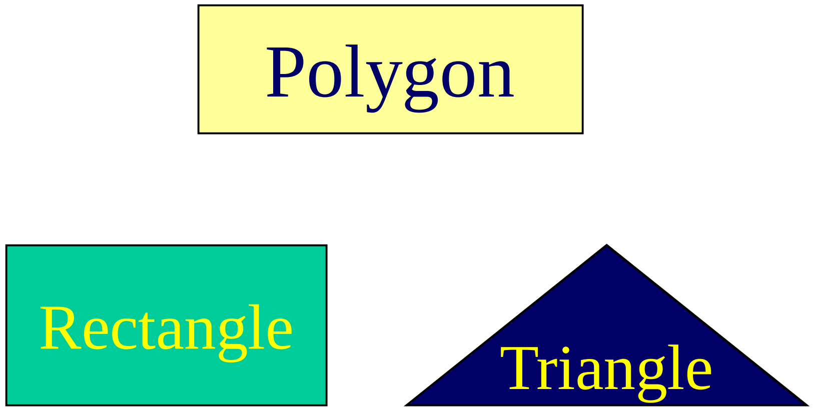
OBJECT ORIENTED PROGRAMMING USING C++

Inheritance Concept



```
class Rectangle{
   private:
     int numVertices;
     float *xCoord, *yCoord;
   public:
     void set(float *x, float *y, int nV);
     float area();
};
```

```
class Polygon{
  private:
    int numVertices;
    float *xCoord, *yCoord;
  public:
    void set(float *x, float *y, int nV);
};
```

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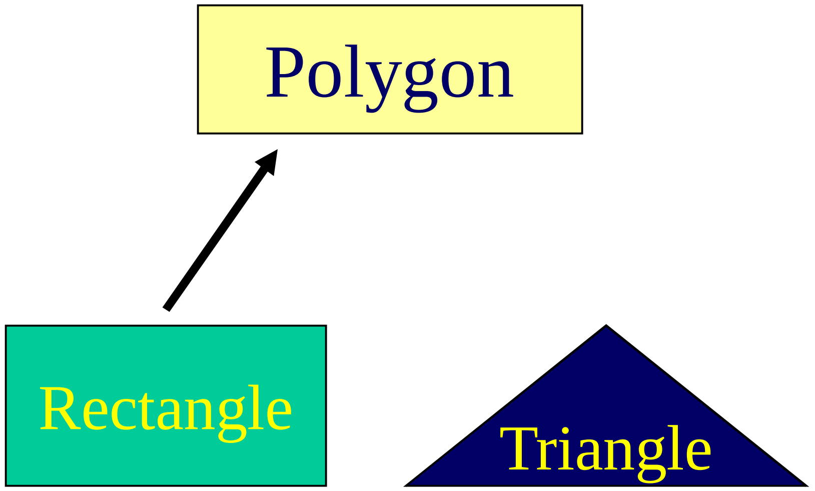
Inheritance Concept



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    protected:
      int numVertices;
      float *xCoord, float *yCoord;
    public:
       void set(float *x, float *y, int nV);
};
```

```
class Rectangle : public Polygon{
    public:
       float area();
};
```

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class Rectangle{
    protected:
      int numVertices;
      float *xCoord, float *yCoord;
    public:
       void set(float *x, float *y, int nV);
       float area();
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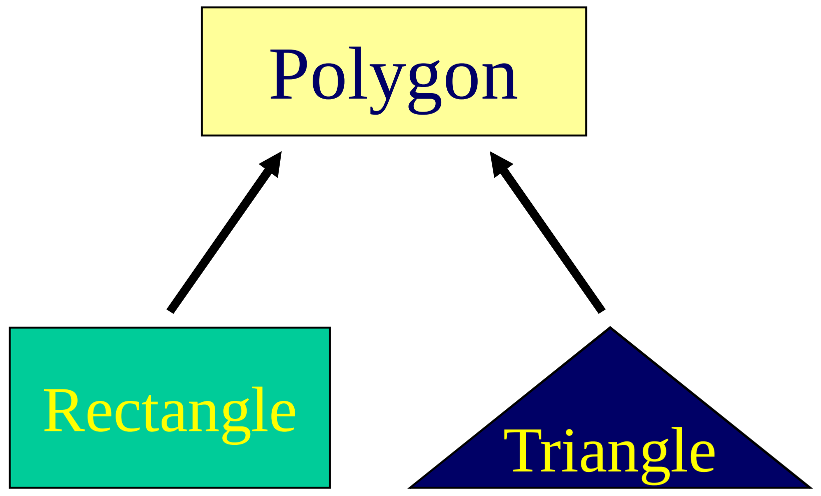
Inheritance Concept



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      protected:
        int numVertices;
        float *xCoord, float *yCoord;
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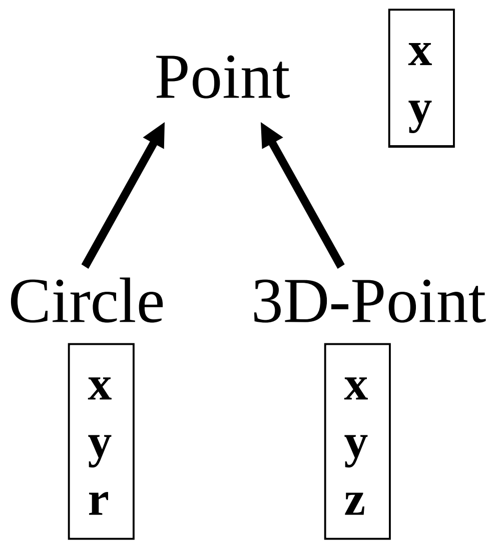
Inheritance Concept



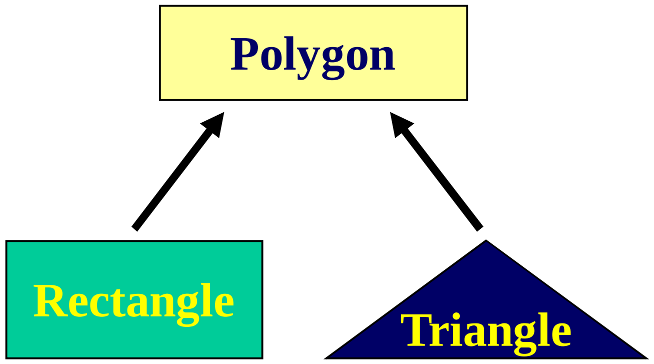
```
class Point{
    protected:
      int x, y;
    public:
      void set (int a, int b);
};
```

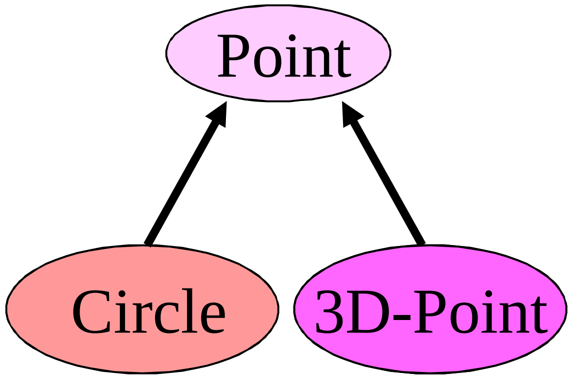
```
class Circle : public Point{
    private:
          double r;
};
```

```
class 3D-Point: public Point{
    private:
          int z;
};
```

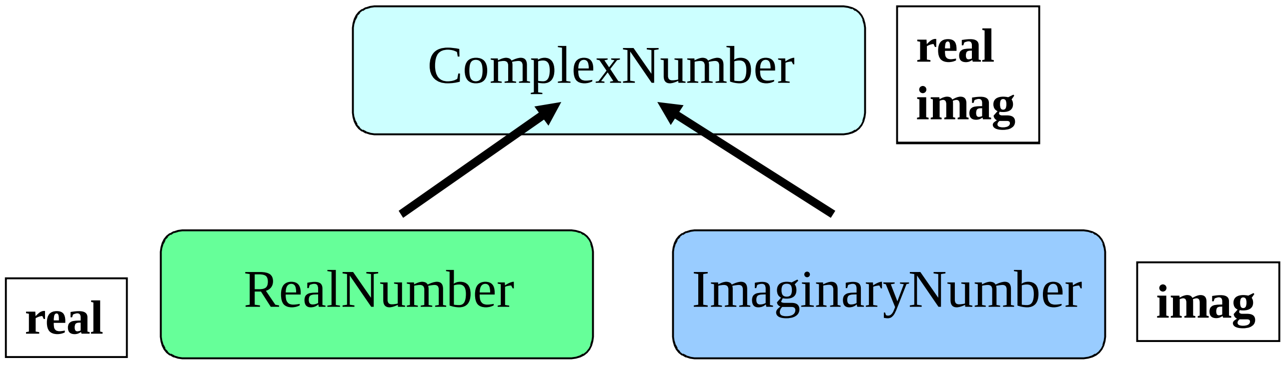
Inheritance Concept

- Augmenting the original class





- Specializing the original class



Why Inheritance ?

Inheritance is a mechanism for

- building class types from existing class types
- defining new class types to be a
  - specialization
  - augmentation

  of existing types

Define a Class Hierarchy

- Syntax:

class *DerivedClassName* : access-level *BaseClassName*

where

– access-level specifies the type of derivation
  - private by default, or
  - public

- Any class can serve as a base class
  – Thus a derived class can also be a base class

Class Derivation

$$\begin{tikzcd}
\text{Point} \\
\text{3D-Point} \arrow[u] \\
\text{Sphere} \arrow[u]
\end{tikzcd}$$

```
class Point{
    protected:
      int x, y;
    public:
      void set (int a, int b);
};
```

```
class 3D-Point : public Point{
    private:
      double z;
    … …
};
```

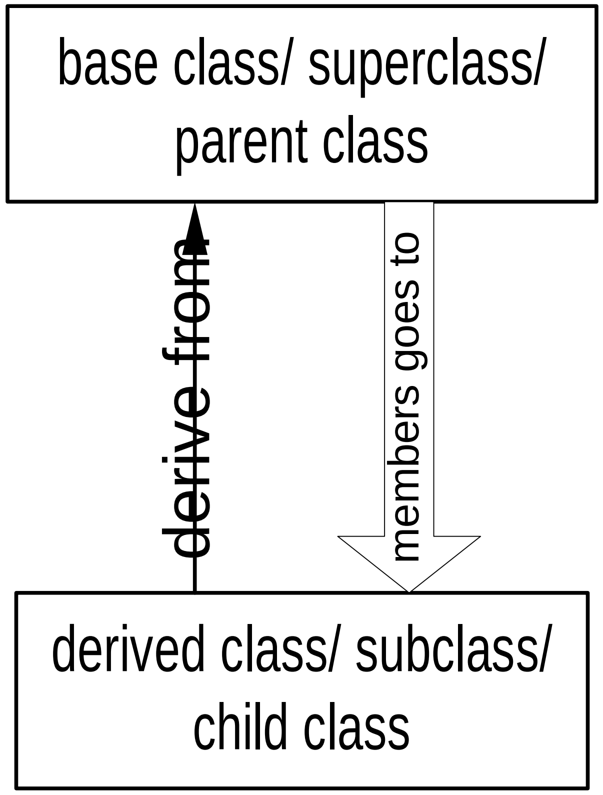
```
class Sphere : public 3D-Point{
    private:
      double r;
    … …
};
```

Point is the base class of 3D-Point, while 3D-Point is the base class of Sphere

What to inherit?

- In principle, every member of a base class is inherited by a derived class
  - just with different access permission

Access Control Over the Members


base class/ superclass/ parent class
derive from
members goes to
derived class/ subclass/ child class

- Two levels of access control over class members
  - class definition
  - inheritance type

```
class Point{
    protected: int x, y;
    public: void set(int a, int b);
};
```

```
class Circle : public Point{
    … …
};
```

Access Rights of Derived Classes

Type of Inheritance

Access Control for Members

	private	protected	public
private	-	-	-
protected	private	protected	protected
public	private	protected	public

- The type of inheritance defines the access level for the members of derived class that are inherited from the base class

Class Derivation

```
class mother{
    protected: int mProc;
    public: int mPubl;
    private: int  mPriv;
};
```

private/protected/public

```
class daughter : --------- mother{
    private: double dPriv;
    public: void dFoo ( );
};
```

```
void daughter :: dFoo ( ){
    mPriv = 10;   //error
    mProc = 20;
};
```

```
class grandDaughter : public daughter {
    private: double gPriv;
    public: void gFoo ( );
};
```

```
int main() {
    /*….*/
}
```

What to inherit?

- In principle, every member of a base class is inherited by a derived class
  - just with different access permission
- However, there are exceptions for
  - constructor and destructor
  - operator=() member
  - friends

  Since all these functions are class-specific

Constructor Rules for Derived Classes

The default constructor and the destructor of the base class are always called when a new object of a derived class is created or destroyed.

```
class A {
  public:
    A ( )
      {cout<< “A:default”<<endl;}
    A (int a)
      {cout<<“A:parameter”<<endl;}
};
```

```
class B : public A
{
  public:
    B (int a)
        {cout<<“B”<<endl;}
};
```

```
B test(1);
```

output:

```
A:default
B
```

Constructor Rules for Derived Classes

You can also specify an constructor of the base class other than the default constructor

DerivedClassCon (derivedClass args) : BaseClassCon (baseClass args)
{ DerivedClass constructor body }

```
class A {
  public:
    A ( )
      {cout<< “A:default”<<endl;}
    A (int a)
      {cout<<“A:parameter”<<endl;}
};
```

```
class C : public A {
  public:
    C (int a) : A(a)
        {cout<<“C”<<endl;}
};
```

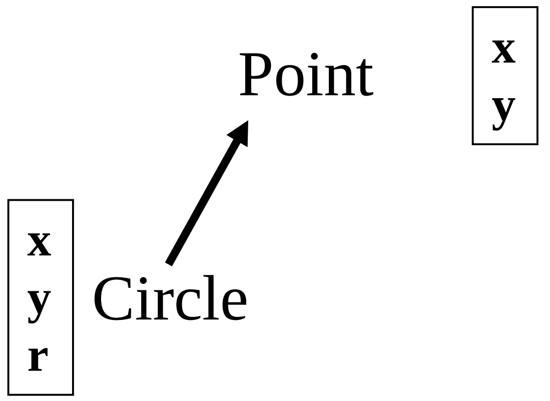
```
C test(1);
```

output:

```
A:parameter
C
```

Define its Own Members

The derived class can also define its own members, in addition to the members inherited from the base class



```
class Circle : public Point{
      private:
            double r;
      public:
            void set_r(double c);
};
```

```
class Point{
      protected:
        int x, y;
      public:
        void set(int a, int b);
};
```

```
class Circle{
      protected:
        int x, y;
      private:
        double r;
      public:
        void set(int a, int b);
        void set_r(double c);
};
```

Even more …

- A derived class can override methods defined in its parent class. With overriding,
  - the method in the subclass has the identical signature to the method in the base class.
  - a subclass implements its own version of a base class method.

```
class A {
  protected:
    int x, y;
  public:
    void print ()
           {cout<<“From A”<<endl;}
};
```

```
class B : public A {
  public:
    void print ()
       {cout<<“From B”<<endl;}
};
```

Access a Method

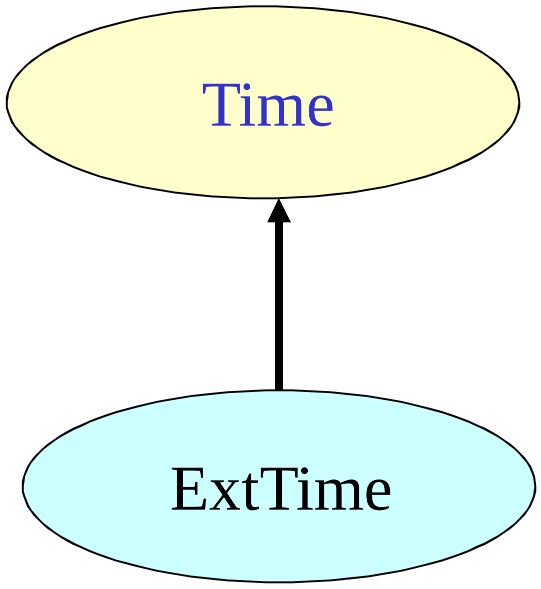
```
class Point{
    protected:
      int x, y;
    public:
      void set(int a, int b)
          {x=a; y=b;}
      void foo ();
      void print();
};
```

```
class Circle : public Point{
  private:  double r;
  public:
    void set (int a, int b, double c) {
       Point :: set(a, b); //same name function call
       r = c;
    }
    void print();  };
```

```
Point A;
A.set(30,50);  // from base class Point
A.print(); // from base class Point
```

```
Circle C;
C.set(10,10,100);   // from class Circle
C.foo ();  // from base class Point
C.print(); // from class Circle
```

Putting Them Together



- Time is the base class
- ExtTime is the derived class with public inheritance
- The derived class can
  - inherit all members from the base class, except the constructor
  - access all public and protected members of the base class
  - define its private data member
  - provide its own constructor
  - define its public member functions
  - override functions inherited from the base class

class **`Time`** Specification

```
// SPECIFICATION   FILE                                        ( time.h)

class  Time{

  public :

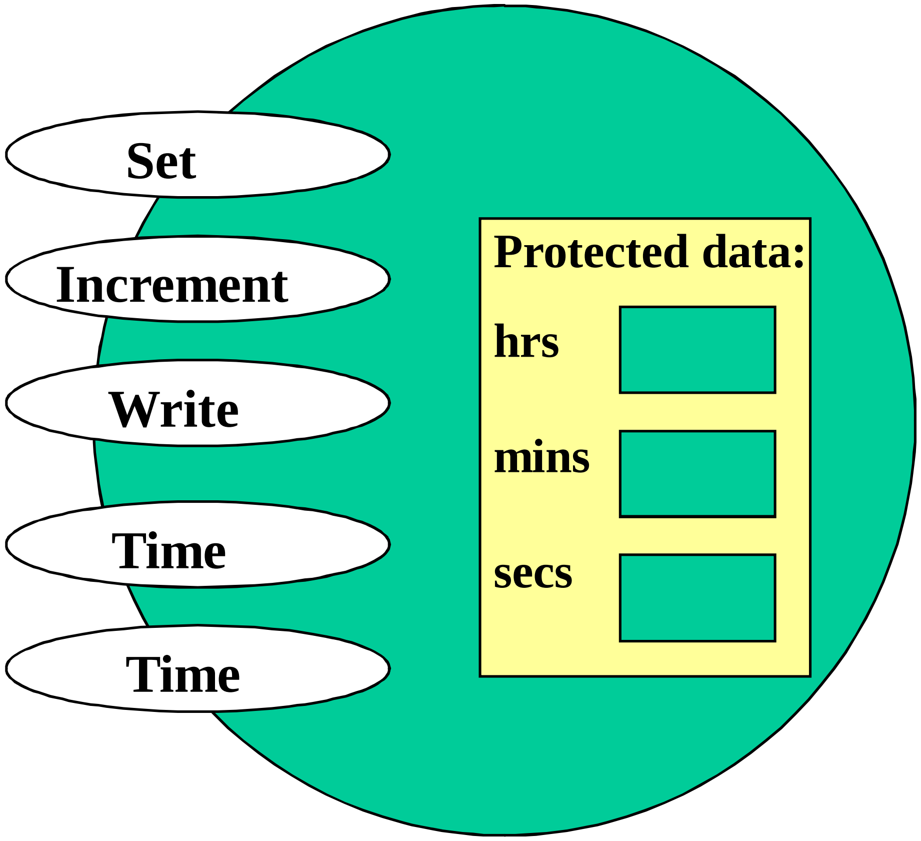
     void     Set ( int h, int m, int s ) ;
     void     Increment ( ) ;
     void     Write ( )  const ;
     Time     ( int initH, int initM, int initS ) ;   //  constructor
     Time     ( ) ;                                   //  default constructor

  protected :

     int           hrs ;
     int           mins ;
     int           secs ;
} ;
```

Class Interface Diagram

`Time` class



Derived Class `ExtTime`

```
// SPECIFICATION   FILE                                        ( exttime.h)

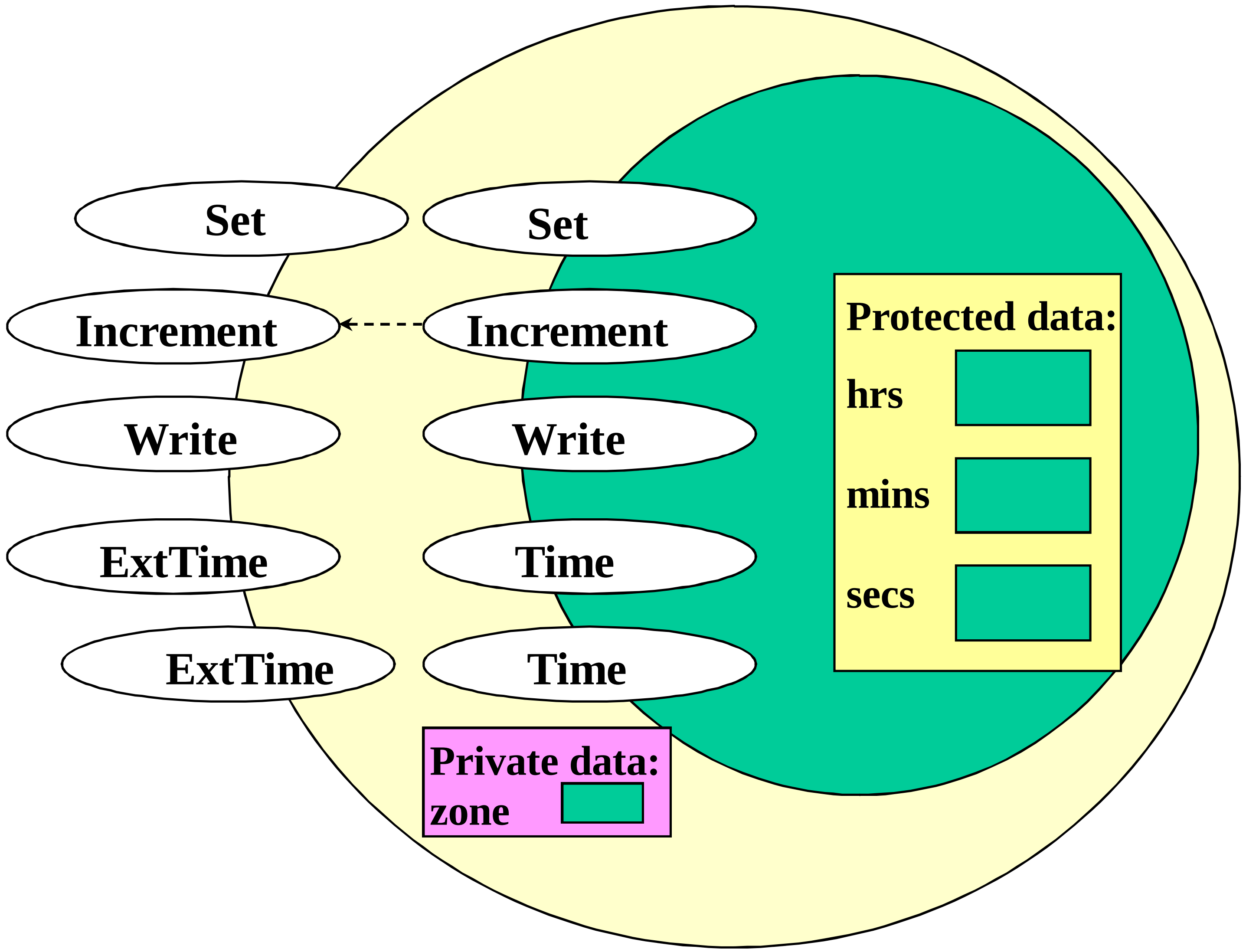
#include   "time.h"
enum  ZoneType {EST, CST, MST, PST, EDT, CDT, MDT, PDT } ;

class  ExtTime   :  public  Time
            // Time is the base class and use public inheritance
{
  public :
    void        Set ( int h, int m, int s, ZoneType timeZone ) ;
    void        Write ( )  const;    //overridden
    ExtTime    (int initH, int initM, int initS, ZoneType initZone ) ;
    ExtTime    ();   // default constructor

private :
    ZoneType  zone ;        //  added data member
} ;
```

Class Interface Diagram

`ExtTime` class



Implementation of `ExtTime`

Default Constructor

```
ExtTime :: ExtTime (  )
{
     zone  =  EST ;
}
```

```
ExtTime et1;
```

et1

```
hrs = 0
mins = 0
secs = 0
zone = EST
```

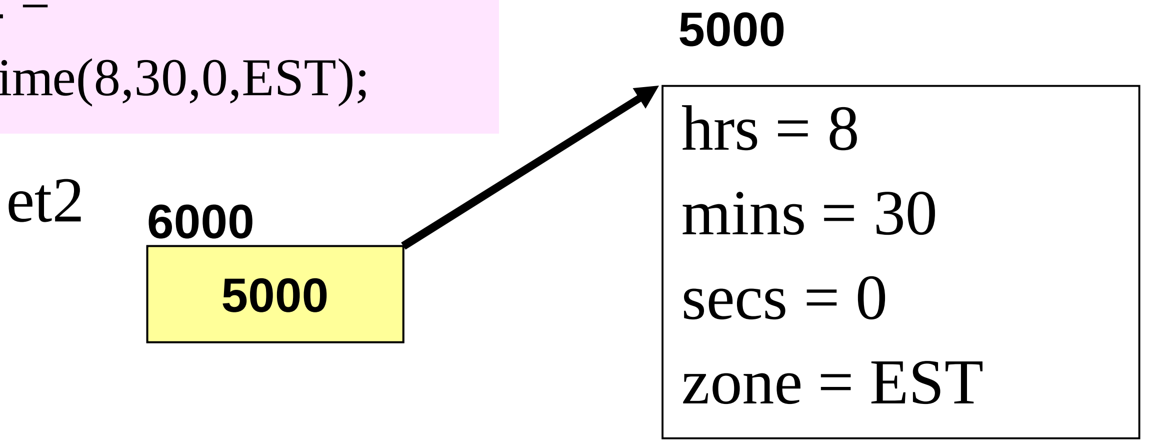
The default constructor of base class, Time(), is automatically called, when an ExtTime object is created.

Implementation of **`ExtTime`**

Another Constructor

```
ExtTime :: ExtTime (int initH, int initM, int initS, ZoneType initZone)
            : Time (initH, initM, initS)
            // constructor initializer
{
        zone  = initZone ;
}
```

```
ExtTime *et2 =
    new ExtTime(8,30,0,EST);
```



Implementation of `ExtTime`

```
void  ExtTime :: Set (int h, int m, int s, ZoneType timeZone)
{
      Time :: Set (hours, minutes, seconds);  // same name function call
      zone  = timeZone ;
}
```

```
void  ExtTime :: Write ( )   const  // function overriding
{
   string  zoneString[8] =
             {“EST”, “CST”, MST”, “PST”, “EDT”, “CDT”, “MDT”, “PDT”} ;

  Time :: Write ( ) ;
  cout  <<‘  ‘<<zoneString[zone]<<endl;
}
```

Working with **`ExtTime`**

```
#include  “exttime.h”
… …
int main()
{
        ExtTime    thisTime ( 8, 35, 0, PST ) ;
        ExtTime    thatTime ;                         // default constructor called

        thatTime.Write( ) ;                           // outputs 00:00:00 EST

        thatTime.Set (16, 49, 23, CDT) ;
        thatTime.Write( ) ;                           // outputs 16:49:23 CDT

        thisTime.Increment ( ) ;
        thisTime.Increment ( ) ;
        thisTime.Write ( ) ;                          // outputs 08:35:02  PST
}
```

Take Home Message

- Inheritance is a mechanism for defining new class types to be a specialization or an augmentation of existing types.

- In principle, every member of a base class is inherited by a derived class with different access permissions, except for the constructors