Algorithms and Data Structures

EADS 2023Z LAB/103

Task #3 (term 2023Z)

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I answered the questions in page 2.

Task #3 deadline is Wednesday, January 10th, 2024, 2 pm.

There are several steps to complete:

- Design `avl_tree` class according to very limited specification below.
- Implementing your class write unit tests in parallel (try to write test before actual implementation of the behaviour of your tree).
- You should implement your class template in the `avl_tree.h` file, and provide tests of your container in `avl_tree_test.h` and `avl_tree_test.cpp` files.
- Implement external function template `maxinfo_selector`.
- Implement external function `count_words`.
- Be prepared to modify fragments of your solution or write additional function/template during the lab class on January 10th.

1 PART1 - CLASS DESIGN

Design a class to represent AVL tree. Write unit tests for the designed class, at least one test per method.

```
template <typename Key, typename Info> class
avl_tree
{ public:
      avl_tree();
      avl_tree (const avl_tree& src);
      ~avl_tree();
      avl_tree& operator=(const avl_tree& src);

      // insert (key, info) pair

      // remove given key

      // check if given key is present

      // print nicely formatted tree structure
      Info& operator[](const Key& key);
      const Info& operator[](const Key& key) const;

      // what else can be useful in such a collection?
};
```

2 PART 2 – ADDITIONAL FUNCTIONS

Implement two additional functions:

```
template <typename Key, typename Info> std::vector<std::pair<Key,
Info>>       maxinfo_selector(const avl_tree<Key, Info>& tree,
unsigned cnt);
```

`maxinfo_selector` returns *cnt* elements of the *tree* with the highest values of the info member.

```
avl_tree<string, int> count_words(istream& is);
```

`count_words` creates a dictionary mapping words found in the is stream to number of occurrences of the word in this stream. You can use beagle_voyage.txt (yes, this is The Voyage of the Beagle by Charles Darwin as published on the Gutenberg Project page - https://www.gutenberg.org/) as a slightly larger test for your `count_words` function.

How the execution time of your `count_words` compares to the word counter implemented with the map collection from the standard library?

Ans: The AVL tree implementation of count_words is faster due to the efficient balancing of AVL trees, which ensures consistently quick lookups and insertions, leading to better overall performance for this specific task compared to the std::map.

You can use following code to measure the execution time (don't forget to include chrono header):

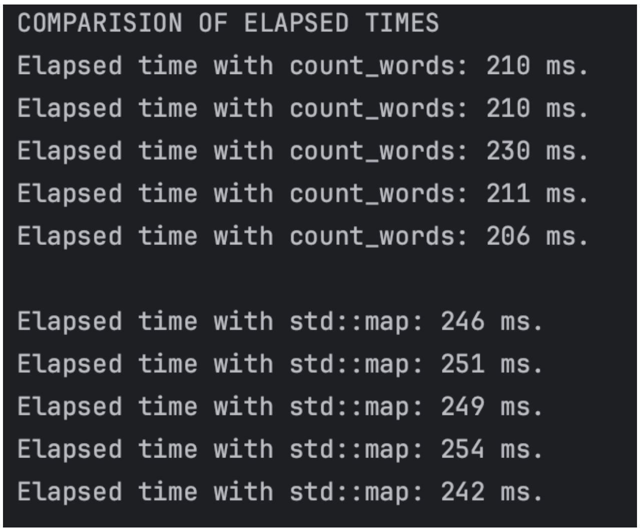
```
    for (int rep = 0; rep < 5; ++rep)
    {
        ifstream is("beagle_voyage.txt");
if (!is)          {
            cout << "Error opening input file.\n";
return 1;
        }
        auto start_time = std::chrono::high_resolution_clock::now();

        string word;
        map<string, int> wc;  // counting word occurrences in the stream
while (is >> word)
        {
            wc[word]++;
        }          auto end_time =
std::chrono::high_resolution_clock::now();          auto time =
end_time - start_time;

        std::cout << "Ellapsed time: " << time/std::chrono::milliseconds(1)
                     << " ms.\n";
    }
```

If the computations are not lengthy it is good to repeat time measurements several times. The result on my machine is following:

```
Ellapsed time: 40 ms.
Ellapsed time: 41 ms.
Ellapsed time: 49 ms.
Ellapsed time: 42 ms.
Ellapsed time: 43 ms.
```

(Is your avl_tree implementation slower 🙁 or faster ☺?).

Mine are slower ☹



```
COMPARISION OF ELAPSED TIMES
Elapsed time with count_words: 210 ms.
Elapsed time with count_words: 210 ms.
Elapsed time with count_words: 230 ms.
Elapsed time with count_words: 211 ms.
Elapsed time with count_words: 206 ms.

Elapsed time with std::map: 246 ms.
Elapsed time with std::map: 251 ms.
Elapsed time with std::map: 249 ms.
Elapsed time with std::map: 254 ms.
Elapsed time with std::map: 242 ms.
```