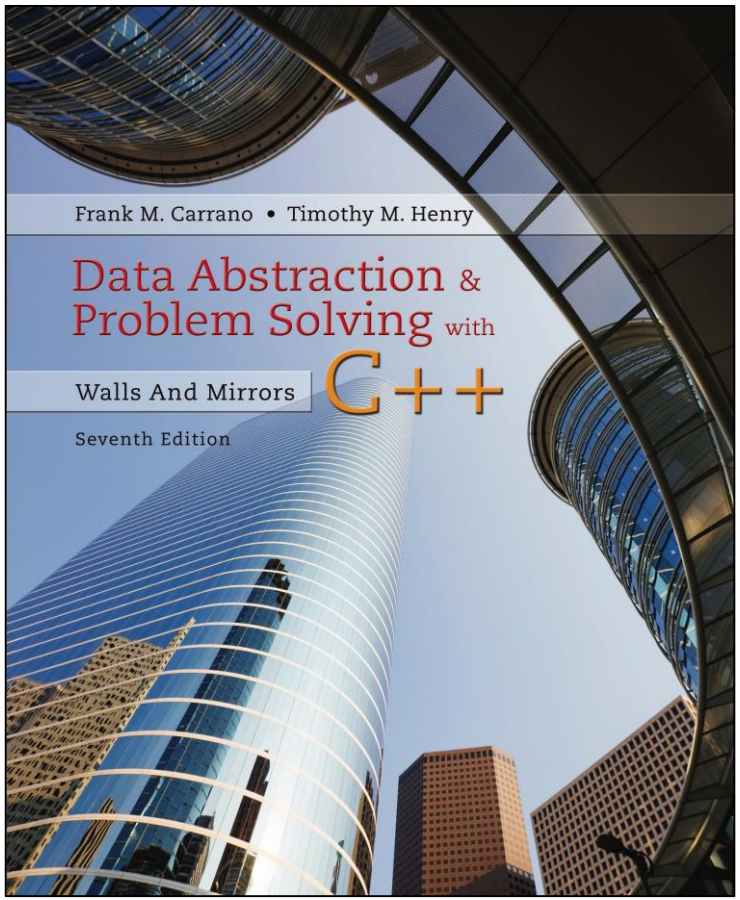
Data Abstraction & Problem Solving with C++: Walls and Mirrors

Seventh Edition



C++ Interlude 1

C++ Classes

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A Problem to Solve (1 of 9)

- Consider a video game where a character carries three types of boxes
  - Plain box
  - Toy box
  - Magic box
- Plain box design
  - Get and Set public methods

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A Problem to Solve (2 of 9)

Listing C1-1 The header file for the class **PlainBox**

```
1  /** @file PlainBox.h */
2
3  #ifndef PLAIN_BOX_
4  #define PLAIN_BOX_
5
6  // Set the type of data stored in the box
7  typedef double ItemType;
8  // Declaration for the class PlainBox
9  class PlainBox
10 {
11 private:
12    // Data field
13    ItemType item;
14
15 public:
```

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A Problem to Solve (3 of 9)

Listing C1-1 [continued]

```
14
15  public:
16     // Default constructor
17     PlainBox();
18
19     // Parameterized constructor
20     PlainBox(const ItemType& theItem);
21
22     // Method to change the value of the data field
23     void setItem(const ItemType& theItem);
24
25     // Method to get the value of the data field
26     ItemType getItem() const;
27  }; // end PlainBox
28  #endif
```

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A Problem to Solve (4 of 9)

- Elements of the class
  - Private data fields
  - Constructors, destructors
  - Methods
  - Use of #ifndef, #define, and #endif preprocessor directives
  - Use of initializers
  - Use of typedef
  - Inheritance

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A Problem to Solve (5 of 9)

Listing C1-2 Implementation file for the **PlainBox** class

```
1  /** @file PlainBox.cpp */
2
3  #include "PlainBox.h"
4
5  PlainBox::PlainBox()
6  {
7  }  // end default constructor
8  PlainBox::PlainBox(const ItemType& theItem)
9  {
10    item = theItem;
11 }  // end constructor
12 void PlainBox::setItem(const ItemType& theItem)
13 {
14    item = theItem;
15 }  // end setItem
16
17 ItemType PlainBox::getItem() const
18 {
19    return item;
20 }  // end getItem
```

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A Problem to Solve (6 of 9)

Listing C1-3 Template header file for the **PlainBox** class

```
1  /** @file PlainBox.h */
2
3  #ifndef PLAIN_BOX_
4  #define PLAIN_BOX_
5
6  template<class ItemType> // Indicates this is a template definition
7
8  // Declaration for the class PlainBox
9  class  PlainBox
10 {
11 private:
12    // Data field
13    ItemType item;
14 public:
15    // Default constructor
16    PlainBox();
```

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A Problem to Solve (7 of 9)

Listing C1-3 [continued]

```
16      PlainBox();
17
18      // Parameterized constructor
19      PlainBox(const ItemType& theItem);
20
21      // Mutator method that can change the value of the data field
22      void setItem(const ItemType& theItem);
23
24      // Accessor method to get the value of the data field
25      ItemType getItem() const;
26  }; // end PlainBox
27
28  #include "PlainBox.cpp" // Include the implementation file
29  #endif
```

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A Problem to Solve (8 of 9)

Listing C1-4 Implementation file for the **PlainBox** template class

```
1  /** @file PlainBox.cpp */
2  #include "PlainBox.h"
3
4  template<class ItemType>
5  PlainBox<ItemType>::PlainBox()
6  {
7  }  // end default constructor
8
9  template<class ItemType>
10 PlainBox<ItemType>::PlainBox(const ItemType& theItem) : item(theItem)
11 {
12 }  // end constructor
13
```

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A Problem to Solve (9 of 9)

Listing C1-4 [continued]

```
14  template<class ItemType>
15  void PlainBox<ItemType>::setItem(const ItemType& theItem)
16  {
17     item = theItem;
18  }  // end setItem
19
20  template<class ItemType>
21  ItemType PlainBox<ItemType>::getItem() const
22  {
23     return item;
24  }  // end getItem
```

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Base Classes and Derived Classes (1 of 3)

- Use **PlainBox** as a base class, or superclass
- The **ToyBox** class is the derived class, or subclass, of the **PlainBox**
- Derived class inherits
  - All the members of its base class,
  - (Except the constructors and destructor)

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Base Classes and Derived Classes (2 of 3)

Listing C1-5 Template header file for the class **ToyBox**

```
1  /** @file ToyBox.h */
2
3  #ifndef TOY_BOX_
4  #define TOY_BOX_
5  #include "PlainBox.h"
6
7  enum Color {BLACK, RED, BLUE, GREEN, YELLOW, WHITE};
8
9  template<class ItemType>
10 class ToyBox : public PlainBox<ItemType>
11 {
12 private:
13    Color boxColor;
14
15 public:
16    ToyBox();
17    ToyBox(const Color& theColor);
18    ToyBox(const ItemType& theItem, const Color& theColor);
19    Color getColor() const;
20 }; // end ToyBox
21 #include "ToyBox.cpp"
22 #endif
```

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Base Classes and Derived Classes (3 of 3)

Listing C1-6 Implementation file for the class **ToyBox**

```
1  /** @file ToyBox.cpp */
2
3  #include "ToyBox.h"
4
5  template<class ItemType>
6  ToyBox<ItemType>::ToyBox() : boxColor(BLACK)
7  {
8  }  // end default constructor
9
10 template<class ItemType>
11 ToyBox<ItemType>::ToyBox(const Color& theColor) : boxColor(theColor)
12 {
13 }  // end constructor
14
15 template<class ItemType>
16 ToyBox<ItemType>::ToyBox(const ItemType& theItem, const Color& theColor)
17                         : PlainBox<ItemType>(theItem), boxColor(theColor)
18 {
19 }  // end constructor
20
21 template<class  ItemType>
22 Color ToyBox<ItemType>::getColor() const
23 {
24    return boxColor;
25 }  // end getColor
```

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Overriding Base-Class Methods (1 of 3)

- You can add as many new members to derived class as desired
- You can redefine inherited methods
  - Called overriding a base-class method.
- A method overrides a base-class method when
  - The two methods have the same name and parameter declarations

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Overriding Base-Class Methods (2 of 3)

Listing C1-7 Header file for the class **MagicBox**

```
1  /** @file MagicBox.h */
2
3  #ifndef MAGIC_BOX_
4  #define MAGIC_BOX_
5  #include "PlainBox.h"
6
7  template<class ItemType>
8  class MagicBox: public PlainBox<ItemType>
9  {
10 private:
11    bool firstItemStored;
12
13 public:
14    MagicBox();
15    MagicBox(const ItemType& theItem);
16    void setItem(const ItemType& theItem);
17 }; // end MagicBox
18 #include "MagicBox.cpp"
19 #endif
```

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Overriding Base-Class Methods (3 of 3)

Listing C1-8 Implementation file for the class **MagicBox**

```
1  /** @file MagicBox.cpp */
2  #include "MagicBox.h"
3  template<class ItemType>
4  MagicBox<ItemType>::MagicBox(): firstItemStored(false)
5  {
6     // PlainBox constructor is called implicitly.
7     // Box has no magic initially
8  }  // end default constructor
9
10 template<class ItemType>
11 MagicBox<ItemType>::MagicBox(const ItemType& theItem): firstItemStored(false)
12 {
13    // Box has no magic initially
14    setItem(theItem); // Calls MagicBox version of setItem
15    // Box has magic now
16 }  // end constructor
17
18 template<class ItemType>
19 void MagicBox<ItemType>::setItem(const ItemType& theItem)
20 {
21    if (!firstItemStored)
22    {
23       PlainBox<ItemType>::setItem(theItem);
24       firstItemStored = true; // Box has magic now
25    }  // end if
26 }  // end setItem
```

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Virtual Methods, Abstract Classes (1 of 2)

- Using keyword **virtual** in front of the prototype
  - Tells the C++ compiler that the code this method executes is determined at runtime
- Pure virtual method
  - Virtual method that has no implementation
- Abstract class
  - Has at least one pure virtual method

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Virtual Methods, Abstract Classes (2 of 2)

Listing C1-9 An abstract class that is an interface for the ADT box

```
1  /** @file BoxInterface.h */
2
3  #ifndef BOX_INTERFACE_
4  #define BOX_INTERFACE_
5
6  template <class ItemType>
7  class  BoxInterface
8  {
9  public:
10    virtual void  setItem(const ItemType& theItem) = 0;
11    virtual ItemType getItem() const = 0;
12    virtual ~BoxInterface() {} // C++ Interlude 2 explains virtual destructors
13 }; // end BoxInterface
14 #endif
```

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