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Algorithms and Datastructures
Summer Term 2020
Exercise Sheet 6

Due: Wednesday, 24th of June, 4 pm.

Exercise 1: Binary Search Tree - Range Queries *(10 Points)*

(a) Implement the binary search tree (BST) data structure and the `insert` operation. You can use the template `BST.py`. *(4 Points)*

(b) Implement the operation `getrange`(x_{min}, x_{max}) on binary search trees which returns all keys x in the tree with $x_{min} \leq x < x_{max}$ (cf. lectue notes week 6 slide 21). *(4 Points)*

(c) Use your implementation of BST and your `insert` function to insert all words from the file `inputs.txt` into a BST with respect to the lexicographic ordering on words over the alphabet $\{a, \ldots, z\}$[1]. Use your data structure to output all words from the BST beginning with a certain prefix. As a unit test, output all words with prefix "qw". Copy the result into your `experiences.txt` file. *(2 Points)*

Exercise 2: Binary Search Tree - Operations *(10 Points)*

(a) Describe a function that takes a binary search tree B and a key x as input and generates the following output:

- If there is an element v in B with $v.key = x$, return v.
- Otherwise, return the pair (u, w) where u is the tree element with the next smaller key and w is the element with the next larger key. It should be $u =$ None ($w =$ None, resp.) if x is smaller (larger, resp.) than any key in the tree or if the tree is empty.

For your description you can use pseudo code or a sufficiently detailed description in English.

Analyze the runtime of your function. *(4 Points)*

(b) Describe a function which returns the depth of a binary search tree and analyze the runtime. *(2 Points)*

(c) Describe a function that for a given binary search tree with n nodes and a given $k \leq n$ returns a list with the k smallest keys from the tree. Analyze the runtime. *(4 Points)*

[1] Python supports the comparison of strings with respect to the lexicographic ordering, i.e., you can just use "<", "<=" etc.