Dictionary template class

Documentation

Author : Wiktor Łazarski

Index number : 281875

Field of study : Computer Science

Faculty : Electronics and Information Technology, Warsaw University of Technology

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1.1 *Dictionary* template overview

Dictionary class was implemented and compiled by MinGW for Windows compiler in CodeBlocks. Flags that were used during compilation are as follow :

```
mingw32-g++.exe -Wall -fexceptions -O2 -std=c++11
```

C++11 standard is highly recommended for proper use of *Dictionary* class template.

Link to full project : https://github.com/Wiktos/Dictionary

Dictionary is a class template implemented as AVLTree, abstract data structure. It supports logarithms complexity of binary search algorithm. Template class code is available in *dictionary.h* file. Implementation of all methods and *DictionaryException* class are available in *dictionary.tpp*.

1.2 Template parameters

```
template <typename K, typename V>
class Dictionary
```

K	Typename of key by which *Node* will be recognized in *Dictionary*.
I	Typename of data stored in particular *Node*.

1.3 Member types

Private member types :

Member type	Definition
`struct Node`	*Node* is a structure that contain Key value, Info value and pointer to left and right *Node* in tree.
`Node *root`	*Node* pointer which hold root of *Dictionary*.

Public member types :

Member type	Definition
`key_type`	Type of key held in *Node*
`value_type`	Type of value held in *Node*
`class DictionaryException`	*DictionaryException* is an exception class. *DictionaryException* exceptions are thrown where member function is called with invalid arguments.

1.4 Member functions

Public member functions :

Constructors :

```
Dictionary() noexcept;
```

```
Dictionary(const Dictionary& source);
```

```
Dictionary(Dictionary&& source) noexcept;
```

```
Dictionary(std::initializer_list<std::pair<key_type, value_type>> ls);
```

(All constructor are defined and implemented in header file)

Operators :

```
Dictionary& operator=(const Dictionary& rhs);
```

```
Dictionary& operator=(Dictionary&& rhs);
```

Capacity :

```
bool is_empty() const noexcept;
```

```
int height() const noexcept;
```

Element access :

```
key_type& get_max();
```

```
const key_type& get_max() const;
```

```
key_type& get_min();
```

```
const key_type& get_min() const;
```

```
value_type& get_value(const key_type& key);
```

```
const value_type& get_value(const key_type& key) const;
```

Modifiers :

```
void insert(const key_type& new_key, const value_type& new_value);
```

```
void clear();
```

```
void remove(const key_type& key);
```

1.4 Member functions

Operations:

```
void graph(std::ostream& os) const;
```

```
void print_inorder(std::ostream& os) const;
```

```
void print_preorder(std::ostream& os) const;
```

```
void print_postorder(std::ostream& os) const;
```

```
bool contain(const key_type& key) const;
```

Destructor:

```
~Dictionary();
```

Private member functions :

Element access :

```
key_type& get_max(Node *start) const;
```

```
key_type& get_min(Node *start) const;
```

```
Node* get_node(const key_type& key, Node *start) const;
```

Modifiers :

```
Node* insert(const key_type& key, const value_type& val, Node *start);
```

```
void clear(Node *start);
```

```
Node* remove(const key_type& key, Node* start);
```

Operations:

```
void graph(std::ostream& os, int width, Node *start) const;
```

```
void inorder(std::ostream& os, Node *start) const;
```

```
void preorder(std::ostream& os, Node *start) const;
```

```
void postorder(std::ostream& os, Node *start) const;
```

```
bool contain(const key_type& key, Node *start) const;
```

```
Node* copy(Node *start);
```

1.4 Member functions

Tree balance

```
Node* lrotation(Node *node) noexcept;
```

```
Node* rrotation(Node *node) noexcept;
```

```
Node* llrotation(Node *node) noexcept;
```

```
Node* lrrotation(Node *node) noexcept;
```

```
Node* rrrotation(Node *node) noexcept;
```

```
Node* rlrotation(Node *node) noexcept;
```

Most of public function simply call private versions. The reason for this solution is that I wanted to hide passing *Node* structure object as an parameter of public function.

2.1 Public member functions

2.1.1 Standard member functions

Default constructor
`Dictionary() noexcept;`
Parameters : none
Complexity : constant $O(1)$
Exception : exception safe
Notes : Assign *root* equals *nullptr*.

Copy constructor
`Dictionary(const Dictionary& source);`
Parameters : source – constant reference to *Dictionary* copy pattern
Complexity : linear $O(2^n)$
Exception : *std::bad_alloc* may be thrown
Notes : Copy constructor call *copy* private method.

Move constructor
`Dictionary(Dictionary&& source) noexcept;`
Parameters : source – reference to *Dictionary* that will be moved to current created object
Complexity : constant $O(1)$
Exception : exception safe
Notes : Set source *root* equals *nullptr*.

2.1 Public member functions

Constructor with *std::initializer_list*
`Dictionary(std::initializer_list<std::pair<key_type, value_type>> ls);`
Parameters : ls – *std::initializer_list* object containing *std::pair*s of keys and infos that will be stored in *Dictionary*
Complexity : linear $O(1ogn)$
Exception : *std::bad_alloc* may be thrown
Notes : none

Destructor
`~Dictionary();`
Parameters : none
Complexity : linear $O(2^n)$
Exception : too deep recursion may terminate your program.
Notes : Call *clear* funtion that delete all allocated memory.

2.1.2 Operators

Copy assigment operator =
`Dictionary& operator=(const Dictionary& rhs);`
Parameters : rhs – constant reference to *Dictionary* copy pattern
Complexity : linear $O(2^n)$
Exception : *std::bad_alloc* may be thrown
Notes : Return reference to *this* .

2.1 Public member functions

Move assigment operator =
`Dictionary& operator=(Dictionary&& rhs);`
Parameters : rhs – reference to *Ring* that will be moved to our object
Complexity : constant $O(1)$
Exception : too deep recursion may terminate your program.
Notes : Set rhs *Dictionary root* as *nullptr*.

2.1.3 Capacity

Check if *Dictionary* is empty
`bool is_empty() const noexcept;`
Parameters : none
Complexity : constant $O(1)$
Exception : exception safe
Notes : Check if *root* == *nullptr*.

Return *Dictionary's* height
`int height() const noexcept;`
Parameters : none
Complexity : constant $O(1)$
Exception : exception safe
Notes : Return current value of *root->heigth* or 0 if *root == nullptr*.

2.1 Public member functions

2.1.4 Element access

Get *Dictionary* object max *Key* value
`key_type& get_max();`
Parameters : none
Complexity : constant $O(\log n)$
Exception : too deep recursion may terminate your program.
Notes : none

Get *const Dictionary* object max *Key* value
`const key_type& get_max() const;`
Parameters : none
Complexity : constant $O(\log n)$
Exception : too deep recursion may terminate your program.
Notes : none

Get *Dictionary* object min *Key* value
`key_type& get_min();`
Parameters : none
Complexity : constant $O(\log n)$
Exception : too deep recursion may terminate your program.
Notes : none

Get *const Dictionary* object min *Key* value
`const key_type& get_min() const;`
Parameters : none
Complexity : constant $O(\log n)$
Exception : too deep recursion may terminate your program.
Notes : none

2.1 Public member functions

Get *Value* of given *Key*
`value_type& get_value(const key_type& key);`
Parameters : none
Complexity : constant $O(\log n)$
Exception : too deep recursion may terminate your program.
Notes : none

Get *Value* of given *Key* for *const Dictionary* objects
`const value_type& get_value(const key_type& key) const;`
Parameters : none
Complexity : constant $O(\log n)$
Exception : too deep recursion may terminate your program.
Notes : none

2.1.5 Modifiers

Insert new *Node* to the *Dictionary*
`void insert(const key_type& new_key, const value_type& new_value);`
Parameters : new_key – element's key that will be stored in new *Node* New_value – element's info that will be stored in new *Node*
Complexity : constant $O(\log n)$
Exception : *DictionaryException* is thrown if *new_key* already exist in *Dictionary*.
Notes : none

2.1 Public member functions

Clear *Dictionary*
`void clear();`
Parameters : none
Complexity : constant $O(2^n)$
Exception : too deep recursion may terminate your program.
Notes : clearing is pernament

Removing *Node* with a given *key* from *Dictionary*
`void remove(const key_type& key);`
Parameters : key – key of *Node* that will be removed
Complexity : constant $O(\log n)$
Exception : *DictionaryException* is thrown if *key* does not exist. *std::bad_alloc* may be thrown
Notes : none

2.1.6 Operations

Graph *Dictionary*
`void graph(std::ostream& os) const;`
Parameters : os – output stream which will contain graphed *Dictionary*.
Complexity : linear $O(2^n)$
Exception : too deep recursion may terminate your program.
Notes : none

2.1 Public member functions

Print *Dictionary* inorder
`void print_inorder(std::ostream& os) const;`
Parameters : os – output stream which will contain printed *Dictionary*.
Complexity : linear $O(2^n)$
Exception : too deep recursion may terminate your program.
Notes : none

Print *Dictionary* preorder
`void print_preorder(std::ostream& os) const;`
Parameters : os – output stream which will contain printed *Dictionary*.
Complexity : linear $O(2^n)$
Exception : too deep recursion may terminate your program.
Notes : none

Print *Dictionary* postorder
`void print_postorder(std::ostream& os) const;`
Parameters : os – output stream which will contain printed *Dictionary*.
Complexity : linear $O(2^n)$
Exception : too deep recursion may terminate your program.
Notes : none

Check if *Dictionary* contain *Node* with a given *key*
`bool contain(const key_type& key) const;`
Parameters : key – key that will be looked in *Dictionary*.
Complexity : linear $O(\log n)$
Exception : too deep recursion may terminate your program.
Notes : none

2.2 Private member functions

All overloaded methods in private section are called in public overloaded methods. They contain the hole buissness login of AVLTree data structure. Those functions are recursive and may terminate your program if recursion will be to deep.

Tree balance methods :

Left rotation
`Node* lrotation(Node *node) noexcept;`
Parameters : node – *Node* on which rotation will be performer.
Complexity : linear $O(1)$
Exception : exception safe
Notes : perform single left rotation on *Node*.

Right rotation
`Node* rrotation(Node *node) noexcept;`
Parameters : node – *Node* on which rotation will be performer.
Complexity : linear $O(1)$
Exception : exception safe
Notes : perform single right rotation on *Node*.

Left-left rotation
`Node* llrotation(Node *node) noexcept;`
Parameters : node – *Node* on which rotation will be performer.
Complexity : linear $O(1)$
Exception : exception safe
Notes : rotation on *Node* which is performed if *Node's bf < -1* and *Node* on the left site has *bf <= 0.*

2.2 Private member functions

Left-right rotation
`Node* lrrotation(Node *node) noexcept;`
Parameters : node – *Node* on which rotation will be performer.
Complexity : linear $O(1)$
Exception : exception safe
Notes : rotation on *Node* which is performed if *Node's bf < -1* and *Node* on the left site has *bf > 0.*

Right-right rotation
`Node* rrrotation(Node *node) noexcept;`
Parameters : node – *Node* on which rotation will be performer.
Complexity : linear $O(1)$
Exception : exception safe
Notes : rotation on *Node* which is performed if *Node's bf > 1* and *Node* on the right site has *bf >= 0.*

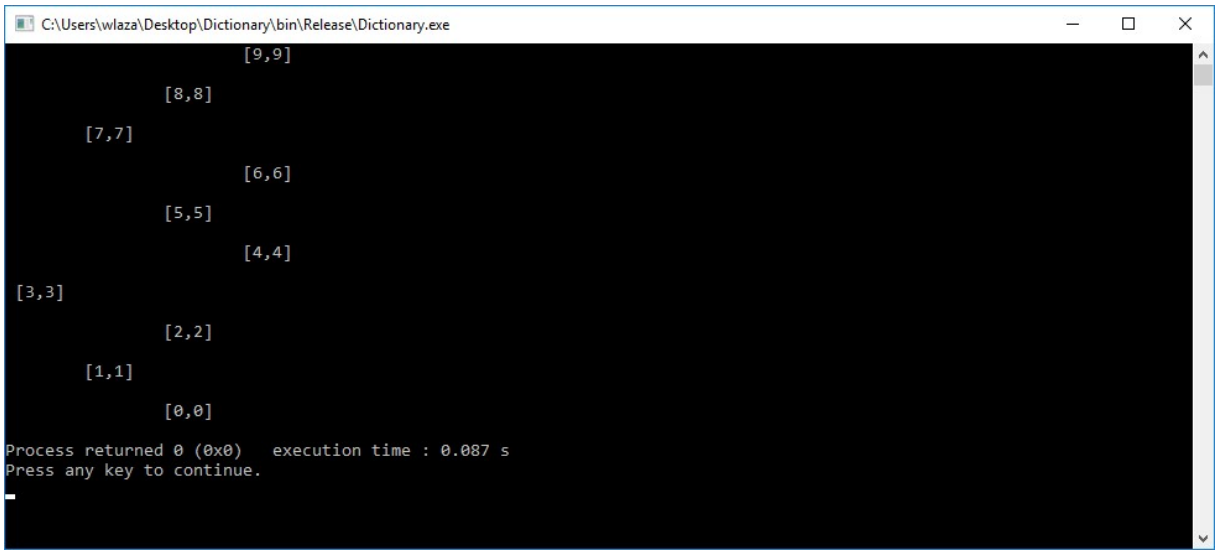
Right-left rotation
`Node* rlrotation(Node *node) noexcept;`
Parameters : node – *Node* on which rotation will be performer.
Complexity : linear $O(1)$
Exception : exception safe
Notes : rotation on *Node* which is performed if *Node's bf > 1* and *Node* on the right site has *bf < 0.*

3.1 Organisation of tests

All tests are implemanted and performed in *main.cpp* file. If any error occurs, it will be printed on standard error stream (*std::cerr*). To see if tree keeps proper balance of every *Node* I use *graph* method and simply look at the console output.

Example

Dictionary<int, int> graphed after inserting nodes from 0,0 to 9,9 in a row.



Same dictionary after removing *root* (3, 3).