

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

ЛАБОРАТОРНАЯ РАБОТА №5

по курсу “Объектно-ориентированное программирование”

I семестр, 2021/22 учебный год

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Задание:

Дополнить класс-контейнер из лабораторной работы №4 умными указателями.

Вариант №8:

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

Описание программы:

Исходный код разделён на 10 файлов:

- point.h – описание класса точки
- point.cpp – реализация класса точки
- figure.h – описание класса фигуры
- 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:

Было неочевидно, что в функции (методы) надо передавать константы, из-за этого возникали ошибки. Исправлено припиской const.

Тестирование:

```
The list is empty
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
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)
```

Вывод:

При выполнении задания я на практике освоила основы работы с умными указателями. Они позволяют избежать проблем с утечками памяти, разыменовыванием нулевого указателя (или с обращением к неинициализированной области памяти), а также с удалением уже удалённого объекта. С одной стороны, это удобный инструмент, который упрощает работу, с другой, не так уж и необходимый.

Исходный код:

figure.h

```
1. #ifndef FIGURE_H
2. #define FIGURE_H
3.
4. #include "point.h"
5.
6. class Figure {
7. public:
8.     virtual size_t VertexesNumber() = 0;
9.     virtual void Print(std::ostream& os) = 0;
10.    virtual double Area() = 0;
11.    virtual ~Figure() {};
12. };
13.
14. #endif // FIGURE_H
```

point.h

```
1. #ifndef POINT_H
2. #define POINT_H
3.
4. #include <iostream>
5.
6. class Point {
7. public:
8.     Point();
9.     Point(std::istream &is);
10.    Point(double x, double y);
11. }
```

```

12. double dist(Point& other);
13.
14. friend std::istream& operator>>(std::istream& is, Point& p);
15. friend std::ostream& operator<<(std::ostream& os, Point& p);
16.
17. private:
18. double x_;
19. double y_;
20. };
21.
22. #endif // POINT_H

```

point.cpp

```

1. #include "point.h"
2.
3. #include <cmath>
4.
5. Point::Point() : x_(0.0), y_(0.0) {}
6.
7. Point::Point(double x, double y) : x_(x), y_(y) {}
8.
9. Point::Point(std::istream &is) {
10. is >> x_ >> y_;
11. }
12.
13. double Point::dist(Point& other) {
14. double dx = (other.x_ - x_);
15. double dy = (other.y_ - y_);
16. return std::sqrt(dx*dx + dy*dy);
17. }
18.
19. std::istream& operator>>(std::istream& is, Point& p) {
20. is >> p.x_ >> p.y_;
21. return is;
22. }
23.
24. std::ostream& operator<<(std::ostream& os, Point& p) {
25. os << "(" << p.x_ << ", " << p.y_ << ")";
26. return os;
27. }

```

octagon.h

```

1. #ifndef OCTAGON_H
2. #define OCTAGON_H
3.
4. #include <iostream>
5.
6. #include "figure.h"
7.
8. class Octagon : public Figure {
9. public:

```

```

10. Octagon();
11. Octagon(Point t_1, Point t_2, Point t_3, Point t_4,
12.         Point t_5, Point t_6, Point t_7, Point t_8);
13. Octagon(std::istream &is);
14. Octagon(const Octagon& other);
15.
16. size_t VertexesNumber();
17. double Area();
18. void Print(std::ostream& os);
19.
20. virtual ~Octagon();
21.
22. friend std::istream& operator>>(std::istream& is, Octagon& o);
23. friend std::ostream& operator<<(std::ostream& os, Octagon& o);
24.
25. private:
26. Point t1;
27. Point t2;
28. Point t3;
29. Point t4;
30. Point t5;
31. Point t6;
32. Point t7;
33. Point t8;
34. };
35.
36. #endif // OCTAGON_H

```

octagon.cpp

```

1. #include "octagon.h"
2.
3. #include <iostream>
4. #include <cmath>
5.
6. Octagon::Octagon()
7. : t1(0.0, 0.0), t2(0.0, 0.0), t3(0.0, 0.0), t4(0.0, 0.0),
8.   t5(0.0, 0.0), t6(0.0, 0.0), t7(0.0, 0.0), t8(0.0, 0.0) {}
9.
10. Octagon::Octagon(Point t_1, Point t_2, Point t_3, Point t_4,
11.                  Point t_5, Point t_6, Point t_7, Point t_8)
12. : t1(t_1), t2(t_2), t3(t_3), t4(t_4),
13.  t5(t_5), t6(t_6), t7(t_7), t8(t_8) {}
14.
15. Octagon::Octagon(std::istream &is) {
16.   is >> t1 >> t2 >> t3 >> t4 >> t5 >> t6 >> t7 >> t8;
17. }
18.
19. Octagon::Octagon(const Octagon& other)
20. : Octagon(other.t1, other.t2, other.t3, other.t4,
21.          other.t5, other.t6, other.t7, other.t8) {}
22.
23. std::istream& operator>>(std::istream& is, Octagon& o) {

```

```

24. is >> o.t1 >> o.t2 >> o.t3 >> o.t4 >> o.t5 >> o.t6 >> o.t7 >> o.t8;
25. return is;
26. }
27.
28. std::ostream& operator<<(std::ostream& os, Octagon& o) {
29. os << "Octagon: " << o.t1 << " " << o.t2 << " " << o.t3 << " " << o.t4
30. << " " << o.t5 << " " << o.t6 << " " << o.t7 << " " << o.t8;
31. return os;
32. }
33.
34. size_t Octagon::VertexesNumber()
35. {
36. return (size_t)8;
37. }
38.
39. double Heron(Point A, Point B, Point C) {
40. double AB = A.dist(B);
41. double BC = B.dist(C);
42. double AC = A.dist(C);
43. double p = (AB + BC + AC) / 2;
44. return sqrt(p * (p - AB) * (p - BC) * (p - AC));
45. }
46.
47. double Octagon::Area() {
48. double area1 = Heron(t1, t2, t3);
49. double area2 = Heron(t1, t4, t3);
50. double area3 = Heron(t1, t4, t5);
51. double area4 = Heron(t1, t5, t6);
52. double area5 = Heron(t1, t6, t7);
53. double area6 = Heron(t1, t7, t8);
54. return area1 + area2 + area3 + area4 + area5 + area6;
55. }
56.
57. void Octagon::Print(std::ostream& os)
58. {
59. std::cout << "Octagon: " << t1 << " " << t2 << " " << t3 << " " << t4
60. << " " << t5 << " " << t6 << " " << t7 << " " << t8 << "\n";
61. }
62.
63. Octagon::~Octagon() {}

```

item.h:

```

#ifndef ITEM_H
#define ITEM_H

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

#define ShOct std::shared_ptr<Octagon>
#define ShItem std::shared_ptr<Item>

class Item

```

```

{
public:
    Item(const ShOct &s);
    Item(const Item &other);

    ShItem Left();
    ShItem Right();

    void ToLeft(ShItem node);
    void ToRight(ShItem node);

    ShOct GetOctagon();

    friend std::ostream &operator<<(std::ostream &os, const Item& node);

    virtual ~Item();

private:
    ShOct octagon;
    ShItem prev;
    ShItem next;
};

#endif // ITEM_H

```

item.cpp:

```

#include "item.h"

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

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

ShItem Item::Left()
{
    return this->prev;
}

ShItem Item::Right()
{
    return this->next;
}

void Item::ToLeft(ShItem node)
{

```

```

    this->prev = node;
}

void Item::ToRight(ShItem node)
{
    this->next = node;
}

ShOct Item::GetOctagon()
{
    return this->octagon;
}

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

Item::~Item() {}

```

tlinkedlist.h:

```

#include "item.h"

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

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

ShItem Item::Left()
{
    return this->prev;
}

ShItem Item::Right()
{
    return this->next;
}

void Item::ToLeft(ShItem node)
{
    this->prev = node;
}

void Item::ToRight(ShItem node)

```



```

{
    this->next = node;
}

ShOct Item::GetOctagon()
{
    return this->octagon;
}

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

Item::~Item() {}

```

tlinkedlist.cpp:

```

#include "tlinkedlist.h"

TLinkedList::TLinkedList() : beginning(nullptr), end(nullptr) {}

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

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

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

ShOct TLinkedList::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();
    }
    ShItem node = beginning;
    for (size_t i = 1; i < position; ++i) {
        node = node->Right();
    }
    return node->GetOctagon();
}

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

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

void TLinkedList::InsertFirst(ShOct octagon)
{
    ShItem node(new Item(octagon));
    if (beginning == nullptr) {
        beginning = (end = node);
        return;
    }
    node->ToLeft(nullptr);
    node->ToRight(beginning);
    beginning->ToLeft(node);
    beginning = node;
}

void TLinkedList::InsertLast(ShOct octagon)
{
    ShItem node(new Item(octagon));
    if (beginning == nullptr) {
        beginning = (end = node);
        return;
    }
    node->ToLeft(end);
    node->ToRight(nullptr);
    end->ToRight(node);
    end = node;
}

```

```

void TLinkedList::Insert(ShOct 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;
    }
    ShItem node(new Item(octagon));
    ShItem now = beginning;
    for (size_t i = 1; i < position; ++i) {
        now = now->Right();
    }
    ShItem before = now->Left();
    before->ToRight(node);
    now->ToLeft(node);
    node->ToLeft(before);
    node->ToRight(now);
}

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

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

```

```

    end->ToRight(nullptr);
}

void TLinkedList::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;
    }
    ShItem node = beginning;
    for (size_t i = 1; i < position; ++i) {
        node = node->Right();
    }
    ShItem node_left = node->Left();
    ShItem node_right = node->Right();
    node_left->ToRight(node_right);
    node_right->ToLeft(node_left);
}

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

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

TLinkedList::~TLinkedList()

```

```

{
    while (beginning != nullptr) {
        RemoveFirst();
    }
}

```

main.cpp:

```

#include "tlinkedlist.h"

int main(void)
{
    TLinkedList 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);

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

    /*ShOct o1(new Octagon);
    ShOct o2(new Octagon);
    ShOct o3(new Octagon);
    std::cin >> *o1 >> *o2 >> *o3;*/
    l.Remove(5);
    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;

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;
return 0;
}
```