

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

## **ЛАБОРАТОРНАЯ РАБОТА №6**

по курсу “Объектно-ориентированное программирование”

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### Задание:

Дополнить класс-контейнер из лабораторной работы №5 шаблоном типа данных.

### Вариант №8:

- Фигура: Восьмиугольник (Octagon)
- Контейнер: Список (TLinkedList)

### Описание программы:

Исходный код разделён на 10 файлов:

- `figure.h` – описание класса фигуры
- `point.h` – описание класса точки
- `point.cpp` – реализация класса точки
- `octagon.h` – описание класса восьмиугольника
- `octagon.cpp` – реализация класса восьмиугольника
- `item.h` – описание элемента списка
- `item.cpp` – реализация элемента списка
- `tlinkedlist.h` – описание списка
- `tlinkedlist.cpp` – реализация списка
- `main.cpp` – основная программа

### Дневник отладки:

Без указания шаблона перед функцией программа не компилировалась, пришлось перед каждой функцией писать `template <class ...>`, только вместо этого написан макрос.

### Тестирование:

```
The list is empty
1
47
47 -> 47
47 -> 47 -> 47
47 -> 47 -> 47 -> 27.5
47 -> 47 -> 27.5 -> 47 -> 27.5
47 -> 47 -> 27.5 -> 47 -> 27.5 -> 24
24 -> 47 -> 47 -> 27.5 -> 47 -> 27.5 -> 24
0
24 -> 47 -> 47 -> 27.5 -> 27.5 -> 24
6
24 -> 47 -> 47 -> 27.5 -> 27.5
47 -> 47 -> 27.5 -> 27.5
```

```
47 -> 47 -> 27.5
```

```
27.5 -> 47 -> 47 -> 27.5
```

```
Octagon: (2, 0) (1, 2) (1, 5) (5, 6) (6, 5) (7, 3) (6, 1) (4, 0)
```

```
Octagon: (3, 1) (2, 4) (4, 8) (7, 8) (9, 6) (10, 3) (9, 1) (6, 0)
```

```
Octagon: (3, 1) (2, 4) (4, 8) (7, 8) (9, 6) (10, 3) (9, 1) (6, 0)
```

```
Octagon: (2, 0) (1, 2) (1, 5) (5, 6) (6, 5) (7, 3) (6, 1) (4, 0)
```

```
Octagon: (2, 0) (1, 2) (1, 5) (5, 6) (6, 5) (7, 3) (6, 1) (4, 0)
```

## Вывод:

При выполнении задания я получила навык работы с шаблонами. Они позволяют реализовать функции и контейнеры, тип элементов которых не будет строго зафиксирован. Навык работы с шаблонами крайне полезен, так как сильно упрощает написание многих программ. Но, видимо, я не в полном объёме освоила эту конструкцию, так как перед функциями приходилось её каждый раз писать.

## Исходный код:

### figure.h

```
#ifndef FIGURE_H
#define FIGURE_H

#include "point.h"

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

#endif // FIGURE_H
```

### 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);

bool operator==(const Point &other);
friend std::istream& operator>>(std::istream& is, Point& p);
friend std::ostream& operator<<(std::ostream& os, const Point& p);

private:
    double x_;
    double y_;
};

#endif // POINT_H

```

### 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);
}

bool Point::operator==(const Point &other)
{
    return ((x_ == other.x_) && (y_ == other.y_));
}

std::istream& operator>>(std::istream& is, Point& p)
{
    is >> p.x_ >> p.y_;
    return is;
}

std::ostream& operator<<(std::ostream& os, const Point& p)
{
    os << "(" << p.x_ << ", " << p.y_ << ")";
    return os;
}

```

### octagon.h:

```

#ifndef OCTAGON_H
#define OCTAGON_H

```

```

#include "figure.h"

class Octagon : public Figure
{
public:
    Octagon();
    Octagon(Point t_1, Point t_2, Point t_3, Point t_4,
            Point t_5, Point t_6, Point t_7, Point t_8);
    Octagon(const Octagon& other);
    Octagon(std::istream &is);

    Octagon &operator=(const Octagon &other);
    bool operator==(const Octagon &other);
    friend std::istream& operator>>(std::istream& is, Octagon& o);
    friend std::ostream& operator<<(std::ostream& os, const Octagon& o);

    double Area();
    size_t VertexesNumber();

    virtual ~Octagon();

private:
    Point t1;
    Point t2;
    Point t3;
    Point t4;
    Point t5;
    Point t6;
    Point t7;
    Point t8;
};

#endif // OCTAGON_H

```

### octagon.cpp:

```

#include "octagon.h"

#include <iostream>
#include <cmath>

Octagon::Octagon()
: t1(0.0, 0.0), t2(0.0, 0.0), t3(0.0, 0.0), t4(0.0, 0.0),
  t5(0.0, 0.0), t6(0.0, 0.0), t7(0.0, 0.0), t8(0.0, 0.0) {}

Octagon::Octagon(Point t_1, Point t_2, Point t_3, Point t_4,
                Point t_5, Point t_6, Point t_7, Point t_8)
: t1(t_1), t2(t_2), t3(t_3), t4(t_4),
  t5(t_5), t6(t_6), t7(t_7), t8(t_8) {}

Octagon::Octagon(const Octagon& other)
: Octagon(other.t1, other.t2, other.t3, other.t4,
          other.t5, other.t6, other.t7, other.t8) {}

Octagon::Octagon(std::istream &is)

```

```
{
    is >> t1 >> t2 >> t3 >> t4 >> t5 >> t6 >> t7 >> t8;
}
```

```
Octagon &Octagon::operator=(const Octagon &other)
```

```
{
    if (this == &other) {
        return *this;
    }
    t1 = other.t1;
    t2 = other.t2;
    t3 = other.t3;
    t4 = other.t4;
    t5 = other.t5;
    t6 = other.t6;
    t7 = other.t7;
    t8 = other.t8;
    return *this;
}
```

```
bool Octagon::operator==(const Octagon &o)
```

```
{
    if ((t1 == o.t1) && (t2 == o.t2) && (t3 == o.t3) && (t4 == o.t4) &&
        (t5 == o.t5) && (t6 == o.t6) && (t7 == o.t7) && (t8 == o.t8))
        return true;
    else
        return false;
}
```

```
std::istream& operator>>(std::istream& is, Octagon& o)
```

```
{
    is >> o.t1 >> o.t2 >> o.t3 >> o.t4 >> o.t5 >> o.t6 >> o.t7 >> o.t8;
    return is;
}
```

```
std::ostream& operator<<(std::ostream& os, const Octagon& o)
```

```
{
    os << "Octagon: " << o.t1 << " " << o.t2 << " " << o.t3 << " " << o.t4
        << " " << o.t5 << " " << o.t6 << " " << o.t7 << " " << o.t8;
    return os;
}
```

```
size_t Octagon::VertexesNumber()
```

```
{
    return (size_t)8;
}
```

```
double Heron(Point A, Point B, Point C)
```

```
{
    double AB = A.dist(B);
    double BC = B.dist(C);
    double AC = A.dist(C);
    double p = (AB + BC + AC) / 2;
    return sqrt(p * (p - AB) * (p - BC) * (p - AC));
}
```

```

double Octagon::Area()
{
    double area1 = Heron(t1, t2, t3);
    double area2 = Heron(t1, t4, t3);
    double area3 = Heron(t1, t4, t5);
    double area4 = Heron(t1, t5, t6);
    double area5 = Heron(t1, t6, t7);
    double area6 = Heron(t1, t7, t8);
    return area1 + area2 + area3 + area4 + area5 + area6;
}

Octagon::~Octagon() {}

```

### item.h:

```

#ifndef ITEM_H
#define ITEM_H

#define tT template <typename T>
#define sIT std::shared_ptr<Item<T>>
#define sT std::shared_ptr<T>
#define IT Item<T>
#define sI std::shared_ptr<Item>

#include "octagon.h"
#include <memory>
#include <iostream>

tT
class Item
{
public:
    Item(const sT &s);
    Item(const Item &other);

    sI Left();
    sI Right();

    void ToLeft(sI node);
    void ToRight(sI node);

    sT GetOctagon() const;

    template <class O>
    friend std::ostream &operator<<(std::ostream &os, const Item<O> &node);

    virtual ~Item();

private:
    sT octagon;
    sIT prev;
    sIT next;
};

```

```
#endif // ITEM_H
```

### item.cpp:

```
#include "item.h"

tT
IT::Item(const sT &o)
{
    this->octagon = o;
    this->next = nullptr;
    this->prev = nullptr;
}

tT
IT::Item(const IT &other)
{
    this->octagon = other.octagon;
    this->next = other.next;
    this->prev = other.prev;
}

tT
sIT IT::Left()
{
    return this->prev;
}

tT
sIT IT::Right()
{
    return this->next;
}

tT
void IT::ToLeft(sIT node)
{
    this->prev = node;
}

tT
void IT::ToRight(sIT node)
{
    this->next = node;
}

tT
sT IT::GetOctagon() const
{
    return this->octagon;
}
```



```

tT
std::ostream &operator<<(std::ostream &os, const IT& node)
{
    os << node.octagon << std::endl;
    return os;
}

tT
IT::~Item() {}

template class Item<Octagon>;
template std::ostream& operator<<(std::ostream& os, const Item<Octagon>& item);

```

### tlinkedlist.h:

```

#ifndef TLINKEDLIST_H
#define TLINKEDLIST_H

#define LT TLinkedList<T>

#include "item.h"

tT
class TLinkedList
{
public:
    TLinkedList();
    TLinkedList(const LT &other);

    sT First();
    sT Last();
    sT GetItem(size_t idx);

    size_t Length();
    bool Empty();

    void InsertFirst(sT octagon);
    void InsertLast(sT octagon);
    void Insert(sT octagon, size_t position);

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

    template <class I>
    friend std::ostream &operator<<(std::ostream &os, const TLinkedList<I> &list);

    void Clear();
    virtual ~TLinkedList();

private:
    sIT beginning;
    sIT end;
};

```

```
#endif // TLINKEDLIST_H
```

### **tlinkedlist.cpp:**

```
#include "tlinkedlist.h"
```

```
tT  
LT::TLinkedList() : beginning(nullptr), end(nullptr) {}
```

```
tT  
LT::TLinkedList(const TLinkedList &other)  
{  
    beginning = other.beginning;  
    end = other.end;  
}
```

```
tT  
sT LT::First()  
{  
    if (beginning == nullptr) {  
        std::cout << "The list is empty" << std::endl;  
        exit(1);  
    }  
    return beginning->GetOctagon();  
}
```

```
tT  
sT LT::Last()  
{  
    if (end == nullptr) {  
        std::cout << "The list is empty" << std::endl;  
        exit(1);  
    }  
    return end->GetOctagon();  
}
```

```
tT  
sT LT::GetItem(size_t position)  
{  
    size_t n = this->Length();  
    if (beginning == nullptr) {  
        std::cout << "The list is empty" << std::endl;  
        exit(1);  
    }  
    if (position > n) {  
        std::cout << "The is no such position" << std::endl;  
        exit(1);  
    }  
    if (position == 1) {  
        return beginning->GetOctagon();  
    }  
    if (position == n) {  
        return end->GetOctagon();  
    }  
    sIT node = beginning;
```

```

    for (size_t i = 1; i < position; ++i) {
        node = node->Right();
    }
    return node->GetOctagon();
}

```

```

tT
bool LT::Empty()
{
    return (beginning == nullptr);
}

```

```

tT
size_t LT::Length()
{
    size_t size = 0;
    for (sIT i = beginning; i != nullptr; i = i->Right()) {
        ++size;
    }
    return size;
}

```

```

tT
void LT::InsertFirst(sT octagon)
{
    sIT node(new IT(octagon));
    if (beginning == nullptr) {
        beginning = (end = node);
        return;
    }
    node->ToLeft(nullptr);
    node->ToRight(beginning);
    beginning->ToLeft(node);
    beginning = node;
}

```

```

tT
void LT::InsertLast(sT octagon)
{
    sIT node(new IT(octagon));
    if (beginning == nullptr) {
        beginning = (end = node);
        return;
    }
    node->ToLeft(end);
    node->ToRight(nullptr);
    end->ToRight(node);
    end = node;
}

```

```

tT
void LT::Insert(sT octagon, size_t position)
{
    size_t n = this->Length();
    if (position > n + 1) {

```

```

    std::cout << "The is no such position" << std::endl;
    return;
}
if (position == 1) {
    InsertFirst(octagon);
    return;
}
if (position == n + 1) {
    InsertLast(octagon);
    return;
}
sIT node(new IT(octagon));
sIT now = beginning;
for (size_t i = 1; i < position; ++i) {
    now = now->Right();
}
sIT before = now->Left();
before->ToRight(node);
now->ToLeft(node);
node->ToLeft(before);
node->ToRight(now);
}

```

tT

```

void LT::RemoveFirst()
{
    if (beginning == nullptr) {
        std::cout << "The list is empty" << std::endl;
        return;
    }
    if (end == beginning) {
        beginning = (end = nullptr);
        return;
    }
    sIT node = beginning;
    beginning = beginning->Right();
    beginning->ToLeft(nullptr);
}

```

tT

```

void LT::RemoveLast()
{
    if (end == nullptr) {
        std::cout << "The list is empty" << std::endl;
        return;
    }
    if (end == beginning) {
        beginning = (end = nullptr);
        return;
    }
    sIT node = end;
    end = end->Left();
    end->ToRight(nullptr);
}

```

```

tT
void LT::Remove(size_t position)
{
    size_t n = this->Length();
    if (beginning == nullptr) {
        std::cout << "The list is empty" << std::endl;
        return;
    }
    if (position > n) {
        std::cout << "The is no such position" << std::endl;
        return;
    }
    if (position == 1) {
        RemoveFirst();
        return;
    }
    if (position == n) {
        RemoveLast();
        return;
    }
    sIT node = beginning;
    for (size_t i = 1; i < position; ++i) {
        node = node->Right();
    }
    sIT node_left = node->Left();
    sIT node_right = node->Right();
    node_left->ToRight(node_right);
    node_right->ToLeft(node_left);
}

```

```

tT
std::ostream &operator<<(std::ostream &os, const LT &list)
{
    if (list.beginning == nullptr) {
        os << "List is empty" << std::endl;
        return os;
    }
    for (sIT i = list.beginning; i != nullptr; i = i->Right()) {
        if (i->Right() != nullptr)
            os << i->GetOctagon()->Area() << " -> ";
        else
            os << i->GetOctagon()->Area();
    }
    return os;
}

```

```

tT
void LT::Clear()
{
    while (beginning != nullptr) {
        RemoveFirst();
    }
}

```

tT

```

LT::~TLinkedList()
{
    while (beginning != nullptr) {
        RemoveFirst();
    }
}

template class TLinkedList<Octagon>;
template std::ostream& operator<<(std::ostream& os, const TLinkedList<Octagon>& list);

```

### main.cpp:

```

#include "tlinkedlist.h"

int main(void)
{
    TLinkedList<Octagon> l;
    Point x1(3, 1);
    Point x2(2, 4);
    Point x3(4, 8);
    Point x4(7, 8);
    Point x5(9, 6);
    Point x6(10, 3);
    Point x7(9, 1);
    Point x8(6, 0);

    Point y1(3, 0);
    Point y2(1, 2);
    Point y3(1, 4);
    Point y4(3, 5);
    Point y5(5, 5);
    Point y6(7, 4);
    Point y7(7, 2);
    Point y8(5, 0);

    Point z1(2, 0);
    Point z2(1, 2);
    Point z3(1, 5);
    Point z4(5, 6);
    Point z5(6, 5);
    Point z6(7, 3);
    Point z7(6, 1);
    Point z8(4, 0);

    std::shared_ptr<Octagon> o1(new Octagon(x1, x2, x3, x4, x5, x6, x7, x8));
    std::shared_ptr<Octagon> o2(new Octagon(y1, y2, y3, y4, y5, y6, y7, y8));
    std::shared_ptr<Octagon> o3(new Octagon(z1, z2, z3, z4, z5, z6, z7, z8));

    /*std::shared_ptr<Octagon> o1(new Octagon);
    std::shared_ptr<Octagon> o2(new Octagon);
    std::shared_ptr<Octagon> o3(new Octagon);
    std::cin >> *o1 >> *o2 >> *o3;*/

    l.Remove(5);
    std::cout << l.Empty() << std::endl;
    l.Insert(o1, 1);

```

```
std::cout << l << std::endl;
l.Insert(o1, 2);
std::cout << l << std::endl;
l.Insert(o1, 3);
std::cout << l << std::endl;
l.Insert(o3, 4);
std::cout << l << std::endl;
l.Insert(o3, 3);
std::cout << l << std::endl;
l.Insert(o2, 6);
std::cout << l << std::endl;
l.Insert(o2, 1);
std::cout << l << std::endl;
std::cout << l.Empty() << std::endl;
l.Remove(5);
std::cout << l << std::endl;
std::cout << l.Length() << std::endl;
l.Remove(l.Length());
std::cout << l << std::endl;
l.RemoveFirst();
std::cout << l << std::endl;
l.RemoveLast();
std::cout << l << std::endl;
l.InsertFirst(o3);
std::cout << l << std::endl;
std::cout << *l.GetItem(1) << std::endl;
std::cout << *l.GetItem(2) << std::endl;
std::cout << *l.GetItem(3) << std::endl;
std::cout << *l.GetItem(4) << std::endl;
std::cout << *l.Last() << std::endl;
return 0;
}
```