

## Exercise 6

Course exam at Fri 12.5., please register through Oodi.

31. Simulate the function of B-tree manually for width  $t=3$ . Add letters to the tree so that all lower case characters precede all upper case characters, i.e.,  $a < z < A < Z$ . Add to tree (initially empty) characters [T i e t o r a k n j A l g m J O E c p u s B]. Each node is split to two when it has  $2t-1$  keys. Draw the tree again after each split. After second to last add (character s), one leaf node is split, and because of that, also to root node. Draw this add in two stages.
32. Let us assume that we have 100 000 000 elements, each 50 bytes. We can use 500 MB main memory for buffers. Each access (search) of PCIe connected SSD mass storage takes 0.1 ms, and the sustained transfer rate (both read and write) is 2000 MB/s. Calculate how long it takes to do selection sort for the data. In each step of selection sort, we find the smallest element of the remaining file, and swap it to the first element of the remaining file. On the next step, the remaining unsorted part of the file is one element smaller (shrink from start). How you use the mass memory as a buffer? Remember to draw a picture of the sorting process. It is enough to calculate the time needed for mass memory accesses and transfers.
33. Use the assumptions of task 32, and calculate the time usage of merge sort. In merge sort we start from sorted sequences of length one, and on each iteration we produce double length sorted sequences. You can also tune it somewhat by using the 500 MB of main memory as the buffer.
- 34-35. Recap the class *RandomAccessFile* of Java API. Make a program that can be used to measure the access time and bandwidth of the mass memory of your PC. Try to make such test setup that avoids the impact of operating system caching. You can use example program (*RandomAccessFileExample.java*) from course [www-page](#) as a skeleton.
36. Fill in the course feedback form in Oodi. All comments and suggestions for improvement are welcome, thank you.