**Федеральное государственное автономное образовательное учреждение высшего образования**

**"Московский Авиационный Институт (Национальный Исследовательский Университет"**

Институт “Информационные технологии и прикладная математика”

**Лабораторная работа № 5**

по курсу «ООП»

Тема: Основы работы с коллекциями: итераторы

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1. Постановка задачи

Вариант 17

Фигура: треугольник; контейнер: очередь.

Создать шаблон динамической коллекции, согласно варианту задания.

1) Коллекция должна быть реализована с помощью умных указателей (std::shared\_ptr, std::weak\_ptr). Опционально использование std::unique\_ptr;

2) В качестве параметра шаблона коллекция должна принимать тип данных - фигуры;

3) Реализовать forward\_iterator по коллекции;

4) Коллекция должны возвращать итераторы begin() и end();

5) Коллекция должна содержать метод вставки на позицию итератора insert(iterator);

6) Коллекция должна содержать метод удаления из позиции итератора erase(iterator);

7) При выполнении недопустимых операций (например выход за границы коллекции или удаление несуществующего элемента) необходимо генерировать исключения;

8) Итератор должен быть совместим со стандартными алгоритмами (например, std::count\_if)

9) Коллекция должна содержать метод доступа

10) Реализовать программу, которая:

позволяет вводить с клавиатуры фигуры (с типом int в качестве параметра шаблона фигуры) и добавлять в коллекцию;

позволяет удалять элемент из коллекции по номеру элемента;

выводит на экран введенные фигуры c помощью std::for\_each;

выводит на экран количество объектов, у которых площадь меньше заданной (с помощью std::count\_if).

2. Описание программы

Репозиторий: <https://github.com/esnikolaeva/oop/tree/main/oop_exercise_05>

Контейнер “очередь” реализован с помощью умных указателей. Сам класс

Queue содержит умный указатель std::shared\_ptr на первый элемент очереди, умный указатель std::weak\_\_ptr на последний элемент и размер очереди size\_t size.

Элемент очереди реализован с помощью class Node, который содержит в себе умный указатель std::shared\_ptr на следующий элемент очереди, умный указатель std::weak\_ptr на предыдущий элемент и значение.

Указатель на предыдущий элемент очереди сделан с помощью weak\_ptr, чтобы можно было легко удалять элемент из очереди, изменяя только указатели next, тем самым то, на что указывали раньше shared\_ptr, удаляется, т. к. на него указывают только weak\_ptr, а weak\_ptr содержит слабую ссылку и не учитывается при подсчете количества указателей на какой-то объект.

3. Тестирование

**Тест 01:**

Operations: Add/ Remove/ Print/ Front/ Back/ Count\_if/ Menu/ Exit

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Add

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Add an item to the back of the queue[Push] or to the iterator position[Iter]

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Push

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Input points: 0 0 3 0 3 7

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Add

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Add an item to the back of the queue[Push] or to the iterator position[Iter]

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Push

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Input points: 1 1 4 1 4 8

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Add

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Add an item to the back of the queue[Push] or to the iterator position[Iter]

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Iter

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Input points: -1 -1 3 -1 3 7

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Input index: 1

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Print

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

[0, 0] [3, 0] [3, 7] <- [-1, -1] [3, -1] [3, 7] <- [1, 1] [4, 1] [4, 8]

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Remove

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Delete item from front of queue[Pop] or to the iterator position[Iter]

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Pop

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Front

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

[-1, -1] [3, -1] [3, 7]

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Back

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

[1, 1] [4, 1] [4, 8]

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Count\_if

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Input area: 22

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

The number of figures with an area less than a given 2

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Remove

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Delete item from front of queue[Pop] or to the iterator position[Iter]

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Iter

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Input index: 2

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Print

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

[-1, -1] [3, -1] [3, 7] <- [1, 1] [4, 1] [4, 8]

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Remove

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Delete item from front of queue[Pop] or to the iterator position[Iter]

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Pop

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Remove

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Delete item from front of queue[Pop] or to the iterator position[Iter]

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Pop

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Print

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Exit

**Тест 02:**

Operations: Add/ Remove/ Print/ Front/ Back/ Count\_if/ Menu/ Exit

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Add

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Add an item to the back of the queue[Push] or to the iterator position[Iter]

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Push

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Input points: 0 0 5 0 5 9

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Add

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Add an item to the back of the queue[Push] or to the iterator position[Iter]

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Iter

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Input points: 10 10 12 10 12 15

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Input index: 3

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Add

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Add an item to the back of the queue[Push] or to the iterator position[Iter]

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Iter

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Input points: 0 0 1 1 -1 -1

Vertices must not be on the same line.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Print

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

[0, 0] [5, 0] [5, 9] <- [10, 10] [12, 10] [12, 15]

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Front

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

[0, 0] [5, 0] [5, 9]

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Back

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

[10, 10] [12, 10] [12, 15]

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Exit

**Тест 03:**

Operations: Add/ Remove/ Print/ Front/ Back/ Count\_if/ Menu/ Exit

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Back

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Empty item

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Front

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Empty item

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Add

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Add an item to the back of the queue[Push] or to the iterator position[Iter]

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Push

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Input points: 0 0 1 0 1 3

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Add

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Add an item to the back of the queue[Push] or to the iterator position[Iter]

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Push

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Input points: 0 0 1 0 1 1

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Remove

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Delete item from front of queue[Pop] or to the iterator position[Iter]

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Pop

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Print

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

[0, 0] [1, 0] [1, 1]

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Exit

4. Листинг

**main.cpp:**

#include <iostream>

#include <string>

#include <algorithm>

#include <exception>

#include "queue.h"

#include "triangle.h"

#include "vertex.h"

#include "vector.h"

int main() {

Queue<Triangle<int>> q;

std::string cmd;

std::cout << "Operations: Add/ Remove/ Print/ Front/ Back/ Count\_if/ Menu/ Exit" << std::endl;

std::cout << "\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_" << std::endl;

while (std::cin >> cmd) {

if (cmd == "Add") {

std::cout << "\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_" << std::endl;

std::cout << "Add an item to the back of the queue[Push] or to the iterator position[Iter]" << std::endl;

std::cout << "\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_" << std::endl;

std::cin >> cmd;

std::cout << "\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_" << std::endl;

if (cmd == "Push") {

Triangle<int> t;

std::cout << "Input points: ";

try {

std::cin >> t;

}

catch (std::exception &e) {

std::cout << e.what() << std::endl;

std::cout << "\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_" << std::endl;

continue;

}

q.Push(t);

std::cout << "\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_" << std::endl;

}

else if (cmd == "Iter") {

Triangle<int> t;

std::cout << "Input points: ";

try {

std::cin >> t;

}

catch (std::exception &e) {

std::cout << e.what() << std::endl;

std::cout << "\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_" << std::endl;

continue;

}

std::cout << "\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_" << std::endl;

std::cout << "Input index: ";

int i;

std::cin >> i;

std::cout << "\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_" << std::endl;

Queue<Triangle<int>>::ForwardIterator it = q.Begin();

for (int cnt = 0; cnt < i; cnt++) {

it++;

}

q.Insert(it, t);

}

else {

std::cout << "Invalid input" << std::endl;

std::cin.clear();

std::cin.ignore(30000, '\n');

std::cout << "\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_" << std::endl;

continue;

}

}

else if (cmd == "Remove") {

std::cout << "\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_" << std::endl;

std::cout << "Delete item from front of queue[Pop] or to the iterator position[Iter]" << std::endl;

std::cout << "\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_" << std::endl;

std::cin >> cmd;

std::cout << "\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_" << std::endl;

if (cmd == "Pop") {

q.Pop();

}

else if (cmd == "Iter") {

std::cout << "Input index: ";

int i;

std::cin >> i;

std::cout << "\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_" << std::endl;

Queue<Triangle<int>>::ForwardIterator it = q.Begin();

for (int cnt = 0; cnt < i; cnt++) {

it++;

}

q.Erase(it);

}

else {

std::cout << "Invalid input" << std::endl;

std::cin.clear();

std::cin.ignore(30000, '\n');

std::cout << "\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_" << std::endl;

continue;

}

}

else if (cmd == "Print") {

std::cout << "\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_" << std::endl;

q.Print();

std::cout << "\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_" << std::endl;

}

else if (cmd == "Front") {

std::cout << "\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_" << std::endl;

Triangle<int> value;

try {

value = q.Front();

}

catch (std::exception &e) {

std::cout << e.what() << std::endl;

std::cout << "\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_" << std::endl;

continue;

}

std::cout << value << std::endl;

std::cout << "\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_" << std::endl;

}

else if (cmd == "Back") {

std::cout << "\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_" << std::endl;

Triangle<int> value;

try {

value = q.Back();

}

catch (std::exception &e) {

std::cout << e.what() << std::endl;

std::cout << "\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_" << std::endl;

continue;

};

std::cout << value << std::endl;

std::cout << "\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_" << std::endl;

}

else if (cmd == "Count\_if") {

std::cout << "\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_" << std::endl;

std::cout << "Input area: ";

double area;

std::cin >> area;

std::cout << "\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_" << std::endl;

std::cout << "The number of figures with an area less than a given " << std::count\_if(q.Begin(), q.End(), [area](Triangle<int> t){

return Area(t) < area;

}) << std::endl;

std::cout << "\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_" << std::endl;

}

else if (cmd == "Menu") {

std::cout << "\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_" << std::endl;

std::cout << "Operations: Add/ Remove/ Print/ Front/ Back/ Count\_if/ Menu/ Exit" << std::endl;

std::cout << "\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_" << std::endl;

}

else if (cmd == "Exit") {

break;

}

else {

std::cout << "\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_" << std::endl;

std::cout << "Invalid input" << std::endl;

std::cin.clear();

std::cin.ignore(30000, '\n');

std::cout << "\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_" << std::endl;

}

}

return 0;

}

**queue.h:**

#ifndef QUEUE\_H

#define QUEUE\_H 1

#include <iostream>

#include <memory>

#include <algorithm>

template<typename T>

class Queue {

using value\_type = T;

using size\_type = size\_t;

using reference = value\_type &;

using const\_reference = const value\_type &;

using pointer = value\_type \*;

using const\_pointer = const value\_type \*;

private:

class Node {

public:

Node(T val) : next{nullptr}, prev{next}, value{val} {};

friend class Queue;

private:

std::shared\_ptr<Node> next;

std::weak\_ptr<Node> prev;

T value;

};

public:

class ForwardIterator {

public:

using value\_type = T;

using reference = T&;

using pointer = T\*;

using difference\_type = ptrdiff\_t;

using iterator\_category = std::forward\_iterator\_tag;

friend class Queue;

ForwardIterator(std::shared\_ptr<Node> it = nullptr) : ptr{it} {};

ForwardIterator(const ForwardIterator &other) : ptr{other.ptr} {};

ForwardIterator operator++() {

if (ptr.lock() == nullptr) {

return \*this;

}

ptr = ptr.lock()->next;

return \*this;

}

ForwardIterator operator++(int s) {

if (ptr.lock() == nullptr) {

return \*this;

}

ForwardIterator old{this->ptr.lock()};

++(\*this);

return old;

}

reference operator\*() {

return ptr.lock()->value;

}

const\_reference operator\*() const {

return ptr.lock()->value;

}

std::shared\_ptr<Node> operator->() {

return ptr.lock();

}

std::shared\_ptr<const Node> operator->() const {

return ptr.lock();

}

bool operator==(const ForwardIterator &rhs) const {

return ptr.lock() == rhs.ptr.lock();

}

bool operator!=(const ForwardIterator &rhs) const {

return ptr.lock() != rhs.ptr.lock();

}

ForwardIterator Next() const {

if (ptr.lock() == nullptr)

return ForwardIterator{};

return ptr.lock()->next;

}

private:

std::weak\_ptr<Node> ptr;

};

Queue() : head{nullptr}, tail{head}, size{0} {};

void Push(const T& val) {

if (!head) {

head = std::make\_shared<Node>(val);

tail = head;

}

else {

std::shared\_ptr<Node> newElem = std::make\_shared<Node>(val);

newElem->prev = tail;

tail.lock()->next = newElem;

tail = newElem;

}

size++;

}

ForwardIterator Insert(const ForwardIterator it, const T& val) {

if (it == ForwardIterator{}) {

if (tail.lock() == nullptr) {

Push(val);

return Begin();

}

std::shared\_ptr<Node> newElem = std::make\_shared<Node>(val);

newElem->prev = tail;

tail.lock()->next = newElem;

tail = newElem;

size++;

return newElem;

}

if (it == Begin()) {

std::shared\_ptr<Node> newElem = std::make\_shared<Node>(val);

newElem->next = it.ptr.lock();

it->prev.lock() = newElem;

head = newElem;

size++;

return newElem;

}

std::shared\_ptr<Node> newElem = std::make\_shared<Node>(val);

newElem->next = it.ptr.lock();

it->prev.lock()->next = newElem;

newElem->prev = it->prev;

it->prev.lock() = newElem;

size++;

return newElem;

}

void Pop() {

if (head) {

head = head->next;

size--;

}

}

ForwardIterator Erase(const ForwardIterator it) {

if (it == ForwardIterator{}) { //удаление несуществующего элемента

return End();

}

if (it->prev.lock() == nullptr && head == tail.lock()) { //удаление очереди, состоящей только из одного элемента

head = nullptr;

tail = head;

size = 0;

return End();

}

if (it->prev.lock() == nullptr) { //удаление первого элемента

it->next->prev.lock() = nullptr;

head = it->next;

size--;

return head;

}

ForwardIterator res = it.Next();

if (res == ForwardIterator{}) { //удаление последнего элемента

it->prev.lock()->next = nullptr;

size--;

return End();

}

//удаление элементов в промежутке

it->next->prev = it->prev;

it->prev.lock()->next = it->next;

size--;

return res;

}

reference Front() {

if (head == nullptr)

throw std::out\_of\_range("Empty item");

return this->head->value;

}

const\_reference Front() const {

if (head == nullptr)

throw std::out\_of\_range("Empty item");

return this->head->value;

}

reference Back() {

if (head == nullptr)

throw std::out\_of\_range("Empty item");

return this->tail.lock()->value;

}

const\_reference Back() const {

if (head == nullptr)

throw std::out\_of\_range("Empty item");

return this->tail.lock()->value;

}

ForwardIterator Begin() {

return head;

}

ForwardIterator End() {

return ForwardIterator{};

}

bool Empty() const {

return size == 0;

}

size\_type Size() const {

return size;

}

void Swap(Queue &rhs) {

std::shared\_ptr<Node> temp = head;

head = rhs.head;

rhs.head = temp;

}

void Clear() {

head = nullptr;

tail = head;

size = 0;

}

void Print() {

ForwardIterator it = Begin();

std::for\_each(Begin(), End(), [it, this](auto e)mutable{

std::cout << e;

if (it.Next() != this->End()) {

std::cout << " <- ";

}

it++;

});

std::cout << "\n";

}

private:

std::shared\_ptr<Node> head;

std::weak\_ptr<Node> tail;

size\_t size;

};

#endif //QUEUE\_H

**vertex.h:**

#ifndef VERTEX\_H

#define VERTEX\_H 1

template<typename T>

struct vertex {

using vertex\_t = std::pair<T, T>;

};

template<typename T>

std::istream &operator>>(std::istream &is, std::pair<T, T> &v) {

is >> v.first >> v.second;

return is;

}

template<typename T>

std::ostream &operator<<(std::ostream &os, const std::pair<T,T> &v) {

os << "[" << v.first << ", " << v.second << "]";

return os;

}

#endif // VERTEX\_H

**vector.h:**

#ifndef VECTOR\_H

#define VECTOR\_H 1

#include <utility>

#include <cmath>

#include <iostream>

#include "vertex.h"

template<typename T>

struct Vector {

using vertex\_t = std::pair<T, T>;

T p1, p2;

Vector(T x\_cord, T y\_cord) : p1{x\_cord}, p2{y\_cord} {};

Vector(vertex\_t &p1, vertex\_t &p2) : p1{p2.first - p1.first},

p2{p2.second - p1.second} {};

double operator\*(const Vector<T> &a) const {

return (p1 \* a.p1) + (p2 \* a.p2);

}

Vector<T> &operator=(const Vector<T> &a) {

p1 = a.p1;

p2 = a.p2;

return \*this;

}

};

template<typename T>

double Length(const Vector<T> &vector) {

return sqrt(vector.p1 \* vector.p1 + vector.p2 \* vector.p2);

}

template<typename T>

double Length(const std::pair<T, T> &A,

const std::pair<T, T> &B) {

return sqrt(pow((B.first - A.first), 2) +

pow((B.second - A.second), 2));

}

template<typename T>

bool is\_parallel(const Vector<T> &A, const Vector<T> &B) {

return (A.p1 \* B.p2) - (A.p2 \* B.p1) == 0;

}

#endif //VECTOR\_H

**triangle.h:**

#ifndef TRIANGLE\_H

#define TRIANGLE\_H

#include <utility>

#include <iostream>

#include "vector.h"

#include "vertex.h"

template<typename T>

struct Triangle {

using vertex\_t = std::pair<T,T>;

vertex\_t vertices[3];

};

template<typename T>

typename Triangle<T>::vertex\_t Center(const Triangle<T> &t);

template<typename T>

double Area(const Triangle<T> &t);

template<typename T>

std::ostream &Print(std::ostream &os, const Triangle<T> &t);

template<typename T>

std::istream &Read(std::istream &is, Triangle<T> &t);

template<typename T>

std::istream &operator>>(std::istream &is, Triangle<T> &t);

template<typename T>

std::ostream &operator<<(std::ostream &os, const Triangle<T> &t);

template<typename T>

typename Triangle<T>::vertex\_t Center(const Triangle<T> &t) {

T x, y;

x = (t.vertices[0].first + t.vertices[1].first + t.vertices[2].first) / 3;

y = (t.vertices[0].second + t.vertices[1].second + t.vertices[2].second) / 3;

return std::make\_pair(x, y);

}

template<typename T>

double Area(const Triangle<T> &t) {

double res = 0;

for (int i = 0; i <= 1; i++) {

res += (t.vertices[i].first \* t.vertices[i + 1].second -

t.vertices[i + 1].first \* t.vertices[i].second);

}

res += (t.vertices[2].first \* t.vertices[0].second -

t.vertices[0].first \* t.vertices[2].second);

res = 0.5 \* std::abs(res);

return res;

}

template<typename T>

std::ostream &Print(std::ostream &os, const Triangle<T> &t) {

for (int i = 0; i < 3; i++) {

os << t.vertices[i];

if (i != 2) {

os << " ";

}

}

return os;

}

template<typename T>

std::istream &Read(std::istream &is, Triangle<T> &t) {

for (int i = 0; i < 3; i++) {

is >> t.vertices[i].first >> t.vertices[i].second;

}

double AB = Length(t.vertices[0], t.vertices[1]),

BC = Length(t.vertices[1], t.vertices[2]),

AC = Length(t.vertices[0], t.vertices[2]);

if (AB >= BC + AC || BC >= AB + AC || AC >= AB + BC) {

throw std::logic\_error("Vertices must not be on the same line.");

}

return is;

}

template<typename T>

std::istream &operator>>(std::istream &is, Triangle<T> &t) {

return Read(is, t);

}

template<typename T>

std::ostream &operator<<(std::ostream &os, const Triangle<T> &t) {

return Print(os, t);

}

#endif // TRIANGLE\_H

5. Список литературы

Справочник по языку [Электронный ресурс]. URL: <https://ravesli.com/uroki-cpp/> (дата обращения 15.01.2021).

Справочник по языку [Электронный ресурс]. URL:

<https://metanit.com/cpp/tutorial/> (дата обращения 15.01.2021).