实验 4 多态性与虚函数

序号：

班级 信安 20-2 学号 20101110201 姓名 李天昊

[实验目的]

1、了解多态性的概念；

2、了解虚函数的用途及使用方法；

3、了解纯虚函数和抽象类的概念和用法。

[实验要求]

给出以下各实验内容的源程序代码，并把编译、运行过程中出现的问题以及解决方法填入实验报告中，按时上交。

[实验学时]

2 学时。

[实验内容]

1、写一个程序，定义抽象基类 Shape，由它派生出 3 个派生类：Circle(圆形)、Square(正方形)、Rectangle(矩形)。利用指针、虚函数 printArea()、printLength()分别输出以上三者的面积和周长，三个图形的数据在定义对象时给定。另外实现一个通用的函数计算面积和周长，而不需要考虑是何种图形。

```cpp
#include <iostream>
using namespace std;
/* ============================================== */
/*              BASE CLASS - CShape              */
/* ============================================== */

class CShape {
public:
    virtual double Area() = 0;
    virtual double Length() = 0;
    virtual void printArea() = 0;
    virtual void printLength() = 0;
```

```
    virtual void printInfo(CShape *rhs);
};


void CShape::printInfo(CShape *rhs) {
    // cout << "area: " << (*rhs).Area() << "    length: " << (*rhs).Length() <<
endl;
    cout << "area: " << rhs->Area() << "    length: " << rhs->Length() << endl;
}


/* ============================================== */
/*              DERIVED CLASS - CCircle              */
/* ============================================== */


class CCircle: public CShape {
private:
    double r;
    const double PI = 3.1415926;
public:
    CCircle(double _r): r(_r) {    }
    virtual double Area();
    virtual double Length();
    virtual void printArea();
    virtual void printLength();
};


double CCircle::Area() {
    return PI * r * r;
}


double CCircle::Length() {
```

```cpp
    return 2 * PI * r;
}


void CCircle::printArea() {
    cout << " > Circle Area:     " << Area() << endl;
}


void CCircle::printLength() {
    cout << " > Circle Length: " << Length() << endl;
}


/* =========================================== */
/*            DERIVED CLASS - CSquare           */
/* =========================================== */


class CSquare: public CShape {
private:
    double a;
public:
    CSquare(double _a): a(_a) {    }
    virtual double Area();
    virtual double Length();
    virtual void printArea();
    virtual void printLength();
};


double CSquare::Area() {
    return a * a;
}
```

```cpp
double CSquare::Length() {
    return 4 * a;
}


void CSquare::printArea() {
    cout << " > Square Area:     " << Area() << endl;
}


void CSquare::printLength() {
    cout << " > Square Length: " << Length() << endl;
}


/* =============================================== */
/*           DERIVED CLASS - CRectangle          */
/* =============================================== */

class CRectangle: public CShape {
private:
    double w;
    double h;
public:
    CRectangle(double _w, double _h): w(_w), h(_h) {   }
    virtual double Area();
    virtual double Length();
    virtual void printArea();
    virtual void printLength();
};


double CRectangle::Area() {
    return w * h;
```

```cpp
}

double CRectangle::Length() {
    return 2 * (w + h);
}

void CRectangle::printArea() {
    cout << " > Rectangle Area:     " << Area() << endl;
}

void CRectangle::printLength() {
    cout << " > Rectangle Length: " << Length() << endl;
}

void Show(CShape *rhs) {
    rhs->printInfo(rhs);
}


int main() {

    CShape *pShape = nullptr;

    // 圆
    pShape = new CCircle(123.456);
    Show(pShape);
    // 正方形
    pShape = new CSquare(123.456);
    Show(pShape);
    // 矩形
```

```
    pShape = new CRectangle(123.456, 234.567);
    Show(pShape);


    delete pShape;
    return 0;
}
```

2、 要求正方体、球、圆柱的表面积，可以抽象出一个公共的基类 Container
   为抽象类，在其中定义一个公共的数据成员 radius(此数据可以作为正方
   形的边长、球的半径、圆柱体底面圆半径)，以及求表面积的纯虚函数
   area()。由此抽象类派生出要描述的三个类，利用基类指针和虚函数，分
   别计算三种图形的表面积。

```cpp
#include <iostream>
using namespace std;
const size_t MAX_CONTAINER_SIZE = 100;


/* ============================================== */
/*              BASE CLASS - CContainer           */
/* ============================================== */

class CContainer {
protected:
    double radius;
public:
    CContainer(double r): radius(r) {    }
    // Calculate surface area
    virtual double Area() = 0;
    // print surface area
    virtual void printArea() = 0;
};
```

```
/* ============================================ */
/*          DERIVED CLASS - CCube            */
/* ============================================ */


class CCube: public CContainer {
public:
    CCube(double r): CContainer(r) {    }
    virtual double Area();
    virtual void printArea();
};


double CCube::Area() {
    return 6 * radius * radius;
}


void CCube::printArea() {
    cout << "> Cube surface area is " << Area() << endl;
}


/* ============================================ */
/*          DERIVED CLASS - CBall            */
/* ============================================ */


class CBall: public CContainer {
private:
    const double PI = 3.1415926;
public:
    CBall(double r): CContainer(r) {    }
    virtual double Area();
```

```cpp
    virtual void printArea();
};


double CBall::Area() {
    return 4 * PI * radius * radius;
}


void CBall::printArea() {
    cout << "> Ball surface area is " << Area() << endl;
}


/* ============================================= */
/*            DERIVED CLASS - CCylinder          */
/* ============================================= */

class CCylinder: public CContainer {
private:
    const double PI = 3.1415926;
    double height;
public:
    CCylinder(double r, double h): CContainer(r), height(h) {    }
    virtual double Area();
    virtual void printArea();
};


double CCylinder::Area() {
    return (2 * PI * radius *radius) + (height * 2 * PI * radius);
}


void CCylinder::printArea() {
```

```
        cout << "> Cylinder surface area is " << Area() << endl;
}

// CContainer *pContainers[MAX_CONTAINER_SIZE];

void Show(CContainer *rhs) {
        rhs->printArea();
}

int main() {

        CContainer *p = nullptr;

        // 立方体
        p = new CCube(123.456);
        Show(p);
        // 球体
        p = new CBall(123.456);
        Show(p);
        // 圆柱体
        p = new CCylinder(123.456, 78.90);
        Show(p);

        delete p;
        return 0;
}
```

[实验总结]给出对本次实验的总结。

1、通过上机实验，进一步加深了对多态性概念的理解；
2、掌握了虚函数的用途及使用方法；
3、了解纯虚函数和抽象类的概念和用法。