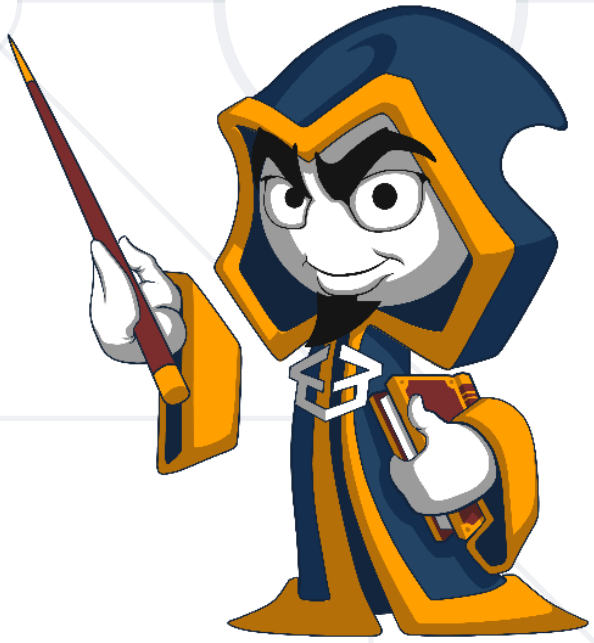
Generics

Adding Type Safety and Code Reusability



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Generics

Definition, Type Parameters and Safety

What Are Generics?

- Generics introduce the concept of **Type Parameters**
- Allow designing classes and methods without **parameter type specification**
- A generic **class** or a **method** accepts a certain type when it is **instantiated** by client code

```
public class CustomStack<T> { }
CustomStack<int> =
                new CustomStack<int>();
```

Generics - Type Safety

- Add **type safety** for the client
- Provide a powerful way to **reuse** code

```
List<int> strings = new List<int>();
List<Person> people = new List<Person>();
```

- Example: we need a collection that will store only strings

```
List<string> strings = new List<string>();
strings.Add(3); // Compile time error
```

Type Parameters

- Blueprint for a **type** - **T** (**Type Parameter**)
- You can use it **anywhere** inside the **generic** class

```
class List<T>
{
  public Add (T element) {…}

  public T Remove () {…}

  public T Peek { get; }
}
```

Generic Classes

Non-Generic Classes (1)

```
public class ObjectList
{
  private object[] elements;
  public ObjectList ()
  { this.elements = new object[4]; }
  public void Add(object value){}
  public object Get(int index)
  {
    return this.elements[index];
  }
}
```

Non-Generic Classes (2)

```
var objectList = new ObjectList();
objectList.Add(1);
objectList.Add(new Customer());
objectList.Add(new Account());

var firItem = objectList[0]; // firItem is object
var secItem = (Customer)objectList[1]; // cast
```

Generic Classes

- Encapsulate operations to a **non-particular data type**
- Defined with **Type Parameters** - **T**

```
class List<T> { }
class Stack<T> { }
```

- Most commonly used are **generic collections**:
  - Linked Lists, Hash tables, Stacks, Queues, Trees, etc.
  - Collections with **multiple** type **parameters** – Dictionary<**T**, **V**>

Generic Methods

Non-Generic Methods

- Take a **certain** input and a **certain** output **type**

```
public class CustomerList
{
   public Customer Remove(Customer customer)
   {
      return removedCustomer;
   }
}
```

Generic Methods

- Take **generic input** and return **generic output**

```
public List<T> CreateList<T>(T item)
{
    List<T> list = new List<T>();
      …
    return list;
}
```

Problem: Box of T

- Create a collection, that can store anything and has the following **methods**:
  - `Add()` should add on top of its contents
  - `Remove()` should remove the topmost element and **return it**
- It should have two public methods:
  - `void Add(T element)`
  - `T Remove()`
  - `int Count`

Check your solution here: https://judge.softuni.org/Contests/Practice/Index/1474#0

Solution: Box of T

```
public class Box<T>
{
  // TODO: Add fields and constructor
  public int Count => this.data.Count;

  public void Add(T item) { this.data.Add(item);

  public T Remove() {
  var rem = this.data.Last();
  this.data.RemoveAt(this.data.Count - 1);
  return rem; }
}
```

Problem: Generic Array Creator

- Create a class **ArrayCreator** with a single method:

```
static T[] Create(int length, T item)
```

- It should return an array with the given length
- Every element should be **set to the default item**

Check your solution here: https://judge.softuni.org/Contests/Practice/Index/1474#1

Solution: Generic Array Creator

```
public static class ArrayCreator
{
  public static T[] Create<T>(int length, T item)
  {
    T[] array = new T[length];
    for(int i = 0; i < length; i++)
    { array[i] = item; }
    return array;
  }
}
```

Generic Constraints

Apply Restrictions

Generic Constraints (1)

- **Constraints** are represented in generics using **where**
- Restricting generic classes to **reference types** only:

```
public void MyMethod<T>()
        where T : class
```

- **class** is the keyword

```
public void MyMethod<T>()
        where T : struct
```

- **struct** is the keyword

Why Constraints?

- IL generated for `Equals<string>` would be different to that of `Equals<int>`

```
public static bool Equals<T> (T t1, T t2)
{
  return (t1 == t2);
}
```

- The case could be different if the **types** that are being compared have a **new definition of == operator**

Generic Constraints (2)

- Specifying a **constructor** as a constraint

```
public void MyMethod<T>()
        where T : new()
```

- Only a **default constructor** can be used in the constraints
- **Parameterized constructor** will be a **compilation error**

Generic Constraints (3)

- Specifying a static **base class** as a constraint

```
public void MyMethod<T>()
        where T : BaseClass
{
   ...
}
```

- The type **argument** must **be** or **derive from** the **specified** base class

Generic Constraints (4)

- Specifying **a generic base class** as a constraint

```
public void AddAll<TItem>(List<TItem> items)
  where TItem : T
{
  ...
}
```

- The **type argument** supplied for **T** must **be** or **derive from** the **argument** supplied for **TItem**
- **T** comes from the **generic class**

Combine Generic Constraints

- Specifying **a generic base class** as a constraint

```
public void MyMethod<T>()
  where T : BaseClass, new()
{
  ...
}
```

- Invalid combination of constraints: **`class`** and **`struct`**

Problem: Equality Scale

- Create a class `EqualityScale<T>` that:
  - Holds two elements: `left` and `right`
  - Receives the elements through its single constructor:
    - `EqualityScale(T left, T right)`
  - Has a method: `bool AreEqual()`
- The greater of the two elements is the heavier

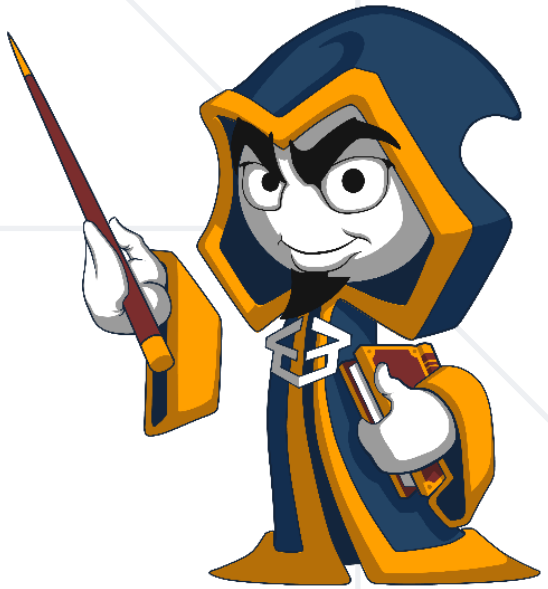
Check your solution here: https://judge.softuni.org/Contests/Practice/Index/1474#2

Solution: Equality Scale

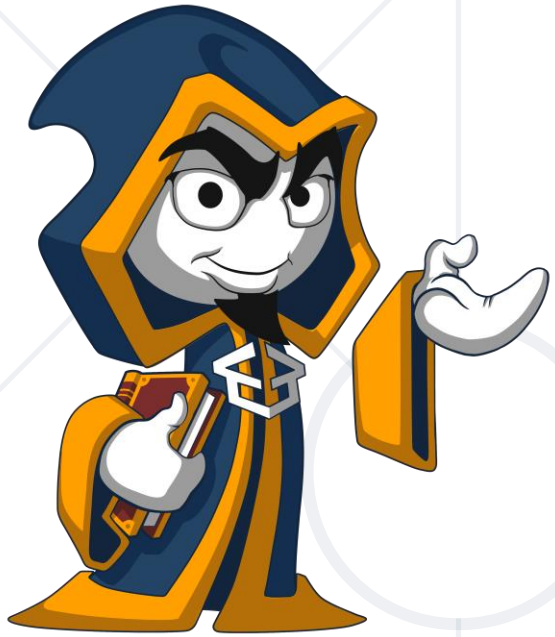
```
public class EqualityScale<T>
{
  private T left;
  private T right;
  public EqualityScale(T left, T right) {
    this.left = left;
    this.right = right;
  }
  public bool AreEqual() {
     bool result = this.left.Equals(this.right);
     return result;
  }
}
```

Summary

- **Generics** add type safety
- Generic code is more **reusable**
- Classes, interfaces and methods can be generic
- Generic **Constraints** can validate generic types



Questions?



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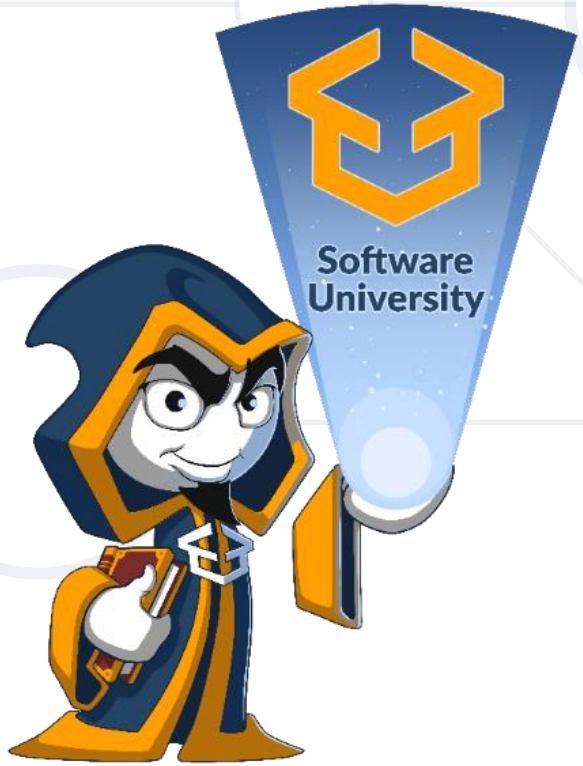

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