Programming 2 - Assignment 3

Felix Dreßler (k12105003)
email FelixDressler01@gmail.com

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1 Testing the Program

The following section shows how the functions of the Program were tested.

1.1 Testing Code - Main.cpp

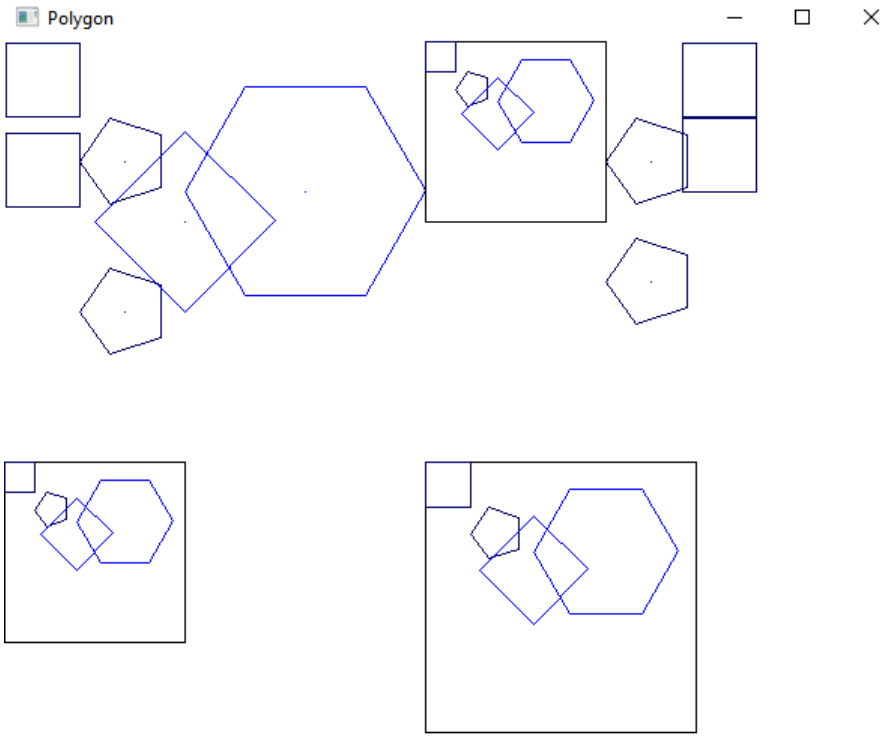
This is the code that was used for testing the functionality.

```
1  //*************************************************************
2  // "Main.cpp"
3  //
4  // is used to test the functions of the "Polygon" class and its derived
5  // classes. Further it also contains functions to test the class "Picture"
6  //
7  // created by Felix Dressler, 11.05.2022
8  //*************************************************************
9
10 #include"Polygon.h"
11 #include"Drawing.h"
12 #include"Picture.h"
13
14 #include<iostream>
15
16 using namespace std;
17
18 using namespace compsys;
19
20
21 int main() {
22   beginDrawing(600, 600, "Polygon", 0xFFFFFF, false);
23
24   Polygon p(100);
25   p.add(1, 1);
26   p.add(50, 1);
27   p.add(50, 50);
28   p.add(1, 50);
29   p.draw();//testin polygon draw
30
31
32   Polygon l(0);
33   l = *p.clone();//testing polygon clone
34   l.draw(0,60);
35
36   Polygon w(p);//testing copy constructor
37   w.draw(450,0);
38
39   Polygon z(0);
40   z = w;//testing copy assignment operator
41   z.draw(450, 50);
42
43   RegularPolygon q(80, 80, 30, 5, 0, 100);
44   q.draw();//testing regular polygon draw
45
46   RegularPolygon a(0,0,0,0,0,0);
47   a = *q.clone();//testing regular polygon clone
48   a.draw(0, 100);
49
50   RegularPolygon e(0, 0, 0, 0, 0, 0);
```

```
51    e = q;//testing copy assignment operator
52    e.draw(350, 0);
53
54    RegularPolygon f(q);//testing copy constructor
55    f.draw(350, 80);
56
57    Square r(120, 120, 60, 0, 0xFF);
58    r.draw();
59
60    Hexagon s(200,100,80,0,0x00FF);
61    s.draw();
62
63    //testing functions of picture
64
65    Picture pic;
66
67    //cout << "add p - Polygon" << endl;
68    pic.add(p);
69    //cout << "add q - Regular" << endl;
70    pic.add(q);
71    //cout << "add r - Regular" << endl;
72    pic.add(r);
73    //cout << "add s - Regular" << endl;
74    pic.add(s);
75
76    pic.draw(280,280,300,300,0.6);
77
78    Picture pic2(pic);
79
80    Picture pic3;
81
82    pic3 = pic;
83
84    pic2.draw(280, 0, 300, 300, 0.4);
85    pic3.draw(0, 280, 300, 300, 0.4);
86
87
88    endDrawing();
89  }
```

1.2 testing - output

This is the output, that was produced by the code above.



2 Problems

This section will briefly discuss the Problems that have occurred during programming.

2.1 virtual functions/Data types

Despite the best efforts, there is still a problem with the code. Specifically concerning the *Picture* class. While drawing a picture, the outputted polygons of type *RegularPolygon* do not contain a center point. In the following two sections, the code which was used to narrow the problem down and its output are presented. The code contains multiple *cout*s to determine where exactly the problem lies. We can see, that while adding polygons to the *LinkedList* of the picture, that holds pointer to polygons, the correct *clone()* function of the respective derived class is called. But when calling the *draw()* function, it always calls the virtual function defined in the *Polygon* class.

This Problem is probably caused by the type that those polygons hold during runtime of the program. Because the *LinkedListPointer* stores just pointer to polygons (*Polygon**) this could be caused by the declaration of the type of pointer inside there.

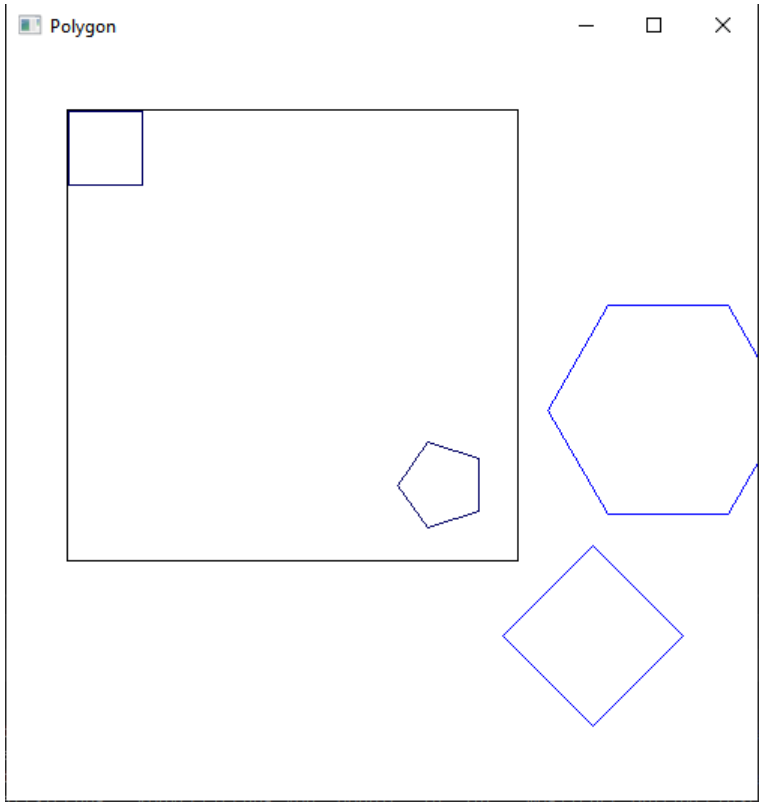
The testing of clone and draw, that we have already done suggests, that these functions are created correctly.

2.1.1 testing code

```
1  //*************************************************************
2  // "Main.cpp"
3  //
4  // is used to test the functions of the "Polygon" class and its derived
5  // classes. Further it also contains functions to test the class "Picture"
6  //
7  // created by Felix Dressler, 11.05.2022
8  //*************************************************************
9
10 #include"Polygon.h"
11 #include"Drawing.h"
12 #include"Picture.h"
13
14 #include<iostream>
15
16 using namespace std;
17
18 using namespace compsys;
19
20
21 int main() {
22   Polygon p(100);
23
24   beginDrawing(500, 500, "Polygon", 0xFFFFFF, false);
25
26   p.add(1, 1);
27   p.add(50, 1);
28   p.add(50, 50);
29   p.add(1, 50);
30
31   RegularPolygon q(250, 250, 30, 5, 0, 100);
32   Square r(350, 350, 60, 0, 0xFF);
```

```
33    Hexagon s(400,200,80,0,0x00FF);
34
35    Picture pic;
36
37    cout << "add p - Polygon" << endl;
38    pic.add(p);
39    cout << "add q - Regular" << endl;
40    pic.add(q);
41    cout << "add r - Regular" << endl;
42    pic.add(r);
43    cout << "add s - Regular" << endl;
44    pic.add(s);
45
46    pic.draw(40,40,300,300,1);
47
48    endDrawing();
49  }
```

2.1.2 output of the testing code




```
          add p - Polygon
          clone - Polygon
          add q - Regular
          clone - Regular Polygon
          add r - Regular
          clone - Regular Polygon
          add s - Regular
          clone - Regular Polygon
          draw - Polygon
```

```
        draw - Polygon
        draw - Polygon
        draw - Polygon
        draw - Polygon
```

3 The Program

3.1 The Program - Polygon

3.1.1 Polygon.h

```
1  //****************************************************************
2  // "Polygon.h"
3  //
4  // contains the classes "Plygon", "RegularPolygon", "Square" and
5  // "Hexagon", which all create polygons. The names of the classes
6  // are already self explanatory.
7  //
8  // created by Felix Dressler, 10.05.2022
9  //****************************************************************
10
11 #pragma once
12
13 #include"LinkedList.h"
14
15 //****************************************************************
16 // "Polygon.h"
17 //
18 // holds a linked list of points of a Polygon and the color of the
19 // outline of the polygon.
20 //****************************************************************
21 class Polygon
22 {
23 private:
24     unsigned int color = 0xFFFF;
25     LinkedListArr points;
26
27 public:
28     // create polygon in denoted color (default black)
29     Polygon(unsigned int color = 0);
30
31     // copy constructor, copy assignment operator, destructor
32     Polygon(Polygon& p);
33     Polygon& operator=(Polygon& p);
34     virtual ~Polygon();
35
36     // create a heap-allocated copy of this polygon
37     virtual Polygon* clone();
38
39     // add point with relative coordinates (x,y) to polygon
40     void add(double x, double y);
41
42     // draws the polygon at absolute coordinates (x0,y0) scaled by factor f;
43     // thus every point (x,y) is drawn at position (x0+x*f, y0+y*f)
44     void draw(double x0 = 0, double y0 = 0, double f = 1);
45
46     //sets the color of the polygon
47     void setColor(unsigned int c){
48         this->color = c;
49     }
50
51     //gives back the color of the polygon
52     unsigned int getColor() {
```

```
53          return color;
54      }
55
56      //gives back the number of points in the polygon
57      int pNum() {
58          return points.length();
59      }
60
61      //gives back the specific coordinate x (n=0) or y (n=1) for a point of Polygon
62      int getCoord(int i, int n) {
63          return points.get(i, n);
64      }
65  };
66
67
68  //****************************************************************
69  // "Polygon.h"
70  //
71  // constructs a special case of a polygon, a regular polygon.
72  // It additionally holds an angle a, x and y middle-point coordinates
73  // and a radius.
74  //****************************************************************
75  class RegularPolygon : public Polygon
76  {
77  private:
78      double a;
79      double x;
80      double y;
81      double r;
82  public:
83      //constructor
84      RegularPolygon(double x, double y, double r, int n,
85          double a = 0, unsigned int c = 0);
86
87      //destructor
88      ~RegularPolygon();
89
90      //draws a regular polygon
91      void draw(double x0 = 0, double y0 = 0, double f = 1);
92
93      //clones a regular polygon
94      RegularPolygon* clone();
95  };
96
97
98  //****************************************************************
99  // "Polygon.h" and "Hexagon"
100 //
101 // constructs two special cases of a regular polygon by fixing
102 // the number of points to 4/6.
103 //****************************************************************
104 class Square : public RegularPolygon
105 {
106 public:
107     //constructs a square
108     Square(double x, double y, double r,
109         double a = 0, unsigned int c = 0);
110 };
111
112 class Hexagon : public RegularPolygon
```

```
{
public:
    //constructs a hexagon
    Hexagon(double x, double y, double r,
        double a = 0, unsigned int c = 0);
};
```

3.1.2 Polygon.cpp

```
//*****************************************************************
// "Polygon.cpp"
//
// contains the methods of the class "Polygon", "RegularPolygon",
// "Square" and "Hexagon".
//
// created by Felix Dressler,
//*****************************************************************

#include"Polygon.h"
#include"LinkedList.h"
#include"Drawing.h"

#define _USE_MATH_DEFINES

#include<cmath>
#include<iostream>

using namespace std;
using namespace compsys;

//constructor for Polygon
Polygon::Polygon(unsigned int color) {
    this->color = color;
    this->points;
}

//copy constructor for polygon
Polygon::Polygon(Polygon& p) {
    this->color = p.color;
    int length = p.points.length();

    for (int i = 0; i < length; i++) {
        this->add(p.points.get(i, 0), p.points.get(i, 1));
    }
}

//copy assignment operator for Polygon
Polygon& Polygon::operator=(Polygon& p) {
    this->color = p.color;
    int length = p.points.length();

    for(int i = 0; i < length; i++) {
        this->add(p.points.get(i, 0), p.points.get(i, 1));
    }


    return *this;
}
```

```
50
51  //destructor for Polygon (in this case there is nothing to be deallocated)
52  Polygon::~Polygon() {
53
54  }
55
56  //*****************************************************************
57  // "clone()"
58  //
59  // virtual function clone, that creates a heap allocated clone
60  // of a polygon.
61  //*****************************************************************
62  Polygon* Polygon::clone() {
63      //cout << "clone - Polygon" << endl;
64      Polygon* p = new Polygon(this->color);
65
66      int length = this->points.length();
67
68      for (int i = 0; i < length; i++) {
69          p->add(this->points.get(i,0), this->points.get(i, 1));
70      }
71
72      return p;
73  }
74
75  //*****************************************************************
76  // "add"
77  //
78  // is a method of the "Polygon" class. It adds a point to a polygon.
79  //*****************************************************************
80  void Polygon::add(double x, double y) {
81      int e[2] = { x,y };
82      points.insert(e);
83  }
84
85  //*****************************************************************
86  // "draw()"
87  //
88  // is a method of Polygon. It draws a Polygon with the left upper
89  // point of the surrounding square at (x0,y0) by using the drawPolygon()
90  // function defined in "Drawing.cpp".
91  //*****************************************************************
92  void Polygon::draw(double x0, double y0, double f) {
93      //cout << "draw - Polygon" << endl;
94      int length = points.length();
95      int* tempx = new int[length];
96      int* tempy = new int[length];
97
98      for (int i = 0; i < length; i++) {
99          tempx[i] = x0 + points.get(i,0)*f;
100         tempy[i] = y0 + points.get(i, 1)*f;
101     }
102
103     drawPolygon(length, tempx, tempy, color);
104
105     delete[] tempx;
106     delete[] tempy;
107 }
108
109
```

```
110
111 //*****************************************************************
112 // constructor of "RegularPolygon"
113 //
114 // constructs a regular polygon with center point (x,y), radius from
115 // the center to the points r, number of points n, angle of the
116 // first point to the horizontal axis a and color c.
117 //*****************************************************************
118 RegularPolygon::RegularPolygon(double x, double y,
119     double r, int n, double a, unsigned int c):Polygon(c) {
120
121     for (double i = 0; i < n; i ++) {
122         this->add(x - (cos(a + i * 2 * M_PI / n) * r),
123             y - (sin(a + i * 2 * M_PI / n) * r));
124     }
125     this->x = x;
126     this->y = y;
127     this->a = a;
128     this->r = r;
129     setColor(c);
130 }
131
132
133 //*****************************************************************
134 // "draw"
135 //
136 // the "draw" function of Polygon is a virtual function, this is the
137 // respective function for "RegularPolygon". It first calls the normal
138 // "Polygon::draw()" and then additionally draws the center point
139 // of the regular polygon.
140 //*****************************************************************
141 void RegularPolygon::draw(double x0, double y0, double f) {
142     //cout << "draw - Regular Polygon" << endl;
143     Polygon::draw(x0,y0,f);
144     drawPoint(x0 + x, y0 + y, getColor());
145 }
146
147 //destructor for Polygon (in this case there is nothing to be deallocated)
148 RegularPolygon::~RegularPolygon() {
149
150 }
151
152
153 //*****************************************************************
154 // "clone()"
155 //
156 // the "clone" function of Polygon is a virtual function, this is the
157 // respective function for "RegularPolygon". It constructs a new
158 // regular polygon with the same values.
159 //*****************************************************************
160 RegularPolygon* RegularPolygon::clone() {
161     //cout << "clone - Regular Polygon" << endl;
162     RegularPolygon* p = new RegularPolygon(*this);
163
164     return p;
165 }
166
167
168 //constructor for Square - constructs a regular polygon
169 //with a fixed number of points (4)
```

```
170 Square::Square(double x, double y,
171     double r, double a, unsigned int c):RegularPolygon(x,y,r,4,a,c) {
172
173 }
174
175
176 //constructor for Square - constructs a regular polygon
177 //with a fixed number of points (6)
178 Hexagon::Hexagon(double x, double y,
179     double r, double a, unsigned int c) :RegularPolygon(x, y, r, 6, a, c) {
180
181 }
```

3.2 The Program - Picture

3.2.1 Picture.h

```
1  //****************************************************************
2  // "Picture.h"
3  //
4  // contains the definition for the class "Picture", which holds polygons
5  // in a linked list and is able to draw those in combination with a frame.
6  //
7  // created by Felix Dresser, 11.05.2022
8  //****************************************************************
9
10 #pragma once
11
12 #include"LinkedListPointer.h"
13 #include"Polygon.h"
14
15 class Picture
16 {
17 private:
18     LinkedListPointer Polygons;
19     unsigned int h;
20     unsigned int w;
21 public:
22     Picture();
23     Picture(Picture& p);
24     Picture& operator=(Picture& p);
25     ~Picture();
26     void add(Polygon& p);
27     void draw(double x, double y, double w, double h, double f = 1.0);
28 };
```

3.2.2 Picture.cpp

```
1  //****************************************************************
2  // "Picture.cpp"
3  //
4  // contains the methods of the class "Picture".
5  //
6  // created by Felix Dressler,
7  //****************************************************************
```

```
8
9  #include"Polygon.h"
10 #include"LinkedListPointer.h"
11 #include"Drawing.h"
12 #include"Picture.h"
13
14 #define _USE_MATH_DEFINES
15
16 #include<iostream>
17 #include<cmath>
18
19 using namespace std;
20
21 //constructor for Picture
22 Picture::Picture() {
23     h = 200;
24     w = 200;
25 }
26
27 //copy constructor for Picture
28 Picture::Picture(Picture& p) {
29     this->h = p.h;
30     this->w = p.w;
31
32     int length = p.Polygons.length();
33     for (int i = 0; i < length; i++) {
34         this->Polygons.insert(p.Polygons.get(i));
35     }
36
37 }
38
39 //copy assignment operator for Picture
40 Picture& Picture::operator=(Picture& p) {
41     this->h = p.h;
42     this->w = p.w;
43
44     int length = p.Polygons.length();
45     for (int i = 0; i < length; i++) {
46         this->Polygons.insert(p.Polygons.get(i));
47     }
48
49     return *this;
50 }
51
52 //destructor for Picture
53 // destructs all heap allocated clones that were created and
54 // added into the Linked List that Picture holds.
55 Picture::~Picture() {
56     int length = Polygons.length();
57
58     for (int i = 0; i < length; i++) {
59         delete Polygons.get(i);
60     }
61 }
62
63 //****************************************************************
64 // "add()"
65 //
66 // adds a Polygon to the linked list of picture by cloning the
67 // respective polygon. This creates a heap allocated copy of the
```

```
68 // polygon, which has to be deleted by the destructor of Picture.
69 //*****************************************************************
70 void Picture::add(Polygon &p) {
71     this->Polygons.insert(p.clone());
72 }
73
74 //*****************************************************************
75 // "draw()"
76 //
77 // first draws a frame of width w and heigth h at position (x,y) for
78 // its upper left corner.
79 // It then draws the polygons that are held in the linked list at
80 // their respective position to (x,y) and resized by a factor f.
81 // (clipping allowed)
82 //*****************************************************************
83 void Picture::draw(double x, double y, double w, double h, double f) {
84     Polygon frame(0);
85     frame.add(0, 0);
86     frame.add(0, h);
87     frame.add(w, h);
88     frame.add(w, 0);
89     frame.draw(x,y,f);
90
91     int length = Polygons.length();
92
93     for (int i = 0; i < length; i++) {
94         Polygons.get(i)->draw(x,y,f);
95     }
96 }
```

3.3 The Program - Linked Lists

3.3.1 LinkedListArr.h

```
1  //*****************************************************************
2  // "LinkedList.h"
3  //
4  // contains the class "LinkedList", that implements a linked list
5  // based on the linked list that was presented in the lecture slides.
6  //
7  // created by Felix Dressler,
8  //*****************************************************************
9
10 #pragma once
11
12 class LinkedListArr
13 {
14   class Node;
15 private:
16   Node* head;
17   int number; //starts with 0 for the first element
18 public:
19   LinkedListArr();
20   ~LinkedListArr();
21
22   int length() const;
23   LinkedListArr& insert(int* e);
```

```
24   int get(int i, int n) const;
25 };
```

3.3.2 LinkedListArr.cpp

```
1  //*****************************************************************
2  // "LinkedList.h"
3  //
4  // contains the methods of the class "LinkedList" based on the
5  // functionality as presented in the lecture slides.
6  //
7  // created by Felix Dressler,
8  //*****************************************************************
9
10 #include "LinkedList.h"
11
12 //Node Element of the Linked List
13 class LinkedListArr::Node {
14   friend class LinkedListArr;
15 private:
16   int* value; Node* next;
17   Node(int* v, Node* n) {
18     next = n;
19     value = new int[2];
20     value[0] = v[0];
21     value[1] = v[1];
22   }
23 };
24
25 //constructor
26 LinkedListArr::LinkedListArr() {
27   head = 0;
28   number = 0;
29 }
30
31 //destructor
32 LinkedListArr::~LinkedListArr() {
33   Node* node = head;
34   while (node != 0) {
35     Node* node0 = node->next;
36     delete node;
37     node = node0;
38   }
39 }
40
41 //gives the number of nodes in the linked list
42 int LinkedListArr::length() const {
43   return number;
44 }
45
46 //inserts a Node into the linked list
47 LinkedListArr& LinkedListArr::insert(int* e) {
48   Node* node = new Node(e, head);
49   head = node;
50   number = number + 1;
51   return *this;
52 }
53
```

```
54 //gives back the value of the element of the linked list in position i
55 int LinkedListArr::get(int i, int n) const {
56   Node* node = head;
57   for (int j = 0; j < number - i - 1; j++)
58     node = node->next;
59   return node->value[n];
60 }
```

3.3.3 LinkedListPointer.h

```
1  //****************************************************************
2  // "LinkedListPointer.h"
3  //
4  // contains the class "LinkedListPointer", that implements a linked list
5  // based on the linked list that was presented in the lecture slides.
6  //
7  // created by Felix Dressler,
8  //****************************************************************
9
10 #pragma once
11
12 #include"Polygon.h"
13
14 class LinkedListPointer
15 {
16     class PointerNode;
17 private:
18     PointerNode* head;
19     int number; //starts with 0 for the first element
20 public:
21     LinkedListPointer();
22     ~LinkedListPointer();
23
24     int length() const;
25     LinkedListPointer& insert(Polygon* e);
26     Polygon* get(int i) const;
27 };
```

3.3.4 LinkedListPointer.cpp

```
1  //****************************************************************
2  // "LinkedListPointer.h"
3  //
4  // contains the methods of the class "LinkedListPointer" based on the
5  // functionality as presented in the lecture slides.
6  //
7  // created by Felix Dressler, 11.05.2022
8  //****************************************************************
9
10 #include"LinkedListPointer.h"
11 #include"Polygon.h"
12
13 #include<iostream>
14
15 using namespace std;
16
```

```
17 //Node Element of the Linked List
18 class LinkedListPointer::PointerNode {
19     friend class LinkedListPointer;
20 private:
21     Polygon* value; PointerNode* next;
22     PointerNode(Polygon* v, PointerNode* n) {
23         next = n;
24         value = v;
25     }
26 };
27
28 //constructor
29 LinkedListPointer::LinkedListPointer() {
30     head = 0;
31     number = 0;
32 }
33
34 //destructor
35 LinkedListPointer::~LinkedListPointer() {
36     PointerNode* node = head;
37     while (node != 0) {
38         PointerNode* node0 = node->next;
39         delete node;
40         node = node0;
41     }
42 }
43
44 //gives the number of nodes in the linked list
45 int LinkedListPointer::length() const {
46     return number;
47 }
48
49 //inserts a Node into the linked list
50 LinkedListPointer& LinkedListPointer::insert(Polygon* e) {
51     PointerNode* node = new PointerNode(e, head);
52     head = node;
53     number = number + 1;
54     return *this;
55 }
56
57 //gives back the value of the element of the linked list in position i
58 Polygon* LinkedListPointer::get(int i) const {
59     PointerNode* node = head;
60     for (int j = 0; j < number - i - 1; j++)
61         node = node->next;
62     return node->value;
63 }
```