МИНИСТЕРСТВО ОБРАЗОВАНИЯ И НАУКИ РОССИЙСКОЙФЕДЕРАЦИИ МОСКОВСКИЙ АВИАЦИОННЫЙ ИНСТИТУТ(НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ УНИВЕРСТИТЕТ)

ЛАБОРАТОРНАЯ РАБОТА №6по курсу объектно-ориентированное программирование I семестр, 2021/22уч. год

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**Задание**

Необходимо спроектировать и запрограммировать на языке C++ шаблон класса-контейнера первого уровня, содержащий одну фигуру (колонка фигура 1), согласно вариантам задания. Класс-контейнер должен содержать объекты используя std::shared\_ptr<…>.

**Вариант 18**

Фигура треугольник, структура бинарное дерево.

**Описание программы**

Программа состоит из 10 файлов: main.cpp, figure.h, point.h, point.cpp, TBinaryTree.h, TBinaryTreeItem.h, TBinaryTree.cpp, TBinaryTree.cpp, triangle.h, triangle.cpp, содержит шаблон класса TBinaryTree.

**Дневник отладки**

При отладке ошибок в выполнении программы не выявлено.

**Выводы**

Проделав лабораторную работу, познакомился с шаблонами в C++.

**Листинг**

main.cpp

#include <iostream>

#include <string>

#include "TBinaryTree.h"

using namespace std;

int main ()

{

cout << "Enter TEST to check program quickly\n";

cout << "Else enter MASTER\n";

string command;

cin >> command;

if (command == "TEST")

{

TBinaryTree<Triangle> TREE;

Point o(0, 0);

Point ax(1, 0);

Point ay(0, 1);

Point bx(2, 0);

Point by(0, 2);

Point cx(3, 0);

Point cy(0, 3);

Triangle A(o, ax, ay);

Triangle B(o, bx, by);

Triangle C(o, cx, cy);

cout << "Triangle A: " << A << endl;

cout << "Triangle B: " << B << endl;

cout << "Triangle C: " << C << endl;

TREE.Push(B);

TREE.Push(A);

TREE.Push(C);

cout << "Push triangle B\nPush triangle A\nPush triangle C\n";

cout << "Print tree:\n" << TREE << endl;

cout << "GetItemNotLess 1:\n";

Triangle R = TREE.GetItemNotLess(1);

cout << R << endl;

cout << "Count triangles with the same area with (0, 0) (2, 0) (0, 1):\n";

Triangle D(o, bx, ay);

cout << TREE.Count(D) << endl;

cout << "Pop triangle C\n";

TREE.Pop(C);

cout << "Print tree:\n" << TREE << endl;

cout << "Is tree empty?\n";

if (TREE.Empty() == 1)

{

cout << "Yes\n";

}

else

{

cout << "No\n";

}

cout << "Done\n";

return 0;

}

if (command == "MASTER")

{

cout << "Commands:\n";

cout << "PUSH -- adds triangle into the tree\n";

cout << "GINL -- returns triangle with area >= than yours\n";

cout << "COUNT -- calculates amount of triangles with the same area in the tree\n";

cout << "POP -- removes triangle from the tree\n";

cout << "EMPTY -- returns is tree is empty\n";

cout << "PRINT -- prints the tree\n";

cout << "END -- clears the tree and ends program\n";

cout << "TEST -- run test script to check the program\n";

cout << "Enter your first command:" << endl;

cin >> command;

TBinaryTree<Triangle> TREE;

while (command != "END")

{

if (command == "PUSH")

{

cout << "Enter chords of 3 points of triangle to PUSH: \n";

Triangle T(cin);

TREE.Push(T);

cout << "Enter next command:\n";

cin >> command;

}

if (command == "GINL")

{

cout << "Enter area: \n";

double a;

cin >> a;

a -= 0.0000001;

Triangle R = TREE.GetItemNotLess(a);

cout << "Result:\n";

cout << R << endl;

cout << "Enter next command:\n";

cin >> command;

}

if (command == "COUNT")

{

cout << "Enter chords of 3 points of triangle to COUNT: \n";

Triangle T(cin);

unsigned r = TREE.Count(T);

cout << "Result is " << r << endl;

cout << "Enter next command:\n";

cin >> command;

}

if (command == "POP")

{

cout << "Enter chords of 3 points of triangle to POP: \n";

Triangle T(cin);

TREE.Pop(T);

cout << "Enter next command:\n";

cin >> command;

}

if (command == "EMPTY")

{

if (TREE.Empty() == 1)

{

cout << "Tree is empty\n";

}

else

{

cout << "Tree is not empty\n";

}

cout << "Enter next command:\n";

cin >> command;

}

if (command == "PRINT")

{

cout << TREE << endl;

cout << "Enter next command:\n";

cin >> command;

}

}

TREE.Clear();

cout << "Done\n";

return 0;

}

}

figure.h

#ifndef FIGURE\_H

#define FIGURE\_H

#include <cstddef>

#include "point.h"

using namespace std;

class Figure

{

public:

virtual ~Figure()

{};

virtual double Area() = 0;

virtual void Print(ostream& os) = 0;

virtual size\_t VertexesNumber() = 0;

};

#endif

point.cpp

#include "point.h"

#include <cmath>

Point::Point() : x\_(0.0), y\_(0.0) {}

Point::Point(double x, double y) : x\_(x), y\_(y) {}

Point::Point(std::istream &is) {

is >> x\_ >> y\_;

}

double Point::dist(Point& other) {

double dx = (other.x\_ - x\_);

double dy = (other.y\_ - y\_);

return std::sqrt(dx\*dx + dy\*dy);

}

std::istream& operator>>(std::istream& is, Point& p) {

is >> p.x\_ >> p.y\_;

return is;

}

std::ostream& operator<<(std::ostream& os, Point& p) {

os << "(" << p.x\_ << ", " << p.y\_ << ")";

return os;

}

point.h

#ifndef POINT\_H

#define POINT\_H

#include <iostream>

class Point {

public:

Point();

Point(std::istream &is);

Point(double x, double y);

double dist(Point& other);

friend std::istream& operator>>(std::istream& is, Point& p);

friend std::ostream& operator<<(std::ostream& os, Point& p);

private:

double x\_;

double y\_;

};

#endif // POINT\_H

TBinaryTreeItem.cpp

#include "TBinaryTreeItem.h"

template <class T>

TBinaryTreeItem<T>::TBinaryTreeItem(const T &t)

{

this->tri = t;

this->left = NULL;

this->right = NULL;

this->counter = 1;

}

template <class T>

TBinaryTreeItem<T>::TBinaryTreeItem(const TBinaryTreeItem<T> &other)

{

this->tri = other.tri;

this->left = other.left;

this->right = other.right;

this->counter = other.counter;

}

template <class T>

TBinaryTreeItem<T>::~TBinaryTreeItem()

{}

template <class TT>

ostream& operator<<(ostream& os, TBinaryTreeItem<TT> tr)

{

os << tr.tri << " ";

return os;

}

#include "triangle.h"

template class TBinaryTreeItem<Triangle>;

template ostream& operator<<(ostream& os, TBinaryTreeItem<Triangle> t);

TBinaryTreeItem.h

#ifndef TBINARYTREE\_ITEM\_H

#define TBINARYTREE\_ITEM\_H

#include "triangle.h"

template<class T>

class TBinaryTreeItem

{

public:

TBinaryTreeItem(const T& tri);

TBinaryTreeItem(const TBinaryTreeItem<T>& other);

virtual ~TBinaryTreeItem();

T tri;

shared\_ptr<TBinaryTreeItem<T>> left;

shared\_ptr<TBinaryTreeItem<T>> right;

unsigned counter;

template<class TT>

friend ostream &operator<<(ostream &os, const TBinaryTreeItem<TT> &t);

};

#endif

TBinaryTree.h

#ifndef TBINARYTREE\_H

#define TBINARYTREE\_H

#include "TBinaryTreeItem.h"

using namespace std;

template <class T>

class TBinaryTree

{

private:

shared\_ptr <TBinaryTreeItem<T>> node;

public:

TBinaryTree();

void Push(const T& tr);

const T& GetItemNotLess(double area);

size\_t Count(const T& t);

void Pop(const T& t);

bool Empty();

template <class TT>

friend ostream& operator<<(ostream& os, const TBinaryTree<TT>& tree);

void Clear();

virtual ~TBinaryTree();

};

#endif

TBinaryTree.cpp

#include "TBinaryTree.h"

using namespace std;

template <class T>

TBinaryTree<T>::TBinaryTree() : node(NULL)

{}

template <class T>

void print\_tree(ostream& os, shared\_ptr <TBinaryTreeItem<T>> node)

{

if (!node)

{

return;

}

if (node->left)

{

os << node->counter << "\*" << node->tri.GetArea() << ": [";

print\_tree(os, node->left);

if (node->right)

{

os << ", ";

print\_tree(os, node->right);

}

os << "]";

}

else if (node->right)

{

os << node->counter << "\*" << node->tri.GetArea() << ": [";

print\_tree(os, node->right);

if (node->left)

{

os << ", ";

print\_tree(os, node->left);

}

os << "]";

}

else

{

os << node->counter << "\*" << node->tri.GetArea();

}

}

template <class TT>

std::ostream& operator << (ostream& os, const TBinaryTree<TT>& tree)

{

print\_tree(os, tree.node);

os;

return os;

}

template <class T>

void TBinaryTree<T>::Push(const T &tr)

{

T t = tr;

if (node == NULL)

{

shared\_ptr <TBinaryTreeItem<T>> c(new TBinaryTreeItem<T>(t));

node = c;

}

else if (node->tri.GetArea() == t.GetArea())

{

node->counter++;

}

else

{

shared\_ptr<TBinaryTreeItem<T>> prev = node;

shared\_ptr<TBinaryTreeItem<T>> cur;

bool bebra = true;

if (t.GetArea() < prev->tri.GetArea())

{

cur = node->left;

}

else if (t.GetArea() > prev->tri.GetArea())

{

cur = node->right;

bebra = false;

}

while (cur != NULL)

{

if (cur->tri == t)

{

cur->counter++;

}

else

{

if (t.GetArea() < cur->tri.GetArea())

{

prev = cur;

cur = prev->left;

bebra = true;

}

else if (t.GetArea() > cur->tri.GetArea())

{

prev = cur;

cur = prev->right;

bebra = false;

}

}

}

shared\_ptr<TBinaryTreeItem<T>> c(new TBinaryTreeItem<T>(t));

cur = c;

if (bebra == true)

{

prev->left = cur;

}

else

{

prev->right = cur;

}

}

}

template <class T>

shared\_ptr<TBinaryTreeItem<T>> \_\_Pop(shared\_ptr<TBinaryTreeItem<T>> node)

{

if (node->left == NULL)

{

return node;

}

return \_\_Pop(node->left);

}

template <class T>

shared\_ptr<TBinaryTreeItem<T>> \_Pop(shared\_ptr<TBinaryTreeItem<T>> node, T &t)

{

if (node == NULL)

{

return node;

}

else if (t.GetArea() < node->tri.GetArea())

{

node->left = \_Pop(node->left, t);

}

else if (t.GetArea() > node->tri.GetArea())

{

node->right = \_Pop(node->right, t);

}

else

{

if (node->left == NULL && node->right == NULL)

{

if (node->counter > 1)

{

--node->counter;

return node;

}

node = NULL;

return node;

}

else if (node->left == NULL && node->right != NULL)

{

if (node->counter > 1)

{

--node->counter;

return node;

}

node = node->right;

node->right = NULL;

return node;

}

else if (node->right == NULL && node->left != NULL)

{

if (node->counter > 1)

{

--node->counter;

return node;

}

node = node->left;

node->left = NULL;

return node;

}

else

{

shared\_ptr<TBinaryTreeItem<T>> bebra = \_\_Pop(node->right);

node->tri.A = bebra->tri.GetArea();

node->right = \_Pop(node->right, bebra->tri);

}

}

return node;

}

template <class T>

void TBinaryTree<T>::Pop(const T &t)

{

T tr = t;

node = \_Pop(node, tr);

}

template <class T>

unsigned \_Count(shared\_ptr<TBinaryTreeItem<T>> cur, unsigned res, T& t)

{

if (cur != NULL)

{

\_Count(cur->left, res, t);

\_Count(cur->right, res, t);

if (cur->tri.GetArea() == t.GetArea())

{

return cur->counter;

}

}

return 0;

}

template <class T>

size\_t TBinaryTree<T>::Count(const T& t)

{

T tr = t;

return \_Count(node, 0, tr);

}

template <class T>

T& \_GetItemNotLess(double area, shared\_ptr<TBinaryTreeItem<T>> node)

{

if (node->tri.GetArea() >= area)

{

return node->tri;

}

else

{

\_GetItemNotLess(area, node->right);

}

}

template <class T>

const T& TBinaryTree<T>::GetItemNotLess(double area)

{

return \_GetItemNotLess(area, node);

}

template <class T>

void \_Clear(shared\_ptr<TBinaryTreeItem<T>> cur)

{

if (cur!= NULL)

{

\_Clear(cur->left);

\_Clear(cur->right);

cur = NULL;

}

}

template <class T>

void TBinaryTree<T>::Clear()

{

\_Clear(node);

node = NULL;

}

template <class T>

bool TBinaryTree<T>::Empty()

{

return (node == NULL);

}

template <class T>

TBinaryTree<T>::~TBinaryTree()

{

Clear();

}

template class TBinaryTree<Triangle>;

template ostream& operator<<(ostream& os, const TBinaryTree<Triangle>& tr);

triangle.h

#ifndef TRIANGLE\_H

#define TRIANGLE\_H

#include <iostream>

#include "figure.h"

using namespace std;

class Triangle : public Figure

{

private:

Point p1, p2, p3;

public:

Triangle();

Triangle(istream& is);

double Area();

void Print(ostream& os);

size\_t VertexesNumber();

virtual ~Triangle();

};

#endif

triangle.cpp

#include <cmath>

#include "triangle.h"

using namespace std;

Triangle::Triangle(istream& is)

{

is >> p1 >> p2 >> p3;

}

void Triangle::Print(ostream& os)

{

os << "Triangle: " << p1 << " " << p2 << " " << p3 << endl;

}

double Triangle::Area()

{

double a = p1.dist(p2);

double b = p2.dist(p3);

double c = p3.dist(p1);

double p = (a + b + c)/2;

double s = sqrt(p \* (p - a) \* (p - b) \* (p - c));

return s;

}

size\_t Triangle::VertexesNumber()

{

return 3;

}

Triangle::~Triangle()

{

cout << "Done\n";

}