

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

## **ЛАБОРАТОРНАЯ РАБОТА №4**

по курсу “Объектно-ориентированное программирование» 1 семестр,  
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## Задание

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

Нельзя использовать:

Стандартные контейнеры `std`.

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 14 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(a1, a2)`;
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. tlinkedlistitem.h
11. tlinkedlistitem.cpp
12. CMakeLists.txt

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

## Дневник отладки

Проблем не возникло

## Вывод

Я освоила на практике работу с односвязным списком, реализовала конструкторы и функции работы с ним. Перегрузила оператор вывода.

## 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 (;;)
    {
        int n;
        cout << "Enter number of triangles: ";
        while (n < 0)
        {
            cout << "Invalid number. Try again: ";
            n = 0;
        }
        TLinkedList* pList = new TLinkedList(n);
        pList->Print();
        cout << "Press 1 to add triangle, 2 to delete triangle, 3 to print list, 4 to exit: ";
        int c;
        while (c < 1 || c > 4)
        {
            cout << "Invalid choice. Try again: ";
            c = 0;
        }
        if (c == 1)
        {
            int n;
            cout << "Enter number of triangles to add: ";
            while (n < 0)
            {
                cout << "Invalid number. Try again: ";
                n = 0;
            }
            pList->Add(n);
        }
        else if (c == 2)
        {
            int n;
            cout << "Enter number of triangles to delete: ";
            while (n < 0)
            {
                cout << "Invalid number. Try again: ";
                n = 0;
            }
            pList->Delete(n);
        }
        else if (c == 3)
        {
            pList->Print();
        }
        else if (c == 4)
        {
            return 0;
        }
    }
}
```

```

{
    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("Cannot get the item from empty list");
    return pFirstItem->pTriangle;
}

shared_ptr<Triangle> TLinkedList::Last()
{
    if (Empty())
        throw runtime_error("Cannot 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;
}

```

#### TLinkedListItem.h:

```

#pragma once
#include <memory>

using namespace std;

template <class T>
class TLinkedListItem
{
private:
    shared_ptr<T> pValue;
    shared_ptr<TLinkedListItem<T>> pNextItem;

public:
    TLinkedListItem() {}
    TLinkedListItem(shared_ptr<T> pValue, shared_ptr<TLinkedListItem<T>>
pNextItem);
    virtual ~TLinkedListItem();
    shared_ptr<T> getValuePtr();
    shared_ptr<TLinkedListItem<T>> getNextItemPtr();
    void setNextItemPtr(shared_ptr<TLinkedListItem<T>> pNextItem);
};

```

#### TLinkedListItem.cpp:

```

#include <memory>
#include "triangle.h"
#include "tlinkedlistitem.h"

using namespace std;

template<class T>
inline TLinkedListItem<T>::TLinkedListItem(shared_ptr<T> pValue,

```

```

shared_ptr<TLinkedListItem<T>> pNextItem)
{
    this->pValue = pValue;
    this->pNextItem = pNextItem;
}

template<class T>
TLinkedListItem<T>::~~TLinkedListItem()
{
}

template<class T>
shared_ptr<T> TLinkedListItem<T>::getValuePtr()
{
    return pValue;
}

template<class T>
shared_ptr<TLinkedListItem<T>> TLinkedListItem<T>::getNextItemPtr()
{
    return pNextItem;
}

template<class T>
void TLinkedListItem<T>::setNextItemPtr(shared_ptr<TLinkedListItem<T>>
pNextItem)
{
    this->pNextItem = pNextItem;
}

template class TLinkedListItem<Triangle>;

```

### 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
    tlinkedlistitem.h
    tlinkedlistitem.cpp
)

```

