Microsoft® Official Course

Module 4

Creating Classes and Implementing Type-Safe Collections

Microsoft®

Module Overview

- Creating Classes
- Defining and Implementing Interfaces
- Implementing Type-Safe Collections

Lesson 1: Creating Classes

- Creating Classes and Members
- Instantiating Classes
- Using Constructors
- Reference Types and Value Types
- Demonstration: Comparing Reference Types and Value Types
- Creating Static Classes and Members
- Testing Classes

Creating Classes and Members

- Use the **class** keyword

```
public class DrinksMachine
{
   // Methods, fields, properties, and events.
}
```

- Specify an access modifier:
  - public
  - internal
  - private
- Add methods, fields, properties, and events

Instantiating Classes

- To instantiate a class, use the **new** keyword

```
DrinksMachine dm = new DrinksMachine();
```

- To infer the type of the new object, use the **var** keyword

```
var dm = new DrinksMachine();
```

- To call members on the instance, use the dot notation

```
dm.Model = "BeanCrusher 3000";
dm.Age = 2;
dm.MakeEspresso();
```

Using Constructors

- Constructors are a type of method:
  - Share the name of the class
  - Called when you instantiate a class
- A default constructor accepts no arguments

```
public class DrinksMachine
{
   public void DrinksMachine()
   {
      // This is a default constructor.
   }
}
```

- Classes can include multiple constructors
  - Overloaded constructors

Using Constructors

- Constructors can accept parameters

```
public class Coffee
{
   public void Coffee(String name)
   {
      Name = name;
   }
}
```

- Use constructors to initialize member variables
- Alternatively, use object initializers

```
Coffee coffee1 = new Coffee {
  Name="Flat White",
  Strength = 4
};
```

Reference Types and Value Types

- Value types
  - Contain data directly

```
int First = 100;
int Second = First;
```

  - In this case, **First** and **Second** are two distinct items in memory
- Reference types
  - Point to an object in memory

```
object First = new Object();
object Second = First;
```

  - In this case, **First** and **Second** point to the same item in memory

Demonstration: Comparing Reference Types and Value Types

In this demonstration, you will learn how to:

- Create a value type to store an integer value
- Create a reference type to store an integer value
- Observe the differences in behavior when you copy the value type and the reference type
- Observe boxing and unboxing in action

Creating Static Classes and Members

- Use the static keyword to create a static class

```
public static class Conversions
{
   // Static members go here.
}
```

- Call members directly on the class name

```
double weightInKilos = 80;
double weightInPounds =
   Conversions.KilosToPounds(weightInKilos);
```

- Add static members to non-static classes

Introduction to Testing

- Many different types of testing
  - Unit tests
  - Integration tests
  - System testing
- Roles in testing: developers vs testers
- Design for testability
  - TDD

Testing Classes with Unit Tests

Arrange

- Create the conditions for the test
- Configure any input values required

Act

- Invoke the action that you want to test

Assert

- Verify the results of the action
- Fail the test if the results were not as expected

Lesson 2: Defining and Implementing Interfaces

- Introducing Interfaces
- Defining Interfaces
- Implementing Interfaces
- Implementing Multiple Interfaces
- Implementing the IComparable Interface
- Implementing the IComparer Interface

Introducing Interfaces

- Interfaces define a set of characteristics and behaviors
  - Member signatures only
  - No implementation details
  - Cannot be instantiated
- Interfaces are implemented by classes or structs
  - Implementing class or struct must implement every member
  - Implementation details do not matter to consumers
  - Member signatures must match definitions in interface
- By implementing an interface, a class or struct guarantees that it will provide certain functionality

Defining Interfaces

- Use the **interface** keyword

```
public interface IBeverage
{
    // Methods, properties, events, and indexers.
}
```

- Specify an access modifier:
  - public
  - internal
- Add interface members:
  - Methods, properties, events, and indexers
  - Signatures only, no implementation details

Implementing Interfaces

- Add the name of the interface to the class declaration

```
public class Coffee : IBeverage
```

- Implement all interface members
- Use the interface type and the derived class type interchangeably

```
Coffee coffee1 = new Coffee();
IBeverage coffee2 = new Coffee();
```

The **coffee2** variable will only expose members defined by the **IBeverage** interface

Implementing Multiple Interfaces

- Add the names of each interface to the class declaration

```
public class Coffee : IBeverage, IInventoryItem
```

- Implement every member of every interface
- Use explicit implementation if two interfaces have a member with the same name

```
// This is an implicit implementation.
public bool IsFairTrade { get; set; }

//These are explicit implementations.
public bool IInventoryItem.IsFairTrade { get; }
public bool IBeverage.IsFairTrade { get; set; }
```

Implementing the IComparable Interface

- If you want instances of your class to be sortable in collections, implement the **IComparable** interface

```
public interface IComparable
{
   int CompareTo(Object obj);
}
```

- The **ArrayList.Sort** method calls the **IComparable.CompareTo** method on collection members to sort items in a collection

Implementing the IComparer Interface

- To sort collections by custom criteria, implement the **IComparer** interface

```
public interface IComparer
{
   int Compare(Object x, Object y);
}
```

- To use an **IComparer** implementation to sort an **ArrayList**, pass an **IComparer** instance to the **ArrayList.Sort** method

```
ArrayList coffeeList = new ArrayList();
// Add some items to the collection.
coffeeList.Sort(new CoffeeRatingComparer());
```

Lesson 3: Implementing Type-Safe Collections

- Introducing Generics
- Advantages of Generics
- Constraining Generics
- Using Generic List Collections
- Using Generic Dictionary Collections
- Using Collection Interfaces
- Creating Enumerable Collections
- Demonstration: Adding Data Validation and Type-Safety to the Application Lab

Introducing Generics

- Create classes and interfaces that include a type parameter

```
public class CustomList<T>
{
   public T this[int index] { get; set; }
   public void Add(T item) { ... }
   public void Remove(T item) { ... }
}
```

- Specify the type argument when you instantiate the class

```
CustomList<Coffee> coffees =
   new CustomList<Coffee>();
```

Advantages of Generics

Generic types offer three advantages over non-generic types:

- Type safety
- No casting
- No boxing and unboxing

Constraining Generics

You can constrain type parameters in six ways:

- where T : <name of interface>
- where T : <name of base class>
- where T : U
- where T : new()
- where T : struct
- where T : class

Using Generic List Collections

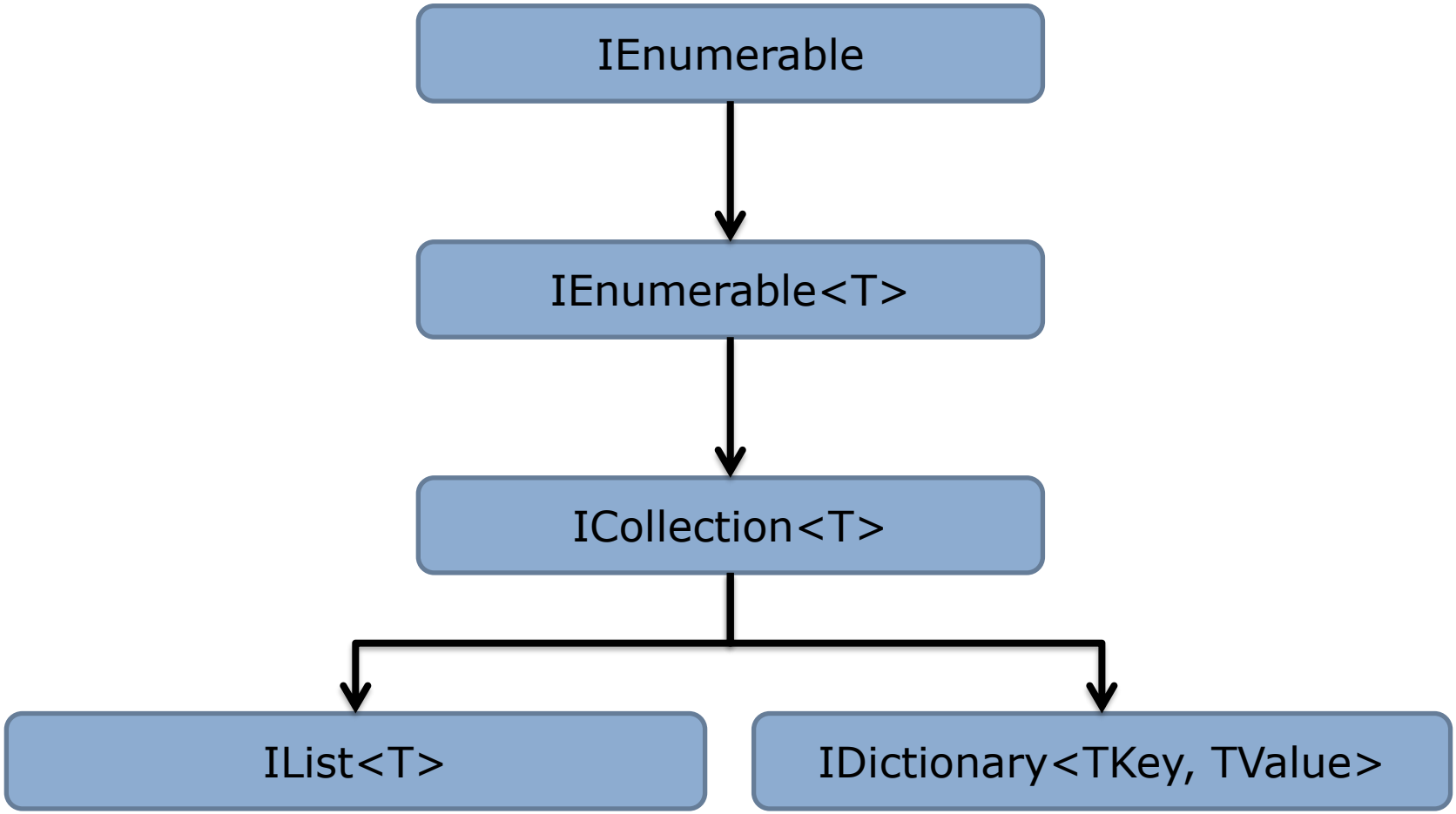
Generic list classes store collections of objects of type **T**:

- **List<T>** is a general purpose generic list
- **LinkedList<T>** is a generic list in which each item is linked to the previous item and the next item in the collection
- **Stack<T>** is a last in, first out collection
- **Queue<T>** is a first in, first out collection

Using Generic Dictionary Collections

- Generic dictionary classes store key-value pairs
- Both the key and the value are strongly typed
- **Dictionary<TKey, TValue>** is a general purpose, generic dictionary class
- **SortedList<TKey, TValue>** and **SortedDictionary<TKey, TValue>** collections are sorted by key

Using Collection Interfaces



Creating Enumerable Collections

- Implement **IEnumerable<T>** to support enumeration (**foreach**)
- Implement the **GetEnumerator** method by either:
  - Creating an **IEnumerator<T>** implementation
  - Using an iterator
- Use the **yield return** statement to implement an iterator

yield return

```
IEnumerable Demo()
{
    yield return "Hello";
    yield return “World";
}

void Main()
{
    foreach (string line in Demo())
    {
        Console.WriteLine(line);
    }
}
```

Demonstration: Adding Data Validation and Type-Safety to the Application Lab

In this demonstration, you will learn about the tasks that you perform in the lab for this module.

Lab: Adding Data Validation and Type-Safety to the Application

- Exercise 1: Implementing the Teacher, Student, and Grade Structs as Classes
- Exercise 2: Adding Data Validation to the Grade Class
- Exercise 3: Displaying Students in Name Order
- Exercise 4: Enabling Teachers to Modify Class and Grade Data

Logon Information

- Virtual Machine: 20483B-SEA-DEV11, MSL-TMG1
- User Name: Student
- Password: Pa$$w0rd

Estimated Time: 75 minutes

Lab Scenario

- Now that the user interface navigation features are working, you decide to replace the simple structs with classes to make your application more efficient and straightforward.
- You have also been asked to include validation logic in the application to ensure that when a user adds grades to a student, that the data is valid before it is written to the database. You decide to create a unit test project that will perform tests against the required validation for different grade scenarios.
- Teachers who have seen the application have expressed concern that the students in their classes are displayed in a random order. You decide to use the IComparable interface to enable them to be displayed in alphabetical order.
- Finally, you have been asked to add functionality to the application to enable teachers to add students to and remove students from a class, and to add student grades to the database.

Module Review and Takeaways

- Review Question(s)