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Кафедра: 806 «Вычислительная математика и программирование»

Лабораторная работа №5
по курсу «ООП»

Тема:
Основы работы с коллекциями: итераторы.

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1. **Код программы:**

vertex.hpp

```
#ifndef D_VERTEX_HPP_
#define D_VERTEX_HPP_ 1

#include <iostream>

template<class T>
struct vertex {
T x;
T y;
};

template <class T>
std::istream& operator>> (std::istream& is, vertex<T>& p) {
is >> p.x >> p.y;
return is;
}

template<class T>
std::ostream& operator<< (std::ostream& os, const vertex<T>& p) {
os << '[' << ' ' << p.x << ' ' << p.y << ' ' << ']';
return os;
}

template <class T>
vertex<T> operator+ (vertex<T> p1, vertex<T> p2) {
vertex<T> p;
p.x = p1.x + p2.x;
p.y = p1.y + p2.y;
return p;
}

template <class T>
vertex<T>& operator/ (vertex<T>& p, int num) {
p.x = p.x / num;
p.y = p.y / num;
return p;
}

#endif // D_VERTEX_HPP_
```

square.hpp

```
#ifndef D_SQUARE_HPP_
#define D_SQUARE_HPP_ 1

#include <iostream>
#include <assert.h>
#include <math.h>

#include "vertex.hpp"

template<class T>
struct Square {
public:
Square(std::istream &is);
bool correct() const;

vertex<double> center() const;
double area() const;
void print() const;

private:
vertex<T> a1,a2,a3,a4;
};



template<class T>
Square<T>::Square(std::istream &is){
is >> a1 >> a2 >> a3 >> a4;
assert(correct());
}

template<class T>
bool Square<T>::correct() const {
T vec1_x = a2.x - a1.x;
T vec1_y = a2.y - a1.y;

T vec2_x = a3.x - a2.x;
T vec2_y = a3.y - a2.y;

T vec3_x = a4.x - a1.x;
T vec3_y = a4.y - a1.y;

T vec4_x = a4.x - a3.x;
T vec4_y = a4.y - a3.y;
```

```
T dotProduct1 = vec1_x * vec2_x + vec1_y * vec2_y;
T dotProduct2 = vec3_x * vec1_x + vec3_y * vec1_y;
T dotProduct3 = vec3_x * vec4_x + vec3_y * vec4_y;

T vec1_length = sqrt(vec1_x * vec1_x + vec1_y * vec1_y);
T vec2_length = sqrt(vec2_x * vec2_x + vec2_y * vec2_y);

if (dotProduct1 == 0 && dotProduct2 == 0 && dotProduct3 == 0 && vec1_length
== vec2_length) {
return true;
}
return false;
}

template<class T>
vertex<double> Square<T>::center() const {
vertex<double> p;
p.x = (a1.x + a2.x + a3.x + a4.x) / 4;
p.y = (a1.y + a2.y + a3.y + a4.y) / 4;
return p;
}


template<class T>
double Square<T>::area() const {
const T vecX = a2.x - a1.x;
const T vecY = a2.y - a1.y;

return vecX * vecX + vecY * vecY;
}

template<class T>
void Square<T>::print() const {
std::cout << "Vertices: " << a1 << " " << a2 << " " << a3 << " " << a4 << '\n';
std::cout << "Area:" << area() << std::endl;
std::cout << "Center:" << center() << std::endl;
}
#endif
```

queue.hpp

```
#ifndef D_QUEUE_HPP_
#define D_QUEUE_HPP_ 1
```

```
#include <iterator>
#include <memory>
#include <utility>

namespace containers {

template <class T>
struct queue {
private:
struct element;
public:
queue() = default;

struct forward_iterator {
public:
using value_type = T;
using reference = T&;
using pointer = T*;
using difference_type = std::ptrdiff_t;
using iterator_category = std::forward_iterator_tag;

forward_iterator(element *ptr);

T& operator* ();
forward_iterator& operator++ ();
forward_iterator operator++ (int);

bool operator== (const forward_iterator& o) const;
bool operator!= (const forward_iterator& o) const;
private:
element* ptr_ = nullptr;

friend queue;
};

forward_iterator begin();
forward_iterator end();

void insert(forward_iterator& it, const T& value);
void insert_to_num(int pos, const T& value);
void erase(forward_iterator& it);
void erase_to_num(int pos);

void pop();
void push(const T& value);
```

```
T& top();

private:
struct element {
T value;
std::unique_ptr<element> next_element = nullptr;
forward_iterator next();
};
std::unique_ptr<element> first = nullptr;
};

template <class T>
typename queue<T>::forward_iterator queue<T>::begin() {
if (first == nullptr) {
return nullptr;
}
return forward_iterator(first.get());
}

template <class T>
typename queue<T>::forward_iterator queue<T>::end() {
return forward_iterator(nullptr);
}

template <class T>
void queue<T>::insert_to_num(int pos, const T& value) {
forward_iterator iter = this->begin();
for (int i = 0; i < pos; ++i) {
if (i == pos) {
break;
}
++iter;
}
this->insert(iter, value);
}

template <class T>
void queue<T>::insert(containers::queue<T>::forward_iterator& ptr, const T&
value) {
auto val = std::unique_ptr<element>(new element{value});
forward_iterator it = this->begin();
if (ptr == this->begin()) {
val->next_element = std::move(first);
first = std::move(val);
return;
}
```

```
while ((it.ptr_ != nullptr) && (it.ptr_->next() != ptr)) {
++it;
}
if (it.ptr_ == nullptr) {
throw std::logic_error ("ERROR");
}
val->next_element = std::move(it.ptr_->next_element);
it.ptr_->next_element = std::move(val);
}

template <class T>
void queue<T>::erase_to_num(int pos) {
forward_iterator iter = this->begin();
for (int i = 0; i < pos; ++i) {
if (i == pos) {
break;
}
++iter;
}
this->erase(iter);
}

template <class T>
void queue<T>::erase(containers::queue<T>::forward_iterator& ptr) {
forward_iterator it = this->begin(), end = this->end();
if (ptr == end) {
throw std::logic_error("ERROR");
}
if (ptr == it) {
this->pop();
return;
}
while ((it.ptr_ != nullptr) && (it.ptr_->next() != ptr)) {
++it;
}
if (it.ptr_ == nullptr) {
throw std::logic_error("ERROR");
}
it.ptr_->next_element = std::move(ptr.ptr_->next_element);
}

template <class T>
void queue<T>::pop() {
if (first == nullptr) {
throw std::logic_error ("queue is empty");
}
```

```
first = std::move(first->next_element);
}

template <class T>
void queue<T>::push(const T& value) {
forward_iterator it(nullptr);
insert(it, value);
}

template <class T>
T& queue<T>::top() {
if (first == nullptr) {
throw std::logic_error("queue is empty");
}
return first->value;
}

template<class T>
typename queue<T>::forward_iterator queue<T>::element::next() {
return forward_iterator(this->next_element.get());
}

template<class T>
queue<T>::forward_iterator::forward_iterator(containers::queue<T>::element *ptr)
{
ptr_ = ptr;
}

template<class T>
T& queue<T>::forward_iterator::operator*() {
return this->ptr_->value;
}

template<class T>
typename queue<T>::forward_iterator& queue<T>::forward_iterator::operator++()
{
if (ptr_ == nullptr) throw std::logic_error ("out of queue borders");
*this = ptr_->next();
return *this;
}

template<class T>
typename queue<T>::forward_iterator queue<T>::forward_iterator::operator++
(int) {
forward_iterator old = *this;
++*this;
```

```
return old;
}

template<class T>
bool queue<T>::forward_iterator::operator==(const forward_iterator& other) const
{
return ptr_ == other.ptr_;
}

template<class T>
bool queue<T>::forward_iterator::operator!=(const forward_iterator& other) const
{
return ptr_ != other.ptr_;
}
}

#endif // D_CONTAINERS_QUEUE_HPP_
```

main.cpp

```
#include <algorithm>
#include <iostream>

#include "queue.hpp"
#include "square.hpp"

int main()
{
int posision;
containers::queue<Square<int>> q;

std::cout << "1 - push\n"
<< "2 - top\n"
<< "3 - pop\n"
<< "4 - erase_to_num\n"
<< "5 - insert_to_num\n"
<< "6 - for_each\n"
<< "7 - count_if\n"
<< "0 - exit\n";

for (;;) {
int command;
std::cin >> command;

if (command == 1) {
```

```
Square<int> Square(std::cin);
q.push(Square);
std::cout << std::endl;
} else if (command == 2) {
q.top().print();
} else if (command == 4) {
std::cin >> posision;
q.erase_to_num(posision);
} else if (command == 0) {
break;
} else if (command == 5) {
std::cin >> posision;
Square<int> f(std::cin);
q.insert_to_num(posision, f);
} else if (command == 3) {
q.pop();
} else if (command == 6) {
std::for_each(q.begin(), q.end(), [] (Square<int> Square) {return Square.print();});
} else if (command == 7) {
int are;
std::cin >> are;
std::cout << std::count_if(q.begin(), q.end(), [are](Square<int> r){return r.area() <
are;}) << std::endl;
} else {
std::cout << "ERROR" << std::endl;
break;
}
}

return 0;
}
```

CMakeLists.txt

```
project(lab5)

add_executable(lab5
main.cpp)

set(CMAKE_CXX_FLAGS "${CMAKE_CXX_FLAGS} -Wall -Wextra")
```

2. **Ссылка на репозиторий:**
   https://github.com/obydenkova/oop_exercise_05

3. **Набор testcases:**

test_01.test

```
1
-1 0
0 1
1 0
0 -1
1
-2 0
0 2
2 0
0 -2
5
1
-3 0
0 3
3 0
0 -3
2
3
6
4
1
2
0
```

test_01.result

```
1 - push
2 - top
3 - pop
4 - erase_to_num
5 - insert_to_num
6 - for_each
7 - count_if
0 - exit
1
-1 0
0 1
1 0
0 -1

1
-2 0
0 2
2 0
0 -2
```

5
1
-3 0
0 3
3 0
0 -3
2
Vertices: [-1 0] [0 1] [1 0] [0 -1]
Area:2
Center:[0 0]
3
6
Vertices: [-3 0] [0 3] [3 0] [0 -3]
Area:18
Center:[0 0]
Vertices: [-2 0] [0 2] [2 0] [0 -2]
Area:8
Center:[0 0]
4
1
2
Vertices: [-3 0] [0 3] [3 0] [0 -3]
Area:18
Center:[0 0]
0
test_02.test
5
0
-1 0
0 1
1 0
0 -1
1
-3 0
0 3
3 0
0 -3
5
2
-2 0
0 2
2 0
0 -2
6
7

10
7
20
3
6
0

test_02.result
1 - push
2 - top
3 - pop
4 - erase_to_num
5 - insert_to_num
6 - for_each
7 - count_if
0 - exit
5 0
-1 0
0 1
1 0
0 -1
1
-3 0
0 3
3 0
0 -3

5 2
-2 0 0 2 2 0 0 -2
6
Vertices: [-1 0] [0 1] [1 0] [0 -1]
Area:2
Center:[0 0]
Vertices: [-3 0] [0 3] [3 0] [0 -3]
Area:18
Center:[0 0]
Vertices: [-2 0] [0 2] [2 0] [0 -2]
Area:8
Center:[0 0]
7
10
2
2
Vertices: [-1 0] [0 1] [1 0] [0 -1]
Area:2
Center:[0 0]

7
20
3
3
6
Vertices: [-3 0] [0 3] [3 0] [0 -3]
Area:18
Center:[0 0]
Vertices: [-2 0] [0 2] [2 0] [0 -2]
Area:8
Center:[0 0]
0

4. **Объяснение результатов работы программы:**

При вводе команды «1» происходит вставка элемента в очередь, при вводе «2» выводится первый элемент из нашей очереди, «3» удаляется первый элемент очереди, «4» удаление элемента очереди по итератору, «5» удаление из очереди по номеру итератора, «6» выводятся все фигуры, «7» выводится количество фигур площадь которых меньше заданной.

5. **Вывод:**

В данной лабораторной работе я освоила основы работы с коллекциями и итераторами. Создала свой STL контейнер основанный на умных указателях.