МИНИСТЕРСТВО ОБРАЗОВАНИЯ И НАУКИ РОССИЙСКОЙ  
ФЕДЕРАЦИИ МОСКОВСКИЙ АВИАЦИОННЫЙ ИНСТИТУТ

(НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ УНИВЕРСИТЕТ)

ЛАБОРАТОРНАЯ РАБОТА №8 по курсу объектно-ориентированное программирование I семестр, 2021/22 уч. год

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**Цель работы:**  
Целью лабораторной работы является:   
  
Закрепление навыков по работе с памятью в C++;   
Создание аллокаторов памяти для динамических структур данных.  
  
Задание:  
  
Используя структуру данных, разработанную для лабораторной работы №5, спроектировать и разработать аллокатор памяти для динамической структуры данных.   
Цель построения аллокатора – 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 оператор new и delete у классов-фигур.   
  
Нельзя использовать:   
  
Стандартные контейнеры std.   
  
Программа должна позволять:   
  
Вводить произвольное количество фигур и добавлять их в контейнер;   
Распечатывать содержимое контейнера;   
Удалять фигуры из контейнера.

**Дневник отладки**

Во время выполнения лабораторной были некие трудности с реализацией линейного списка и аллокатора, позже они были полностью ликвидирован.

**Недочёты**  
Недочётов не было обнаружено.

**Выводы**

Лабораторная работа №8 позволила мне реализовать свой класс аллокаторов, полностью прочувствовать процесс выделения памяти на низкоуровневых языках программирования. Лабораторная прошла успешно.

**Исходный код**

figure.h

#ifndef FIGURE\_H

#define FIGURE\_H

#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

main.cpp  
  
#include <iostream>

#include "pentagon.h"

#include "TBinaryTree.h"

#include "TBinaryTreeItem.h"

int main () {

//lab1

Pentagon a (std::cin);

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

Pentagon b (std::cin);

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

Pentagon c (std::cin);

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

Pentagon d (std::cin);

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

Pentagon e (std::cin);

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

//lab2

TBinaryTree<Pentagon> tree;

std:: cout << "Is tree empty? " << tree.Empty() << std:: endl;

tree.Push(a);

std:: cout << "And now, is tree empty? " << tree.Empty() << std:: endl;

tree.Push(b);

tree.Push(c);

tree.Push(d);

tree.Push(e);

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;

//lab5

TIterator<TBinaryTreeItem<Pentagon>, Pentagon> iter(tree.root);

std:: cout << "The figure that you have put in root is: " << \*iter << std:: endl;

iter.GoToLeft();

std:: cout << "The first result of Left-Iter function is: " << \*iter << std:: endl;

iter.GoToRight();

std:: cout << "The first result of Right-Iter function is: " << \*iter << std:: endl;

TIterator<TBinaryTreeItem<Pentagon>, Pentagon> first(tree.root->GetLeft());

TIterator<TBinaryTreeItem<Pentagon>, Pentagon> second(tree.root->GetLeft());

if (first == second) {

std:: cout << "YES, YOUR ITERATORS ARE EQUALS" << std::endl;

}

TIterator<TBinaryTreeItem<Pentagon>, Pentagon> third(tree.root->GetRight());

TIterator<TBinaryTreeItem<Pentagon>, Pentagon> fourth(tree.root->GetLeft());

if (third != fourth) {

std:: cout << "NO, YOUR ITERATORS ARE NOT EQUALS" << std::endl;

}

return 0;

}

pentagon.cpp  
  
#include "pentagon.h"

#include <cmath>

Pentagon::Pentagon() {}

Pentagon::Pentagon(std::istream &InputStream)

{

InputStream >> a;

InputStream >> b;

InputStream >> c;

InputStream >> d;

InputStream >> e;

std:: cout << "Pentagon that you wanted to create has been created" << std:: endl;

}

void Pentagon::Print(std::ostream &OutputStream) {

OutputStream << "Pentagon: ";

OutputStream << a << " " << b << " " << c << " " << d << " " << e << std:: endl;

}

size\_t Pentagon::VertexesNumber() {

size\_t number = 5;

return number;

}

double Pentagon::Area() {

double q = abs(a.X() \* b.Y() + b.X() \* c.Y() + c.X() \* d.Y() + d.X() \* e.Y() + e.X() \* a.Y() - b.X() \* a.Y() - c.X() \* b.Y() - d.X() \* c.Y() - e.X() \* d.Y() - a.X() \* e.Y());

double s = q / 2;

this->area = s;

return s;

}

double Pentagon:: GetArea() {

return area;

}

Pentagon::~Pentagon() {

std:: cout << "My friend, your pentagon has been deleted" << std:: endl;

}

bool operator == (Pentagon& p1, Pentagon& p2){

if(p1.a == p2.a && p1.b == p2.b && p1.c == p2.c && p1.d == p2.d && p1.e == p2.e) {

return true;

}

return false;

}

std::ostream& operator << (std::ostream& os, Pentagon& p){

os << "Pentagon: ";

os << p.a << p.b << p.c << p.d << p.e;

os << std::endl;

return os;

}

Pentagon.h  
  
#ifndef PENTAGON\_H

#define PENTAGON\_H

#include "figure.h"

#include <iostream>

class Pentagon : public Figure {

public:

Pentagon(std::istream &InputStream);

Pentagon();

double GetArea();

size\_t VertexesNumber();

double Area();

void Print(std::ostream &OutputStream);

friend bool operator == (Pentagon& p1, Pentagon& p2);

friend std::ostream& operator << (std::ostream& os, Pentagon& p);

virtual ~Pentagon();

double area;

private:

Point a;

Point b;

Point c;

Point d;

Point e;

};

#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::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);

}

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 Pentagon;

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

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 verex 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 "pentagon.h"

template class TBinaryTree<Pentagon>;

template std::ostream& operator<<(std::ostream& os, TBinaryTree<Pentagon>& stack);

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

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 "pentagon.h"

template class TBinaryTreeItem<Pentagon>;

template std::ostream& operator<<(std::ostream& os, TBinaryTreeItem<Pentagon> &obj);

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->GetPentagon();

}

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

TBinaryTreeItem.h  
  
#ifndef TBINARYTREE\_ITEM\_H

#define TBINARYTREE\_ITEM\_H

#include "pentagon.h"

template <class T>

class TBinaryTreeItem {

public:

TBinaryTreeItem(const T& pentagon);

TBinaryTreeItem(const TBinaryTreeItem<T>& other);

T& GetPentagon();

void SetPentagon(T& pentagon);

std::shared\_ptr<TBinaryTreeItem<T>> GetLeft();

std::shared\_ptr<TBinaryTreeItem<T>> GetRight();

void SetLeft(std::shared\_ptr<TBinaryTreeItem<T>> item);

void SetRight(std::shared\_ptr<TBinaryTreeItem<T>> item);

void SetPentagon(const T& pentagon);

void IncreaseCounter();

void DecreaseCounter();

int ReturnCounter();

virtual ~TBinaryTreeItem();

template<class A>

friend std::ostream &operator<<(std::ostream &os, const TBinaryTreeItem<A> &obj);

private:

T pentagon;

std::shared\_ptr<TBinaryTreeItem<T>> left;

std::shared\_ptr<TBinaryTreeItem<T>> right;

int counter;

};

#endif

TAllocatorBlock.h  
  
#ifndef TALLOCATORBLOCK\_H

#define TALLOCATORBLOCK\_H

#include "TLinkedList.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;

TLinkedList <void\*> used\_blocks;

TLinkedList <void\*> unused\_blocks;

};

#endif

HListItem.cpp  
  
#include <iostream>

#include "HListItem.h"

template <class T> HListItem<T>::HListItem(const std::shared\_ptr<Pentagon> &pentagon) {

this->pentagon = pentagon;

this->next = nullptr;

}

template <class A> std::ostream& operator<<(std::ostream& os,HListItem<A> &obj) {

os << "[" << obj.pentagon << "]" << std::endl;

return os;

}

template <class T> HListItem<T>::~HListItem() {

}

HListItem.h  
  
#ifndef HLISTITEM\_H

#define HLISTITEM\_H

#include <iostream>

#include "pentagon.h"

#include <memory>

template <class T> class HListItem {

public:

HListItem(const std::shared\_ptr<Pentagon> &pentagon);

template <class A> friend std::ostream& operator<<(std::ostream& os, HListItem<A> &obj);

~HListItem();

std::shared\_ptr<T> pentagon;

std::shared\_ptr<HListItem<T>> next;

};

#include "HListItem.cpp"

#endif

TLinkedList.cpp

#include <iostream>

#include "TLinkedList.h"

template <class T> TLinkedList<T>::TLinkedList() {

size\_of\_list = 0;

std::shared\_ptr<HListItem<T>> front;

std::shared\_ptr<HListItem<T>> back;

std::cout << "Pentagon List created" << std::endl;

}

template <class T> TLinkedList<T>::TLinkedList(const std::shared\_ptr<TLinkedList> &other){

front = other->front;

back = other->back;

}

template <class T> size\_t TLinkedList<T>::Length() {

return size\_of\_list;

}

template <class T> bool TLinkedList<T>::Empty() {

return size\_of\_list;

}

template <class T> std::shared\_ptr<Pentagon>& TLinkedList<T>::GetItem(size\_t idx){

int k = 0;

std::shared\_ptr<HListItem<T>> obj = front;

while (k != idx){

k++;

obj = obj->next;

}

return obj->pentagon;

}

template <class T> std::shared\_ptr<Pentagon>& TLinkedList<T>::First() {

return front->pentagon;

}

template <class T> std::shared\_ptr<Pentagon>& TLinkedList<T>::Last() {

return back->pentagon;

}

template <class T> void TLinkedList<T>::InsertLast(const std::shared\_ptr<Pentagon> &&pentagon) {

std::shared\_ptr<HListItem<T>> obj (new HListItem<T>(pentagon));

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 TLinkedList<T>::RemoveLast() {

if (size\_of\_list == 0) {

std::cout << "Pentagon does not pop\_back, because the Pentagon List is empty" << std:: endl;

} else {

if (front == back) {

RemoveFirst();

size\_of\_list--;

return;

}

std::shared\_ptr<HListItem<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 TLinkedList<T>::InsertFirst(const std::shared\_ptr<Pentagon> &&pentagon) {

std::shared\_ptr<HListItem<T>> obj (new HListItem<T>(pentagon));

if(size\_of\_list == 0) {

front = obj;

back = obj;

} else {

obj->next = front;

front = obj;

}

size\_of\_list++;

}

template <class T> void TLinkedList<T>::RemoveFirst() {

if (size\_of\_list == 0) {

std::cout << "Pentagon does not pop\_front, because the Pentagon List is empty" << std:: endl;

} else {

std::shared\_ptr<HListItem<T>> del = front;

front = del->next;

size\_of\_list--;

}

}

template <class T> void TLinkedList<T>::Insert(const std::shared\_ptr<Pentagon> &&pentagon, 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<HListItem<T>> obj (new HListItem<T>(pentagon));

if (position == 0) {

front = obj;

back = obj;

} else {

int k = 0;

std::shared\_ptr<HListItem<T>> prev\_insert = front;

std::shared\_ptr<HListItem<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 TLinkedList<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 {

if (position == 0) {

RemoveFirst();

} else {

int k = 0;

std::shared\_ptr<HListItem<T>> prev\_erase = front;

std::shared\_ptr<HListItem<T>> next\_erase;

std::shared\_ptr<HListItem<T>> del;F

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 TLinkedList<T>::Clear() {

std::shared\_ptr<HListItem<T>> del = front;

std::shared\_ptr<HListItem<T>> prev\_del;

if(size\_of\_list !=0 ) {

while(del->next != nullptr) {

prev\_del = del;

del = del->next;

}

size\_of\_list = 0;

// std::cout << "HListItem deleted" << std::endl;

}

size\_of\_list = 0;

std::shared\_ptr<HListItem<T>> front;

std::shared\_ptr<HListItem<T>> back;

}

template <class T> std::ostream& operator<<(std::ostream& os, TLinkedList<T>& hl) {

if (hl.size\_of\_list == 0) {

os << "The pentagon list is empty, so there is nothing to output" << std::endl;

} else {

os << "Print Pentagon List" << std::endl;

std::shared\_ptr<HListItem<T>> obj = hl.front;

while(obj != nullptr) {

if (obj->next != nullptr) {

os << obj->pentagon << " " << "," << " ";

obj = obj->next;

} else {

os << obj->pentagon;

obj = obj->next;

}

}

os << std::endl;

}

return os;

}

template <class T> TLinkedList<T>::~TLinkedList() {

std::shared\_ptr<HListItem<T>> del = front;

std::shared\_ptr<HListItem<T>> prev\_del;

if(size\_of\_list !=0 ) {

while(del->next != nullptr) {

prev\_del = del;

del = del->next;

}

size\_of\_list = 0;

std::cout << "Pentagon List deleted" << std::endl;

}

}

TLinkedList.h  
  
#ifndef HLIST\_H

#define HLIST\_H

#include <iostream>

#include "HListItem.h"

#include "pentagon.h"

#include <memory>

template <class T> class TLinkedList {

public:

TLinkedList();

int size\_of\_list;

size\_t Length();

std::shared\_ptr<Pentagon>& First();

std::shared\_ptr<Pentagon>& Last();

std::shared\_ptr<Pentagon>& GetItem(size\_t idx);

bool Empty();

TLinkedList(const std::shared\_ptr<TLinkedList> &other);

void InsertFirst(const std::shared\_ptr<Pentagon> &&pentagon);

void InsertLast(const std::shared\_ptr<Pentagon> &&pentagon);

void RemoveLast();

void RemoveFirst();

void Insert(const std::shared\_ptr<Pentagon> &&pentagon, size\_t position);

void Remove(size\_t position);

void Clear();

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

~TLinkedList();

private:

std::shared\_ptr<HListItem<T>> front;

std::shared\_ptr<HListItem<T>> back;

};

#include "TLinkedList.cpp"

#endif