

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

ЛАБОРАТОРНАЯ РАБОТА №8

по курсу “Объектно-ориентированное программирование”

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Задание:

Используя структуру данных, разработанную для лабораторной работы №7, спроектировать и разработать аллокатор памяти для динамической структуры данных. Целью построения аллокатора является минимизация вызова операции `malloc`.

Аллокатор должен выделять большие блоки памяти для хранения фигур и при создании новых фигур-объектов выделять место под объекты в этой памяти.

Аллокатор должен хранить списки использованных/свободных блоков. Для хранения списка свободных блоков нужно применять динамическую структуру данных (контейнер 2-го уровня, согласно варианту задания).

Для вызова аллокатора должны быть переопределены операторы `new` и `delete` у классов-фигур.

Вариант №18:

- Фигура: Пятиугольник (Pentagon)
- Контейнер первого уровня: Бинарное дерево (TBinaryTree)
- Контейнер второго уровня: Стэк (TStack)

Описание программы:

Исходный код разделён на 16 файлов:

- `figure.h` – описание класса фигуры
- `point.h` – описание класса точки
- `point.cpp` – реализация класса точки
- `trapezoid.h` – описание класса трапеция
- `trapezoid.cpp` – реализация класса трапеция
- `TBinaryTreeItem.h` – описание элемента бинарного дерева
- `TBinaryTreeItem.cpp` – реализация элемента бинарного дерева
- `TBinaryTree.h` – описание бинарного дерева
- `TBinaryTree.cpp` – реализация бинарного дерева
- `main.cpp` – основная программа
- `Iterator.h` – реализация итератора по бинарному дереву
- `HStackItem.h` – описание класса элемента стека
- `HStackItem.cpp` – реализация класса элемента стека
- `TStack.h` – описание стека
- `TStack.cpp` – реализация класса стека
- `TAllocatorBlock.h` – реализация аллокатора по заданию

Дневник отладки: При выполнении работы ошибок выявлено не было.

Вывод: В ходе данной лабораторной работы я самостоятельно научился реализовывать аллокатор – очень важную вещь, если мы с вами говорим о низкоуровневых языках программирования типа С или С++. Я считаю, что каждый программист должен уметь реализовывать подобное, ведь работа с памятью – это база С++. Плюс собственноручной реализации аллокатора в том, что мы можем пользоваться другой логикой при выделении памяти, например, в структурах данных. Вполне вероятно, что во многих случаях именно самостоятельно написанное выделение памяти сможет прийти на помощь программисту.

Исходный код:

point.h:

```
#ifndef POINT_H
#define POINT_H

#include <iostream>

class Point {
public:
    Point();
    Point(std::istream &is);
    Point(double x, double y);
    friend bool operator == (Point& p1, Point& p2);
    friend class Trapezoid;
    double dist(Point& other);
    double X();
    double Y();
    friend std::istream& operator>>(std::istream& is, Point& p);
    friend std::ostream& operator<<(std::ostream& os, Point& p);

private:
    double x;
    double y;
};

#endif
```

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);
}

double Point::X() {
    return x;
};
double Point::Y() {
    return y;
};

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

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

bool operator==(Point &p1, Point& p2) {
    return (p1.x == p2.x && p1.y == p2.y);
}

```

figure.h:

```

#ifndef FIGURE_H
#define FIGURE_H
#include <memory>
#include "point.h"

class Figure {
public:
    virtual double Area() = 0;
    virtual void Print(std::ostream &os) = 0;
    virtual size_t VertexesNumber() = 0;
    virtual ~Figure() {};
};

#endif

```

trapezoid.h:

```

#ifndef PENTAGON_H
#define PENTAGON_H

#include "figure.h"
#include <iostream>

class Trapezoid : public Figure {
public:
    Trapezoid(std::istream &InputStream);
    Trapezoid();
    double GetArea();
    size_t VertexesNumber();
    double Area();
    void Print(std::ostream &OutputStream);
    friend bool operator==(Trapezoid& p1, Trapezoid& p2);
    friend std::ostream& operator << (std::ostream& os, Trapezoid& p);
    virtual ~Trapezoid();
    double area;

private:
    Point a;

```

```

    Point b;
    Point c;
    Point d;
};
#endif

```

pentagon.cpp:

```

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

Trapezoid::Trapezoid() {
    a.X() == 0.0; a.Y() == 0.0;
    b.X() == 0.0; b.Y() == 0.0;
    c.X() == 0.0; c.Y() == 0.0;
    d.X() == 0.0; d.Y() == 0.0;
}

Trapezoid::Trapezoid(std::istream &InputStream)
{
    InputStream >> a;
    InputStream >> b;
    InputStream >> c;
    InputStream >> d;
    std::cout << "Trapezoid that you wanted to create has been created" << std::endl;
}

void Trapezoid::Print(std::ostream &OutputStream) {
    OutputStream << "Trapezoid: ";
    OutputStream << a << " " << b << " " << c << " " << d << std::endl;
}

size_t Trapezoid::VertexesNumber() {
    size_t number = 4;
    return number;
}

double Trapezoid::Area() {
    double k = (a.Y() - d.Y()) / (a.X() - d.X());
    double m = a.Y() - k * a.X();
    double h = abs(b.Y() - k * b.X() - m) / sqrt(1 + k * k);
    return 0.5 * (a.dist(d) + b.dist(c)) * h;
}

double Trapezoid::GetArea() {
    return area;
}

Trapezoid::~Trapezoid() {
    std::cout << "My friend, your trapezoid has been deleted" << std::endl;
}

bool operator == (Trapezoid& p1, Trapezoid& p2){
    if(p1.a == p2.a && p1.b == p2.b && p1.c == p2.c && p1.d == p2.d) {
        return true;
    }
    return false;
}

std::ostream& operator << (std::ostream& os, Trapezoid& p){
    os << "Trapezoid: ";
    os << p.a << p.b << p.c << p.d;
    os << std::endl;
    return os;
}

```

TBinaryTreeItem.h:

```
#include "TBinaryTreeItem.h"

template <class T>
TBinaryTreeItem<T>::TBinaryTreeItem(const T &pentagon) {
    this->pentagon = pentagon;
    this->left = this->right = NULL;
    this->counter = 1;
}

template <class T>
TBinaryTreeItem<T>::TBinaryTreeItem(const TBinaryTreeItem<T> &other) {
    this->pentagon = other.pentagon;
    this->left = other.left;
    this->right = other.right;
    this->counter = other.counter;
}

template <class T>
T& TBinaryTreeItem<T>::GetPentagon() {
    return this->pentagon;
}

template <class T>
void TBinaryTreeItem<T>::SetPentagon(const T& pentagon){
    this->pentagon = pentagon;
}

template <class T>
std::shared_ptr<TBinaryTreeItem<T>> TBinaryTreeItem<T>::GetLeft(){
    return this->left;
}

template <class T>
std::shared_ptr<TBinaryTreeItem<T>> TBinaryTreeItem<T>::GetRight(){
    return this->right;
}

template <class T>
void TBinaryTreeItem<T>::SetLeft(std::shared_ptr<TBinaryTreeItem<T>> item) {
    if (this != NULL){
        this->left = item;
    }
}

template <class T>
void TBinaryTreeItem<T>::SetRight(std::shared_ptr<TBinaryTreeItem<T>> item) {
    if (this != NULL){
        this->right = item;
    }
}

template <class T>
void TBinaryTreeItem<T>::IncreaseCounter() {
    if (this != NULL){
        counter++;
    }
}

template <class T>
void TBinaryTreeItem<T>::DecreaseCounter() {
    if (this != NULL){
        counter--;
    }
}
```

```

}

template <class T>
int TBinaryTreeItem<T>::ReturnCounter() {
    return this->counter;
}

template <class T>
TBinaryTreeItem<T>::~~TBinaryTreeItem() {
    std::cout << "Destructor TBinaryTreeItem was called\n";
}

template <class T>
std::ostream &operator<<(std::ostream &os, TBinaryTreeItem<T> &obj)
{
    os << "Item: " << obj.GetPentagon() << std::endl;
    return os;
}

#include "trapezoid.h"
template class TBinaryTreeItem<Trapezoid>;
template std::ostream& operator<<(std::ostream& os, TBinaryTreeItem<Trapezoid> &obj);

```

TBinaryTreeItem.cpp:

```

#include "TBinaryTreeItem.h"

template <class T>
TBinaryTreeItem<T>::TBinaryTreeItem(const T &pentagon) {
    this->pentagon = pentagon;
    this->left = this->right = NULL;
    this->counter = 1;
}

template <class T>
TBinaryTreeItem<T>::TBinaryTreeItem(const TBinaryTreeItem<T> &other) {
    this->pentagon = other.pentagon;
    this->left = other.left;
    this->right = other.right;
    this->counter = other.counter;
}

template <class T>
T& TBinaryTreeItem<T>::GetPentagon() {
    return this->pentagon;
}

template <class T>
void TBinaryTreeItem<T>::SetPentagon(const T& pentagon){
    this->pentagon = pentagon;
}

template <class T>
std::shared_ptr<TBinaryTreeItem<T>> TBinaryTreeItem<T>::GetLeft(){
    return this->left;
}

template <class T>
std::shared_ptr<TBinaryTreeItem<T>> TBinaryTreeItem<T>::GetRight(){
    return this->right;
}

template <class T>
void TBinaryTreeItem<T>::SetLeft(std::shared_ptr<TBinaryTreeItem<T>> item) {
    if (this != NULL){

```

```

        this->left = item;
    }
}

template <class T>
void TBinaryTreeItem<T>::SetRight(std::shared_ptr<TBinaryTreeItem<T>> item) {
    if (this != NULL){
        this->right = item;
    }
}

template <class T>
void TBinaryTreeItem<T>::IncreaseCounter() {
    if (this != NULL){
        counter++;
    }
}

template <class T>
void TBinaryTreeItem<T>::DecreaseCounter() {
    if (this != NULL){
        counter--;
    }
}

template <class T>
int TBinaryTreeItem<T>::ReturnCounter() {
    return this->counter;
}

template <class T>
TBinaryTreeItem<T>::~TBinaryTreeItem() {
    std::cout << "Destructor TBinaryTreeItem was called\n";
}

template <class T>
std::ostream &operator<<(std::ostream &os, TBinaryTreeItem<T> &obj)
{
    os << "Item: " << obj.GetPentagon() << std::endl;
    return os;
}

#include "trapezoid.h"
template class TBinaryTreeItem<Trapezoid>;
template std::ostream& operator<<(std::ostream& os, TBinaryTreeItem<Trapezoid> &obj);

```

TBinaryTree.h:

```

#ifndef TBINARYTREE_H
#define TBINARYTREE_H
#include "TBinaryTreeItem.h"
template <class T>

class TBinaryTree {
public:
    TBinaryTree();
    TBinaryTree(const TBinaryTree<T> &other);
    void Push(T &pentagon);
    std::shared_ptr<TBinaryTreeItem<T>> Pop(std::shared_ptr<TBinaryTreeItem<T>> root, T &pentagon);
    T& GetItemNotLess(double area, std::shared_ptr<TBinaryTreeItem<T>> root);
    void Clear();
    bool Empty();
    int Count(double minArea, double maxArea);
    template <class A>

```



```

friend std::ostream& operator<<(std::ostream& os, TBinaryTree<A>& tree);
virtual ~TBinaryTree();
std::shared_ptr<TBinaryTreeItem<T>> root;
};
#endif

```

TBinaryTree.cpp:

```

#include "TBinaryTree.h"

template <class T>
TBinaryTree<T>::TBinaryTree () {
    root = NULL;
}

template <class T>
std::shared_ptr<TBinaryTreeItem<T>> copy (std::shared_ptr<TBinaryTreeItem<T>> root) {
    if (!root) {
        return NULL;
    }
    std::shared_ptr<TBinaryTreeItem<T>> root_copy(new TBinaryTreeItem<T>(root->GetPentagon()));
    root_copy->SetLeft(copy(root->GetLeft()));
    root_copy->SetRight(copy(root->GetRight()));
    return root_copy;
}

template <class T>
TBinaryTree<T>::TBinaryTree (const TBinaryTree<T> &other) {
    root = copy(other.root);
}

template <class T>
void Print (std::ostream& os, std::shared_ptr<TBinaryTreeItem<T>> node){
    if (!node){
        return;
    }
    if(node->GetLeft()){
        os << node->GetPentagon().GetArea() << ": [";
        Print (os, node->GetLeft());
        if (node->GetRight()){
            if (node->GetRight()){
                os << ", ";
                Print (os, node->GetRight());
            }
        }
        os << "]";
    } else if (node->GetRight()) {
        os << node->GetPentagon().GetArea() << ": [";
        Print (os, node->GetRight());
        if (node->GetLeft()){
            if (node->GetLeft()){
                os << ", ";
                Print (os, node->GetLeft());
            }
        }
        os << "]";
    }
    else {
        os << node->GetPentagon().GetArea();
    }
}

template <class T>
std::ostream& operator<< (std::ostream& os, TBinaryTree<T>& tree){
    Print(os, tree.root);
}

```

```

os << "\n";
return os;
}

```

```

template <class T>
void TBinaryTree<T>::Push (T &pentagon) {
    if (root == NULL) {
        std::shared_ptr<TBinaryTreeItem<T>> help(new TBinaryTreeItem<T>(pentagon));
        root = help;
    }
    else if (root->GetPentagon() == pentagon) {
        root->IncreaseCounter();
    }
    else {
        std::shared_ptr<TBinaryTreeItem<T>> parent = root;
        std::shared_ptr<TBinaryTreeItem<T>> current;
        bool childInLeft = true;
        if (pentagon.GetArea() < parent->GetPentagon().GetArea()) {
            current = root->GetLeft();
        }
        else if (pentagon.GetArea() > parent->GetPentagon().GetArea()) {
            current = root->GetRight();
            childInLeft = false;
        }
        while (current != NULL) {
            if (current->GetPentagon() == pentagon) {
                current->IncreaseCounter();
            }
            else {
                if (pentagon.GetArea() < current->GetPentagon().GetArea()) {
                    parent = current;
                    current = parent->GetLeft();
                    childInLeft = true;
                }
                else if (pentagon.GetArea() > current->GetPentagon().GetArea()) {
                    parent = current;
                    current = parent->GetRight();
                    childInLeft = false;
                }
            }
        }
        std::shared_ptr<TBinaryTreeItem<T>> item (new TBinaryTreeItem<T>(pentagon));
        current = item;
        if (childInLeft == true) {
            parent->SetLeft(current);
        }
        else {
            parent->SetRight(current);
        }
    }
}

```

```

template <class T>
std::shared_ptr<TBinaryTreeItem<T>> FMRST(std::shared_ptr<TBinaryTreeItem<T>> root) {
    if (root->GetLeft() == NULL) {
        return root;
    }
    return FMRST(root->GetLeft());
}

```

```

template <class T>
std::shared_ptr<TBinaryTreeItem<T>> TBinaryTree<T>:: Pop(std::shared_ptr<TBinaryTreeItem<T>> root, T &pentagon) {
    if (root == NULL) {
        return root;
    }
    else if (pentagon.GetArea() < root->GetPentagon().GetArea()) {

```

```

    root->SetLeft(Pop(root->GetLeft(), pentagon));
}
else if (pentagon.GetArea() > root->GetPentagon().GetArea()) {
    root->SetRight(Pop(root->GetRight(), pentagon));
}
else {
    //first case of deleting - we are deleting a list
    if (root->GetLeft() == NULL && root->GetRight() == NULL) {
        root = NULL;
        return root;
    }
    //second case of deleting - we are deleting a vertex with only one child
    else if (root->GetLeft() == NULL && root->GetRight() != NULL) {
        std::shared_ptr<TBinaryTreeItem<T>> pointer = root;
        root = root->GetRight();
        return root;
    }
    else if (root->GetRight() == NULL && root->GetLeft() != NULL) {
        std::shared_ptr<TBinaryTreeItem<T>> pointer = root;
        root = root->GetLeft();
        return root;
    }
    //third case of deleting
    else {
        std::shared_ptr<TBinaryTreeItem<T>> pointer = FMRST(root->GetRight());
        root->GetPentagon().area = pointer->GetPentagon().GetArea();
        root->SetRight(Pop(root->GetRight(), pointer->GetPentagon()));
    }
}
return root;
}

```

```

template <class T>
void RecursiveCount(double minArea, double maxArea, std::shared_ptr<TBinaryTreeItem<T>> current, int& ans) {
    if (current != NULL) {
        RecursiveCount(minArea, maxArea, current->GetLeft(), ans);
        RecursiveCount(minArea, maxArea, current->GetRight(), ans);
        if (minArea <= current->GetPentagon().GetArea() && current->GetPentagon().GetArea() < maxArea) {
            ans += current->ReturnCounter();
        }
    }
}

```

```

template <class T>
int TBinaryTree<T>::Count(double minArea, double maxArea) {
    int ans = 0;
    RecursiveCount(minArea, maxArea, root, ans);
    return ans;
}

```

```

template <class T>
T& TBinaryTree<T>::GetItemNotLess(double area, std::shared_ptr<TBinaryTreeItem<T>> root) {
    if (root->GetPentagon().GetArea() >= area) {
        return root->GetPentagon();
    }
    else {
        return GetItemNotLess(area, root->GetRight());
    }
}

```

```

template <class T>
void RecursiveClear(std::shared_ptr<TBinaryTreeItem<T>> current){
    if (current!= NULL){
        RecursiveClear(current->GetLeft());
        RecursiveClear(current->GetRight());
        current = NULL;
    }
}

```

```

    }
}

template <class T>
void TBinaryTree<T>::Clear(){
    RecursiveClear(root);
    root = NULL;
}

template <class T>
bool TBinaryTree<T>::Empty() {
    if (root == NULL) {
        return true;
    }
    return false;
}

template <class T>
TBinaryTree<T>::~TBinaryTree() {
    Clear();
    std::cout << "Your tree has been deleted" << std::endl;
}

#include "trapezoid.h"
template class TBinaryTree<Trapezoid>;
template std::ostream& operator<<(std::ostream& os, TBinaryTree<Trapezoid>& stack);

```

TIterator.h:

```

#ifndef TITERATOR_H
#define TITERATOR_H
#include <iostream>
#include <memory>

template <class T, class A>
class TIterator {
public:
    TIterator(std::shared_ptr<T> iter) {
        node_ptr = iter;
    }
    A& operator*() {
        return node_ptr->GetTrapezoid();
    }

    void GoToLeft() { //переход к левому поддереву, если существует
        if (node_ptr == NULL) {
            std::cout << "Root does not exist" << std::endl;
        }
        else {
            node_ptr = node_ptr->GetLeft();
        }
    }
    void GoToRight() { //переход к правому поддереву, если существует
        if (node_ptr == NULL) {
            std::cout << "Root does not exist" << std::endl;
        }
        else {
            node_ptr = node_ptr->GetRight();
        }
    }
    bool operator == (TIterator &iterator) {
        return node_ptr == iterator.node_ptr;
    }
    bool operator != (TIterator &iterator) {
        return !(*this == iterator);
    }
}

```

```
private:
    std::shared_ptr<T> node_ptr;
};
#endif
```

main.cpp:

```
#include <iostream>
#include "trapezoid.h"
#include "TBinaryTree.h"
#include "TBinaryTreeItem.h"

int main () {
    //lab1

    Trapezoid a (std::cin);
    std::cout << "The area of your figure is : " << a.Area() << std::endl;

    Trapezoid b (std::cin);
    std::cout << "The area of your figure is : " << b.Area() << std::endl;

    Trapezoid c (std::cin);
    std::cout << "The area of your figure is : " << c.Area() << std::endl;

    //lab4

    TBinaryTree<Trapezoid> tree;
    std::cout << "Is tree empty? " << tree.Empty() << std::endl;
    std::cout << "And now, is tree empty? " << tree.Empty() << std::endl;
    tree.Push(a);
    tree.Push(b);
    tree.Push(c);
    std::cout << "The number of figures with area in [minArea, maxArea] is: " << tree.Count(0, 100000) << std::endl;
    std::cout << "The result of searching the same-figure-counter is: " << tree.root->ReturnCounter() << std::endl;
    std::cout << "The result of function named GetItemNotLess is: " << tree.GetItemNotLess(0, tree.root) << std::endl;
    std::cout << tree << std::endl;
    tree.root = tree.Pop(tree.root, a);
    std::cout << tree << std::endl;
    return 0;
}
```

HStackItem.h:

```
#ifndef HLISTITEM_H
#define HLISTITEM_H
#include <iostream>
#include "trapezoid.h"
```

```

#include <memory>

template <class T> class HStackItem {
public:
    HStackItem(const std::shared_ptr<Trapezoid> &trapezoid);
    template <class A> friend std::ostream& operator<<(std::ostream& os, HStackItem<A> &obj);
    ~HStackItem();
    std::shared_ptr<T> trapezoid;
    std::shared_ptr<HStackItem<T>> next;
};
#endif

```

HStackItem.cpp:

```

#include <iostream>
#include "HStackItem.h"

template <class T> HStackItem<T>::HStackItem(const std::shared_ptr<Trapezoid> &trapezoid) {
    this->trapezoid = trapezoid;
    this->next = nullptr;
}

template <class A> std::ostream& operator<<(std::ostream& os, HStackItem<A> &obj) {
    os << "[" << obj.trapezoid << "]" << std::endl;
    return os;
}

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

```

TStack.h:

```

#ifndef HLIST_H
#define HLIST_H
#include <iostream>
#include "HStackItem.h"
#include "trapezoid.h"
#include <memory>

```

```

template <class T> class TStack {
public:
    TStack();
    int size_of_list;
    size_t Length();

```

```

std::shared_ptr<Trapezoid>& Last();
std::shared_ptr<Trapezoid>& GetItem(size_t idx);
bool Empty();
TStack(const std::shared_ptr<TStack> &other);
void InsertLast(const std::shared_ptr<Trapezoid> &&trapezoid);
void RemoveLast();
void Insert(const std::shared_ptr<Trapezoid> &&trapezoid, size_t position);
void Remove(size_t position);
void Clear();
template <class A> friend std::ostream& operator<<(std::ostream& os, TStack<A>& list);
~TStack();
private:
    std::shared_ptr<HStackItem<T>>> front;
    std::shared_ptr<HStackItem<T>>> back;
};
#endif

```

TStack.cpp:

```

#include <iostream>
#include "TStack.h"
#include "HStackItem.h"

template <class T> TStack<T>::TStack() {
    size_of_list = 0;
    std::shared_ptr<HStackItem<T>>> front;
    std::shared_ptr<HStackItem<T>>> back;
    std::cout << "Trapezoid Stack created" << std::endl;
}

template <class T> TStack<T>::TStack(const std::shared_ptr<TStack> &other){
    front = other->front;
    back = other->back;
}

template <class T> size_t TStack<T>::Length() {
    return size_of_list;
}

template <class T> bool TStack<T>::Empty() {
    return size_of_list;
}

template <class T> std::shared_ptr<Trapezoid>& TStack<T>::GetItem(size_t idx){
    int k = 0;
    std::shared_ptr<HStackItem<T>>> obj = front;

```

```

while (k != idx){
    k++;
    obj = obj->next;
}
return obj->trapezoid;
}

template <class T> std::shared_ptr<Trapezoid>& TStack<T>::Last() {
    return back->trapezoid;
}

template <class T> void TStack<T>::InsertLast(const std::shared_ptr<Trapezoid> &&trapezoid) {
    std::shared_ptr<HStackItem<T>> obj (new HStackItem<T>(trapezoid));
    if(size_of_list == 0) {
        front = obj;
        back = obj;
        size_of_list++;
        return;
    }
    back->next = obj;
    back = obj;
    obj->next = nullptr;
    size_of_list++;
}

template <class T> void TStack<T>::RemoveLast() {
    if (size_of_list == 0) {
        std::cout << "Trapezoid does not pop_back, because the Trapezoid List is empty" << std::endl;
    } else {
        std::shared_ptr<HStackItem<T>> prev_del = front;
        while (prev_del->next != back) {
            prev_del = prev_del->next;
        }
        prev_del->next = nullptr;
        back = prev_del;
        size_of_list--;
    }
}

template <class T> void TStack<T>::Insert(const std::shared_ptr<Trapezoid> &&trapezoid, size_t position) {
    if (position < 0) {
        std::cout << "Position < zero" << std::endl;
    } else if (position > size_of_list) {
        std::cout << " Position > size_of_list" << std::endl;
    } else {

```



```

std::shared_ptr<HStackItem<T>> obj (new HStackItem<T>(trapezoid));
if (position == 0) {
    front = obj;
    back = obj;
} else {
    int k = 0;
    std::shared_ptr<HStackItem<T>> prev_insert = front;
    std::shared_ptr<HStackItem<T>> next_insert;
    while(k+1 != position) {
        k++;
        prev_insert = prev_insert->next;
    }
    next_insert = prev_insert->next;
    prev_insert->next = obj;
    obj->next = next_insert;
}
size_of_list++;
}
}

template <class T> void TStack<T>::Remove(size_t position) {
    if (position > size_of_list) {
        std::cout << "Position " << position << " > " << "size " << size_of_list << " Not correct erase" << std::endl;
    } else if (position < 0) {
        std::cout << "Position < 0" << std::endl;
    } else {
        int k = 0;
        std::shared_ptr<HStackItem<T>> prev_erase = front;
        std::shared_ptr<HStackItem<T>> next_erase;
        std::shared_ptr<HStackItem<T>> del;
        while( k+1 != position) {
            k++;
            prev_erase = prev_erase->next;
        }
        next_erase = prev_erase->next;
        del = prev_erase->next;
        next_erase = del->next;
        prev_erase->next = next_erase;
        size_of_list--;
    }
}

template <class T> void TStack<T>::Clear() {

```

```

std::shared_ptr<HStackItem<T>> del = front;
std::shared_ptr<HStackItem<T>> prev_del;
if(size_of_list !=0 ) {
    while(del->next != nullptr) {
        prev_del = del;
        del = del->next;
    }
    size_of_list = 0;
    // std::cout << "HStackItem deleted" << std::endl;
}
size_of_list = 0;
std::shared_ptr<HStackItem<T>> front;
std::shared_ptr<HStackItem<T>> back;
}

template <class T> std::ostream& operator<<(std::ostream& os, TStack<T>& hl) {
    if (hl.size_of_list == 0) {
        os << "The trapezoid stack is empty, so there is nothing to output" << std::endl;
    } else {
        os << "Print Trapezoid Stack" << std::endl;
        std::shared_ptr<HStackItem<T>> obj = hl.front;
        while(obj != nullptr) {
            if (obj->next != nullptr) {
                os << obj->trapezoid << " " << "," << " ";
                obj = obj->next;
            } else {
                os << obj->trapezoid;
                obj = obj->next;
            }
        }
        os << std::endl;
    }
    return os;
}

template <class T> TStack<T>::~~TStack() {
    std::shared_ptr<HStackItem<T>> del = front;
    std::shared_ptr<HStackItem<T>> prev_del;
    if(size_of_list !=0 ) {
        while(del->next != nullptr) {
            prev_del = del;
            del = del->next;
        }
    }
}

```

```

size_of_list = 0;

std::cout << "Trapezoid Stack deleted" << std::endl;

}

}

```

TAllocatorBlock.h:

```

#ifndef TALLOCATORBLOCK_H
#define TALLOCATORBLOCK_H

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

class TAllocatorBlock {
public:
    TAllocatorBlock(const size_t& size, const size_t count){
        this->size = size;
        for(int i = 0; i < count; ++i){
            unused_blocks.Insert(malloc(size));
        }
    }

    void* Allocate(const size_t& size){
        if(size != this->size){
            std::cout << "Error during allocation\n";
        }
        if(unused_blocks.Length()){
            for(int i = 0; i < 5; ++i){
                unused_blocks.Insert(malloc(size));
            }
        }
        void* tmp = unused_blocks.GetItem(1);
        used_blocks.Insert(unused_blocks.GetItem(1));
        unused_blocks.Remove(0);
        return tmp;
    }

    void Deallocate(void* ptr){
        unused_blocks.Insert(ptr);
    }

    ~TAllocatorBlock(){
        while(used_blocks.size()){
            try{
                free(used_blocks.GetItem(1));
            }
        }
    }
}

```

```

        used_blocks.Remove(0);
    } catch(...){
        used_blocks.Remove(0);
    }
}
while(unused_blocks.size()){
    try{
        free(unused_blocks.GetItem(1);
        unused_blocks.Remove(0);
    } catch(...){
        unused_blocks.Remove(0);
    }
}
}

private:
    size_t size;
    TStack <void*> used_blocks;
    TStack <void*> unused_blocks;
};

```

#endif

Результат работы:

```

C:\Users\SashaPaladin\CLionProjects\OOP\lab6\cmake-build-debug\lab6.exe
0 0 1 1 2 1 3 0
Trapezoid that you wanted to create has been created
The area of your figure is : 2
0 0 1 1 2 1 3 0
Trapezoid that you wanted to create has been created
The area of your figure is : 2
0 0 1 1 2 1 3 0
Trapezoid that you wanted to create has been created
The area of your figure is : 2
0 0 1 1 2 1 3 0
Trapezoid that you wanted to create has been created
The area of your figure is : 2
0 0 1 1 2 1 3 0
Trapezoid that you wanted to create has been created
The area of your figure is : 2
Is tree empty? 1
And now, is tree empty? 0
The number of figures with area in [minArea, maxArea] is: 5
The result of searching the same-figure-counter is: 5
The result of function named GetItemNotLess is: Trapezoid: (0, 0)(1, 1)(2, 1)(3, 0)

The figure that you have put in root is: Trapezoid: (0, 0)(1, 1)(2, 1)(3, 0)

The first result of Left-Iter function is: Trapezoid: (
Process finished with exit code -1073741819 (0xC0000005)

```