Inheritance

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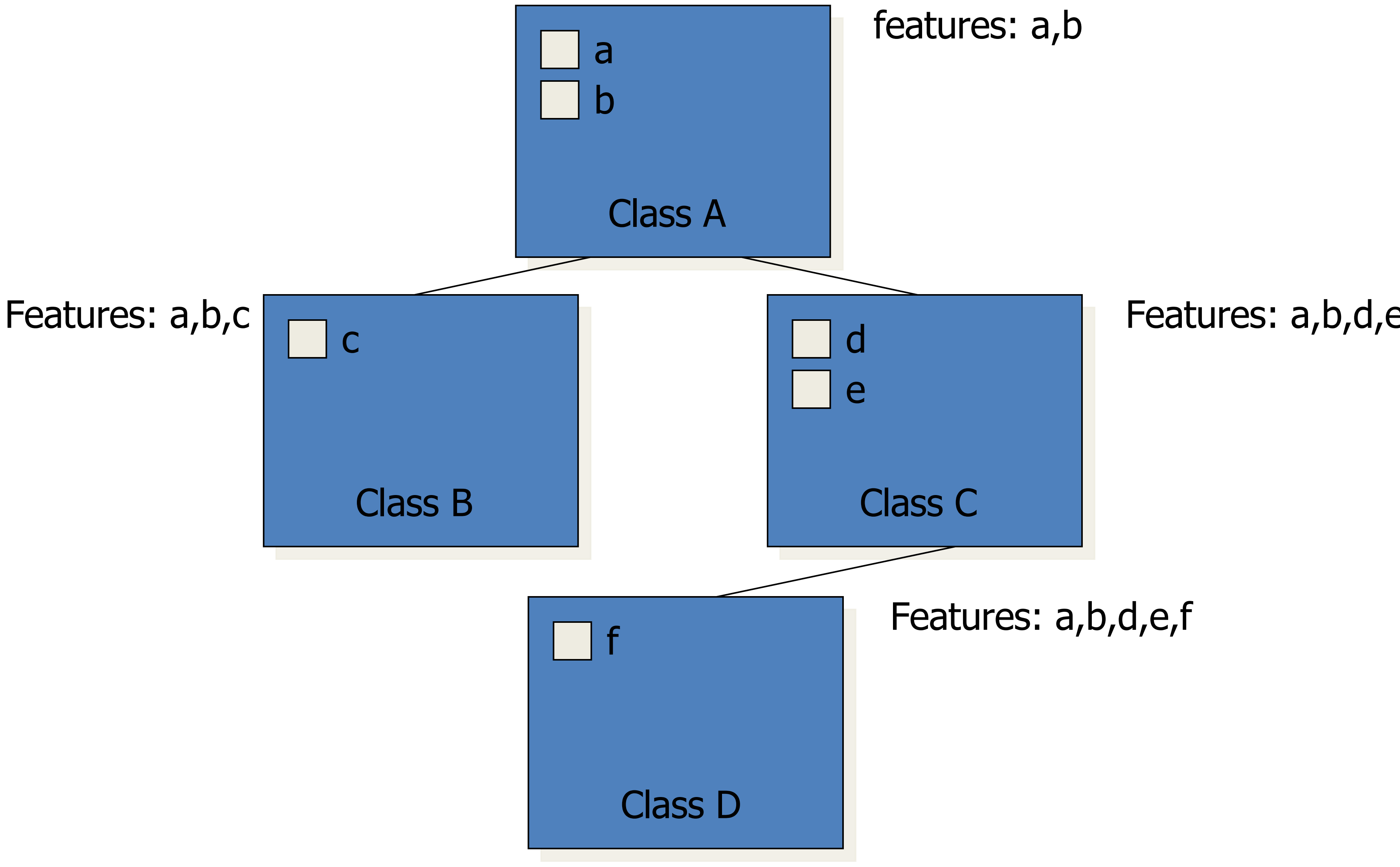
Introduction to Inheritance

- Inheritance is a relationship between two or more classes where derived class inherites behaviour and attributes of pre-existing (base) classes
- Intended to help **reuse** of existing code with little or no modification

Inheritance

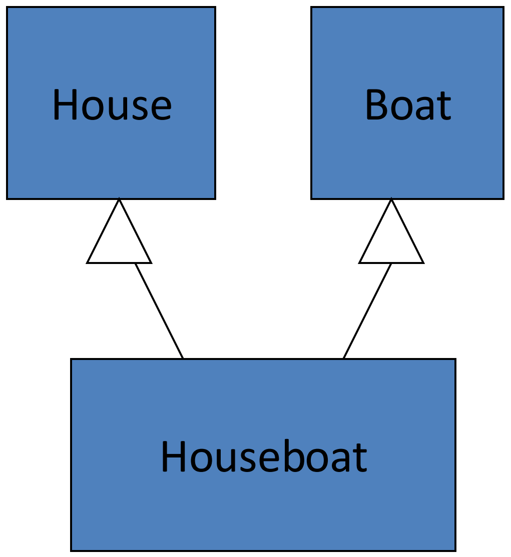
- Inheritance can be continous
  - Derived class can inherit another class, which inherits another class and so on
  - When changing the base class all the derived classes changes also
- Example:
  - Mammal <– Human <– Worker <- Programmer
- Could mammal be a derived class? If so, what would be the base class?

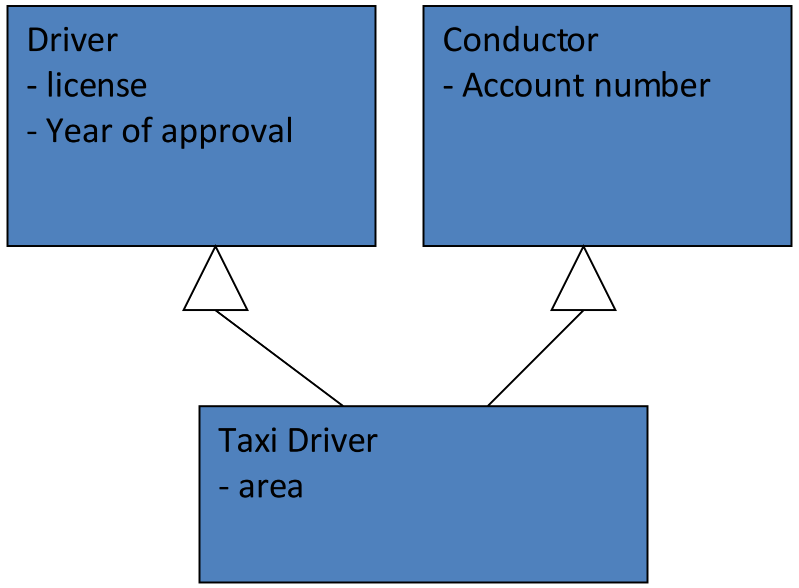
Picture about Inheritance



Multiple Inheritance

- In multiple inheritance a derived class has multiple base classes
- C++ supports multiple base classes, Java don't



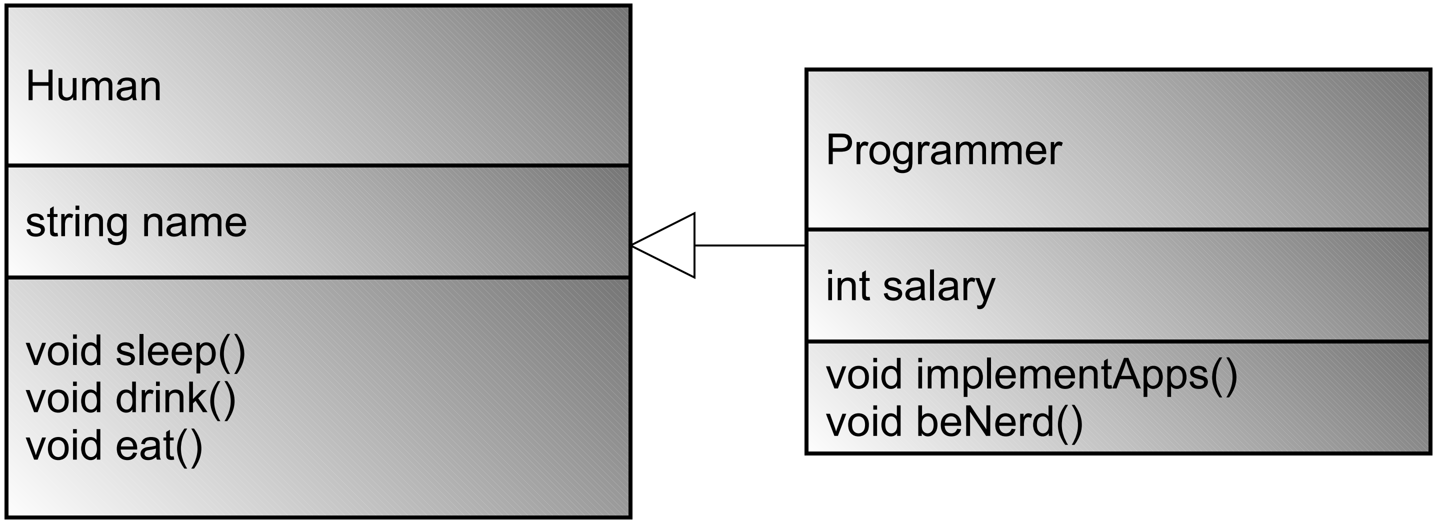


Inheritance and Capsulation

- private
  - Is **accessible** only via the base class
- public
  - Is accessible everywhere (base class, derived class, othe classes)
- protected
  - Is accessible by the base class and derived classes

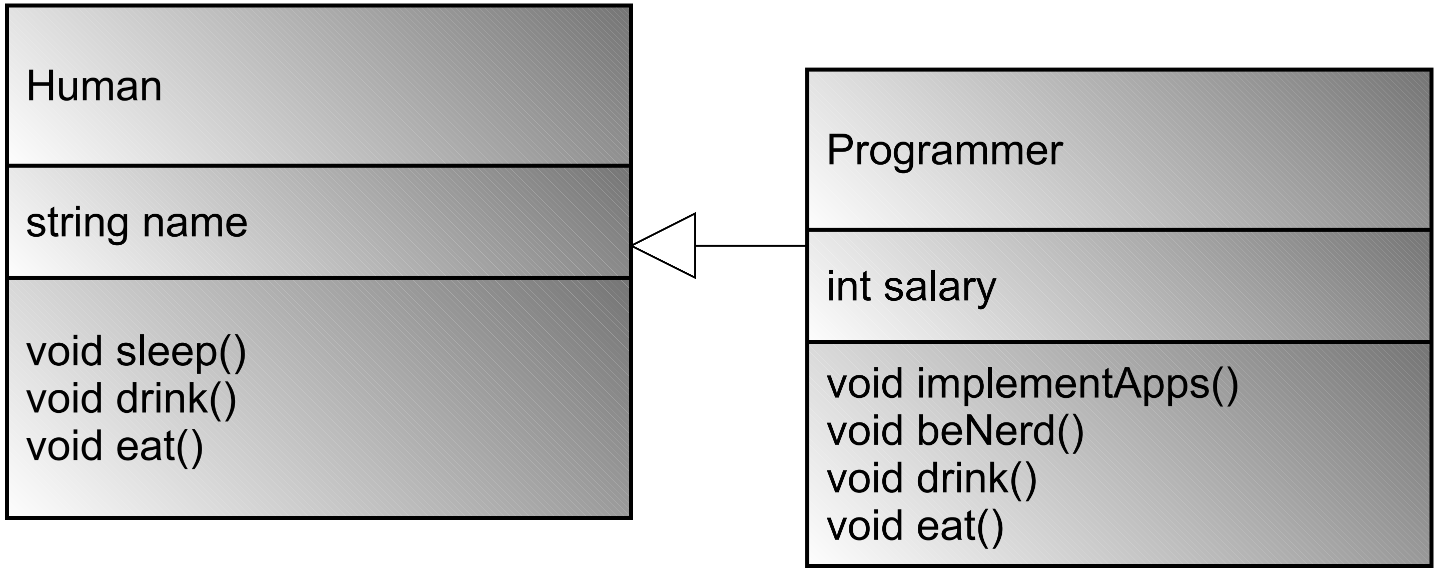
Basic example

- What are Programmer's attributes and methods?



Overriding?

- What about now?



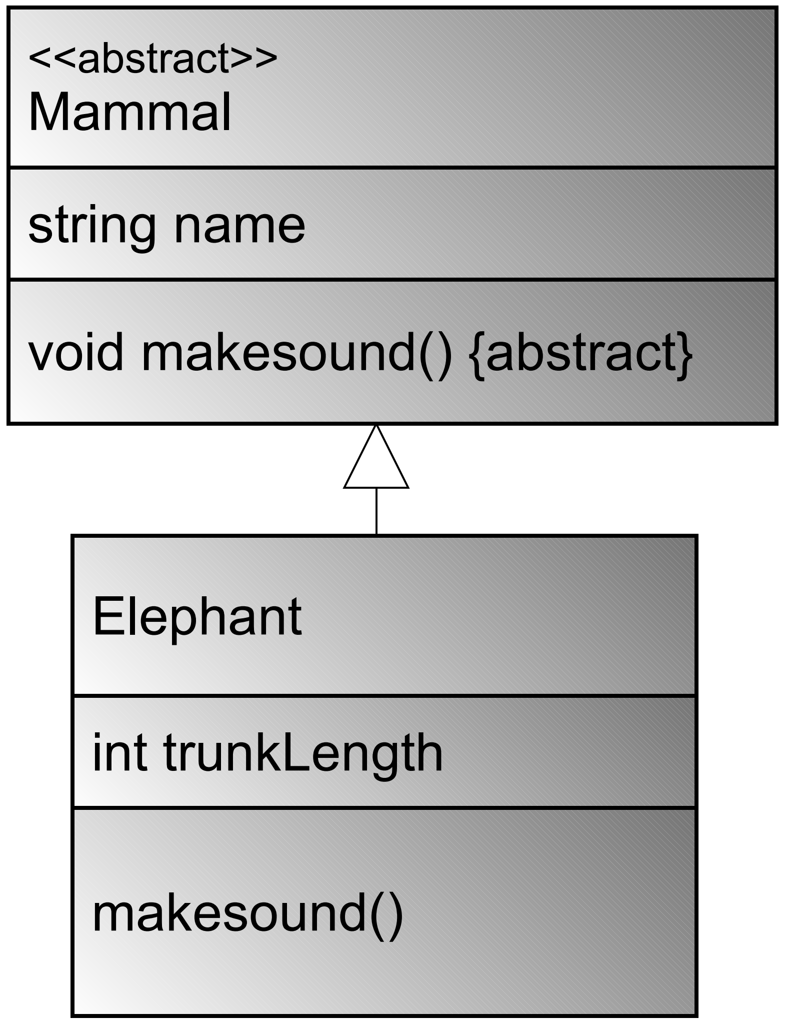
Overriding

- Since programmer eats and drinks differently than humans (only Coke and Pizza) the eat and drink methods are overriden in Programmer!

Abstract Class

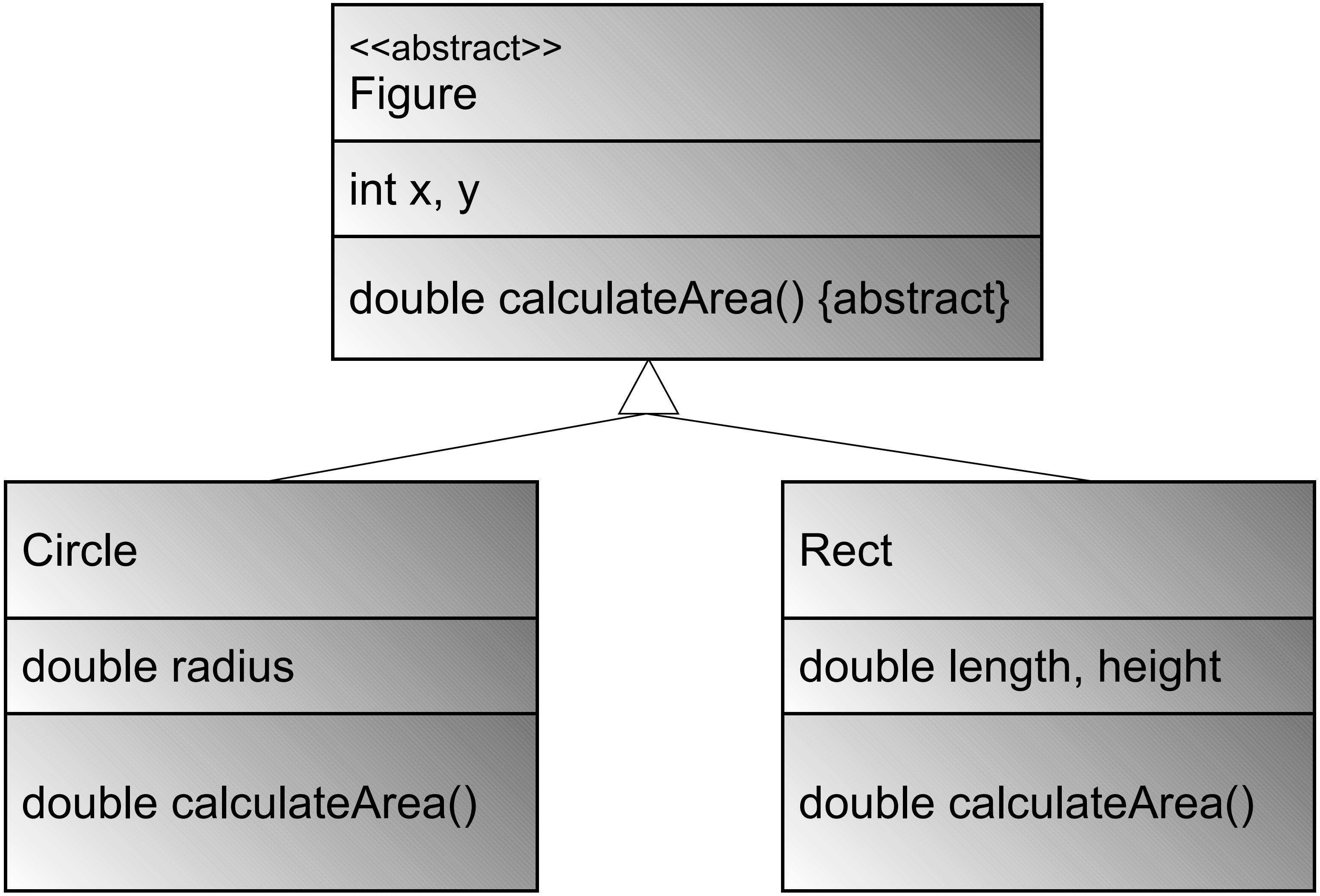
- Abstract class is a class which you cannot instantiate (create objects)
- You can inherit abstract class and create objects from the inherited class, if it is concrete one
- Abstract class in C++ has abstract methods, that do not have implementations
- These methods forces derived classes to implement those methods

Example



<<abstract>>
Mammal
string name
void makesound() {abstract}
Elephant
int trunkLength
makesound()

Example



<<abstract>>
Figure
int x, y
double calculateArea() {abstract}
Circle
double radius
double calculateArea()
Rect
double length, height
double calculateArea()

Exercises

INHERITANCE IN C++

Declaring Inheritance

```
class Circle : public Figure
{

}
```

Declaring Inheritance

```
class Figure
{
    public:
        int x, y;
};

class Circle : public Figure
{
    public:
        int radius;
};

int main()
{
    Circle a;
    a.x = 0;
    a.y = 0;
    a.radius = 10;
}
```

Encapsulation

```
class Figure
{
    protected:
        int x, y;
};

class Circle : public Figure
{
    public:
        int radius;
};

int main()
{
    Circle a;
    a.x = 0;
    a.y = 0;
    a.radius = 10;
}
```

```
example.cpp: In function ‘int main()’:
example.cpp:5: error: ‘int Figure::x’ is protected
example.cpp:17: error: within this context
example.cpp:5: error: ‘int Figure::y’ is protected
example.cpp:18: error: within this context
```

Encapsulation

```
class Figure
{
    protected:
        int x_, y_;
};

class Circle : public Figure
{
    private:
        int radius_;
    public:
        Circle(int x, int y, int
   radius);
};
```

```
Circle::Circle(int x, int y, int
   radius)
{
    x_ = x;
    y_ = y;
    radius_ = radius;
}

int main()
{
    Circle a(0,0,10);
}
```

Encapsulation

```
class Figure
{
    private:
        int x_, y_;
};

class Circle : public Figure
{
    private:
        int radius_;
    public:
        Circle(int x, int y, int
   radius);
};
```

```
Circle::Circle(int x, int y, int
   radius)
{
    x_ = x;
    y_ = y;
    radius_ = radius;
}

int main()
{
    Circle a(0,0,10);
}
```

```
example.cpp: In constructor ‘Circle::Circle(int, int, int)’:
example.cpp:5: error: ‘int Figure::x_’ is private
example.cpp:18: error: within this context
example.cpp:5: error: ‘int Figure::y_’ is private
example.cpp:19: error: within this context
```

Encapsulation

```
class Figure
{
    private:
        int x_, y_;
    public:
        void SetX(int x);
        void SetY(int y);
};
void Figure::SetX(int x)
{
    x_ = x;
}
void Figure::SetY(int y)
{
    y_ = y;
}
```

```
class Circle : public Figure
{
    private:
        int radius_;
    public:
        Circle(int x, int y, int
   radius);
};
Circle::Circle(int x, int y, int
   radius)
{
    SetX(x);
    SetY(y);
    this->radius_ = radius;
}
int main()
{
    Circle a(0,0,10);
}
```

What is the result?

```
class Figure
{
    public:
        Figure() {
            cout << "Figure
   Constructor\n";
        }
        ~Figure() {
            cout << "Figure
   Destructor\n";
        }
};
```

```
class Circle : public Figure
{
    public:
        Circle() {
            cout << "Circle
   Constructor\n";
        }
        ~Circle() {
            cout << "Circle
   Destructor\n";
        }
};

int main()
{
    Circle a;
}
```

Inheritance and Constructors

- When creating a object from derived class, also the member values of the base class must be initialized
- Base constructor is called before the derived classes constructor
- Destructors vice versa.

Calling the Base Classes constructor

```
class Figure
{
    public:
        Figure() {
            cout << "Figure
   Constructor\n";
        }
        ~Figure() {
            cout << "Figure
   Destructor\n";
        }
};
```

```
class Circle : public Figure
{
    public:
        Circle() : Figure() {
            cout << "Circle
   Constructor\n";
        }
        ~Circle() {
            cout << "Circle
   Destructor\n";
        }
};

int main()
{
    Circle a;
}
```

Calling the Base Classes constructor

```
class Figure
{
    private:
        int x_, y_;
    public:
        Figure(int x, int y) : x_(x), y_(y) {
            cout << "Figure Constructor\n";
        }
        ~Figure() {
            cout << "Figure Destructor\n";
        }
};
```

Calling the Base Classes constructor

```
class Circle : public Figure
{
    private:
        double radius_;
    public:
        Circle(int x, int y, int radius) : Figure(x, y),
                                            radius_(radius)
        {
            cout << "Circle Constructor\n";
        }
        ~Circle() {
            cout << "Circle Destructor\n";
        }
};

int main()
{
    Circle a(0,0,5);
}
```

Abstract Class

- In C++, Abstract class is a class that has one abstract method
- Abstract method is a method without implementation.
- Abstract method is created by reserverd word "virtual"

Example of Abstract class

```
class Figure
{
    private:
        int x_, y_;
    public:
        Figure(int x, int y) : x_(x), y_(y) {
            cout << "Figure Constructor\n";
        }
        ~Figure() {
            cout << "Figure Destructor\n";
        }

        virtual double calculateArea() = 0;
};
```

Example of Abstract class

```
class Circle : public Figure
{
    private:
        double radius_;
    public:
        Circle(int x, int y, int radius) : Figure(x, y),
                                           radius_(radius)
        {
            cout << "Circle Constructor\n";
        }
        ~Circle() {
            cout << "Circle Destructor\n";
        }
        double calculateArea() {
            return 3.14 * radius_ * radius_;
        }
};
```

Example of Abstract class

```
int main()
{
    Circle a(0,0,5);
    cout << a.calculateArea() << endl;

    // This Does not work, since figure is abstract:
    // Figure f(0,0);
}
```