4)}.

* Compute the MST via the Kruskal’s algorithm
* Compute the MST via the Prim’s algorithm

Show all steps of each algorithm.

**Exercise [rank \*]**

Prove that the expected reconstruction time of a cuckoo hash table is O(n), if it is built over n items and we consider a sequence of a\*n insertions, where *a* is a constant.