Inheritance in C++

Fundamental Computer Programming- C++ Lab (II)

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Outline

- Introduction
- Base and Derived Classes
- Access Control and Interitance
- Type of Inheritance
- Multiple Inheritance
- Exercises

Introduction

- One of the most important concepts in object-oriented programming.
- Allows us to define a class in terms of another class.
- Makes it easier to create and maintain an application.
- Provides an opportunity to reuse the code functionality and fast implementation time.

Introduction

- When creating a class, instead of writing completely new data members and member functions, the programmer can designate that the new class should inherit the members of an existing class.
- This existing class is called the **base** class, and the new class is referred to as the **derived** class.
- The idea of inheritance implements the **is a relationship**.

Base and Derived Classes

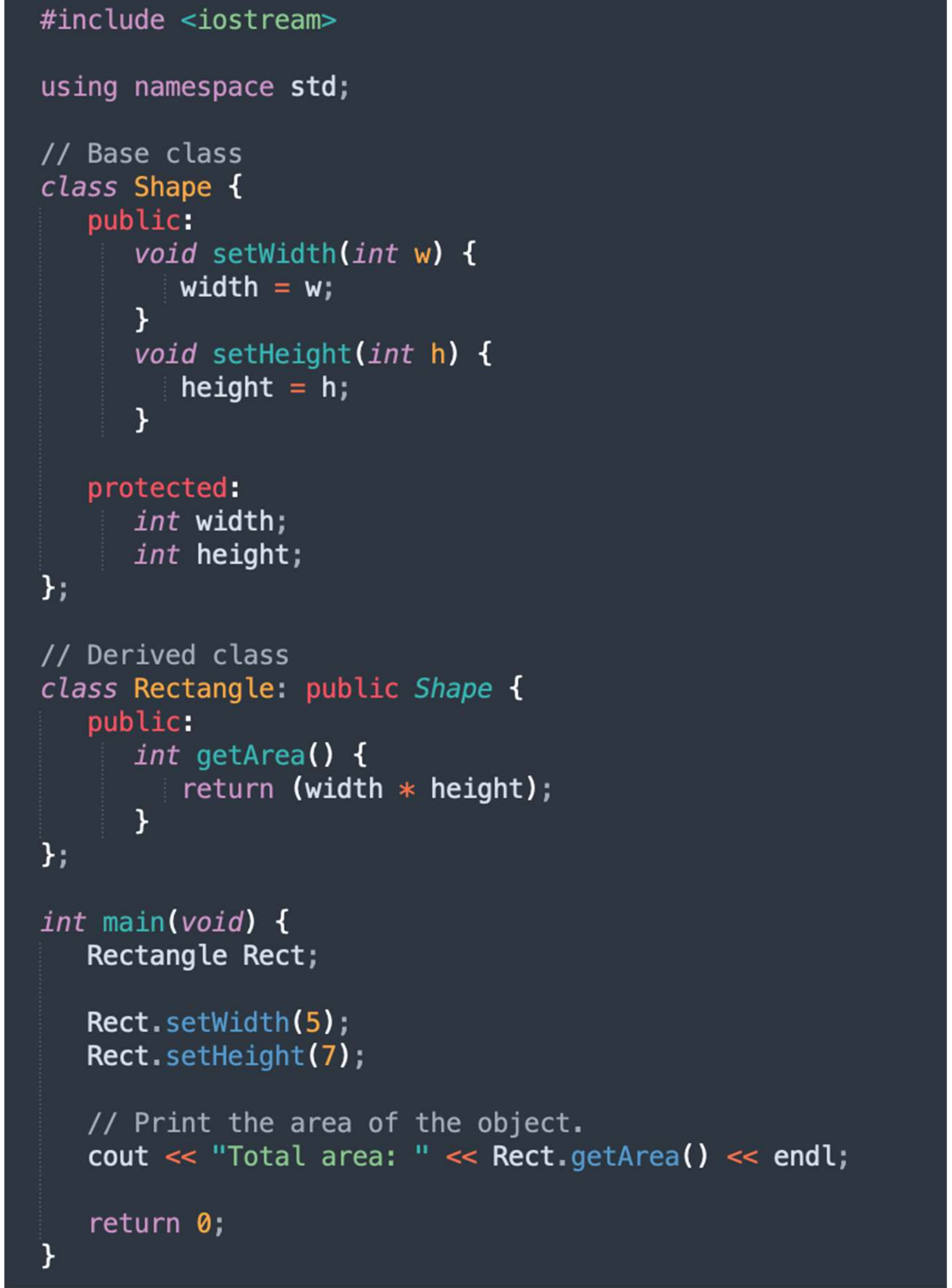
- A class can be derived from more than one classes
- It means it can inherit data and functions from multiple base classes.
- To define a derived class, we use a class derivation list to specify the base class(es).
- A class derivation list names one or more base classes and has the form.

```
class derived-class: access-specifier base-class
```

Example

Base class

Derived class



```cpp
#include <iostream>

using namespace std;

// Base class
class Shape {
   public:
      void setWidth(int w) {
         width = w;
      }
      void setHeight(int h) {
         height = h;
      }

   protected:
      int width;
      int height;
};

// Derived class
class Rectangle: public Shape {
   public:
      int getArea() {
         return (width * height);
      }
};

int main(void) {
   Rectangle Rect;

   Rect.setWidth(5);
   Rect.setHeight(7);

   // Print the area of the object.
   cout << "Total area: " << Rect.getArea() << endl;

   return 0;
}
```

OUTPUT

```
Total area: 35
```

Access Control and Inheritance

- A derived class can access all the non-private members of its base class.
- Summarize the different access types

Access	public	protected	private
Same class	yes	yes	yes
Derived classes	yes	yes	no
Outside classes	yes	no	no

Access Control and Inheritance

- A derived class inherits all base class methods with the following **exceptions:**
  - Constructors, destructors and copy constructors of the base class.
  - Overloaded operators of the base class.
  - The friend functions of the base class.

Type of Inheritance

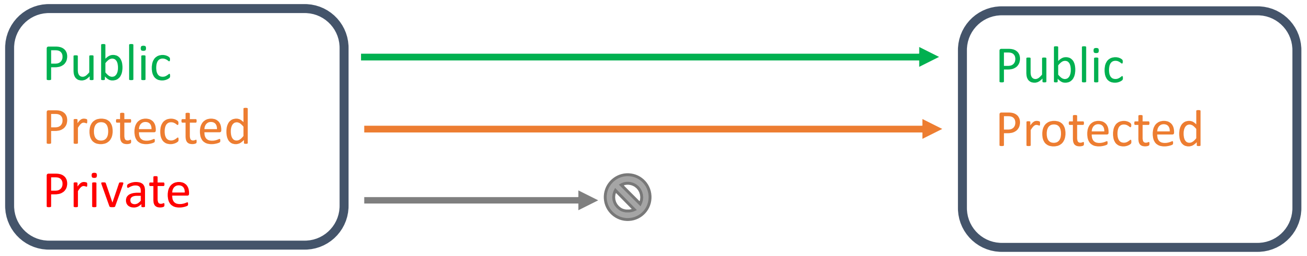
- When deriving a class from a base class, the base class may be inherited through public, protected or private inheritance.

```
class derived-class: access-specifier base-class
```

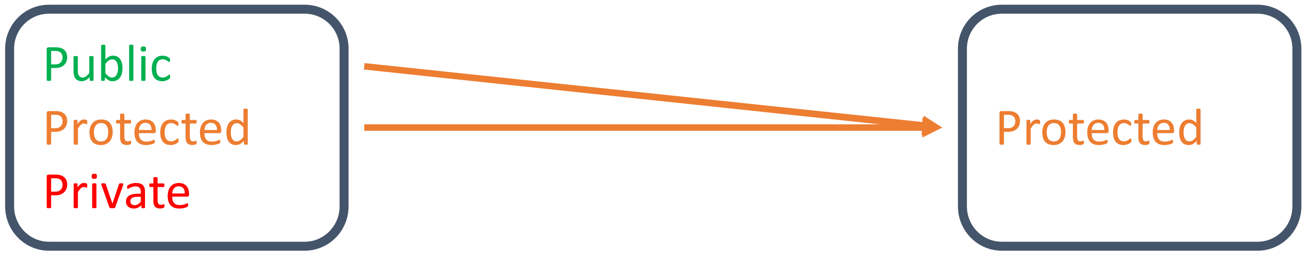
- We hardly use protected or private inheritance, but public inheritance is commonly used

Type of Inheritance

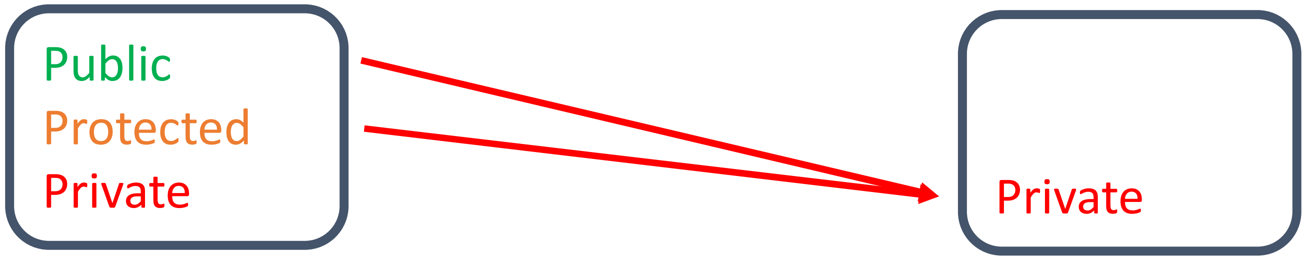
Public Inheritance



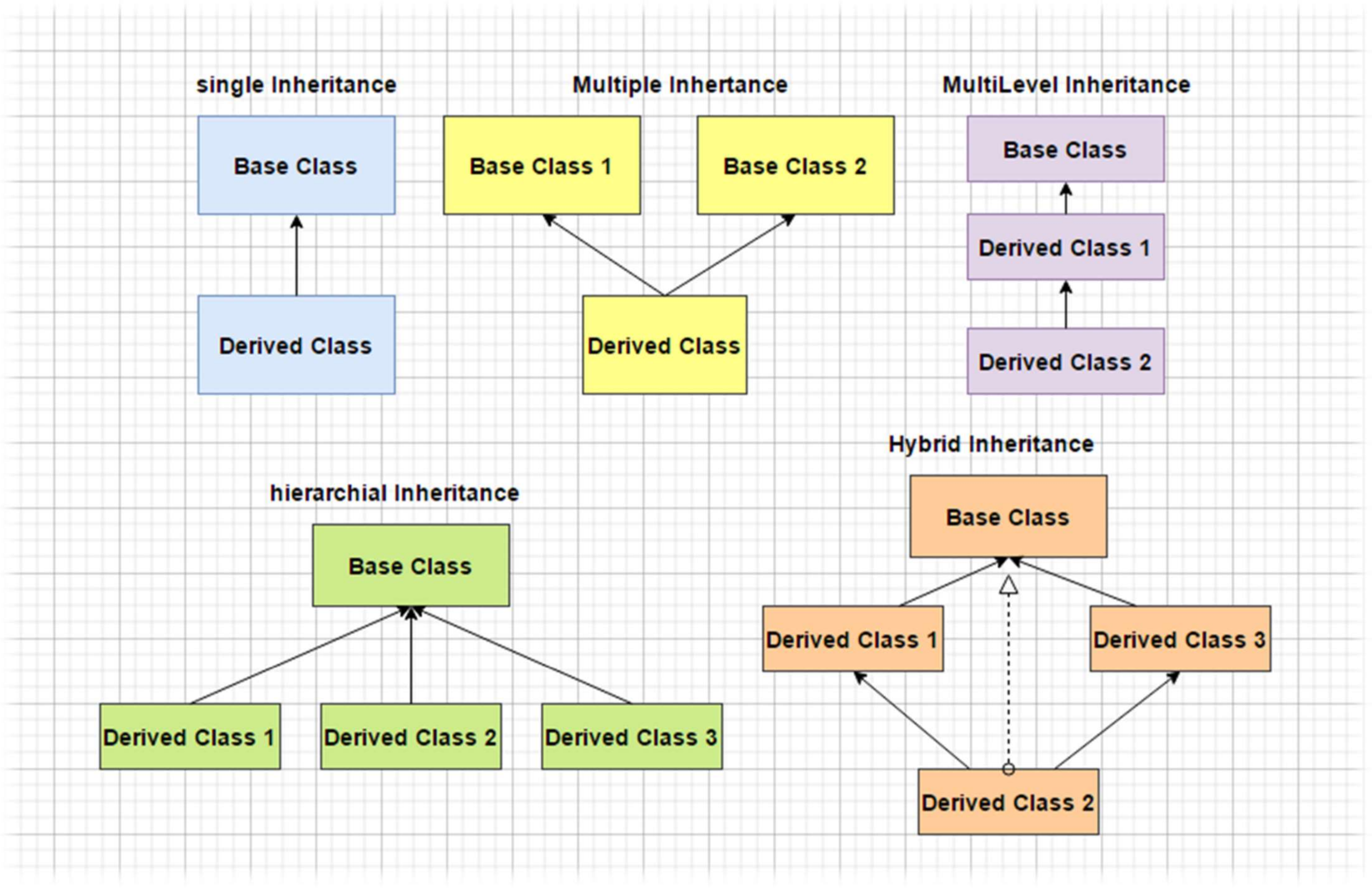
Protected Inheritance



Private Inheritance



Type of Inheritance



Multiple Inheritance

- A C++ class can inherit members from more than one class and here is the extended syntax

```
class derived-class: access base-A, access base-B …
```

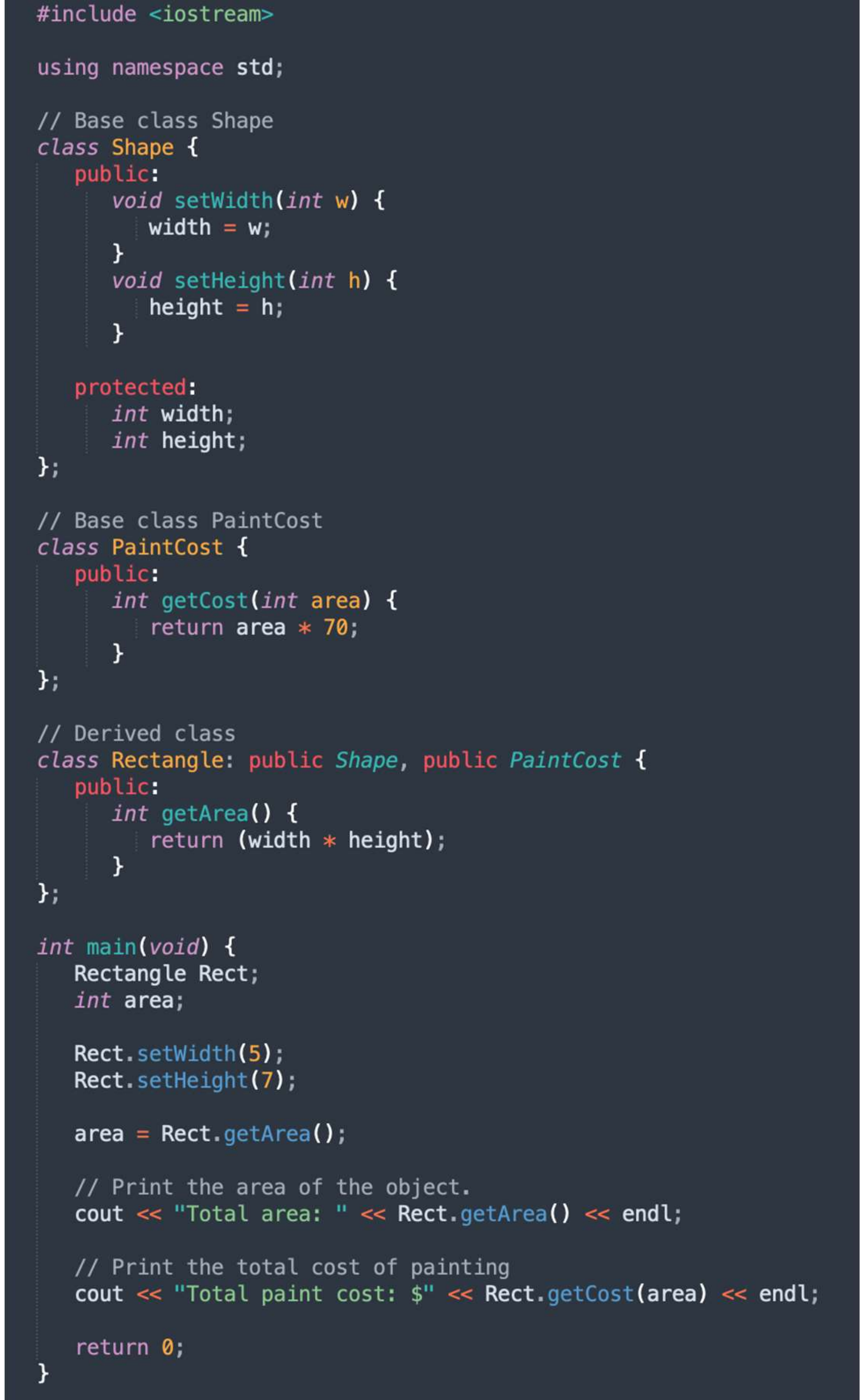
- Where access is one of public, protected, or private and would be given for every base class and they will be separated by comma as shown above.

Example

Base class
Shape

Base class
PaintCost

Derived class

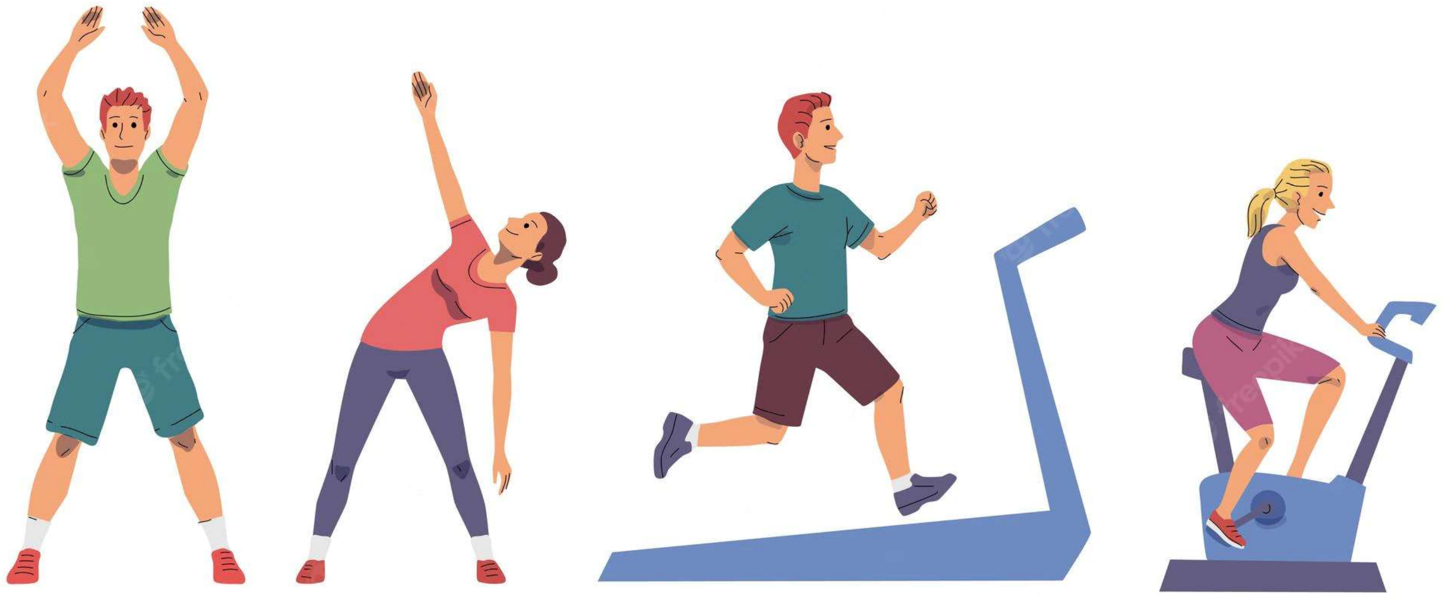


```cpp
#include <iostream>

using namespace std;

// Base class Shape
class Shape {
   public:
      void setWidth(int w) {
         width = w;
      }
      void setHeight(int h) {
         height = h;
      }

   protected:
      int width;
      int height;
};

// Base class PaintCost
class PaintCost {
   public:
      int getCost(int area) {
         return area * 70;
      }
};

// Derived class
class Rectangle: public Shape, public PaintCost {
   public:
      int getArea() {
         return (width * height);
      }
};

int main(void) {
   Rectangle Rect;
   int area;

   Rect.setWidth(5);
   Rect.setHeight(7);

   area = Rect.getArea();

   // Print the area of the object.
   cout << "Total area: " << Rect.getArea() << endl;

   // Print the total cost of painting
   cout << "Total paint cost: $" << Rect.getCost(area) << endl;

   return 0;
}
```

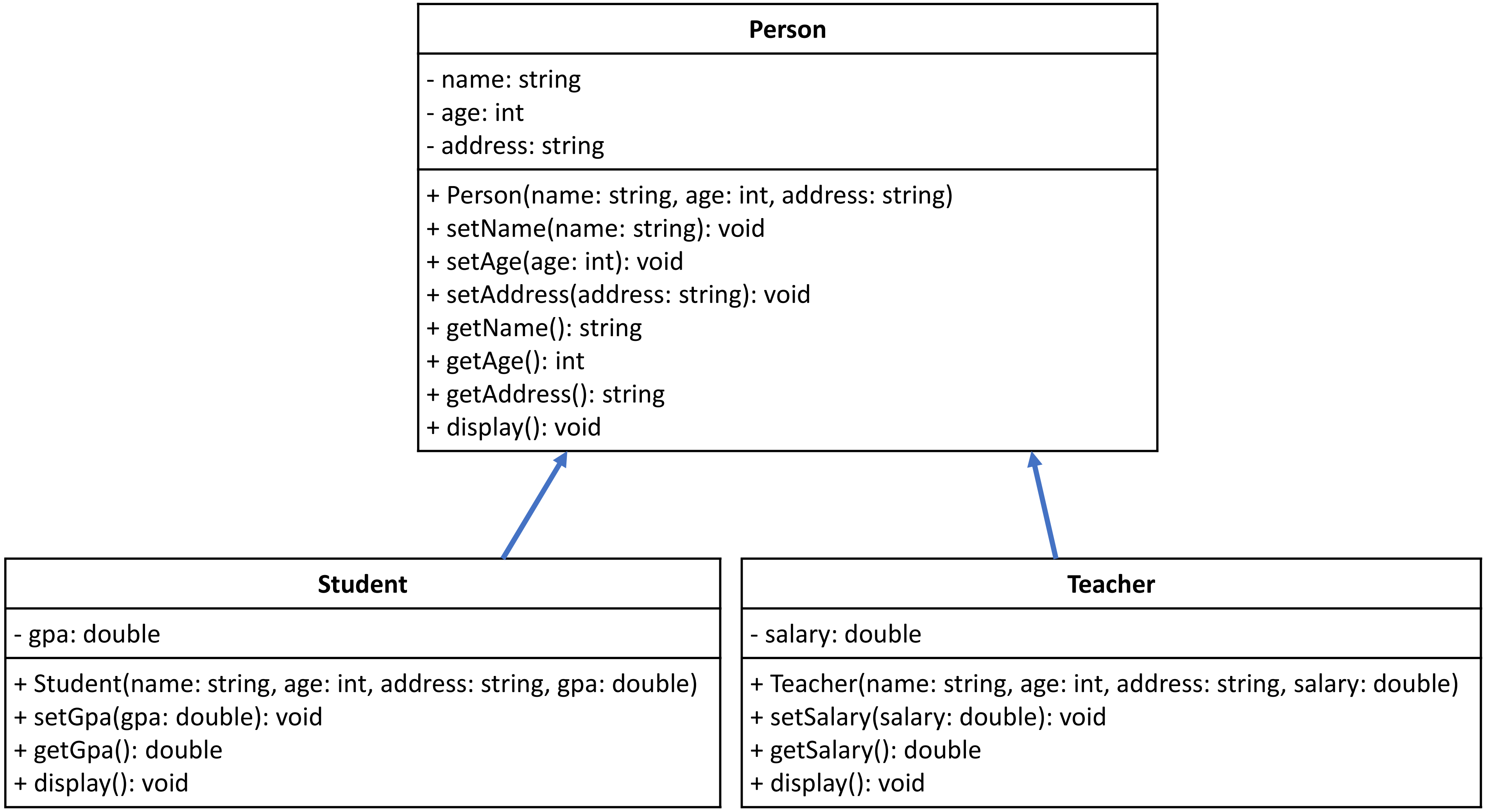
OUTPUT

```
Total area: 35
Total paint cost: $2450
```

Exercises



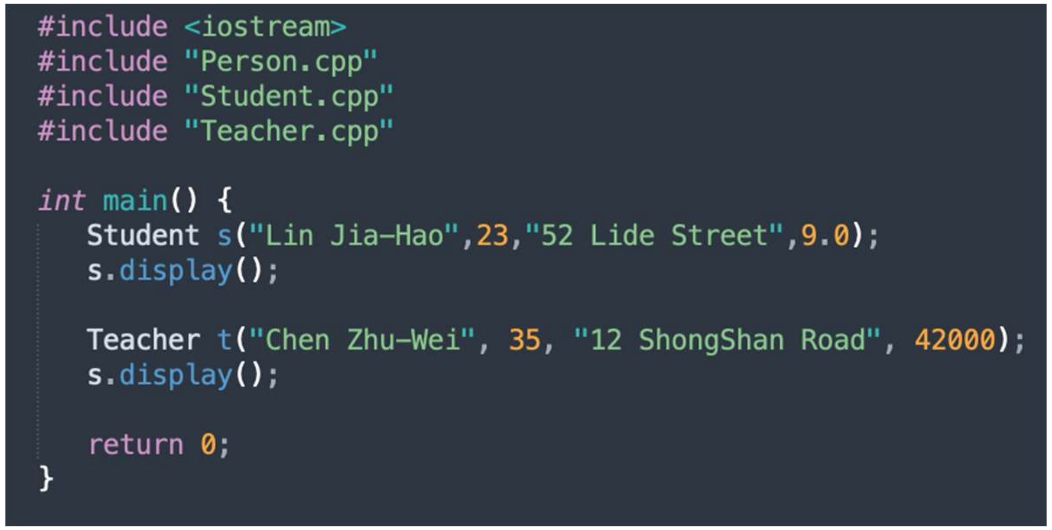
Exercise 1



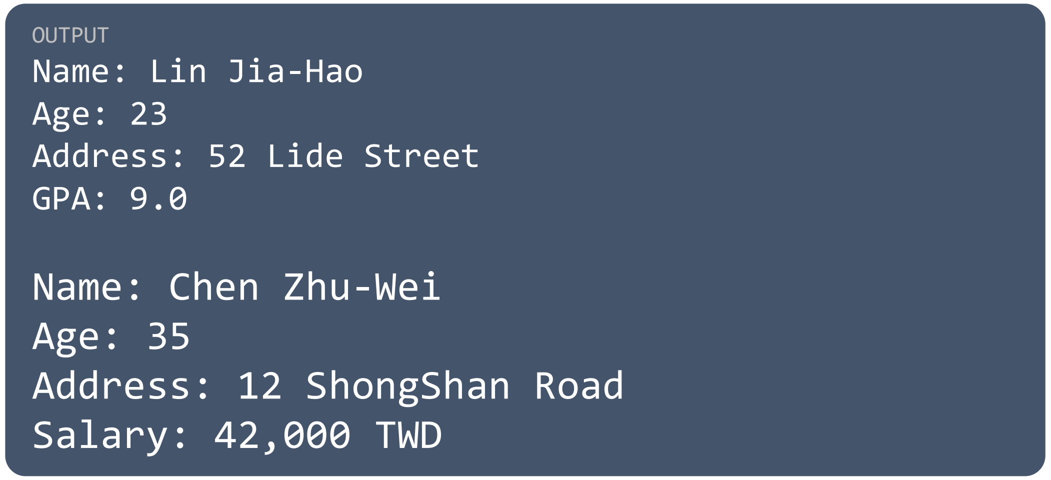
Person
- name: string
- age: int
- address: string
+ Person(name: string, age: int, address: string)
+ setName(name: string): void
+ setAge(age: int): void
+ setAddress(address: string): void
+ getName(): string
+ getAge(): int
+ getAddress(): string
+ display(): void
Student
- gpa: double
+ Student(name: string, age: int, address: string, gpa: double)
+ setGpa(gpa: double): void
+ getGpa(): double
+ display(): void
Teacher
- salary: double
+ Teacher(name: string, age: int, address: string, salary: double)
+ setSalary(salary: double): void
+ getSalary(): double
+ display(): void

Exercise 1

Suggested main funtion:

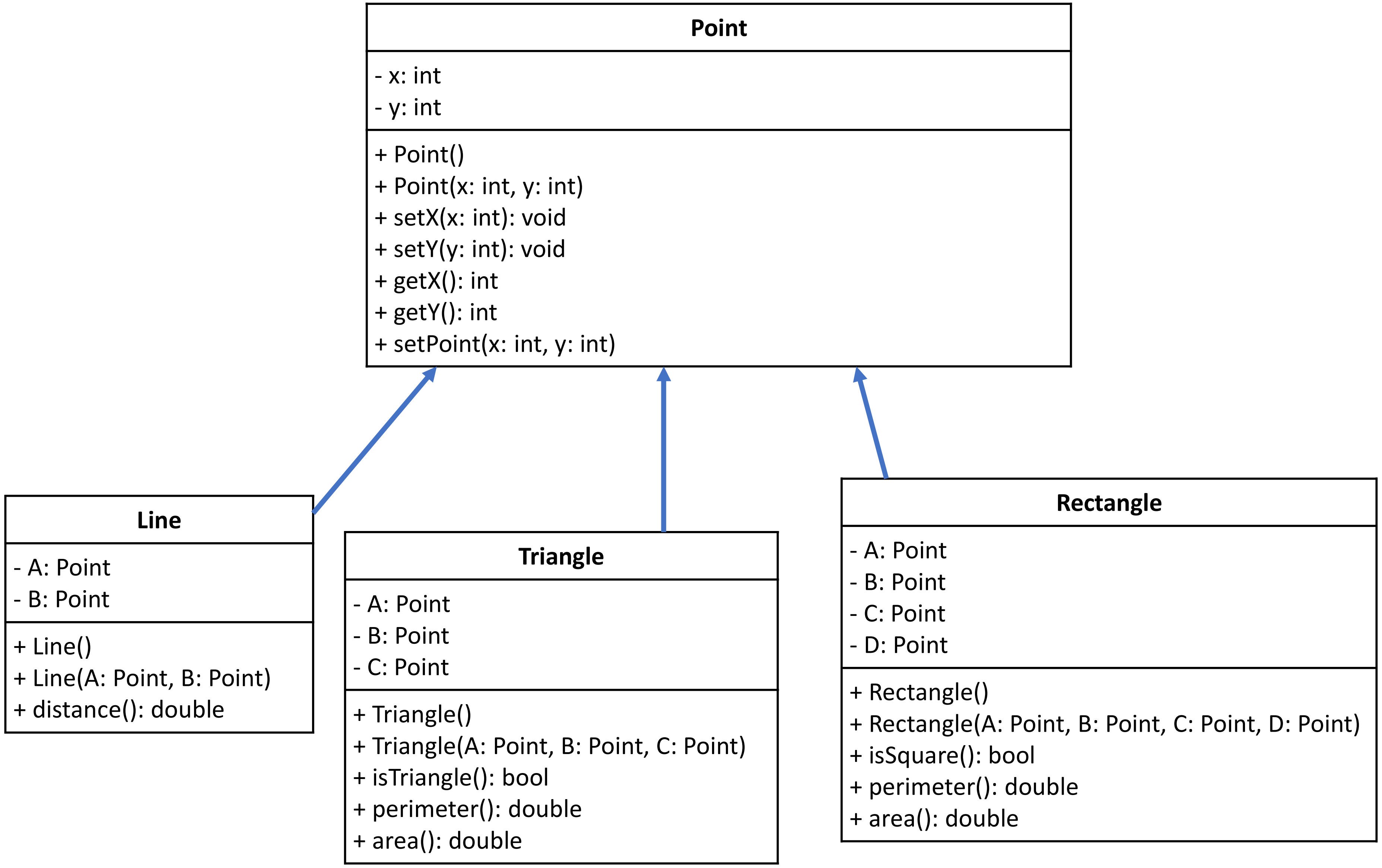


```cpp
#include <iostream>
#include "Person.cpp"
#include "Student.cpp"
#include "Teacher.cpp"

int main() {
   Student s("Lin Jia-Hao",23,"52 Lide Street",9.0);
   s.display();

   Teacher t("Chen Zhu-Wei", 35, "12 ShongShan Road", 42000);
   s.display();

   return 0;
}
```



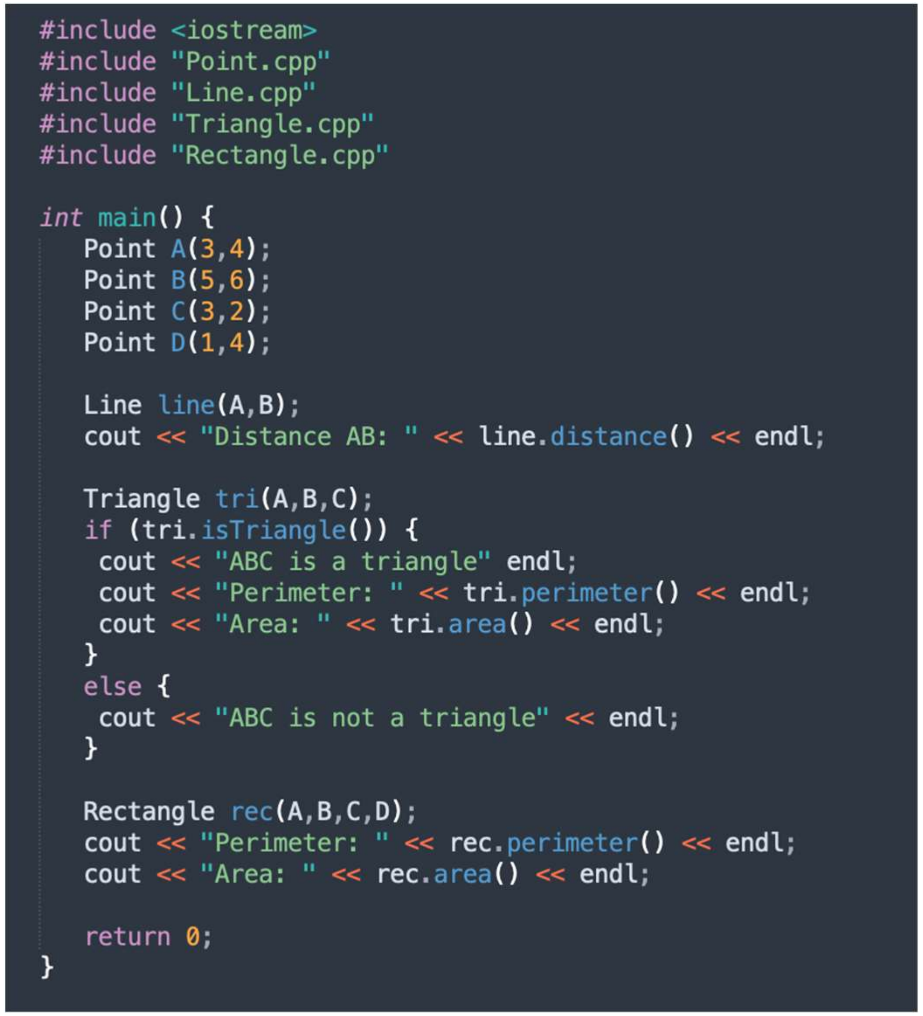
```
OUTPUT
Name: Lin Jia-Hao
Age: 23
Address: 52 Lide Street
GPA: 9.0

Name: Chen Zhu-Wei
Age: 35
Address: 12 ShongShan Road
Salary: 42,000 TWD
```

Exercise 2


Point
- x: int
- y: int
+ Point()
+ Point(x: int, y: int)
+ setX(x: int): void
+ setY(y: int): void
+ getX(): int
+ getY(): int
+ setPoint(x: int, y: int)
Line
- A: Point
- B: Point
+ Line()
+ Line(A: Point, B: Point)
+ distance(): double
Triangle
- A: Point
- B: Point
- C: Point
+ Triangle()
+ Triangle(A: Point, B: Point, C: Point)
+ isTriangle(): bool
+ perimeter(): double
+ area(): double
Rectangle
- A: Point
- B: Point
- C: Point
- D: Point
+ Rectangle()
+ Rectangle(A: Point, B: Point, C: Point, D: Point)
+ isSquare(): bool
+ perimeter(): double
+ area(): double

Exercise 2

Suggested main funtion:



```
#include <iostream>
#include "Point.cpp"
#include "Line.cpp"
#include "Triangle.cpp"
#include "Rectangle.cpp"

int main() {
    Point A(3,4);
    Point B(5,6);
    Point C(3,2);
    Point D(1,4);

    Line line(A,B);
    cout << "Distance AB: " << line.distance() << endl;

    Triangle tri(A,B,C);
    if (tri.isTriangle()) {
     cout << "ABC is a triangle" endl;
     cout << "Perimeter: " << tri.perimeter() << endl;
     cout << "Area: " << tri.area() << endl;
    }
    else {
     cout << "ABC is not a triangle" << endl;
    }

    Rectangle rec(A,B,C,D);
    cout << "Perimeter: " << rec.perimeter() << endl;
    cout << "Area: " << rec.area() << endl;

    return 0;
}
```

Finding perimeter and area formulas by yourself!!

Questions & Answers