

Programming in C^{++} , Exercise List 8

Deadline: 14.05.2016

In this exercise, we study `std::map< >` and `std::unordered_map< >`. They have similar functionality: Each of the two versions of `map<X,Y>` implements a table of elements (x,y) with $x \in X$ and $y \in Y$, in such a way that y can be efficiently looked up, when x is known. One could also say that `map<X,Y>` implements a lookup table from X to Y .

The difference between `std::map<X,Y>` and `std::unordered_map<X,Y>` is the mechanism that is used for lookup: `std::map< >` uses a search tree, so that it requires an order X . `std::unordered_map< >` is based on hashing, so it needs a hash function and an equality function on X .

1. Write a function

```
std::map< std::string, unsigned int > frequencytable(  
    const std::vector< std::string > & text )
```

that constructs a table of frequencies of the words in `text`.

Inserting into a map can be tricky when Y has no default constructor, but in this task you can simply use `[]`. In a later exercise, we will treat `[]` in more detail, because it has some problems with constness of the map and default construction of elements of Y .

2. Write a function

```
std::ostream&  
operator << ( std::ostream& stream,  
             const std::map< std::string, unsigned int > & freq )
```

that prints the frequency table. Use a **range-for**.

3. `std::map< >` uses by default the order `<` on `std::string`. We want the frequency table to be case insensitive. Try for example:

```
std::cout << frequencies( std::vector< std::string >  
    { "AA", "aA", "Aa", "this", "THIS" } );
```

In order to overcome this problem, we will have to provide our own comparator. Define a class

```

struct case_insensitive
{
    bool operator( ) ( const std::string& s1, const std::string& s2 ) const;
    // Return true if s1 < s2, ignoring case of the letters.
};

```

Class `case_insensitive` has only one constructor, namely its default constructor. Test it for example by

```

case_insensitive c;
std::cout << c( "a", "A" ) << c( "a","b" ) << c( "A", "b" ) << "\n";

```

There is no `==`-operator. `std::map` will assume that two objects are equal when both `c(s1,s2)` and `(s2,s1)` are false.

Write `bool operator()` in a reasonable fashion! Making a lower case copy of the string, and using `<` is not reasonable.

4. Once you have finished the `case_insensitive` class, you can do one of the following things, dependent of your level of eagerness:

- Simply replace `std::map< std::string, unsigned int >` by `std::map< std::string, unsigned int, case_insensitive >`, in everything that you wrote before, and sorting should work as desired.
- Make `operator <<` and `frequencytable` polymorphic: Write:

```

template< typename C > std::map< std::string, unsigned int, C >
frequencytable( const std::vector< std::string > & text )
    // frequencytable( test ) will produce a frequency table, using
    // std::less< std::string >, which is the good old <
    // frequencytable<case_insensitive>( test ) will produce a
    // case insensitive frequency table.

```

```

template< typename C >
std::ostream& operator << ( std::ostream& out,
    const std::map< std::string, unsigned int, C > & m );
    // Prints frequencytable, for every possible comparator.

```

5. Now we want to write the same functions with `std::unordered_map`. If we will do nothing, comparison will also be case sensitive here, so we need to create a case-insensitive hash function, and a case-insensitive equality function. They work in the same way as the `case_insensitive` object:

```

struct case_insensitive_hash
{
    size_t operator ( ) ( const std::string& s ) const
};

```

```

struct case_insensitive_equality
{
    bool operator ( ) ( const std::string& s1,
                        const std::string& s2 ) const
};

case_insensitive_hash h;
std::cout << h( "xxx" ) << " " << h( "XXX" ) << "\n";
std::cout << h( "Abc" ) << " " << h( "abC" ) << "\n";
    // Hash value should be case insensitive.

case_insensitive_equality e;
    std::cout << e( "xxx", "XXX" ) << "\n";
    // Prints '1'.

```

6. If everything went well, the following function is now easy to write:

```

std::unordered_map< std::string, unsigned int >
hashed_frequencytable(
    std::vector<std::string> ( { "aa", "AA", "bb", "BB" } );
    // As with frequencytable for map, you can make this
    // function polymorphic.
    // The default parameters are std::hash<std::string> and
    // std::equal_to<std::string>.

```