TAMPERE UNIVERSITY OF TECHNOLOGY
Department of Mathematics

MAT-72006 **Advanced Algorithms and Data Structures** Exercise 1
Recap of basics Sept. 8, 2016

1. Heap:
   (a) Explain the (binary) heap data structure.
   (b) How can you implement a heap using an array?
   (c) What are the implementations of operations PARENT(i), LEFT(i), and RIGHT(i) then?
2. Quicksort:
   (a) Sketch the Quicksort algorithm.
   (b) What is the worst-case partitioning performance of Quicksort?
   (c) How about the best-case?
3. Linked lists:
   (a) What kinds of elements are there in a doubly linked list?
   (b) Give procedures for
      - LIST-SEARCHing a key value k from a list L,
      - LIST-INSERTing element x (with a set key value) into a list L, and
      - LIST-DELETEing an element x from a linked list L.
   (c) What are the time requirements of these operations?
4. Binary Search Trees (BSTs):
   (a) Define the binary search tree property.
   (b) Give recursive and iterative versions of TREE-SEARCH(x, k), where x is a node pointer (initially the root of a BST) and k is the key value being searched for.
   (c) Give the procedure TREE-INSERT(T, z), where T is a BST with root $T.root$ and z is a node with $z.key = v$, and $z.left = z.right =$ NIL.
5. Red-Black Trees (RBTs):
   (a) Define the red-black properties.
   (b) Show that a red-black tree with n internal nodes has height at most $2\log_2(n+1)$.