Московский Авиационный Институт

(Национальный исследовательский Университет)

Факультет: «Информационные технологии и прикладная математика»

Кафедра: 806 «Вычислительная математика и программирование»

**Лабораторная работа**

**по курсу «ООП»**

**Тема:**

**Наследование. Полиморфизм.**

|  |  |
| --- | --- |
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**1. Код программы на языке C++:**

**point.h:**

#ifndef POINT\_H

#define POINT\_H 1

#include <iostream>

class Point {

double x;

double y;

public:

Point();

Point(double a, double b);

Point(const Point &other);

double X() const;

double Y() const;

Point operator+(const Point &a) const;

Point operator-(const Point &a) const;

Point operator\*(double a) const;

Point operator/(double a) const;

friend std::ostream &operator<<(std::ostream &out, const Point &a);

friend std::istream &operator>>(std::istream &in, Point &a);

};

#endif // POINT\_H

**point.cpp:**

#include "point.h"

#include <cmath>

Point::Point() : x{0}, y{0} {}

Point::Point(double a, double b) : x{a}, y{b} {}

Point::Point(const Point &other) : x{other.x}, y{other.y} {}

double Point::X() const {

return x;

}

double Point::Y() const {

return y;

}

Point Point::operator+(const Point &a) const {

return {x + a.x, y + a.y};

}

Point Point::operator-(const Point &a) const {

return {x - a.x, y - a.y};

}

Point Point::operator\*(double a) const {

return {x \* a, y \* a};

}

Point Point::operator/(double a) const {

return {x / a, y / a};

}

std::ostream &operator<<(std::ostream &out, const Point &a) {

out << "(" << a.x << "; " << a.y << ")";

return out;

}

std::istream &operator>>(std::istream &in, Point &a) {

in >> a.x >> a.y;

return in;

}

**figure.h:**

#ifndef FIGURE\_H

#define FIGURE\_H 1

#include "point.h"

#include <iostream>

class Figure {

public:

virtual Point Center() const = 0;

virtual double Area() const = 0;

virtual std::ostream &Print(std::ostream &out) const = 0;

virtual std::istream &Scan(std::istream &in) = 0;

virtual ~Figure() = default;

};

std::ostream &operator<<(std::ostream &out, const Figure &fig);

std::istream &operator>>(std::istream &in, Figure &fig);

#endif //FIGURE\_H

**figure.cpp:**

#include "figure.h"

std::ostream &operator<<(std::ostream &out, const Figure &fig) {

fig.Print(out);

return out;

}

std::istream &operator>>(std::istream &in, Figure &fig) {

fig.Scan(in);

return in;

}

**triangle.h:**

#ifndef TRIANGLE\_H

#define TRIANGLE\_H 1

#include "point.h"

#include "figure.h"

#include "vector.h"

class Triangle : public Figure {

Point A, B, C;

public:

Triangle();

Triangle(Point a, Point b, Point c);

Point Center() const override;

double Area() const override;

std::ostream &Print(std::ostream &out) const override;

std::istream &Scan(std::istream &in) override;

};

#endif //TRIANGLE\_H

**triangle.cpp:**

#include "triangle.h"

#include "figure.h"

#include "point.h"

#include "vector.h"

#include <cmath>

Triangle::Triangle() : A{Point{}}, B{Point{}}, C{Point{}} {}

Triangle::Triangle(Point a, Point b, Point c) : A{a}, B{b}, C{c} {

double AB = Length(A, B), BC = Length(B, C), AC = Length(A, C);

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

throw std::logic\_error("Any side of the triangle must be less than the sum of the other two sides");

}

}

Point Triangle::Center() const {

Point mid\_of\_base{ (A + C) / 2 };

return { (B + mid\_of\_base \* 2) / 3 };

}

double Triangle::Area() const {

double AB = Length(A, B), BC = Length(B, C), AC = Length(A, C);

double perim = AB + BC + AC;

return sqrt((perim / 2) \* (perim / 2 - AB) \* (perim / 2 - BC) \* (perim / 2 - AC));

}

std::ostream &Triangle::Print(std::ostream &out) const {

out << "Triangle: p1 = " << A << ", p2 = " << B << ", p3 = " << C;

return out;

}

std::istream &Triangle::Scan(std::istream &in) {

in >> A >> B >> C;

(\*this) = Triangle(A, B, C);

return in;

}

**square.h:**

#ifndef SQUARE\_H

#define SQUARE\_H 1

#include "point.h"

#include "figure.h"

#include "vector.h"

class Square : public Figure {

Point A, B, C, D;

public:

Square();

Square(Point a, Point b, Point c, Point d);

Point Center() const override;

double Area() const override;

std::ostream &Print(std::ostream &out) const override;

std::istream &Scan(std::istream &in) override;

};

#endif //SQUARE\_H

**square.cpp:**

#include "square.h"

#include "vector.h"

Square::Square() : A{Point{}}, B{Point{}}, C{Point{}}, D{Point{}} {}

Square::Square(Point a, Point b, Point c, Point d) : A{a}, B{b}, C{c}, D{d} {

Vector AB{ A, B }, BC{ B, C }, CD { C, D }, DA { D, A };

if (!is\_parallel(DA, BC)) {

std::swap(A, B);

AB = { A, B };

BC = { B, C };

CD = { C, D };

DA = { D, A };

}

if (!is\_parallel(AB, CD)) {

std::swap(B, C);

AB = { A, B };

BC = { B, C };

CD = { C, D };

DA = { D, A };

}

if (AB \* BC || BC \* CD || CD \* DA || DA \* AB) {

throw std::logic\_error("The sides of the square should be perpendicular");

}

if (Length(AB) != Length(BC) || Length(BC) != Length(CD) || Length(CD) != Length(DA) || Length(DA) != Length(AB)) {

throw std::logic\_error("The sides of the square should be equal");

}

if (!Length(AB) || !Length(BC) || !Length(CD) || !Length(DA)) {

throw std::logic\_error("The sides of the square must be greater than zero");

}

}

Point Square::Center() const {

return Point{ (B + D) / 2 };

}

double Square::Area() const {

return Length(A, B) \* Length(A, B);

}

std::ostream &Square::Print(std::ostream &out) const {

out << "Square: p1 = " << A << ", p2 = " << B << ", p3 = " << C << ", p4 = " << D;

return out;

}

std::istream &Square::Scan(std::istream &in) {

in >> A >> B >> C >> D;

(\*this) = Square(A, B, C, D);

return in;

}

**rectangle.h:**

#ifndef RECTANGLE\_H

#define RECTANGLE\_H 1

#include "point.h"

#include "figure.h"

#include "vector.h"

class Rectangle : public Figure {

Point A, B, C, D;

public:

Rectangle();

Rectangle(Point a, Point b, Point c, Point d);

Point Center() const override;

double Area() const override;

std::ostream &Print(std::ostream &out) const override;

std::istream &Scan(std::istream &in) override;

}

#endif //RECTANGLE\_H

**rectangle.cpp:**

#include "rectangle.h"

#include "vector.h"

Rectangle::Rectangle() : A{Point{}}, B{Point{}}, C{Point{}}, D{Point{}} {}

Rectangle::Rectangle(Point a, Point b, Point c, Point d) : A{a}, B{b}, C{c}, D{d} {

Vector AB{ A, B }, BC{ B, C }, CD { C, D }, DA { D, A };

if (!is\_parallel(DA, BC)) {

std::swap(A, B);

AB = { A, B };

BC = { B, C };

CD = { C, D };

DA = { D, A };

}

if (!is\_parallel(AB, CD)) {

std::swap(B, C);

AB = { A, B };

BC = { B, C };

CD = { C, D };

DA = { D, A };

}

if (AB \* BC || BC \* CD || CD \* DA || DA \* AB) {

throw std::logic\_error("The sides of the rectangle should be perpendicular");

}

if (!Length(AB) || !Length(BC) || !Length(CD) || !Length(DA)) {

throw std::logic\_error("The sides of the rectangle must be greater than zero");

}

}

Point Rectangle::Center() const {

return Point{ (B + D) / 2 };

}

double Rectangle::Area() const {

return Length(D, A) \* Length(B, A);

}

std::ostream &Rectangle::Print(std::ostream &out) const {

out << "Rectangle: p1 = " << A << ", p2 = " << B << ", p3 = " << C << ", p4 = " << D;

return out;

}

std::istream &Rectangle::Scan(std::istream &in) {

in >> A >> B >> C >> D;

(\*this) = Rectangle(A, B, C, D);

return in;

}

**vector.h:**

#ifndef VECTOR\_H

#define VECTOR\_H 1

#include "point.h"

class Vector {

public:

double x, y;

Vector(double x\_cord, double y\_cord);

Vector(Point &p1, Point &p2);

double operator\*(const Vector &a) const;

Vector &operator=(const Vector &a);

};

double Length(const Point &a, const Point &b);

double Length(const Vector &a);

bool is\_parallel(const Vector &a, const Vector &b);

#endif// VECTOR\_H

**vector.cpp:**

#include "vector.h"

#include "point.h"

#include <cmath>

Vector::Vector(double x\_cord, double y\_cord) : x{x\_cord}, y{y\_cord} {}

Vector::Vector(Point &p1, Point &p2) : x{p2.X() - p1.X()}, y{p2.Y() - p1.Y()} {}

double Vector::operator\*(const Vector &a) const {

return (x \* a.x) + (y \* a.y);

}

Vector &Vector::operator=(const Vector &a) {

x = a.x;

y = a.y;

return \*this;

}

double Length(const Point &a, const Point &b) {

return sqrt(pow((b.X() - a.X()), 2) + pow((b.Y() - a.Y()), 2));

}

double Length(const Vector &a) {

return sqrt(pow(a.x, 2) + pow(a.y, 2));

}

bool is\_parallel(const Vector &a, const Vector &b) {

return (a.x \* b.y) - (a.y \* b.x) == 0;

}

**main.cpp:**

#include <iostream>

#include <vector>

#include <string>

#include <exception>

#include <cmath>

#include "point.h"

#include "vector.h"

#include "figure.h"

#include "triangle.h"

#include "square.h"

#include "rectangle.h"

int main() {

std::vector<Figure \*> figures;

std::string command;

std::cout << "Operations: Add/ Print/ Area/ Center/ Total\_area/ Print\_all/ Delete/ Delete\_all/ Quit" << std::endl;

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

while (std::cin >> command) {

if (command == "Add") {

std::string fig\_type;

std::cout << "Figures: Triangle/ Square/ Rectangle" << std::endl;

std::cin >> fig\_type;

Figure \*new\_fig;

if (fig\_type == "Triangle") {

new\_fig = new Triangle;

}

else if (fig\_type == "Square") {

new\_fig = new Square;

}

else if (fig\_type == "Rectangle") {

new\_fig = new Rectangle;

}

else {

std::cout << "Invalid figure type" << std::endl;

std::cin.clear();

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

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

continue;

}

try {

std::cout << "Points: ";

std::cin >> (\*new\_fig);

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

}

catch (std::exception &e) {

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

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

delete new\_fig;

continue;

}

figures.push\_back(new\_fig);

}

else if (command == "Print") {

unsigned int index;

std::cout << "Index: ";

std::cin >> index;

if (index < 0 || index >= figures.size()) {

std::cout << "No object at that index" << std::endl;

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

continue;

}

std::cout << "Figure at index " << index << ": " << \*figures[index] << std::endl;

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

}

else if (command == "Area") {

unsigned int index;

std::cout << "Index: ";

std::cin >> index;

if (index < 0 || index >= figures.size()) {

std::cout << "No object at that index" << std::endl;

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

continue;

}

std::cout << \*figures[index] << ". Area: " << figures[index]->Area() << std::endl;

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

}

else if (command == "Center") {

unsigned int index;

std::cout << "Index: ";

std::cin >> index;

if (index < 0 || index >= figures.size()) {

std::cout << "No object at that index" << std::endl;

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

continue;

}

std::cout << \*figures[index] << ". Center: " << figures[index]->Center() << std::endl;

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

}

else if (command == "Total\_area") {

double area = 0;

for (Figure \*ptr : figures) {

area += ptr->Area();

}

std::cout << "Total area: " << area << std::endl;

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

}

else if (command == "Print\_all") {

for (unsigned int i = 0; i < figures.size(); i++) {

std::cout << i << ". " << \*figures[i] << std::endl;

}

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

}

else if (command == "Delete") {

unsigned int index;

std::cout << "Index: ";

std::cin >> index;

if (index < 0 || index >= figures.size()) {

std::cout << "No object at that index" << std::endl;

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

continue;

}

delete figures[index];

figures.erase(figures.begin() + index);

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

}

else if (command == "Delete\_all") {

for (std::vector<Figure \*>::iterator i = figures.begin(); i != figures.end(); i++) {

delete \*i;

}

figures.clear();

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

}

else if (command == "Quit") {

for (unsigned int i = 0; i < figures.size(); i++) {

delete figures[i];

}

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

return 0;

}

else {

std::cout << "Wrong. Operations: Add/ Print/ Area/ Center/ Total\_area/ Print\_all/ Delete/ Delete\_all/ Quit" << std::endl;

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

}

}

return 0;

}

**CmakeLists.txt:**

cmake\_minimum\_required (VERSION 3.2)

project(oop\_exercise\_03)

add\_executable(oop\_exercise\_03 main.cpp point.cpp figure.cpp triangle.cpp square.cpp rectangle.cpp vector.cpp)

set(CMAKE\_CXX\_FLAGS "${CMAKE\_CXX\_FLAGS} -Wall")

set\_target\_properties(oop\_exercise\_03 PROPERTIES CXX\_STANDART 14 CXX\_STANDART\_REQUIRED ON)

**2. Ссылка на репозиторий на GitHub.**

<https://github.com/Markov-A-N/oop_exercise_03.git>

**3. Набор testcases.**

test\_00.test:

Add

Square

0 0 0 5 5 5 5 0

Add

Triangle

0 0 1 1 2 0

Add

Rectangle

6 7 6 15 20 15 20 7

Area

0

Area

1

Area

2

Print\_all

Center

0

Center

1

Center

2

Total\_area

Delete

2

Total\_area

Delete\_all

Print\_all

Quit

test\_01.test:

Add

Triangle

-5 -5 -4 -4 -3 -5

Add

Square

0 0 1 1 2 1 2 0

Add

Triangle

0 0 1 1 2 0

Add

Rectangle

6 7 6 15 20 15 20 7

Area

0

Area

1

Area

2

Area

3

Print\_all

Center

0

Center

1

Center

2

Center

3

Total\_area

Delete

0

Total\_area

Delete\_all

Print\_all

Quit

**4. Результаты выполнения тестов.**

test\_00.result:

Operations: Add/ Print/ Area/ Center/ Total\_area/ Print\_all/ Delete/ Delete\_all/ Quit

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

Figures: Triangle/ Square/ Rectangle

Points: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Figures: Triangle/ Square/ Rectangle

Points: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Figures: Triangle/ Square/ Rectangle

Points: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Index: Square: p1 = (0; 0), p2 = (0; 5), p3 = (5; 5), p4 = (5; 0). Area: 25

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

Index: Triangle: p1 = (0; 0), p2 = (1; 1), p3 = (2; 0). Area: 1

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

Index: Rectangle: p1 = (6; 7), p2 = (6; 15), p3 = (20; 15), p4 = (20; 7). Area: 112

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

0. Square: p1 = (0; 0), p2 = (0; 5), p3 = (5; 5), p4 = (5; 0)

1. Triangle: p1 = (0; 0), p2 = (1; 1), p3 = (2; 0)

2. Rectangle: p1 = (6; 7), p2 = (6; 15), p3 = (20; 15), p4 = (20; 7)

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

Index: Square: p1 = (0; 0), p2 = (0; 5), p3 = (5; 5), p4 = (5; 0). Center: (2.5; 2.5)

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

Index: Triangle: p1 = (0; 0), p2 = (1; 1), p3 = (2; 0). Center: (1; 0.333333)

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

Index: Rectangle: p1 = (6; 7), p2 = (6; 15), p3 = (20; 15), p4 = (20; 7). Center: (13; 11)

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

Total area: 138

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

Index: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Total area: 26

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

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

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

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

test\_01.result:

Operations: Add/ Print/ Area/ Center/ Total\_area/ Print\_all/ Delete/ Delete\_all/ Quit

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

Figures: Triangle/ Square/ Rectangle

Points: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Figures: Triangle/ Square/ Rectangle

Points: The sides of the square should be perpendicular

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

Figures: Triangle/ Square/ Rectangle

Points: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Figures: Triangle/ Square/ Rectangle

Points: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Index: Triangle: p1 = (-5; -5), p2 = (-4; -4), p3 = (-3; -5). Area: 1

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

Index: Triangle: p1 = (0; 0), p2 = (1; 1), p3 = (2; 0). Area: 1

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

Index: Rectangle: p1 = (6; 7), p2 = (6; 15), p3 = (20; 15), p4 = (20; 7). Area: 112

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

Index: No object at that index

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

0. Triangle: p1 = (-5; -5), p2 = (-4; -4), p3 = (-3; -5)

1. Triangle: p1 = (0; 0), p2 = (1; 1), p3 = (2; 0)

2. Rectangle: p1 = (6; 7), p2 = (6; 15), p3 = (20; 15), p4 = (20; 7)

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

Index: Triangle: p1 = (-5; -5), p2 = (-4; -4), p3 = (-3; -5). Center: (-4; -4.66667)

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

Index: Triangle: p1 = (0; 0), p2 = (1; 1), p3 = (2; 0). Center: (1; 0.333333)

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

Index: Rectangle: p1 = (6; 7), p2 = (6; 15), p3 = (20; 15), p4 = (20; 7). Center: (13; 11)

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Index: No object at that index

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Total area: 114

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Index: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Total area: 113

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**5. Объяснение результатов работы программы.**

Реализован абстрактный класс Figure, имеющий чисто виртуальные функции для вычисления центра, площади, для ввода/вывода из потоков. В конструкторах классов-наследников Triangle, Square, Rectangle предусмотрены проверки на корректность введенных точек. Также точки передаются в любом порядке. Площадь треугольника высчитывается по формуле Герона (s = sqrt(p(p-a)(p-b)(p-c)), где p — полупериметр). Площадь квадрата высчитывается по формуле (a \* a). Площадь прямоугольника высчитывается по стандартной формуле (a \* b). Центр треугольника вычисляется по формуле (B + mid\_of\_base \* 2) / 3, где B — точка, не лежащая на основании, mid\_of\_base — середина основания. Центры квадрата и прямоугольника вычисляются по одной формуле:

(B + D) / 2, где B и D — точки, лежащие на одной диагонали.

Для удобства использования создано меню:

* Add FIG\_TYPE POINTS — создание новой фигуры типа FIG\_TYPE по переданным точкам. Фигура добавляется в конец вектора.
* Print INDEX — вывод фигуры по индексу.
* Area INDEX — вывод площади фигуры по индексу.
* Center INDEX — вывод центра фигуры по индексу.
* Total\_area — общая площадь фигур в векторе.
* Print\_all — вывод всех фигур в векторе.
* Delete — удаление фигуры по индексу.
* Delete\_all — удаление всех фигур.
* Quit — выход.

**6. Вывод.**

Наследование — принцип ООП, позволяющий благодаря ему создавать иерархические классификации. Используя наследование, можно создать общий класс, который определяет характеристики, присущие множеству связанных элементов.

Полиморфизм — процесс, в котором различные реализации функции могут быть доступны посредством одного и того же имени. В C++ полиморфизм поддерживается как во время выполнения, так и в период компиляции программы. Перегрузка операторов и функций — примеры полиморфизма, относящегося ко времени компиляции. Но несмотря на мощность механизма перегрузки операторов и функций, он не в состоянии решить все задачи. Поэтому в C++ также реализован полиморфизм периода выполнения на основе использования производных классов (класс, который наследует базовый класс) и виртуальных функций (функция, которая объявляется в базовом классе с использованием ключевого слова virtual и переопределяется в одном или нескольких производных классах).