

МИНИСТЕРСТВО ОБРАЗОВАНИЯ И НАУКИ РОССИЙСКОЙ ФЕДЕРАЦИИ
МОСКОВСКИЙ АВИАЦИОННЫЙ ИНСТИТУТ
(НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ УНИВЕРСИТЕТ)

ЛАБОРАТОРНАЯ РАБОТА №3

по курсу “Объектно-ориентированное программирование» 1 семестр,
2021/22 уч. год

Студент: Колпакова Диана Саргаевна, группа М8О-208Б-20

Преподаватель: Дорохов Евгений Павлович

Задание

1. Необходимо спроектировать и запрограммировать на языке C++ класс-контейнер первого уровня, содержащий **одну фигуру (колонка фигура 1)**, согласно вариантам задания. Классы должны удовлетворять следующим правилам:
 - Требования к классу фигуры аналогичны требованиям из лабораторной работы No1;
 - Требования к классу контейнера аналогичны требованиям из лабораторной работы No2;
 - Класс-контейнер должен содержать объекты используя `std::shared_ptr<...>`.

Нельзя использовать:

- Стандартные контейнеры `std`;
- Шаблоны (`template`);
- Объекты «по-значению».

Программа должна позволять:

- Вводить произвольное количество фигур и добавлять их в контейнер;
- Распечатывать содержимое контейнера;
- Удалять фигуры из контейнера.

Вариант 9:

Фигура №1	Имя класса	Фигура №2	Имя класса	Фигура №3	Имя класса
Треугольник	Triangle	Квадрат	Square	Прямоугольник	Rectangle

Описание программы

Исходный код лежит в 10 файлах:

1. `main.cpp`: часть программы, отвечающая за взаимодействие с пользователем через консоль. В ней происходит инициализация объектов и вызов функций работы с ними, заполнение стандартного контейнера вектор введенными объектами и печать его содержимого;
2. `point.h`: описание класса Point точек $A(a_1, a_2)$;
3. `point.cpp`: реализация класса Point;
4. `figure.h`: описание абстрактного класса-родителя Figure;
5. `figure.cpp`: реализация класса Figure;

6. triangle.h: описание класса Triangle треугольников, заданных по трем точкам, наследника Figure;
7. triangle.cpp: реализация класса Triangle;
8. tlinkedlist.h
9. tlinkedlist.cpp
10. CMakeLists.txt

Также используется файл CMakeLists.txt с конфигурацией CMake для автоматизации сборки программы.

Дневник отладки

Проблем не возникло

Вывод

Во время выполнения работы я освоила умные указатели. При использовании их можно избежать проблем с утечкой памяти, с повторным удалением объекта, а также с обращением к неинициализированной области памяти.

Исходный код

main.cpp:

```
// OOP, Lab 3 variant 9, Diana Kolpakova
// Triangle, TLinkedList, shared_ptr

#include <iostream>

#include "figure.h"
#include "triangle.h"
#include "tlinkedlist.h"

using namespace std;

int main()
{
    cout.setf(ios_base::boolalpha);
    cout << "oop_exercise_3 (c) Diana Kolpakova" << endl;
    cout << "Triangles, TLinkedList, shared_ptr" << endl;

    shared_ptr<TLinkedList> pList(new TLinkedList());
```

```

for (;;)
{
    cout << endl;
    cout << "Select an action for the linked list of triangles" << endl;
    cout << "1) Is the list empty?" << endl;
    cout << "2) Get number of triangles in the list" << endl;
    cout << "3) Show the first triangle from the list" << endl;
    cout << "4) Show the last triangle from the list" << endl;
    cout << "5) Show the triangle at a specified position in the list" <<
endl;
    cout << "6) Show areas of all triangles in the list" << endl;
    cout << "7) Add a new triangle to the beginning of the list" << endl;
    cout << "8) Add a new triangle to the end of the list" << endl;
    cout << "9) Add a new triangle to a specified position in the list" <<
endl;
    cout << "a) Remove the first triangle from the list" << endl;
    cout << "b) Remove the last triangle from the list" << endl;
    cout << "c) Remove the triangle at a specified position in the list" <<
endl;
    cout << "d) Remove all triangles from the list" << endl;
    cout << "l) Show all triangles from the list" << endl;
    cout << "x) End the program" << endl;

    try
    {
        shared_ptr<Triangle> pTriangle;
        size_t position;

        char ch;
        cin >> ch;
        switch (ch)
        {
            case '1':
                cout << "Is the list empty: " << pList->Empty() << endl;
                break;
            case '2':
                cout << "Length of the list: " << pList->Length() << endl;
                break;
            case '3':
                pTriangle = pList->First();
                cout << *pTriangle << endl;
                break;
            case '4':
                pTriangle = pList->Last();
                cout << *pTriangle << endl;
                break;
            case '5':
                cout << "Enter position in the list:";
                cin >> position;
                pTriangle = pList->GetItem(position);
                cout << *pTriangle << endl;
                break;
            case '6':
                cout << "Triangle areas:" << endl;
                if (pList->Empty())
                {
                    cout << "Empty list" << endl;

```

```

    }
    else
    {
        cout << *pList << endl;
    }
    break;
case '7':
    pTriangle = shared_ptr<Triangle>(new Triangle());
    cout << "Enter 3 points of triangle (6 numbers):";
    cin >> *(pTriangle);
    pList->InsertFirst(pTriangle);
    cout << *pTriangle << endl;
    break;
case '8':
    pTriangle = shared_ptr<Triangle>(new Triangle());
    cout << "Enter 3 points of triangle (6 numbers):";
    cin >> *(pTriangle);
    pList->InsertLast(pTriangle);
    cout << *pTriangle << endl;
    break;
case '9':
    cout << "Enter 3 points of triangle (6 numbers):";
    pTriangle = shared_ptr<Triangle>(new Triangle());
    cin >> *(pTriangle);
    cout << "Enter position in the list:";
    cin >> position;
    pList->Insert(pTriangle, position);
    cout << *pTriangle << endl;
    break;
case 'a':
case 'A':
    pList->RemoveFirst();
    cout << "Removed the first triangle" << endl;
    break;
case 'b':
case 'B':
    pList->RemoveLast();
    cout << "Removed the last triangle" << endl;
    break;
case 'c':
case 'C':
    cout << "Enter position in the list:";
    cin >> position;
    pList->Remove(position);
    cout << "Removed the triangle at specified position" <<
endl;
    break;
case 'd':
case 'D':
    pList->Clear();
    cout << "Removed all" << endl;
    break;
case 'l':
case 'L':
    cout << "Triangles:" << endl;
    if (pList->Empty())
    {

```

```

        cout << "Empty list" << endl;
    }
    else
    {
        for (size_t i = 0; i < pList->Length(); i++)
        {
            pTriangle = pList->GetItem(i);
            cout << "#" << i << " " << *pTriangle << endl;
        }
        break;
    case 'q':
    case 'Q':
    case 'x':
    case 'X':
        cout << "Exiting" << endl;
        return 0;
    default:
        cout << "Error: invalid action selected" << endl;
        break;
    }
}
catch (exception& ex)
{
    cout << "Exception: " << ex.what() << endl;
}
}
}

```

point.h:

```

#pragma once
#include <iostream>

using namespace std;

class Point
{
private:
    double x;
    double y;

public:
    Point();
    Point(double x, double y);

    static double Distance (const Point& point1, const Point& point2);

    friend istream& operator>>(istream& is, Point& point);
    friend ostream& operator<<(ostream& os, Point& point);

    bool operator==(const Point& other);
};

```

point.cpp:

```

#include <cmath>
#include "point.h"

using namespace std;

Point::Point()
{
    this->x = 0.0;
    this->y = 0.0;
}

Point::Point(double x, double y)
{
    this->x = x;
    this->y = y;
}

double Point::Distance(const Point& point1, const Point& point2)
{
    double dx = point1.x - point2.y;
    double dy = point1.y - point2.y;
    double distance = sqrt(dx * dx + dy * dy);
    return distance;
}

bool Point::operator==(const Point& other)
{
    return (this->x == other.x)
        && (this->y == other.y);
}

istream& operator>>(istream& is, Point& point)
{
    is >> point.x >> point.y;
    return is;
}

ostream& operator<<(ostream& os, Point& point)
{
    os << "(" << point.x << ", " << point.y << ")";
    return os;
}

```

figure.h:

```

#pragma once
#include "point.h"

class Figure
{
public:
    virtual size_t VertexesNumber() = 0;
    virtual double Area() = 0;
};

```

triangle.h:

```

#pragma once
#include "figure.h"

class Triangle : public Figure
{
private:
    Point point1;
    Point point2;
    Point point3;

public:
    Triangle();
    Triangle(Point point1, Point point2, Point point3);
    Triangle(const Triangle& other);

    virtual size_t VertexesNumber() override;
    virtual double Area() override;

    friend istream& operator>>(istream& is, Triangle& triangle);
    friend ostream& operator<<(ostream& os, Triangle& triangle);

    Triangle& operator=(const Triangle& other);
    bool operator==(const Triangle& other);
};

```

triangle.cpp:

```

#include "triangle.h"

using namespace std;

Triangle::Triangle()
{
    this->point1 = Point();
    this->point2 = Point();
    this->point3 = Point();
}

Triangle::Triangle(Point point1, Point point2, Point point3)
{
    this->point1 = point1;
    this->point2 = point2;
    this->point3 = point3;
}

Triangle::Triangle(const Triangle& other)
{
    this->point1 = other.point1;
    this->point2 = other.point2;
    this->point3 = other.point3;
}

size_t Triangle::VertexesNumber()
{
    return 3;
}

```



```

double Triangle::Area()
{
    double length12 = Point::Distance(point1, point2);
    double length23 = Point::Distance(point2, point3);
    double length31 = Point::Distance(point3, point1);
    double semiPerimeter = (length12 + length23 + length31) / 2.0;
    return sqrt(semiPerimeter * (semiPerimeter - length12) * (semiPerimeter -
length23) * (semiPerimeter - length31));
}

istream& operator>>(istream& is, Triangle& triangle)
{
    is >> triangle.point1 >> triangle.point2 >> triangle.point3;
    return is;
}

ostream& operator<<(ostream& os, Triangle& triangle)
{
    os << "Triangle: " << triangle.point1 << ", " << triangle.point2 << ", " <<
triangle.point3;
    return os;
}

Triangle& Triangle::operator=(const Triangle& other)
{
    this->point1 = other.point1;
    this->point2 = other.point2;
    this->point3 = other.point3;
    return *this;
}

bool Triangle::operator==(const Triangle& other)
{
    return (this->point1 == other.point1)
        && (this->point2 == other.point2)
        && (this->point3 == other.point3);
}

```

tlinkedlist.h:

```

#pragma once
#include "triangle.h"

class TLinkedList
{
private:
    struct Item
    {
        shared_ptr<Triangle> pTriangle;
        shared_ptr<Item> pNextItem;
    };

    size_t length;
    shared_ptr<Item> pFirstItem;
    shared_ptr<Item> pLastItem;

public:
    TLinkedList();

```

```

TLinkedList(const TLinkedList& other);
virtual ~TLinkedList();

shared_ptr<Triangle> First();
shared_ptr<Triangle> Last();
shared_ptr<Triangle> GetItem(size_t position);

void InsertFirst(shared_ptr<Triangle> pTriangle);
void InsertLast(shared_ptr<Triangle> pTriangle);
void Insert(shared_ptr<Triangle> pTriangle, size_t position);

void RemoveFirst();
void RemoveLast();
void Remove(size_t position);

void Clear();
bool Empty();
size_t Length();

friend std::ostream& operator<<(std::ostream& os, const TLinkedList& list);
};

```

tlinkedlist.cpp:

```

#include "tlinkedlist.h"

TLinkedList::TLinkedList()
{
    pFirstItem = nullptr;
    pLastItem = nullptr;
    length = 0;
}

TLinkedList::TLinkedList(const TLinkedList& other)
{
    pFirstItem = nullptr;
    pLastItem = nullptr;
    length = 0;

    shared_ptr<Item> pCurrentItem = other.pFirstItem;
    while (pCurrentItem != nullptr)
    {
        InsertLast(pCurrentItem->pTriangle);
        pCurrentItem = pCurrentItem->pNextItem;
    }
}

shared_ptr<Triangle> TLinkedList::First()
{
    if (Empty())
        throw runtime_error("Cannon get the item from empty list");
    return pFirstItem->pTriangle;
}

shared_ptr<Triangle> TLinkedList::Last()
{
    if (Empty())
        throw runtime_error("Cannon get the item from empty list");
}

```

```

        return pLastItem->pTriangle;
    }

void TLinkedList::InsertFirst(shared_ptr<Triangle> pTriangle)
{
    shared_ptr<Item> pNewItem(new Item());
    pNewItem->pTriangle = pTriangle;
    pNewItem->pNextItem = pFirstItem;

    pFirstItem = pNewItem;
    if (Empty())
        pLastItem = pNewItem;

    length++;
}

void TLinkedList::InsertLast(shared_ptr<Triangle> pTriangle)
{
    shared_ptr<Item> pNewItem(new Item());
    pNewItem->pTriangle = pTriangle;
    pNewItem->pNextItem = nullptr;

    if (pLastItem != nullptr)
        pLastItem->pNextItem = pNewItem;
    pLastItem = pNewItem;
    if (Empty())
        pFirstItem = pNewItem;

    length++;
}

void TLinkedList::Insert(shared_ptr<Triangle> pTriangle, size_t position)
{
    if (position == 0)
    {
        InsertFirst(pTriangle);
        return;
    }
    else if (position == length)
    {
        InsertLast(pTriangle);
        return;
    }
    else if (position > length)
        throw runtime_error("Specified poition is out of range");

    int i = 0;
    shared_ptr<Item> pCurrentItem = pFirstItem;
    shared_ptr<Item> pPreviousItem = nullptr;
    while (pCurrentItem != nullptr)
    {
        if (i == position)
            break;
        pPreviousItem = pCurrentItem;
        pCurrentItem = pCurrentItem->pNextItem;
        i++;
    }
}

```

```

    shared_ptr<Item> pNewItem(new Item());
    pNewItem->pTriangle = pTriangle;
    pNewItem->pNextItem = pCurrentItem;

    pPreviousItem->pNextItem = pNewItem;

    length++;
}

void TLinkedList::RemoveFirst()
{
    if (Empty())
        throw runtime_error("Cannon remove the item from empty list");
    shared_ptr<Item> pNextItem = pFirstItem->pNextItem;
    pFirstItem = pNextItem;
    length--;
    if (Empty())
        pLastItem = nullptr;
}

void TLinkedList::RemoveLast()
{
    if (Empty())
        throw runtime_error("Cannon remove the item from empty list");

    shared_ptr<Item> pCurrentItem = pFirstItem;
    shared_ptr<Item> pPreviousItem = nullptr;
    while (pCurrentItem != nullptr)
    {
        if (pCurrentItem == pLastItem)
            break;
        pPreviousItem = pCurrentItem;
        pCurrentItem = pCurrentItem->pNextItem;
    }

    if (pPreviousItem != nullptr)
        pPreviousItem->pNextItem = nullptr;
    pLastItem = pPreviousItem;
    length--;
    if (Empty())
        pFirstItem = nullptr;
}

void TLinkedList::Remove(size_t position)
{
    if (Empty())
        throw runtime_error("Cannon remove the item from empty list");
    if (position == 0)
    {
        RemoveFirst();
        return;
    }
    else if (position == length - 1)
    {
        RemoveLast();
        return;
    }
}

```

```

    }
    else if (position >= length)
        throw runtime_error("Specified poition is out of range");

    int i = 0;
    shared_ptr<Item> pCurrentItem = pFirstItem;
    shared_ptr<Item> pPreviousItem = nullptr;
    while (pCurrentItem != nullptr)
    {
        if (i == position)
            break;
        pPreviousItem = pCurrentItem;
        pCurrentItem = pCurrentItem->pNextItem;
        i++;
    }

    pPreviousItem->pNextItem = pCurrentItem->pNextItem;
    length--;
}

shared_ptr<Triangle> TLinkedList::GetItem(size_t position)
{
    if (Empty())
        throw runtime_error("Cannon get the item from empty list");
    if (position >= length)
        throw runtime_error("Specified position is out of range");

    int i = 0;
    shared_ptr<Item> pCurrentItem = pFirstItem;
    while (pCurrentItem != nullptr)
    {
        if (i == position)
            return pCurrentItem->pTriangle;
        pCurrentItem = pCurrentItem->pNextItem;
        i++;
    }

    throw runtime_error("Something went wrong");
}

bool TLinkedList::Empty()
{
    return length == 0;
}

size_t TLinkedList::Length()
{
    return length;
}

void TLinkedList::Clear()
{
    shared_ptr<Item> pCurrentItem = pFirstItem;
    while (pCurrentItem != nullptr)
    {
        shared_ptr<Item> pNextItem = pCurrentItem->pNextItem;
        pCurrentItem = pNextItem;
    }
}

```

```

    }
    pFirstItem = nullptr;
    pLastItem = nullptr;
    length = 0;
}

TLinkedList::~TLinkedList()
{
    Clear();
}

std::ostream& operator<<(std::ostream& os, const TLinkedList& list)
{
    shared_ptr<TLinkedList::Item> pCurrentItem = list.pFirstItem;
    while (pCurrentItem != nullptr)
    {
        os << pCurrentItem->pTriangle->Area();
        if (pCurrentItem != list.pLastItem)
            os << " -> ";
        pCurrentItem = pCurrentItem->pNextItem;
    }
    return os;
}

```

CMakeLists.txt:

```

cmake_minimum_required(VERSION 3.21)
project(oop_exercise_3)

set(CMAKE_CXX_STANDARD 14)

include_directories(.)

add_executable(oop_exercise_3
    figure.cpp
    figure.h
    main.cpp
    point.cpp
    point.h
    tlinkedlist.cpp
    tlinkedlist.h
    triangle.cpp
    triangle.h)

```