# **ASP.NET Web API Basic Authentication**

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## ****Authentication and Authorization in Web API****

The discussion with the definition of **Authentication** and **Authorization:**

**Authentication**is the process of identifying the user. For example, one user let’s say James logs in with his username and password, and the server uses his username and password to authenticate James.

**Authorization**is the process of deciding whether the authenticated user is allowed to perform an action on a specific resource (Web API Resource) or not. For example, James (who is an authenticated user) has the permission to get a resource but does not have the permission to create a resource.

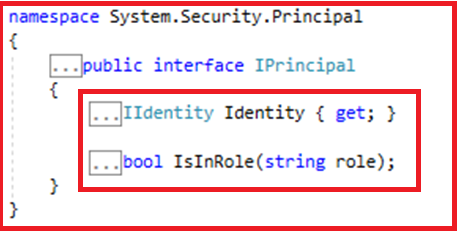
##### **Authentication in Web API**

The Web API Service assumes that the authentication process should happen in the host Server and we generally host the Web API Service at IIS. The IIS Server uses the **HTTP modules** for checking the authentication of a user. You can configure your project to use any of the built-in authentication modules which are available in IIS or ASP.NET, or you can also create your own HTTP module to perform custom authentication.

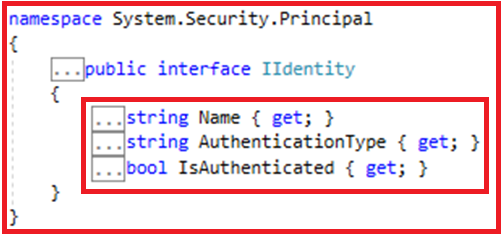
When the host (IIS Server) authenticates the user, it generally creates a principal object (i.e. **IPrincipal** object) under which the code is going to run. So, once the Principal object (**IPrincipal** object) is created, then the host (i.e. IIS Server) attaches that **principal object** to the **current thread** by setting **Thread.CurrentPrincipal**.

##### **Understanding Principal Object**

The Principal object contains two things one is the **Identity** object which actually contains the information about the user and the other one is the **IsInRole** property which is a boolean property and this property is set to true if the user is assigned with any roles else false. The following diagram shows the IPrincipal interface definition.



Let’s have a look at the Identity interface definition which contains the user’s information.



The Identity Object which is a property of Principal Object contains three properties i.e. **Name** (string type), **AuthenticationType**(string type), and **IsAuthenticated** (boolean type). If the user is authenticated, then the **Identity.IsAuthenticated** property will return **true**else **false**. The **Name** property of the Identity object will store the name of Identity, generally, identity is nothing but the logged-in username. Similarly, the **AuthenticationType** property returns the type of authentication used to identify the user.

The Identity interface is generally implemented by the **GenericIdentity**and **WindowsIdentity**classes.

##### **HTTP Message Handlers for Authentication in Web API**

Instead of using the host (i.e. IIS Server where the Web API service is hosted) for authentication, you can also write the authentication logic into a custom **HTTP Message** **Handler**. In that case, the **HTTP Message Handler** is going to check the incoming HTTP request for authenticating the user and then set the Principal Object.

##### **Differences HTTP Message Handler over HTTP Module:**

An **HTTP Module** sees all the incoming requests that go through the ASP.NET pipeline whereas a message handler only sees the incoming requests which are routed to the Web API Service.

It is also possible to select a specific **HTTP Message Handler** and then you can use that specific **HTTP Message Handler** for authentication for a specific route. The **HTTP Modules** are specific to IIS whereas the **HTTP Message Handlers** can be used with both **web-hosting** (within a server) and **self-hosting** (within an application).

The HTTP Modules participate in IIS logging, auditing, and so on. Generally, if you don’t want to support self-hosting, then HTTP Module is a better option but if you want to support self-hosting then HTTP Message Handler is a better option.

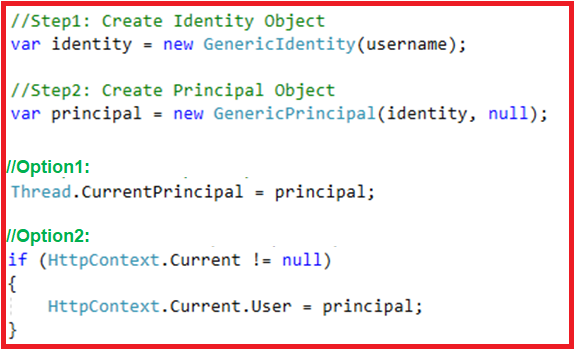
##### **Setting the Principal Object**

If you are going to implement your own custom logic for authenticating the user then you can set the principal object at two places which are as follows:

**Thread.CurrentPrincipal**. This is the standard way to set the thread’s principal in .NET.

**HttpContext.Current.User**. This property is specific to ASP.NET.

The following image shows how to create and set the principal object with the current thread. Here I am showing you both the options to set the Principal object.

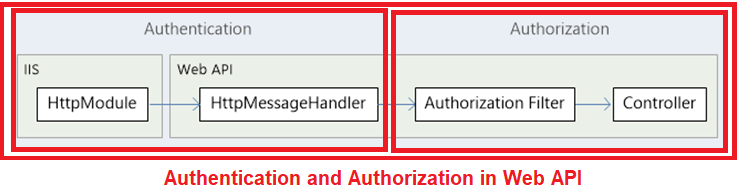


If you are going to host the Web API service in IIS, then you need to set the principal object in both places because of the security concerns i.e. security becomes inconsistent. In the case of Self-hosting the **HttpContext.Current** value is null. To ensure your code is host-agnostic (i.e. to support both web hosting and self-hosting), you need to check for null before assigning the Principal object to the **HttpContext.Current** as shown in the above image.

#### ****Authorization in Web API****

The Authorization Process is going to happen before executing the Controller Action Method which provides you the flexibility to decide whether you want to grant access to that resource or not.

We can implement this in ASP.NET Web API by using the Authorization filters which will be executed before the controller action method executed. So, if the request is not authorized for that specific resource, then the filter returns an error response to the client without executing the controller action method. The following diagram explains the above.



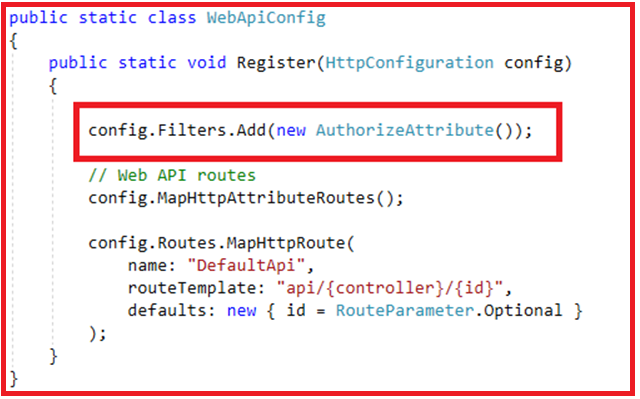
##### **Using the [Authorize] Attribute**

The ASP.NET Web API Framework provides a built-in authorization filter attribute i.e. **AuthorizeAttribute** and you can use this built-in filter attribute to checks whether the user is authenticated or not. If not, then it simply returns the HTTP status code **401 Unauthorized**, without invoking the controller action method.

You can apply the above built-in filter globally, at the controller level, or at the action level.

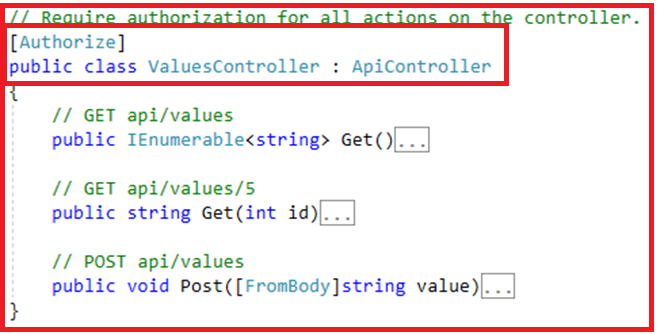
###### **At Globally**:

If you want to check the authentication for all the Web API controllers, then it is better to add the **AuthorizeAttribute** filter to the global filter list within the **Register** method of the **WebApiConfig** class as shown in the below image:



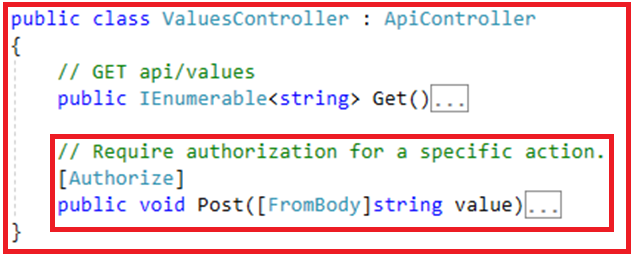
###### **At Controller Level**:

If you want to provide authentication for all the action methods of a specific controller, then it is better and recommended to add the **Authorize** filter at the controller level as shown in the below image.

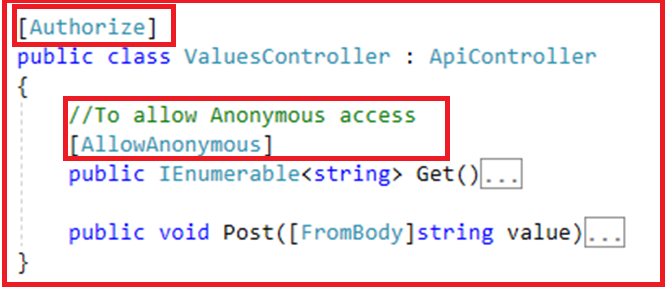


###### **At Action Level**:

If you want to provide authentication for specific action methods of a controller, then it is better to add the **Authorize**filter attribute to the action method which required authentication as shown in the below image.

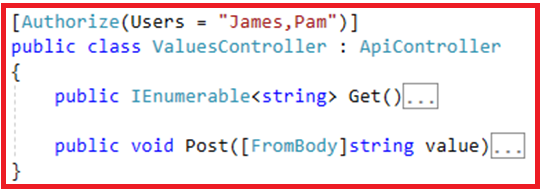


Another way of doing this is, restrict the controller by decorating the controller with **Authorize** filter attribute and then allow anonymous access to the action methods which does not require authentication by using the **AllowAnonymous** attribute. In the below example, the Post method is restricted, but the Get method allows anonymous access.

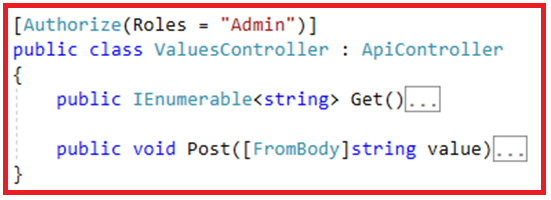


As of now, we have discussed two things. If we want to check the authentication before invoking the action method then we need to use the built-in **Authorize** Filter Attribute. If we want any action method to be accessed by the anonymous users then we need to decorate that action method with the **AllowAnonymous** attribute. Along the way, we can also limit access to specific users or to users with specific roles.

###### **Restrict by Users:**



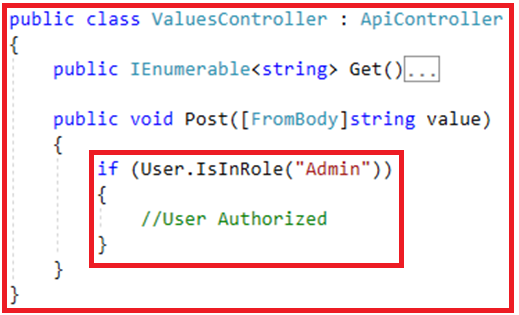
###### **Restrict by Roles:**



**Note:** The point to remember here is that the **AuthorizeAttribute**filter for Web API is located in the **System.Web.Http** namespace. In MVC there is also an **AuthorizeAttribute**filter which is located in the **System.Web.Mvc** namespace, which is not compatible with Web API controllers.

##### **Authorization Inside a Controller Action**

In some scenarios, you might allow a request to proceed, but you need to change the behavior based on the principal. For example, the information that you are going to return from the action depends on the user’s role. Within a controller action method, you can get the current principal object from the **ApiController.User** property is shown in the below image.



1. **Why do we need Authentication in Web API?**
2. **How does Basic Authentication Work in Web API?**
3. **How to Implement Basic Authentication in ASP.NET Web API?**
4. **How to Enable Basic Authentication in Web API?**
5. **Testing the ASP.NET Web API Basic Authentication using Postman**

##### **Why do we need Authentication in Web API?**

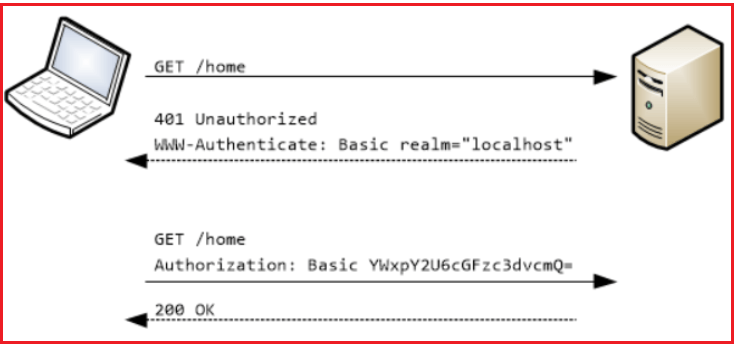
Let’s start the discussion with one of the Rest Constraint i.e. Stateless Constraint. The Stateless Constraint is one of the Rest Constraints which states that the communication between the client and server must be stateless between the requests. This means that we should not be storing the client information on the server which required to process the request. The request that is coming from the client should contain all the necessary information that is required by the server to process that request. This ensures that each request coming from the client can be treated independently by the server.

The above approach is fine and the advantage is that we can separate the client or server at any given point in time without affecting others. Here, the client can be any type of application including JavaScript or any other programming language like Java, PHP, or C#. The server does not remember the client once the request has been processed, So, each and every request coming from the client is new to the server and the server needs to check the request (most of the time the HTTP header) to identify the user.

So, in order to process the request by the server, the client needs to pass its credentials with each and every request and then the server will check and match the credentials with any persistent storage (most of the time it may be a database). If the credentials are found in the persistent storage then the server will treat that HTTP request as a valid request and process it else it simply returns an unauthorized error to the client.

##### **How does Basic Authentication Work in Web API?**

Before implementing the Basic Authentication in ASP.NET Web API, let us first understand how does the basic authentication work in Web API? To understand how does basic authentication works, please have a look at the following diagram.



In Basic Authentication, if the client didn’t send the credentials in the request header (most of the time it is Authorization header), then the server will return**401** (**Unauthorized**). The response will also include a **WWW-Authenticate** header, indicating that the server supports Basic Authentication and that you can see in the above image for the first request which does not include the Authorization header.

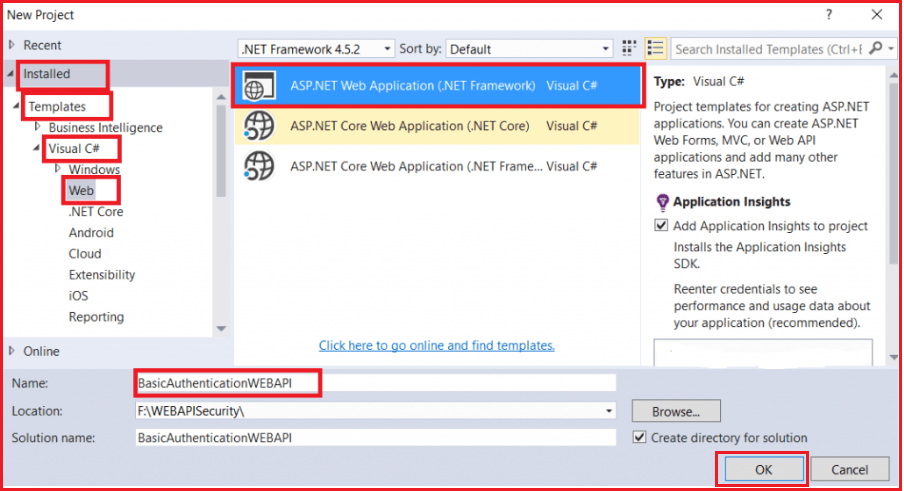
The client sends another request to the server, with the client credentials in the Authorization header. Generally, the client credentials are formatted as the string “**name:password**“, base64-encoded format and this time server validates the client and processes the request and if everything is fine, then you will get 200 OK status which you can see in the above image for the second request.

In Basic Authentication, as we attach the sensitive data (i,e. username and password) in each and every HTTP request, it should be transferred in an encoded format (base64-encoded format) and the protocol should be HTTPS, then only we can protect our data over the internet.

The **ASP.NET Web API Basic Authentication** is performed within the context of a “**realm**.” The server includes the name of the realm in the **WWW-Authenticate** header. The user’s credentials are valid within that realm. The exact scope of a realm is defined by the server. For example, you might define several realms in order to partition resources.

##### **Implementing Basic Authentication in ASP.NET Web API**

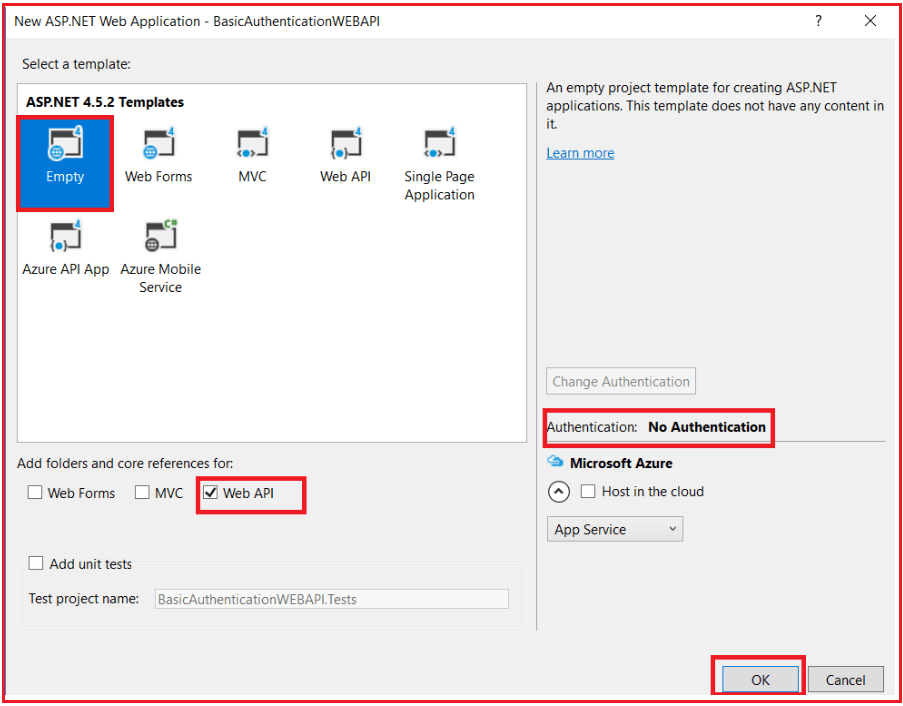
First, create an ASP.NET Web Application with the name **BasicAuthenticationWEBAPI** (you can give any name) as shown in the below image.



Once you click on the **OK** button, it will open the “**Select a template**” window. From the “**Select a template**” window choose

1. **Empty template**
2. **Web API Checkbox**
3. **No Authentication**

And finally, click on the **OK** button as shown below



Once you click on the **OK** Button it will take some time to create the project for us.

##### **Creating Models**

Now we need to create two models i.e. **User** and **Employee**. So Right-click on the Models folder and add a class file with the Name **User.cs** and then copy and paste the below code into it. This is a very simple class having only three properties i.e. ID, UserName and Password.

**namespace** *BasicAuthenticationWEBAPI.Models*

**{**

**public** **class** User

**{**

**public** **int** ID **{** **get**; **set**; **}**

**public** **string** UserName **{** **get**; **set**; **}**

**public** **string** Password **{** **get**; **set**; **}**

**}**

**}**

Similarly, right-click on the Models folder and add a class file with the Name **Employee.cs** and then copy and paste the below code into it. This is also a very simple class having 5 properties i.e. ID, Name, Gender, Dept, and Salary.

**namespace** *BasicAuthenticationWEBAPI.Models*

**{**

**public** **class** Employee

**{**

**public** **int** ID **{** **get**; **set**; **}**

**public** **string** Name **{** **get**; **set**; **}**

**public** **string** Gender **{** **get**; **set**; **}**

**public** **string** Dept **{** **get**; **set**; **}**

**public** **int** Salary **{** **get**; **set**; **}**

**}**

**}**

##### **Creating Business Layer:**

Now we will create two classes that will return the list of users and the list of employees. Right-click on the Models folder and add a class file with the Name **UserBL.cs** and then copy and paste the below code. As you can see, here we created one method to return the list of users. In real-time, you will get the list of users from a database, but here, we are hardcoded the user’s list.

**namespace** *BasicAuthenticationWEBAPI.Models*

**{**

**public** **class** UsersBL

**{**

**public** List**<**User**>** GetUsers**()**

**{**

// In Real-time you need to get the data from any persistent storage

// For Simplicity of this demo and to keep focus on Basic Authentication

// Here we are hardcoded the data

List**<**User**>** userList = new List**<**User**>()**;

userList.Add**(**new User**()**

**{**

ID = 101,

UserName = "MaleUser",

Password = "123456"

**})**;

userList.Add**(**new User**()**

**{**

ID = 101,

UserName = "FemaleUser",

Password = "abcdef"

**})**;

**return** userList;

**}**

**}**

**}**

Similarly, right-click on the Models folder and add a class file with the Name **EmployeeBL.cs** and then copy and paste the below code into it. As you can see, here we created one method to return the list of employees. In real-time, you will get the list of employees from a database, but here, we are hardcoded the employee’s list.

**namespace** *BasicAuthenticationWEBAPI.Models*

**{**

**public** **class** EmployeeBL

**{**

**public** List**<**Employee**>** GetEmployees**()**

**{**

// In Real-time you need to get the data from any persistent storage

// For Simplicity of this demo and to keep focus on Basic Authentication

// Here we hardcoded the data

List**<**Employee**>** empList = new List**<**Employee**>()**;

**for** **(int** i = 0; i **<** 10; i++**)**

**{**

**if** **(**i **>** 5**)**

**{**

empList.Add**(**new Employee**()**

**{**

ID = i,

Name = "Name" + i,

Dept = "IT",

Salary = 1000 + i,

Gender = "Male"

**})**;

**}**

**else**

**{**

empList.Add**(**new Employee**()**

**{**

ID = i,

Name = "Name" + i,

Dept = "HR",

Salary = 1000 + i,

Gender = "Female"

**})**;

**}**

**}**

**return** empList;

**}**

**}**

**}**

Now, we need to create a class that will check whether the username and password are valid or not. Right-click on the Models folder and add a class file with the Name **UserValidate.cs** and then copy and paste the following code into it. As you can see, here, the Login method takes the username and password as input parameters. Then it will check whether the username and password are valid or not. If valid, then it returns TRUE indicating the user is valid else returns FALSE indicating the user is invalid.

**namespace** *BasicAuthenticationWEBAPI.Models*

**{**

**public** **class** UserValidate

**{**

//This method is used to check the user credentials

**public** **static** **bool** Login**(string** username, **string** password**)**

**{**

UsersBL userBL = new UsersBL**()**;

var UserLists = userBL.GetUsers**()**;

**return** UserLists.Any**(**user =**>**

user.UserName.Equals**(**username, StringComparison.OrdinalIgnoreCase**)**

&& user.Password == password**)**;

**}**

**}**

**}**

##### **Create a Basic Authentication Filter in ASP.NET Web API**

Right Click on the Models folder and add a class file with the name **BasicAuthenticationAttribute** and then copy and paste the following code in it. Here, the **BasicAuthenticationAttribute** class is inherited from the **AuthorizationFilterAttribute** class and overrides the OnAuthorization method which makes this class an **AuthorizationFilter**and can be applied like other attributes to the action methods or at the Controller level. Here, first, we are checking the Authorization header and if it is null, we are simply returning an Unauthorized error to the client. If the Authorization header is not null, then we are taking the Authorization header value, then we decode the value and then we split the decoded value and get the user name and password. Then we call the Login method of the UserValidate class to check if the user is a valid user or not. If the user is not valid, then we return an Unauthorized error to the client else we will proceed with the request.

**using** *System;*

**using** *System.Net;*

**using** *System.Net.Http;*

**using** *System.Security.Principal;*

**using** *System.Text;*

**using** *System.Threading;*

**using** *System.Web;*

**using** *System.Web.Http.Controllers;*

**using** *System.Web.Http.Filters;*

**namespace** *BasicAuthenticationWEBAPI.Models*

**{**

**public** **class** BasicAuthenticationAttribute : AuthorizationFilterAttribute

**{**

**private** const **string** Realm = "My Realm";

**public** **override** **void** OnAuthorization**(**HttpActionContext actionContext**)**

**{**

//If the Authorization header is empty or null

//then return Unauthorized

**if** **(**actionContext.Request.Headers.Authorization == **null)**

**{**

actionContext.Response = actionContext.Request

.CreateResponse**(**HttpStatusCode.Unauthorized**)**;

// If the request was unauthorized, add the WWW-Authenticate header

// to the response which indicates that it require basic authentication

**if** **(**actionContext.Response.StatusCode == HttpStatusCode.Unauthorized**)**

**{**

actionContext.Response.Headers.Add**(**"WWW-Authenticate",

**string**.Format**(**"Basic realm=\"{0}\"", Realm**))**;

**}**

**}**

**else**

**{**

//Get the authentication token from the request header

**string** authenticationToken = actionContext.Request.Headers

.Authorization.Parameter;

//Decode the string

**string** decodedAuthenticationToken = Encoding.UTF8.GetString**(**

Convert.FromBase64String**(**authenticationToken**))**;

//Convert the string into an string array

**string[]** usernamePasswordArray = decodedAuthenticationToken.Split**(**':'**)**;

//First element of the array is the username

**string** username = usernamePasswordArray**[**0**]**;

//Second element of the array is the password

**string** password = usernamePasswordArray**[**1**]**;

//call the login method to check the username and password

**if** **(**UserValidate.Login**(**username, password**))**

**{**

var identity = new GenericIdentity**(**username**)**;

IPrincipal principal = new GenericPrincipal**(**identity,**null)**;

Thread.CurrentPrincipal = principal;

**if** **(**HttpContext.Current != **null)**

**{**

HttpContext.Current.User = principal;

**}**

**}**

**else**

**{**

actionContext.Response = actionContext.Request

.CreateResponse**(**HttpStatusCode.Unauthorized**)**;

**}**

**}**

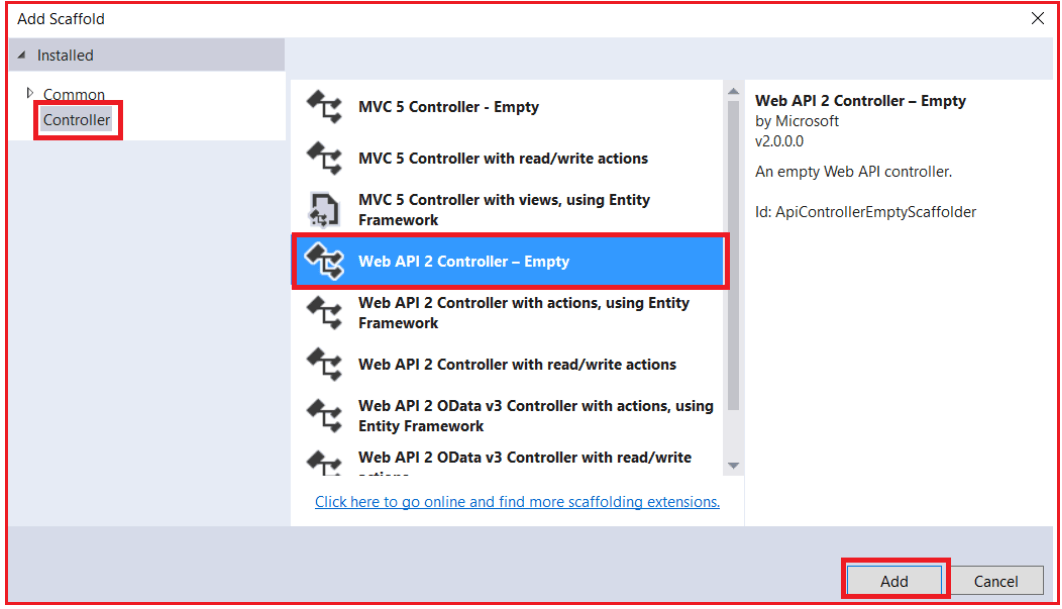
**}**

**}**

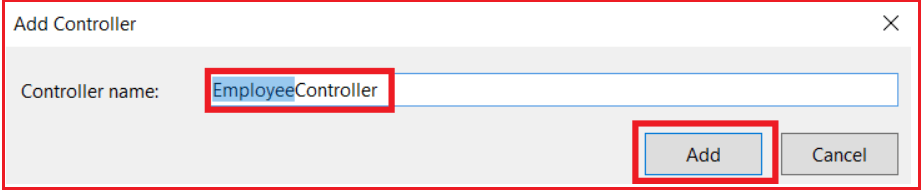
**}**

##### **Adding WebAPI2 Empty Controller**

Right-click on the Controllers folder and select **Add => Controller** which will open the window to select the controller as shown below.



From this window select **Web API 2 Controller – Empty** and click on the **Add** button, which will open another window to give a name to your controller as shown below.

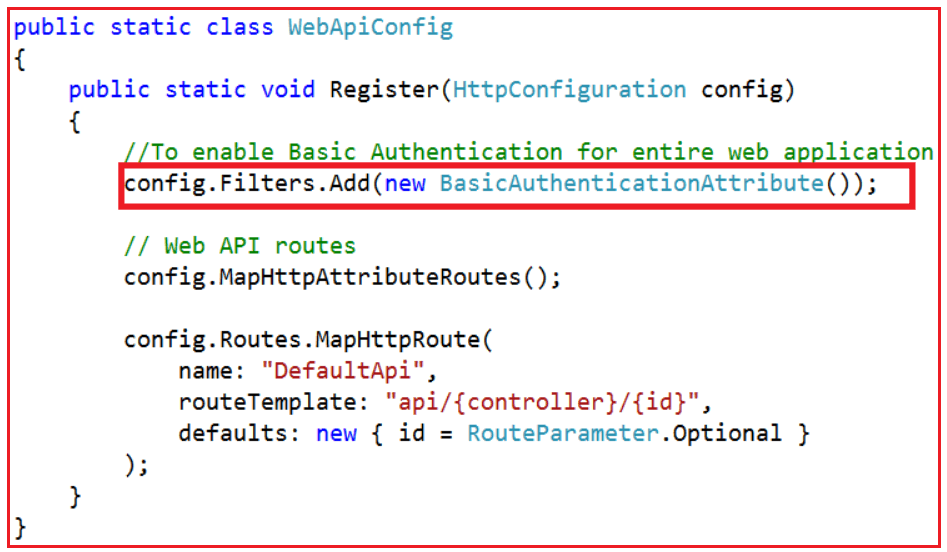


Provide the controller name as Employee and click on the Add button which will add Employee Controller within the controller folder.

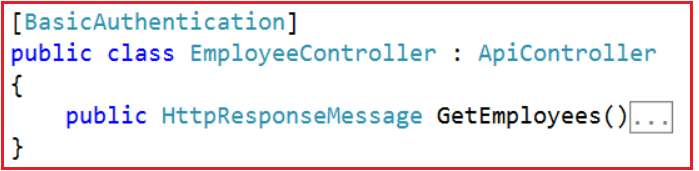
##### **Enable Web API Basic Authentication**

We can enable basic authentication in many different ways by applying the **BasicAuthenticationAttribute**. We can apply the **BasicAuthenticationAttribute** attribute on a specific controller, specific action, or globally which will be applicable to all Web API controllers and action methods.

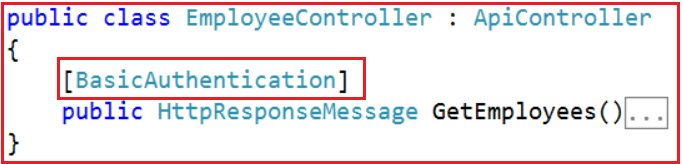
To enable the basic authentication across the entire ASP.NET Web API application, register the **BasicAuthenticationAttribute** as a filter using the **Register()** method in **WebApiConfig** class as shown in the below image.



We can also apply the BasicAuthenticationAttribute attribute on a specific controller which will enable the basic authentication for all the methods that are present in that controller as shown in the below image.



You can also enable the basic authentication at the action method level as shown in the below image which is only applicable to that particular action method which is decorated with the BasicAuthenticationAttribute.



Let’s first add an action method to the Employee Controller with the following business requirements. As we have two users i.e. MaleUser and FemaleUser and if the user login with the MaleUser username we want to display all the “male” employees and if the user login with the FemaleUser username we want to display all the female employees. Along with the above business requirement, we also enable basic authentication at the action method level.

###### **Add the following action method within the Employee controller**

**namespace** *BasicAuthenticationWEBAPI.Controllers*

**{**

**public** **class** EmployeeController : ApiController

**{**

**[**BasicAuthentication**]**

**public** HttpResponseMessage GetEmployees**()**

**{**

**string** username = Thread.CurrentPrincipal.Identity.Name;

var EmpList = new EmployeeBL**()**.GetEmployees**()**;

**switch** **(**username.ToLower**())**

**{**

**case** "maleuser":

**return** Request.CreateResponse**(**HttpStatusCode.OK,

EmpList.Where**(**e =**>** e.Gender.ToLower**()** == "male"**)**.ToList**())**;

**case** "femaleuser":

**return** Request.CreateResponse**(**HttpStatusCode.OK,

EmpList.Where**(**e =**>** e.Gender.ToLower**()** == "female"**)**.ToList**())**;

**default**:

**return** Request.CreateResponse**(**HttpStatusCode.BadRequest**)**;

**}**

**}**

**}**

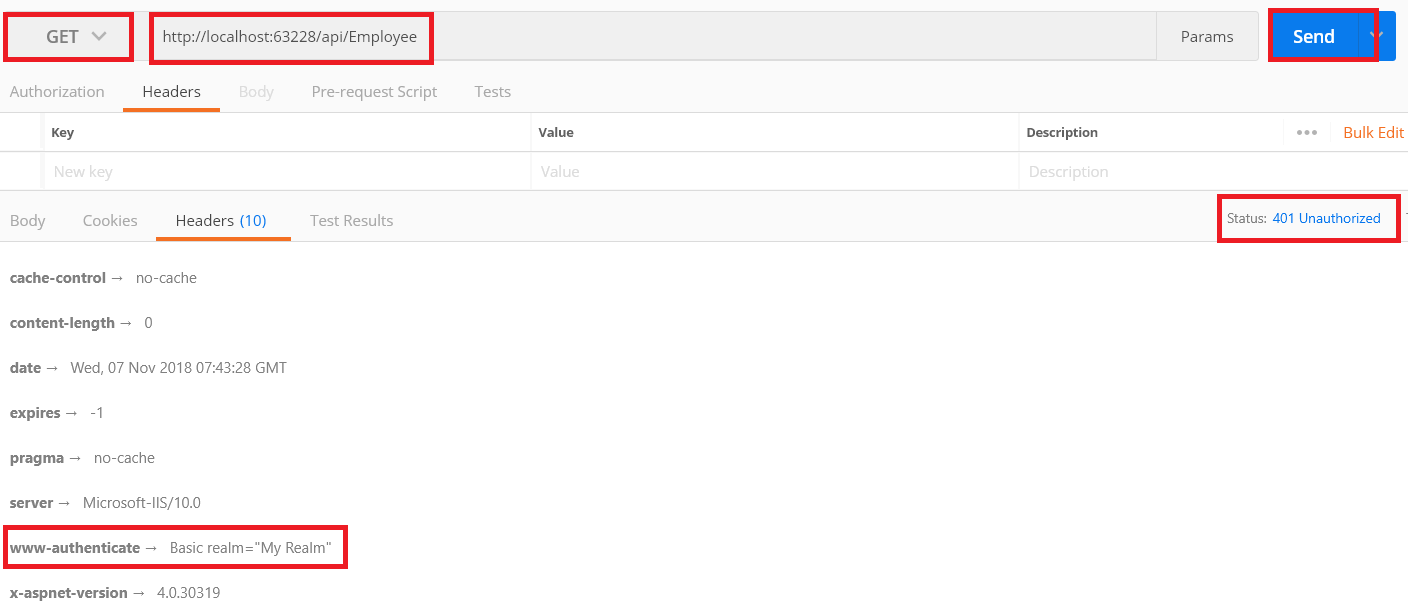
**}**

##### **Testing the Web API Basic Authentication using Postman**

If you are new to the postman, I strongly recommended you to read the following article, where I discussed how to download and use postman to test rest services.

[**https://dotnettutorials.net/lesson/how-to-use-postman-to-test-web-api/**](https://dotnettutorials.net/lesson/how-to-use-postman-to-test-web-api/)

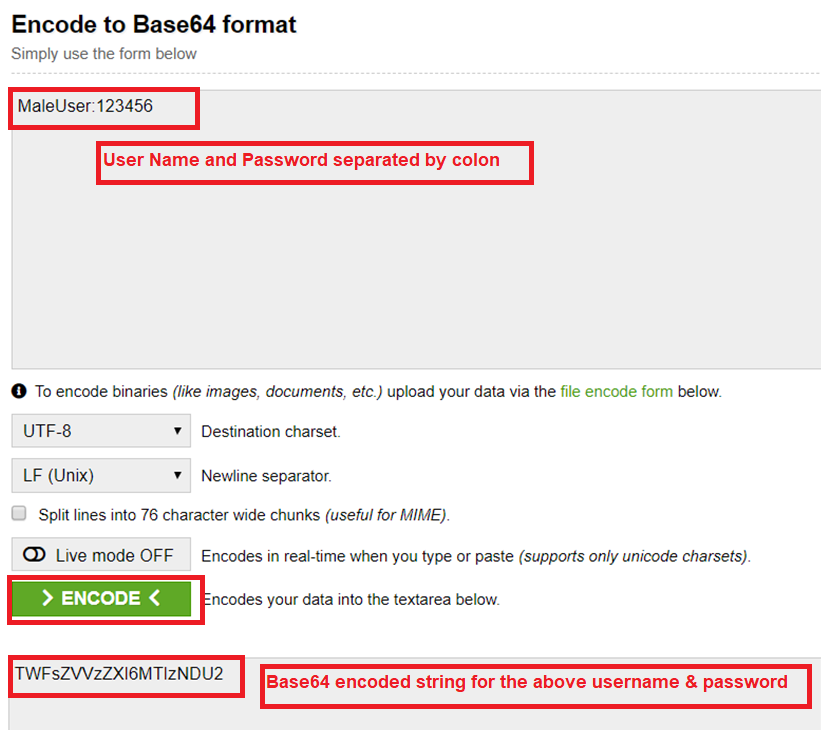
Let’s first make a request without passing the authorization header. Set the method type as GET, provide the request URI and click on the Send button as shown in the below image.



Here you can observe that you will get a 401 status code which is Unauthorized. Let’s make the request to use the Authorization header. The username and password need to be a colon (:) separated and must be in base64 encoded. To do so, just use the following website

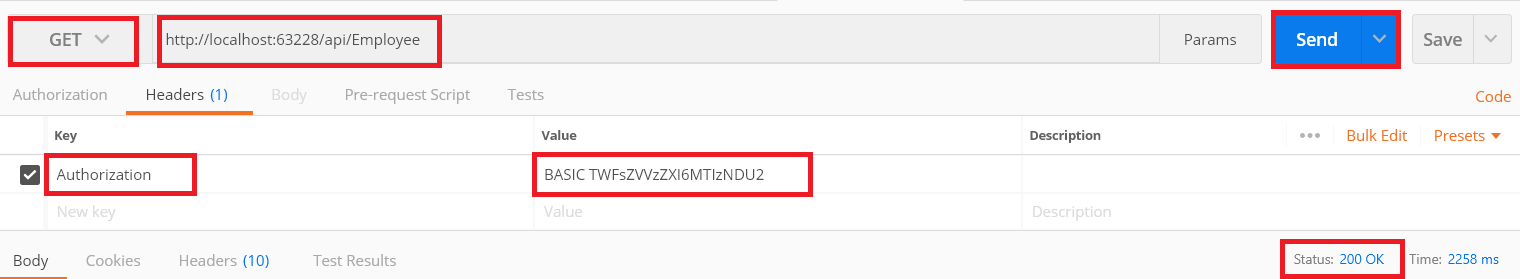
[**https://www.base64encode.org/**](https://www.base64encode.org/)

Enter the username and password separated by a colon (:) in the **“Encode to Base64 format”** textbox, and then click on the **“Encode”**button as shown in the below diagram which will generate the Base64 encoded value.



Once you generate the Base64 encoded string, let’s see how to use basic authentication in the header to pass the Base64 encoded value. Here we need to use the Authorization header and the value will be the Base64 encoded string followed the “BASIC” as shown below.

**Authorization: BASIC TWFsZVVzZXI6MTIzNDU2**



Once you click on the Send button, you can see that the status code is 200 as expected.

# Memento Design Pattern Using C#:

**What is the Memento Pattern?**  
According to the GoF's definition, what this pattern does is:  
  
Without violating encapsulation, capture and externalize an object's internal state so that the object can be restored to this state later.  
  
**A Real world example**  
Let's use an example of a computer game, where we have a player who will need to cross levels 1 to 5 to complete the game and will score different scores at each level. We will create a checkpoint for this player at level 1, with some initial score at a specific instance of time, and store a snapshot of its data. Then we will update the score, level and time of the player. Now with some business rule, say the player looses a life, he will again need to start from that checkpoint. So when he starts again from the checkpoint, we will restore the snapshot data and proceed further accordingly. In order to do this, we will divide the system into the following components.

**Originator or MainClass**This is the main class of the system that maintains the data of the player, in other words its level, score and so on and for which we want to create a snapshot of the data. In our case, it will be a PlayerStatistics class, with 3 properties named Level, Score and CheckPointTime. These are the properties or the data of the player, for which we want to create a snapshot.

**Memento**This class is used to store the snapshot of the Originator class data. In our case, it will be the CheckPointMemento class, only with properties, for which we want to store the data, in other words for each of the properties that we want to have in the snapshot, we create a property in the memento class.

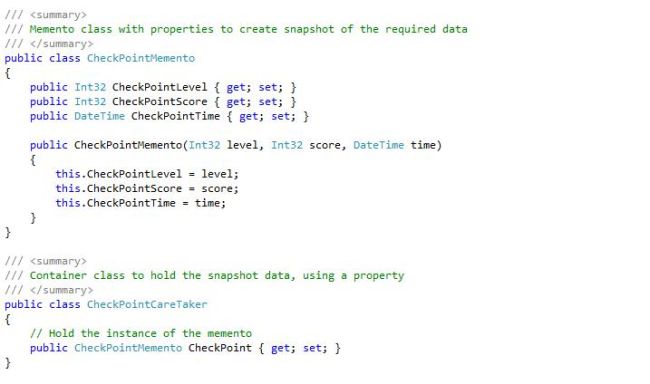
**CareTakerClass**This is like a container class, that holds the Memento class instance, that further holds the snapshot of the original data. In our case, it will be CheckPointCareTaker, and will hold the memento instance using a property defined in it.

So, to start with, we create the following classes:

A PlayerStatistics class and its properties.

A CheckPointMemento class, with the properties for which we want to store the snapshot data of the PlayerStatistics class.

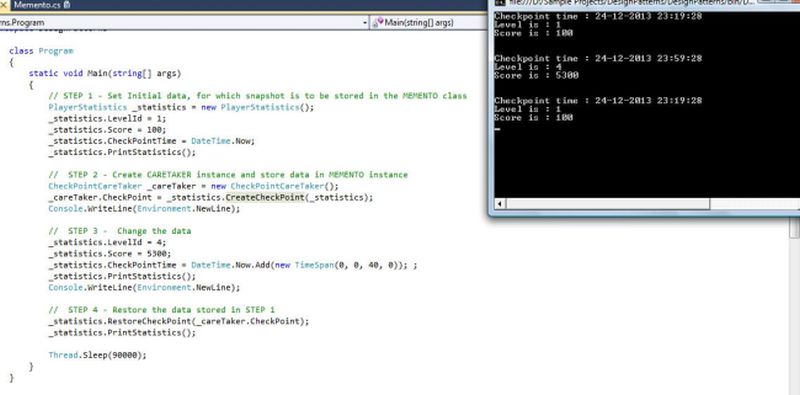
A CheckPointCareTakerclass, that will act as a container for CheckPointMemento class.

See the classes below. These are the memento and caretaker classes.  
  
  
  
Now we will create the main class PlayerStatistics and an important point to note here is that the PlayerStatistics class will have two methods, apart from the properties to hold the player data. These methods are:

**CreateCheckPoint()**This method will be used to return the instance of the memento that is storing the data of which we would like to create a snapshot. The instance returned by this method will be added to the container or the CheckPointCareTaker class, by setting the property.

**RestoreCheckPoint()**This method will receive the memento class instance or you can say the snapshot data that we added at the checkpoint. The data received will then be returned to the original properties.

See the complete code for the Main/originator class, with the properties and the two methods explained above.  
  
  
  
Now we have set up the initial code. It's time to write the client code. So we start by setting some initial data for the player. Then we will store the data in a memento instance and add it to the caretaker container class. Further we will change the data and then finally retrieve the stored data from the memento instance.

So our code will be like the following:  
  
  
  
**How is it working ?**  
Let's explain the client code now.

In Step 1, we simply set the properties of the player data and print them.

In Step 2, we call the CreateCheckPoint() method in the main class, and generate the instance of the memento class type. This instance is then assigned to the CheckPointCareTakerclass, that acts as a container here to hold the snapshot data.

In Step 3, we simply update the data and print it, like we did in Step 1.

In Step 4, we basically perform the undo operation and retrieve the original data that we had at the start. This is done by calling the RestoreCheckPoint method in the main class and passing it the data from the container or caretaker class. The data received is then set back to the properties and printed again.

# Abstract Factory Design Pattern In C#

Abstract Factory pattern also falls under Creational Pattern of Gang of Four (GoF) Design Patterns.

**What is it?**

An interface for creating families of related or dependent objects without specifying their concrete classes. We can say it is just an object maker which can create more than one type of object.

The object it produces is known to the client only by that object's interface, not by the object's actual concrete implementation.

**When to use it?**

We use it when we have a requirement to create a set of related objects, or dependent objects which must be used together as families of objects. Concrete classes should be decoupled from clients.

How does it differ from Factory Method?

First of all, both of them fall under Creational category and it means both will solve the problem relating to object creation. Factory Method and Abstract Factory design pattern are about creating objects.

Factory Method Design Pattern

Here, we define an interface which will expose a method which will create objects for us. Return type of that method is never a concrete type; rather, it will be some interface (or may be an abstract class).

Creates object through inheritance

Produce only one product

Implements code in the abstract creator that makes use of the concrete type that sub class produces

# Abstract Factory Design Pattern

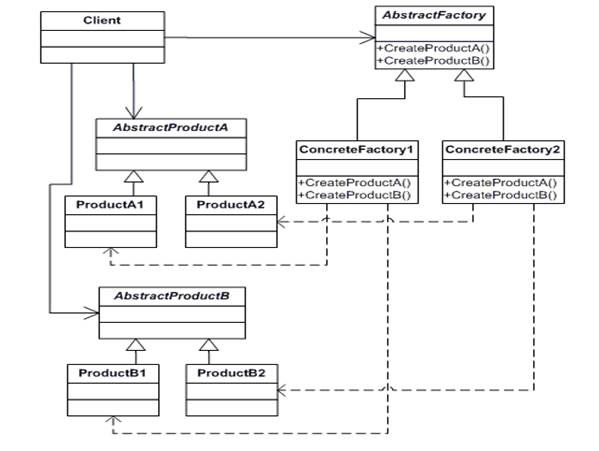
Here, we define an interface which will create families of related or dependent objects. In simple words, interface will expose multiple methods each of which will create some object. Again, here method return types will be generic interfaces. All these objects will together become part of some important functionality.

Creates object through composition

Produce families of products

Concrete factories implement factory method to create product

UML Class Diagram

****

The classes and objects participating in the above UML class diagram are as follow.

AbstractFactory  
This is an interface for operations which is used to create abstract product.

ConcreteFactory  
This is a class which implements the AbstractFactory interface operations to create concrete products.

AbstractProduct  
This declares an interface for a type of product object

Product  
This defines a product object to be created by the corresponding concrete factory also implements the AbstractProduct interface

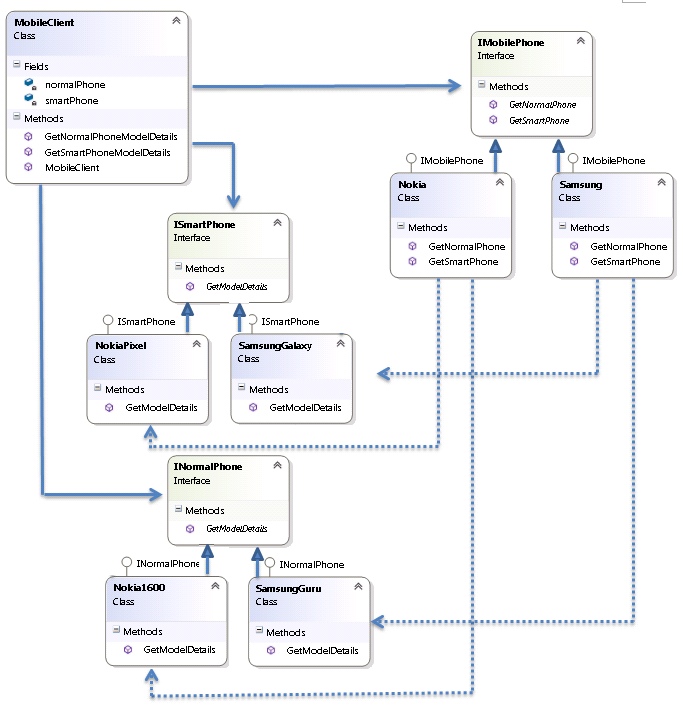
Client  
This is a class which uses AbstractFactory and AbstractProduct interfaces to create a family of related objects.

Now, let’s understand this with a real world example,

The example here has an implementation of an Abstract Factory as an Interface IMobilePhone that has methods that can create a Smart Phone object and a Normal Phone object. The client codes against IMobilePhone and gets ISmartPhone and INormalPhone interfaces.

In case of "Nokia", it creates a family of Nokia objects (SmartPhone and NormalPhone) and in case of "Samsung", creates a family of Samsung objects (SmartPhone and NormalPhone).

The client doesn't care which object (Nokia SmartPhone and NormalPhone or Samsung SmartPhone and NormalPhone), IMobilePhone interface returns as it codes against ISmartPhone and INormalPhone interface.



**Who is what?**

The classes and objects participating in the above class diagram can be identified as shown below.

AbstractFactory- IMobilePhone

ConcreteFactory - Nokia, Samsung

AbstractProduct- ISmartPhone, INormalPhone

Product- NokiaPixel, Nokia1600, SamsungGalaxy, SamsungGuru

Client- MobileClient

**Here are the code blocks for each participant**

AbstractFactory

namespace AbstractFactoryDesignPatternInCSharp

{

    /// <summary>

    /// The 'AbstractFactory' interface.

    /// </summary>

**interface** IMobilePhone

    {

        ISmartPhone GetSmartPhone();

        INormalPhone GetNormalPhone();

    }

}

ConcreteFactoryNokia

namespace AbstractFactoryDesignPatternInCSharp

{

    /// <summary>

    /// The 'ConcreteFactory1' class.

    /// </summary>

**class** Nokia : IMobilePhone

    {

**public** ISmartPhone GetSmartPhone()

        {

**return** **new** NokiaPixel();

        }

**public** INormalPhone GetNormalPhone()

        {

**return** **new** Nokia1600();

        }

    }

}

Samsung

namespace AbstractFactoryDesignPatternInCSharp

{

    /// <summary>

    /// The 'ConcreteFactory2' class.

    /// </summary>

**class** Samsung : IMobilePhone

    {

**public** ISmartPhone GetSmartPhone()

        {

**return** **new** SamsungGalaxy();

        }

**public** INormalPhone GetNormalPhone()

        {

**return** **new** SamsungGuru();

        }

    }

}

AbstractProductISmartPhone

namespace AbstractFactoryDesignPatternInCSharp

{

    /// <summary>

    /// The 'AbstractProductA' interface

    /// </summary>

**interface** ISmartPhone

    {

        string GetModelDetails();

    }

}

INormalPhone

namespace AbstractFactoryDesignPatternInCSharp

{

    /// <summary>

    /// The 'AbstractProductB' interface

    /// </summary>

**interface** INormalPhone

    {

        string GetModelDetails();

    }

}

ProductNokiaPixel

namespace AbstractFactoryDesignPatternInCSharp

{

    /// <summary>

    /// The 'ProductA1' class

    /// </summary>

**class** NokiaPixel : ISmartPhone

    {

**public** string GetModelDetails()

        {

**return** "Model: Nokia Pixel\nRAM: 3GB\nCamera: 8MP\n";

        }

    }

}

SamsungGalaxy

**namespace** AbstractFactoryDesignPatternInCSharp

{

    /// <summary>

    /// The 'ProductA2' class

    /// </summary>

**class** SamsungGalaxy : ISmartPhone

    {

**public** **string** GetModelDetails()

        {

**return** "Model: Samsung Galaxy\nRAM: 2GB\nCamera: 13MP\n";

        }

    }

}  

Nokia1600

namespace AbstractFactoryDesignPatternInCSharp

{

    /// <summary>

    /// The 'ProductB1' class

    /// </summary>

**class** Nokia1600 : INormalPhone

    {

**public** string GetModelDetails()

        {

**return** "Model: Nokia 1600\nRAM: NA\nCamera: NA\n";

        }

    }

}

SamsungGuru

namespace AbstractFactoryDesignPatternInCSharp

{

    /// <summary>

    /// The 'ProductB2' class

    /// </summary>

**class** SamsungGuru : INormalPhone

    {

**public** string GetModelDetails()

        {

**return** "Model: Samsung Guru\nRAM: NA\nCamera: NA\n";

        }

    }

}

Client

namespace AbstractFactoryDesignPatternInCSharp

{

    /// <summary>

    /// The 'Client' class

    /// </summary>

**class** MobileClient

    {

        ISmartPhone smartPhone;

        INormalPhone normalPhone;

**public** Client(IMobilePhone factory)

        {

            smartPhone = factory.GetSmartPhone();

            normalPhone = factory.GetNormalPhone();

        }

**public** string GetSmartPhoneModelDetails()

        {

**return** smartPhone.GetModelDetails();

        }

**public** string GetNormalPhoneModelDetails()

        {

**return** normalPhone.GetModelDetails();

        }

    }

}

Factory Pattern Client Demo

using System;

namespace AbstractFactoryDesignPatternInCSharp

{

    /// <summary>

    /// Abstract Factory Pattern Demo

    /// </summary>

**class** Program

    {

**static** **void** Main()

        {

            IMobilePhone nokiaMobilePhone = **new** Nokia();

            MobileClient nokiaClient = **new** MobileClient(nokiaMobilePhone);

            Console.WriteLine("\*\*\*\*\*\*\*\*\* NOKIA \*\*\*\*\*\*\*\*\*\*");

            Console.WriteLine(nokiaClient.GetSmartPhoneModelDetails());

            Console.WriteLine(nokiaClient.GetNormalPhoneModelDetails());

            IMobilePhone samsungMobilePhone = **new** Samsung();

            MobileClient samsungClient = **new** MobileClient(samsungMobilePhone);

            Console.WriteLine("\*\*\*\*\*\*\* SAMSUNG \*\*\*\*\*\*\*\*\*\*");

            Console.WriteLine(samsungClient.GetSmartPhoneModelDetails());

            Console.WriteLine(samsungClient.GetNormalPhoneModelDetails());

            Console.ReadKey();

        }

    }

}

What Is Factory Design Pattern ?The Factory Design Pattern is a commonly used design pattern where we need to create Loosely Coupled System. Basically, it comes under Creational Pattern and it is used to create instance and reuse it. Factory Pattern is based on real time factory concept. As we know, a factory is used to manufacture something as per the requirement and if new items are added in the manufacturing process, the factory starts manufacturing those items as well. Factory class provides abstraction between Client and Car when creating the instance of the Car [Honda, BMW etc].  
  
**When to use Factory Design Pattern**It is used for creating objects to encapsulate the instantiation logic. Client doesn’t know the actual instantiation logic of entity.  
  
**Problem**For example, where we have created two different classes as Honda and BMW. Those classes are implementing the ICarSupplier interface which has one property as CarColor and one method which provides the Car Model.  
  
On the client side, we are simply creating the objects of two classes to get their member function and behavior.

1. using System;
3. namespace FactoryDesignPattern
4. {
5. **public** **interface** ICarSupplier
6. {
7. string CarColor
8. {
9. get;
10. }
11. **void** GetCarModel();
12. }
13. **class** Honda : ICarSupplier
14. {
15. **public** string CarColor
16. {
17. get { **return** "RED"; }
18. }
20. **public** **void** GetCarModel()
21. {
22. Console.WriteLine("Honda Car Model is Honda 2014");
23. }
24. }
25. **class** BMW : ICarSupplier
26. {
27. **public** string CarColor
28. {
29. get { **return** "WHITE"; }
30. }
31. **public** **void** GetCarModel()
32. {
33. Console.WriteLine("BMW Car Model is BMW 2000");
34. }
35. }
37. **class** ClientProgram
38. {
39. **static** **void** Main(string[] args)
40. {
41. Honda objHonda = **new** Honda();
42. objHonda.GetCarModel();
44. BMW objBMW = **new** BMW();
45. objBMW.GetCarModel();
47. Console.ReadLine();
48. }
49. }
50. }

But what is the problem with this code? Just think, if in the future, a new Car [Nano] is introduced and the client has to create an instance of that class to access all the property and member function, they need to modify the object creation logic and add the following code.  
  
Nano is a new class which also implements ICarSupplier.

1. **class** Nano : ICarSupplier
2. {
3. **public** string CarColor
4. {
5. get { **return** "YELLOW"; }
6. }
7. **public** **void** GetCarModel()
8. {
9. Console.WriteLine("Nano Car Model is Nano 2016");
10. }
11. }

Instantiation of Nano class.

1. Nano objNano = **new** Nano();
2. objNano.GetCarModel();

We can do that if we add new class, we need to modify the instantiation logic at client, as above code shown. The biggest problem is that we don't know how many entities are going to add in future. If new car is added, then we need to write the logic at client end to access that class properties and methods. So, we need to add a Factory which will give you the instance at runtime.  
  
**Solution**  
So, in Factory Design Pattern, there we will add a Factory class where we can add a method which will return the instance of the class based on your requirement. We can see with the following code where GetCarInstance method takes one argument as Id.  
  
On the basis of the Id, it will return the instance of the Car. As per example, if client passes 0, then it will return the instance of the Honda Car, if they pass 1, then it will return the instance of BMW car.

1. **static** **class** CarFactory
2. {
3. **public** **static** ICarSupplier GetCarInstance(**int** Id)
4. {
5. **switch** (Id)
6. {
7. **case** 0:
8. **return** **new** Honda();
9. **case** 1:
10. **return** **new** BMW();
11. **case** 2:
12. **return** **new** Nano();
13. **default**:
14. **return** **null**;
15. }
16. }
17. }

In future, if a new car is launched e.g. Suzuki, there is no need to add anything on the client side. You just need to add one case for Suzuki to get the instance.   
  
**case 3**

1. **return** **new** Suzuki();

And, just pass the id=3 when creating the object of CarFactory class. Just notice with following code, we are passing 3 inside the GetCarInstance and as we have defined in CarFactory, it will return the instance of the Suzuki Car.

1. ICarSupplier objCarSupplier = CarFactory.GetCarInstance(3);
2. objCarSupplier.GetCarModel();
3. Console.WriteLine("And Coloar is " + objCarSupplier.CarColor);

Following is the whole code for demonstration of Factory Design Pattern which will give us an idea of how and where we should implement Factory Design Pattern in Real Life.

1. using System;
3. namespace FactoryDesignPattern
4. {
5. **public** **interface** ICarSupplier
6. {
7. string CarColor
8. {
9. get;
10. }
11. **void** GetCarModel();
12. }
13. **class** Honda : ICarSupplier
14. {
15. **public** string CarColor
16. {
17. get { **return** "RED"; }
18. }
20. **public** **void** GetCarModel()
21. {
22. Console.WriteLine("Honda Car Model is Honda 2014");
23. }
24. }
25. **class** BMW : ICarSupplier
26. {
27. **public** string CarColor
28. {
29. get { **return** "WHITE"; }
30. }
31. **public** **void** GetCarModel()
32. {
33. Console.WriteLine("BMW Car Model is BMW 2000");
34. }
35. }
37. **class** Nano : ICarSupplier
38. {
39. **public** string CarColor
40. {
41. get { **return** "YELLOW"; }
42. }
43. **public** **void** GetCarModel()
44. {
45. Console.WriteLine("Nano Car Model is Nano 2016");
46. }
47. }
48. **class** Suzuki : ICarSupplier
49. {
50. **public** string CarColor
51. {
52. get { **return** "Orange"; }
53. }
54. **public** **void** GetCarModel()
55. {
56. Console.WriteLine("Suzuki Car Model is Suzuki 2006");
57. }
58. }
60. **static** **class** CarFactory
61. {
62. **public** **static** ICarSupplier GetCarInstance(**int** Id)
63. {
64. **switch** (Id)
65. {
66. **case** 0:
67. **return** **new** Honda();
68. **case** 1:
69. **return** **new** BMW();
70. **case** 2:
71. **return** **new** Nano();
72. **case** 3:
73. **return** **new** Suzuki();
74. **default**:
75. **return** **null**;
76. }
77. }
78. }
79. **class** ClientProgram
80. {
81. **static** **void** Main(string[] args)
82. {
84. ICarSupplier objCarSupplier = CarFactory.GetCarInstance(3);
85. objCarSupplier.GetCarModel();
86. Console.WriteLine("And Coloar is " + objCarSupplier.CarColor);
88. Console.ReadLine();
89. }
91. }

# }

# What is Singleton Design Pattern?

Ensures a class has only one instance and provides a global point of access to it.

A singleton is a class that only allows a single instance of itself to be created, and usually gives simple access to that instance.

Most commonly, singletons don't allow any parameters to be specified when creating the instance, since a second request of an instance with a different parameter could be problematic! (If the same instance should be accessed for all requests with the same parameter then the factory pattern is more appropriate.)

There are various ways to implement the Singleton Pattern in C#. The following are the common characteristics of a Singleton Pattern.

A single constructor, that is private and parameterless.

The class is sealed.

A static variable that holds a reference to the single created instance, if any.

A public static means of getting the reference to the single created instance, creating one if necessary.

**Advantages of Singleton Pattern**

The advantages of a Singleton Pattern are:

Singleton pattern can be implemented interfaces.

It can be also inherit from other classes.

It can be lazy loaded.

It has Static Initialization.

It can be extended into a factory pattern.

It helps to hide dependencies.

It provides a single point of access to a particular instance, so it is easy to maintain.

Disadvantages of Singleton Pattern

The disadvantages of a Singleton Pattern are:

Unit testing is more difficult (because it introduces a global state into an application).

This pattern reduces the potential for parallelism within a program, because to access the singleton in a multi-threaded system, an object must be serialized (by locking).

How to Implement Singleton Pattern in your code

There are many ways to implement a Singleton Pattern in C#.

No Thread Safe Singleton.

Thread-Safety Singleton.

Thread-Safety Singleton using Double-Check Locking.

Thread-Safe Singleton without using locks and no lazy instantiation.

Fully lazy instantiation.

Using .NET 4's Lazy<T> type.

**1. No Thread Safe Singleton**

Explanation of the following code:

The following code is not thread-safe.

Two different threads could both have evaluated the test (if instance == null) and found it to be true, then both creates instances, which violates the singleton pattern.

Note that in fact the instance may already have been created before the expression is evaluated, but the memory model doesn't guarantee that the new value of instance will be seen by other threads unless suitable memory barriers have been passed.

**public** **sealed** **class** Singleton

{

    //Private Constructor.

**private** Singleton()

    {

    }

**private** **static** Singleton instance = **null**;

**public** **static** Singleton Instance

    {

**get**

        {

**if** (instance == **null**)

            {

                instance = **new** Singleton();

            }

**return** instance;

        }

    }

}

**2. Thread Safety Singleton**

Explanation of the following code:

This implementation is thread-safe.

In the following code, the thread is locked on a shared object and checks whether an instance has been created or not.

This takes care of the memory barrier issue and ensures that only one thread will create an instance.

For example: Since only one thread can be in that part of the code at a time, by the time the second thread enters it, the first thread will have created the instance, so the expression will evaluate to false.

The biggest problem with this is performance; performance suffers since a lock is required every time an instance is requested.

**public** **sealed** **class** Singleton

{

    Singleton()

    {

    }

**private** **static** **readonly** **object** padlock = **new** **object**();

**private** **static** Singleton instance = **null**;

**public** **static** Singleton Instance

    {

**get**

        {

**lock** (padlock)

                            {

**if** (instance == **null**)

                {

                    instance = **new** Singleton();

                }

**return** instance;

            }

        }

    }

}

**3. Thread Safety Singleton using Double Check Locking**

Explanation of the following code:

In the following code, the thread is locked on a shared object and checks whether an instance has been created or not with double checking.

**public** **sealed** **class** Singleton

{

    Singleton()

    {

    }

**private** **static** **readonly** **object** padlock = **new** **object**();

**private** **static** Singleton instance = **null**;

**public** **static** Singleton Instance

    {

**get**

        {

**if** (instance == **null**)

            {

**lock** (padlock)

                {

**if** (instance == **null**)

                    {

                        instance = **new** Singleton();

                    }

                }

            }

**return** instance;

        }

    }

}

# Façade:

Facade is a **structural design pattern** that provides a simplified interface to a library, a framework, or any other complex set of classes.

If we try to understand this in simpler terms, then we can say that a room is a façade and just by looking at it from outside the door, one cannot predict what is inside the room and how the room is structured from inside. Thus, Façade is a general term for simplifying the outward appearance of a complex or large system.

In software terms, Facade pattern hides the complexities of the systems and provides a simple interface to the clients.

This pattern involves one wrapper class which contains a set of methods available for the client. This pattern is particularly used when a system is very complex or difficult to understand and when the system has multiple subsystems.

Let’s see the below UML diagram,



Here, we can see that the client is calling the Façade class which interacts with multiple subsystems making it easier for the client to interact with them.

However, it is possible that façade may provide limited functionality in comparison to working with the subsystem directly, but it should include all those features which are actually required by the client.

For example, when someone calls the restaurant, suppose, for ordering pizza or some other food, then the operator on behalf of the restaurant gives the voice interface which is actually the façade for their customers.

Customers place their orders just by talking to the operator and they don’t need to bother about how they will prepare the pizza, what all operations will they perform, on what temperature they will cook, etc.

Similarly, in our code sample, we can see that the client is using the restaurant façade class to order pizza and bread of different types without directly interacting with the subclasses.

Now, it's time to dive into the real code.

This is the interface specific to the pizza.

**public** **interface** IPizza {

**void** GetVegPizza();

**void** GetNonVegPizza();

}

This is a pizza provider class which will get pizza for their clients. Here methods can have other private methods which client is not bothered about.

**public** **class** PizzaProvider: IPizza {

**public** **void** GetNonVegPizza() {

        GetNonVegToppings();

        Console.WriteLine("Getting Non Veg Pizza.");

    }

**public** **void** GetVegPizza() {

        Console.WriteLine("Getting Veg Pizza.");

    }

**private** **void** GetNonVegToppings() {

        Console.WriteLine("Getting Non Veg Pizza Toppings.");

    }

}

Similarly, this is the interface specific for the bread.

**public** **interface** IBread {

**void** GetGarlicBread();

**void** GetCheesyGarlicBread();

}

And this is a bread provider class.

**public** **class** BreadProvider: IBread {

**public** **void** GetGarlicBread() {

        Console.WriteLine("Getting Garlic Bread.");

    }

**public** **void** GetCheesyGarlicBread() {

        GetCheese();

        Console.WriteLine("Getting Cheesy Garlic Bread.");

    }

**private** **void** GetCheese() {

        Console.WriteLine("Getting Cheese.");

    }

}

Below is the restaurant façade class, which will be used by the client to order different pizzas or breads.

**public** **class** RestaurantFacade {

**private** IPizza \_PizzaProvider;

**private** IBread \_BreadProvider;

**public** RestaurantFacade() {

        \_PizzaProvider = **new** PizzaProvider();

        \_BreadProvider = **new** BreadProvider();

    }

**public** **void** GetNonVegPizza() {

        \_PizzaProvider.GetNonVegPizza();

    }

**public** **void** GetVegPizza() {

        \_PizzaProvider.GetVegPizza();

    }

**public** **void** GetGarlicBread() {

        \_BreadProvider.GetGarlicBread();

    }

**public** **void** GetCheesyGarlicBread() {

        \_BreadProvider.GetCheesyGarlicBread();

    }

}

Finally, below is the main method of our program,

**void** Main() {

    Console.WriteLine("----------------------CLIENT ORDERS FOR PIZZA----------------------------\n");

    var facadeForClient = **new** RestaurantFacade();

    facadeForClient.GetNonVegPizza();

    facadeForClient.GetVegPizza();

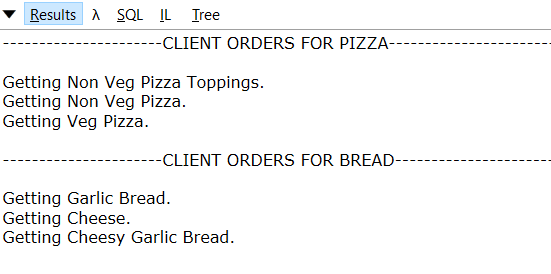
    Console.WriteLine("\n----------------------CLIENT ORDERS FOR BREAD----------------------------\n");

    facadeForClient.GetGarlicBread();

    facadeForClient.GetCheesyGarlicBread();

}

**OUTPUT**



Now, let’s see when we should use this pattern and what could be the real-life scenarios:

**WHEN TO USE THIS PATTERN**

Use this pattern to simplify the problem when there are multiple complex subsystems and interacting with them individually is really difficult/cumbersome.

**REAL LIFE USE CASE**

The shopkeeper is a façade for all the items in the shop.

Online travel portal is a façade for their customers for different holiday/travel packages.

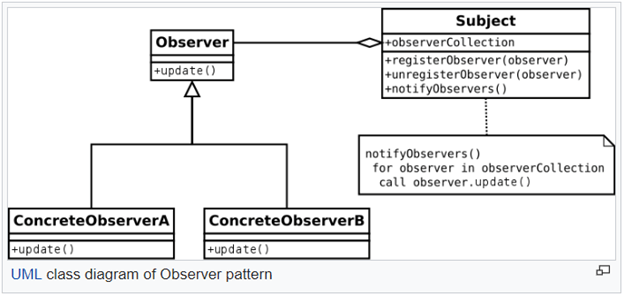
Customer care is a façade for their customers for different services.

# Observer Pattern:

This pattern falls under the category of behavioral pattern. As the name suggests, it is based on the principle where one object observes another object.

So, in simple words, this pattern defines a one-to-many relationship between subject and observer objects so that if the subject changes its state, then all of the dependent observer objects will be notified of the change.

Let’s understand it in more details using the UML diagram, as shown below.

  
Image source: Wikipedia

**For example**

Consider a technical author like we have in C# Corner, who writes blogs, articles etc. So, if someone likes reading articles from a specific author, one can follow/subscribe the author for future articles. This is a real-life scenario of the Observer pattern.

In this case, all the subscribers who want to subscribe to the author are Observer Objects and the author is a Subject.

Now, let’s dive into the actual code to see how it works.

This is the interface which will be implemented by the subject.

**public** **interface** ISubject {

**void** registerObserver(Observer observer);

**void** unregisterObserver(Observer observer);

**void** notifyObservers();

}

This is the Subject class and as per our example mentioned above, the author will be the Subject. So here, we are assuming that the author has already written 1 article and those who will like the article can subscribe or unsubscribe (if they have already subscribed) accordingly.

Now, whenever the subject changes its state, all of its observers will be notified.

**public** **class** Subject: ISubject {

**private** List < Observer > Observers = **new** List < Observer > ();

**private** **int** articlesCount = 1;

**public** **int** Articles {

**get** {

**return** articlesCount;

        }

**set** {

**if** (value > articlesCount) {

                articlesCount++;

                notifyObservers();

            }

        }

    }

**public** **void** registerObserver(Observer observer) {

        Observers.Add(observer);

    }

**public** **void** unregisterObserver(Observer observer) {

        Observers.Remove(observer);

    }

**public** **void** notifyObservers() {

**foreach**(var observer **in** Observers) {

            observer.Update();

        }

    }

}

This is the interface which will be implemented by all the Observer objects. As per our example, all the subscribers/followers for the author will be the Observer objects.

**public** **interface** IObserver {

**void** Update();

}

This is the Observer class which can be used to create different observers.

**public** **class** Observer: IObserver {

**public** **string** ObserverName;

**public** Observer(**string** name) {

        ObserverName = name;

    }

**public** **void** Update() {

        //Observer can update his system accordingly

        Console.WriteLine("Hello " + ObserverName + ", a new article has been published by the author.");

    }

}

Finally, this is the main method which can be used for running this program.

**void** Main() {

    var subject = **new** Subject();

    var observerA = **new** Observer("Observer A");

    var observerB = **new** Observer("Observer B");

    var observerC = **new** Observer("Observer C");

    Console.WriteLine("Intially suppose Subject has already written total " + subject.Articles + " article");

    Console.WriteLine("\n\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\n");

    Console.WriteLine("Registering observers A and B for future articles...............");

    subject.registerObserver(observerA);

    subject.registerObserver(observerB);

    Console.WriteLine("New article published by Subject,so now observers A and B will be notified....\n");

    subject.Articles++;

    Console.WriteLine("---------------------------------------------------------------------------\n");

    Console.WriteLine("Registering observer C for future articles and unregistering observer B from the future articles...............");

    subject.registerObserver(observerC);

    subject.unregisterObserver(observerB);

    Console.WriteLine("New article published by Subject,so now observers A and C will be notified....\n");

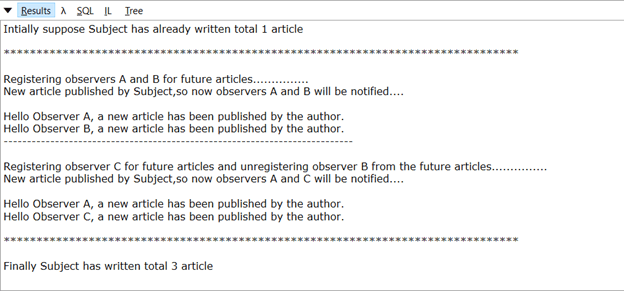
    subject.Articles++;

    Console.WriteLine("\n\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\n");

    Console.WriteLine("Finally Subject has written total " + subject.Articles + " article \n");

}

**OUTPUT**



**When should we use this**

We should use it when multiple objects are dependent on the state of one object.

**Some common Use Cases**

Following someone on Instagram/Twitter and other such platforms.

App users gets notified for the updates.

Email Subscriptions and many more.

# Inversion of Control:

public class clsDAL  
{  
    private clsSqlServer \_sql;   
   
    public clsDAL()  
    {  
        \_sql = new clsSqlServer();   
    }  
}

Consider the above example, where we have a DAL class. The default constructor of the DAL class creates an object of the SqlServer class. That means the DAL Class is responsible for creating an object of the SqlServer class. So there is tight coupling between the DAL class and SqlServer class.  
  
Three main problems in the above code:

The DAL class is responsible for creating an object of the SqlServer class.

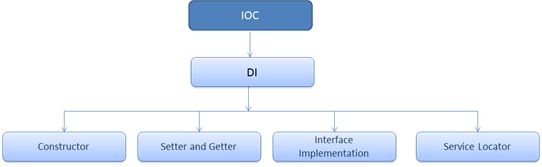
The SqlServer class is directly referenced in the DAL class.

The DAL class should be aware of the SqlServer class type.

Now we understand the problem. Now let's discuss the solution. The solution is to shift the object creation part from this class. We need to shift the object creation control from here i.e. Inversion of control.  
  
**Principles of IOC**

Main classes aggregating other classes should not depend on the direct implementation of the aggregated classes. Both the classes should depend on abstraction.

Abstraction should not depend on details, details should depend on abstraction.

**What is Dependency Injection?**  
  
Inversion of control is implemented by dependency injection because Inversion of control is a principle and dependency injection is a way of implementing IOC.  
  
**Ways of implementing IOC**  
  
Now let's discuss each method with an example.  
  
**Constructor Methodology**

public class clsDAL

{

    private ISql \_sql;    public clsDAL(ISql obj)

    {

         \_sql = obj;

    }

}

In this methodology we pass an object of SQL into the DAL class. Here in the above code you can see that there is a parameterized constructor in the DAL class. And the parameterized constructor accepts an object of SQL. The DAL class is not responsible for creating an object of SQL in this case. So there is no tight coupling between these classes. This method is not useful for the client who only can use a default constructor.  
  
**Setter and Getter**

public class clsDAL

{

    private ISql \_sql;    public Isql Sql

    {

        set

        {

             \_sql = value;

        }

    }

}

In this method we expose an object of SQL through the get/set methods of the DAL class. But it violates the encapsulation rule of OOP. Encapsulation means hiding internal details of an object. So here rather than hiding an object, we are exposing an object.  
  
**Interface Implementation**

interface ISqlDI

{

    void setConnection(ISql obj);

}

public class clsDAL : ISqlDI

{

    private ISql \_sql;

   public void setConnection(ISql obj)

    {

        \_sql = obj;

    }

}

In the preceding code we have implemented an interface which has a setConnection method which sets the SQL object. And the DAL class implements a SQL interface. So with the help of the setConnection method the client can inject a SQL object in the DAL class.  
  
**Server Locator**  
  
static class LocateConnection  
{  
    public static ISql getConnection() { }  
}

 interface clsDAL

{

    private ISql \_sql;

    public clsDAL()

    {

        \_sql = LocateConnection.getConnection();

    }

}

In this method we create a static class and a static method inside this class. The DAL class calls this static method from its default constructor. So in this way the SQL object is injected into the DAL class.

Dependency Injection in C#

Dependency Injection (DI) is a software design pattern. It allows us to develop loosely-coupled code. The intent of Dependency Injection is to make code maintainable. Dependency Injection helps to reduce the tight coupling among software components. Dependency Injection reduces the hard-coded dependencies among your classes by injecting those dependencies at run time instead of design time technically. This article explains how to implement Dependency Injection in C# and .NET code.

We have the following ways to implement Dependency Injection.

Constructor Injection

This is the most commonly used dependency pattern in Object Oriented Programming. The constructor injection normally has only one parameterized constructor, so in this constructor dependency there is no default constructor and we need to pass the specified value at the time of object creation. We can use the injection component anywhere within the class. It addresses the most common scenario where a class requires one or more dependencies.

The following is an example:

**using** System;

**using** System.Collections.Generic;

**using** System.Linq;

**using** System.Text;

**using** System.Threading.Tasks;

**namespace** propertyinjuction

{

**public** **interface** text

    {

**void** print();

    }

**class** format : text

    {

**public** **void** print()

        {

            Console.WriteLine(" here is text format");

        }

    }

    // constructor injection

**public** **class** constructorinjection

    {

**private** text \_text;

**public** constructorinjection(text t1)

        {

**this**.\_text = t1;

        }

**public** **void** print()

        {

            \_text.print();

        }

    }

**class** constructor

    {

**static** **void** Main(**string**[] args)

        {

            constructorinjection cs = **new** constructorinjection(**new** format());

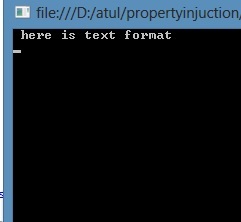
            cs.print();

            Console.ReadKey();

        }

    }

}



By passing the services that implemented the text interface the builder assembled the dependencies.

Property Injection

We use constructor injection, but there are some cases where I need a parameter-less constructor so we need to use property injection.

 The following is an example:

**public** **interface** INofificationAction

{

**void** ActOnNotification(**string** message);

}

**class** atul     {

       INofificationAction task = **null**;

**public** **void** notify(INofificationAction  at ,**string** messages)

       {

**this**.task = at;

       task.ActOnNotification(messages);

       }

   }

**class** EventLogWriter : INofificationAction

   {

**public** **void** ActOnNotification(**string** message)

       {

           // Write to event log here

       }

   }

**class** Program

   {

**static** **void** Main(**string**[] args)

       {

           //services srv = new services();

           //other oth = new other();

           //oth.run();

           //Console.WriteLine();

           EventLogWriter elw = **new** EventLogWriter();

           atul at = **new** atul();

           at.notify(elw, "to logg");

           Console.ReadKey();

       }

   }

You cannot control when the dependency is set at all, it can be changed at any point in the object's lifetime.

Method Injection

In method injection we need to pass the dependency in the method only. The entire class does not need the dependency, just the one method. I have a class with a method that has a dependency. I do not want to use constructor injection because then I would be creating the dependent object every time this class is instantiated and most of the methods do not need this dependent object.

The following is an example:

**using** System;

**using** System.Collections.Generic;

**using** System.Linq;

**using** System.Text;

**using** System.Threading.Tasks;

**namespace** propertyinjuction

{

**public** **interface** Iset

    {

**void** print();

    }

**public** **class** servic : Iset

    {

**public** **void** print()

        {

            Console.WriteLine("print........");

        }

    }

**public** **class** client

    {

**private** Iset \_set;

**public** **void** run(Iset serv)

        {

**this**.\_set = serv;

            Console.WriteLine("start");

**this**.\_set.print();

        }

    }

**class** method

    {

**public** **static** **void** Main()

        {

            client cn = **new** client();

            cn.run(**new** servic());

            Console.ReadKey();

        }

    }

}

# SOLID Principles

There are five SOLID principles:

Single Responsibility Principle (SRP)

Open Closed Principle (OCP)

Liskov Substitution Principle (LSP)

Interface Segregation Principle (ISP)

Dependency Inversion Principle (DIP)

# Single Responsibility Principle (SRP)

**Definition:** A class should have only one reason to change.

In layman terminology, this means that a class should not be loaded with multiple responsibilities and a single responsibility should not be spread across multiple classes or mixed with other responsibilities. The reason is that more changes requested in the future, the more changes the class need to apply.

**Understanding**

Single Responsibility Principle is one of the five SOLID principles which guide developers as they write code or design an application.

In simple terms, a module or class should have a very small piece of responsibility in the entire application. Or as it states, a class/module should have not more than one reason to change.

If a class has only a single responsibility, it is likely to be very robust. It’s easy to verify its working as per logic defined. And it’s easy to change in class as it has single responsibility.

The Single Responsibility Principle provides another benefit. Classes, software components and modules that have only one responsibility are much easier to explain, implement and understand than ones that give a solution for everything.

This also reduces number of bugs and improves development speed and most importantly makes developer’s life lot easier.

**Implementation**

Let’s take a scenario of Garage service station functionality. It has 3 main functions; open gate, close gate and performing service. Below example violates SRP principle. The code below, violates SRP principle as it mixes open gate and close gate responsibilities with the main function of servicing of vehicle.

Public class GarageStation

{

Public void DoOpenGate()

{

*//Open the gate functinality*

}

Public void PerformService(Vehicle vehicle)

{

*//Check if garage is opened*

*//finish the vehicle service*

}

Public void DoCloseGate()

{

*//Close the gate functinality*

}

}

We can correctly apply SRP by refactoring of above code by introducing interface. A new interface called IGarageUtility is created and gate related methods are moved to different class called GarageStationUtility.

Public class GarageStation

{

IGarageUtility \_garageUtil;

Public GarageStation(IGarageUtility garageUtil)

{

this.\_garageUtil=garageUtil;

}

Public void OpenForService()

{

\_garageUtil.OpenGate();

}

Public void DoService()

{

*//Check if service station is opened and then*

*//finish the vehicle service*

}

Public void CloseGarage()

{

\_garageUtil.CloseGate();

}

}

Public class GarageStationUtility : IGarageUtility

{

Public void OpenGate()

{

*//Open the Garage for service*

}

Public void CloseGate()

{

*//Close the Garage functionlity*

}

}

public interface IGarageUtility

{

voidOpenGate();

voidCloseGate();

}

# Open Closed Principle (OCP)

**Definition:** Software entities (classes, modules, functions, etc.) should be open for extension, but closed for modification.

**Understanding**

This principle suggests that the class should be easily extended but there is no need to change its core implementations.

The application or software should be flexible to change. How change management is implemented in a system has a significant impact on the success of that application/ software. The OCP states that the behaviors of the system can be extended without having to modify its existing implementation.

New features should be implemented using the new code, but not by changing existing code. The main benefit of adhering to OCP is that it potentially streamlines code maintenance and reduces the risk of breaking the existing implementation.

**Implementation**

Let’s take an example of bank accounts like regular savings, salary saving, corporate etc. for different customers. As for each customer type, there are different rules and different interest rates. The code below violates OCP principle if the bank introduces a new Account type. Said code modifies this method for adding a new account type.

Public class Account

{

*// members and function declaration*

Public decimal CalcInt(AccType accType)

{

If(accType==”Regular”)*// savings*

{

Inte=bal\*0.4;

If(bal<1000)Inte-=bal\*0.2;

If(bal<50000)Inte+=amt\*0.4;

}

elseif(accType==”Salary”)*// salary savings*

{

inte=bal\*0.5;

}

elseif(accType==”Corporate”)*// Corporate*

{

inte=bal\*0.3;

}

}

}

We can apply OCP by using interface, abstract class, abstract methods and virtual methods when you want to extend functionality. Here I have used interface for example only but you can go as per your requirement.

Interface IAccount

{

*// members and function declaration, properties*

decimal CalcInt();

}

Public Class RegularSavingAcc : IAccount

{

*//regular savings account*

Public decimal CalcInt()

{

Inte=bal\*0.4;

If(bal<1000)inte-=bal\*0.2;

If(bal<50000)inte+=amt\*0.4;

}

}

Public Class SalarySavingAcc : IAccount

{*//Salary savings account*

Public decimal CalcInt()

{

Inte=bal\*0.5;

}

}

Public Class CorporateAcc : IAccount

{

Public decimal CalcInt()

{

Inte=bal\*0.3;

}

}

In the above code three new classes are created; regular saving account, SalarySavingAccount, and CorporateAccount, by extending them from IAccount.

This solves the problem of modification of class and by extending interface, we can extend functionality.

Above code is implementing both OCP and SRP principle, as each class has single is doing a single task and we are not modifying class and only doing an extension.

# Liskov Substitution Principle (LSP)

**Definition by Robert C. Martin:** Functions that use pointers or references to base classes must be able to use objects of derived classes without knowing it.

The **Liskov substitution principle (LSP)** is a definition of a subtyping relation, called **(strong) behavioral subtyping,** that was initially introduced by Barbara Liskov in a 1987 conference keynote address titled **Data abstraction and hierarchy.**

**Understanding**

LSP states that the child class should be perfectly substitutable for their parent class. If class C is derived from P then C should be substitutable for P.

We can check using LSP that inheritance is applied correctly or not in our code.

LSP is a fundamental principle of SOLID Principles and states that if program or module is using base class then derived class should be able to extend their base class without changing their original implementation.

**Implementation**

Let’s consider the code below where LSP is violated. We cannot simply substitute a Triangle, which results in printing shape of a triangle, with Circle.

namespaceDemo

{

publicclassProgram

{

staticvoidMain(string[]args)

{

Triangletriangle=newCircle();

Console.WriteLine(triangle.GetColor());

}

}

publicclassTriangle

{

publicvirtual string GetShape()

{

return" Triangle ";

}

}

publicclassCircle:Triangle

{

public override string GetShape()

{

return"Circle";

}

}

}

 To correct above implementation, we need to refactor this code by introducing interface with method called GetShape.

public class Program

{

static void Main(string[] args)

{

Shape shape = new Circle();

Console.WriteLine(shape.GetShape());

shape = new Triangle();

Console.WriteLine(shape.GetShape());

}

}

public abstract class Shape

{

public abstract string GetShape();

}

public class Triangle : Shape

{

public override string GetShape()

{

return "Triangle";

}

}

public class Circle : Triangle

{

public override string GetShape()

{

return "Circle";

}

}

# Interface Segregation Principle (ISP)

**Definition:** No client should be forced to implement methods which it does not use, and the contracts should be broken down to thin ones.

**Understanding**

Interface segregation principle is required to solve the design problem of the application. When all the tasks are done by a single class or in other words, one class is used in almost all the application classes then it has become a fat class with overburden. Inheriting such class will results in having sharing methods which are not relevant to derived classes but it’s there in the base class so that will inherit in the derived class.

Using ISP, we can create separate interfaces for each operation or requirement rather than having a single class to do the same work.

**Implementation**

In below code, ISP is broken as process method is not required by OfflineOrder class but is forced to implement.

public interface IOrder

{

Void AddToCart();

Void CCProcess();

}

publicclassOnlineOrder:IOrder

{

publicvoidAddToCart()

{

*//Do Add to Cart*

}

publicvoidCCProcess()

{

*//process through credit card*

}

}

publicclassOfflineOrder:IOrder

{

publicvoidAddToCart()

{

*//Do Add to Cart*

}

publicvoidCCProcess()

{

*//Not required for Cash/ offline Order*

thrownewNotImplementedException();

}

}

We can resolve this violation by dividing IOrder Interface.

public interface IOrder

{

voidAddToCart();

}

public interface IOnlineOrder

{

voidCCProcess();

}

publicclassOnlineOrder:IOrder,IOnlineOrder

{

Public void AddToCart()

{

*//Do Add to Cart*

}

Public void CCProcess()

{

*//process through credit card*

}

}

Public class OfflineOrder:IOrder

{

publicvoidAddToCart()

{

*//Do Add to Cart*

}

}

# Dependency Inversion Principle (DIP)

This principle is about dependencies among components. The definition of DIP is given by Robert C. Martin is as follows:

High-level modules should not depend on low-level modules. Both should depend on abstractions.

Abstractions should not depend on details. Details should depend on abstractions.

**Understanding**

The principle says that high-level modules should depend on abstraction, not on the details, of low-level modules. In simple words, the principle says that there should not be a tight coupling among components of software and to avoid that, the components should depend on abstraction.

The terms Dependency Injection (DI) and Inversion of Control (IoC) are generally used as interchangeably to express the same design pattern. The pattern was initially called IoC, but Martin Fowler (known for designing the enterprise software) anticipated the name as DI because all frameworks or runtime invert the control in some way and he wanted to know which aspect of control was being inverted.

Inversion of Control (IoC) is a technique to implement the Dependency Inversion Principle in C#. Inversion of control can be implemented using either an abstract class or interface. The rule is that the lower level entities should join the contract to a single interface and the higher-level entities will use only entities that are implementing the interface. This technique removes the dependency between the entities.

Note:

In below implementation, I have used interface as a reference, but you can use abstract class or interface as per your requirement.

**Implementation**

In below code, we have implemented DIP using IoC using injection constructor. There are different ways to implement Dependency injection. Here, I have use injection thru constructor but you inject the dependency into class's constructor (Constructor Injection), set property (Setter Injection), method (Method Injection), events, index properties, fields and basically any members of the class which are public.

public interface IAutomobile

{

voidIgnition();

voidStop();

}

publicclassJeep:IAutomobile

{

*#region IAutomobile Members*

publicvoidIgnition()

{

Console.WriteLine("Jeep start");

}

publicvoidStop()

{

Console.WriteLine("Jeep stopped.");

}

*#endregion*

}

publicclass SUV :IAutomobile

{

*#region IAutomobile Members*

publicvoidIgnition()

{

Console.WriteLine("SUV start");

}

publicvoidStop()

{

Console.WriteLine("SUV stopped.");

}

*#endregion*

}

publicclassAutomobileController

{

IAutomobile m\_Automobile;

publicAutomobileController(IAutomobile automobile)

{

this.m\_Automobile= automobile;

}

publicvoidIgnition()

{

m\_Automobile.Ignition();

}

publicvoidStop()

{

m\_Automobile.Stop();

}

}

classProgram

{

staticvoidMain(string[]args)

{

IAutomobile automobile =newJeep();

*//IAutomobile automobile = new SUV();*

AutomobileController automobileController=newAutomobileController(automobile);

automobile.Ignition();

automobile.Stop();

Console.Read();

}

}

In the above code, IAutomobile interface is in an abstraction layer and AutomobileController as the higher-level module. Here, we have integrated all in a single code but in real-world, each abstraction layer is a separate class with additional functionality. Here products are completely decoupled from the consumer using IAutomobile interface. The object is injected into the constructor of the AutomobileController class in reference to the interface IAutomobile. The constructor where the object gets injected is called injection constructor.

DI is a software design pattern that allows us to develop loosely coupled code. Using DI, we can reduce tight coupling between software components. DI also allows us to better accomplish future changes and other difficulties in our software. The purpose of DI is to make code sustainable.

# Difference between Authentication and Authorization

|  |  |
| --- | --- |
| **Authentication** | **Authorization** |
| User identity is confirmed | Here, the user is given permission to access the system / resources after validation |
| User and user server is verified | Here it is validated if the user is allowed to access via some defined rules |
| Login details, usernames, passwords, OTPs required | Checks the security level and privilege of the user, thus determining what the user can or cannot have access to |
| Data is available via Token IDs | Data provided via Access token |
| User can partially change the authentication details as per the requirement | User cannot modify the Authorization permissions as it is given to a user by the owner/manager of the system, and only has the authority to change it. |

# NET Core vs .NET Framework

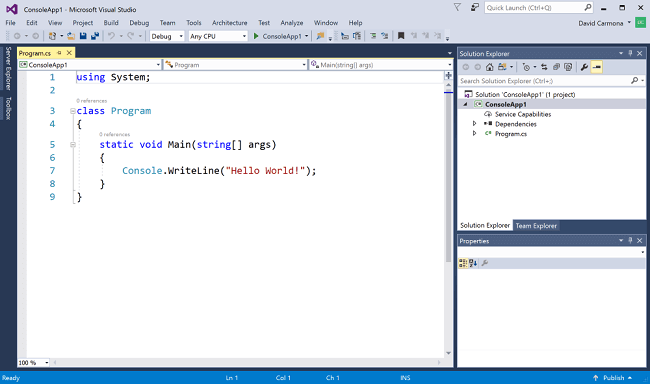
Microsoft maintains both runtimes for building applications with .NET while sharing many of the same APIs. This shared API is called the .NET Standard.



Developers use the .NET Framework to create Windows desktop and server-based applications. This includes ASP.NET web applications. On the other hand, .NET Core is used to create server applications that run on Windows, Linux and Mac. It does not currently support creating desktop applications with a user interface. Developers can write applications and libraries in VB.NET, C# and F# in both runtimes.

# When to Use .NET Core

A cross-platform and open-source framework, .NET Core is best when developing applications on any platform. .NET Core is used for cloud applications or refactoring large enterprise applications into microservices.



You should use .NET Core when:

**There are cross-platform needs.**Use it when the application needs to run across multiple platforms such as Windows, Linux and macOS. Those operating systems are supported as development workstations (and the list of [supported operating systems](https://github.com/dotnet/core/blob/master/roadmap.md) is growing):

Visual Studio is compatible on Windows with a new limited version [on macOS](https://www.visualstudio.com/vs/visual-studio-mac/)

Visual Studio Code can be used on Windows, Linux and macOS

All supported platforms allow the use of the command line

**Using Microservices.** [Microservices](https://stackify.com/what-are-microservices/), a form of service-oriented architecture, are software applications consisting of small, modular business services. Each service can run a unique process, be deployed independently and be created in different programming applications. .NET Core allows a mix of technologies, is lightweight and scalable for each microservice

**Working with Docker containers.**Containers and microservices architecture are often used together. Because it is lightweight and modular, .NET Core works very well with containers. You can deploy cross-platform server apps to Docker containers. .NET Framework works with containers, but the image size is larger

**You have high-performance and scalable system needs.**Microsoft recommends running .NET Core with ASP.NET Core for the best performance and scale. This becomes important when using hundreds of microservices. In such a case, a lower number of servers and virtual machines is best. The efficiency and scalability gained should translate to a better user experience in addition to cost savings

**You are running multiple .NET versions side-by-side.** To install applications with dependencies on different versions of frameworks in .NET, developers need to use .NET Core. Multiple services are executable on the same server with different versions of .NET

**You want command line interface (CLI) control.**Some developers prefer working in lightweight editors and command line control. .NET Core has a CLI for all supported platforms and requires minimal installation on production machines. And, there still is the opportunity to switch to an IDE, such as Visual Studio IDE

# When Not to Use .NET Core

.NET Core does not have some of the .NET features nor support for all libraries and extensions. As such, you may encounter a few situations in which .NET Core may not be the best option (though continued development will likely eliminate this drawback). Consider the following scenarios:

**Windows Forms and WPF applications are not supported**– You still have to use Mono to make a .NET desktop application for macOS

**ASP.NET WebForms don’t exist** – Though Microsoft provides [strategies for migrating ASP.NET Web Forms apps](https://docs.microsoft.com/en-us/dotnet/architecture/porting-existing-aspnet-apps/migrate-web-forms)

**You need to create a WCF service** – .NET Core does not currently support WCF. Instead, you would need to make a REST API with ASP.NET Core MVC

**Missing 3rd-party library support**– .NET Core provides a compatibility shim between .NET Framework and .NET Core. But, you may still have issues with compatibility if the class library uses any .NET Framework APIs that are not supported (though this will help bridge a lot of class libraries to .NET Core)

**Missing .NET Framework features** – Some .NET Framework functionality is still missing in .NET Core. For example, Entity Framework Core is not the exact same as Entity Framework v6

**You need to access Windows-specific APIs** – If your application needs to work with the Windows Registry (WMI or other Windows specific APIs), it won’t work with .NET Core. It is designed to be more sandboxed away from the OS

**Partial support for VB.NET and F#** – Microsoft and the community continue to work on this but it’s not yet 100%

# Developers Should Use .NET Framework When…

.NET Framework is distributed with Windows. Generally, it is used to build Windows desktop and large-scale enterprise applications using .NET workflow and data connection tools.

The .NET Framework provides services that include:

Memory management

Type and memory safety

Security

Networking

Application deployment

Data structures

APIs

.NET Framework can be used with Docker and Windows Containers and is most feasible when:

**It is already being used** – Instead of migrating, extend the application. For example, developers can write a new web service in ASP.NET Core

**You’re using third-party libraries or NuGet packages not available in .NET Core** – Despite .NET Core’s popularity, you’ll need to use the .NET Framework when working with libraries that aren’t compatible with .NET Core. [NuGet is the free and open source package manager](https://www.nuget.org/) for .NET and other Microsoft development platforms. The NuGet ecosystem includes client tools that provide the ability to produce and consume packages. It also has a central package repository for package authors and consumers. It is available as a Visual Studio extension

**You’re using technologies not yet available in .NET Core** – .NET Core does not support all .NET Framework technologies. These not-yet-available technologies include:

ASP.NET Web Forms applications (no plans to port)

ASP.NET Web Pages applications (plans to port)

ASP.NET SignalR server/client implementation (plans to port)

WCF services implementation (no plans to migrate, but it is being considered)

Workflow related services (no plans to port) including Windows Workflow Foundation (WF), Workflow Services (WCF + WF in a single service), and WCF Data Services (formerly known as “ADO.NET Data Services”)

Windows Presentation Foundation (WPF) and Windows Forms (no plans to port)

**The platform does not support .NET Core** – Again, not all Microsoft and third-party platforms support it, such as some of Azure’s services. You may encounter some issues even with supported services, which comes with the territory. With .NET Core increasingly gaining traction, it’s becoming easier to find tutorials and workarounds for issues you may encounter. For instance, we encountered a [502.5 Process Failure](https://stackify.com/net-core-azure-app-service-wont-start/) when trying to start an Azure App Service. So, we published a post offering guidance for others who encounter the same issue

# When Not to Run .NET Framework

There are also a few situations in which you shouldn’t run the .NET Framework. These include when:

Multiple OS platforms are required

High performance and scalability are needed

.NET Core works

Open source framework is required

# **Key Differences between .Net Core and .Net Framework**

.Net Framework is a software development framework designed and maintained by the tech giant Microsoft. It is Windows-based and primarily runs on Windows devices. It is used for the development of standalone desktop as well as web applications. The framework provides all the basic requirements for the development of applications – UI, DB connectivity, Services, APIs, etc.

.Net Core is an open-source Development Platform designed and maintained by Microsoft and the .Net community. .Net Core has been designed, keeping in mind various needs and purposes, focusing on Web Development, Windows Phone Development, and Windows Store Apps Development.

# **Singleton vs Transient vs Scoped**

**Scoped:**

In this service, with every HTTP request, we get a new instance.

The same instance is provided for the entire scope of that request.

This is a better option when you want to maintain a state within a request.

services.AddScoped<IAuthService,AuthService>();

eg., if we have a couple of parameters in the controller, both object contains the same instance across the request

C#

Chart

Description automatically generated

**Transient:**

A new service instance is created for each object in the HTTP request.

This is a good approach for the multithreading approach because both objects are independent of one another.

The instance is created every time they will use **more memory** and **resources**and can have a **negative** impact on performance

Utilize for the **lightweight** service with little or **no state**.

services.AddTransient<ICronJobService,CronJobService>();

C#

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**Singleton:**

Only one service instance was created throughout the lifetime.

Reused the same instance in future, wherever the service is required

Since it's a single lifetime service creation, memory leaks in these services will build up over time.

Also, it has memory efficient as they are created once reused everywhere.

services.AddSingleton<ILoggingService, LoggingService>();

C#

Copy

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When to use which Service

Singleton approach => We can use this for logging service, feature flag(to on and off module while deployment), and email service

Scoped approach => This is a better option when you want to maintain a state within a request.

Transient approach => Use this approach for the lightweight service with little or no state.

**Dependency Injection in Asp.Net Core (Singleton vs Transient vs Scoped)**

Dependency Injection in Asp.Net Core is very important for the architecture of the application. Asp.Net Core framework provides built-in support for the Dependency Injection it means there is no need to install any third-party library to implement Dependency Injection.

[View or Download sample code](https://github.com/nitishwebgentle/Dependency-Injection-in-Asp.Net-Core.git)

In this Post, You will learn the Dependency Inject in .Net Core with example.

What is Dependency Injection in Asp.Net Core?

*Dependency Injection is a principle in software architecture that provides a loosely coupled communication between two classes.*

For example the Communication between –

Controller and Repositories

Controller and Services (Email sender, Logger, etc.)

Business layer and Data layer

Etc.

The concept of Dependency Injection is same for Asp.Net Core MVC and Asp.Net Core Web API.

Benefits of using Dependency Injection in Asp.Net Core?

There are lots of benefits of using Dependency Injection in your application –

IOC Implementation – Dependency Injection is used to implement the Inversion Of Control principle.

Dependency Injection provides a Loosely Coupled Communication between two layers (classes).

Writing the Unit Test Cases are super easy with Dependency Injection.

Help to implement SOLID principles as D in SOLID stands for Dependency Injection.

Dependency Injection provides a Flexible Architecture of the application that helps to update the consumed classes without updating the caller classes.

Abstraction – As the Controllers are completely unaware of the implementation of services.

Etc.

**How to configure Dependency Injection in Asp.Net Core?**

Asp.Net Core provides the built-in support for Dependency Injection.

Dependencies are registered in containers and the container in asp.net core is [IServiceProvider](https://docs.microsoft.com/en-us/dotnet/api/system.iserviceprovider).

The best place to registers the dependency in the asp.net core is the ConfigureServices method of the Startup class.

public void ConfigureServices(IServiceCollection services)

{

services.AddControllers();

// Register the dependencies here

}

Example of Dependency Injection in Asp.Net Core –

Let’s [create a new Asp.Net Core Web API or MVC application](https://nitishkaushik.com/create-asp-net-core-mvc-application-using-visual-studio-and-cli/).

Add a BooksController in the Controllers folder. Click [here](https://nitishkaushik.com/controller-in-asp-net-core-mvc/) to learn more about Controller in Asp.Net Core.

using Microsoft.AspNetCore.Mvc;

namespace SampleAspNetCore.Controllers

{

[Route("api/[controller]")]

[ApiController]

public *class* BooksController : ControllerBase

{

}

}

Create a new Models folder and add a new BookModel class inside this Models folder.

Graphical user interface, text, application

Description automatically generatedBookModel in the Models folder

Add the following properties in the BookModel class.

public *class* BookModel

{

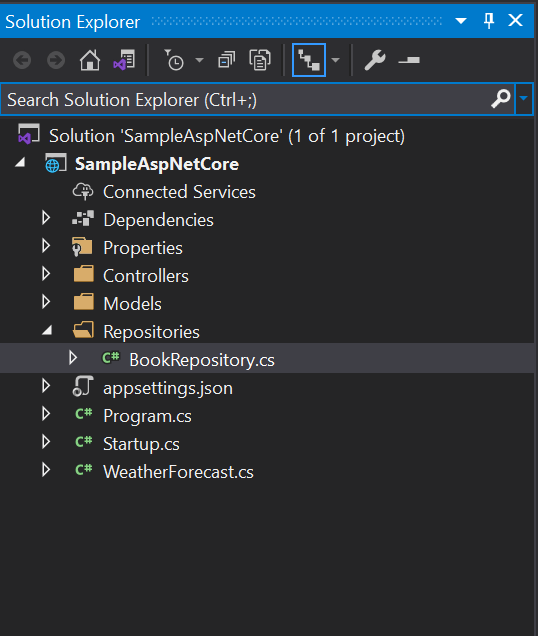
public int Id { get; set; }

public string Name { get; set; }

public int Price { get; set; }

}

Now, Create a new folder with the name Repositories at the root level or a new class library project in the solution (As per your choice or application architecture). And create a new BookRepository class in this folder/ classLib project. I am going to create a new folder at the root level.

Repository layer in asp.net core

We are not using any database in this example. So let’s create some in methods and in-memory data in this BookRepository class.

using SampleAspNetCore.Models;

using System.Collections.Generic;

namespace SampleAspNetCore.Repositories

{

public *class* BookRepository

{

/// <summary>

/// Hold in-memory books data

/// </summary>

private List<BookModel> books = new List<BookModel>();

/// <summary>

/// Add a new book in the books list

/// </summary>

/// <param name="book"></param>

/// <returns>Id of new book</returns>

public int AddBook(BookModel book)

{

book.Id = books.Count + 1; // Create the incremental Id

books.Add(book);

return book.Id;

}

/// <summary>

/// Gets all books

/// </summary>

/// <returns>All books</returns>

public List<BookModel> GetAllBooks()

{

return books;

}

}

}

We need to use this BookRepository class in the BookController to Add and Get the books data.

*If we do not want to follow the concept of Dependency Injection then we can simply create the object of BookRepository using new keyword and use both the methods of this BookRepository class.*

But, If we are following the concept of Dependency Injection then we need to create an interface IBookRepository for BookRepository. We will only expose this IBookRepository to the controller and because of this the controller will never know about the implementation i.e. BookRepository.

using SampleAspNetCore.Models;

using System.Collections.Generic;

namespace SampleAspNetCore.Repositories

{

public interface IBookRepository

{

int AddBook(BookModel book);

List<BookModel> GetAllBooks();

}

}

Make sure to inherit the BookRepository class from IBookRepositoryinterface.

public *class* BookRepository : IBookRepository

Inject the Dependency using Constructor in Asp.Net Core –

The Repository layer is ready. Now we need to make some changes in the controller class and inject the dependency using constructor.

using Microsoft.AspNetCore.Mvc;

using SampleAspNetCore.Models;

using SampleAspNetCore.Repositories;

namespace SampleAspNetCore.Controllers

{

[Route("api/[controller]")]

[ApiController]

public *class* BooksController : ControllerBase

{

private readonly IBookRepository \_bookRepository;

/// <summary>

/// Constructor Injection

/// </summary>

/// <param name="bookRepository"></param>

public BooksController(IBookRepository bookRepository)

{

\_bookRepository = bookRepository;

}

[HttpPost("")]

public IActionResult AddBook([FromBody] BookModel book)

{

int id = \_bookRepository.AddBook(book);

return Ok(id);

}

[HttpGet("")]

public IActionResult GetAllBooks()

{

var books = \_bookRepository.GetAllBooks();

return Ok(books);

}

}

}

*In the above code, you can check that we are not using BookRepository anywhere in the HomeController. We have created the types using IBookRepository interface.*

If you will run this application at this stage then you will get an error. This is because that at this time even the application also does not know about the implementation of the IBookRepository interface. We can tell the implementation to the application by registering our service in the container.

Dependency Injection Lifetime in Asp.Net Core –

Because we are not creating the repository class object directly in the controller, so Asp.Net Core framework provides us few methods to handle the lifetime of the object.

Singleton

Scoped

Transient

Let’s learn about the implementation and difference among Singleton and Scoped and Transient services.

Singleton Service lifetime in Dependency Injection –

Singleton services can be registered using AddSingleton<> method.

There will be only one instance of the Singleton service throughout the application.

Let’s open the Startup class and register the BookRepository using Singleton service.

public void ConfigureServices(IServiceCollection services)

{

services.AddControllers();

services.AddSingleton<IBookRepository, BookRepository>();

// Register other dependencies here

}

Now, we have registered the dependency using the Singleton service and everything is ready to test. Let’s run the application and send a request from any client tool ([postman](https://www.postman.com/downloads/), [fiddler](https://www.telerik.com/fiddler), etc.)

Test the Singleton Service –

Send a POST request at http://localhost:xxxx/api/books with the following JSON in the body.

{

"name": "C#",

"price": 300

}

A screenshot of a computer

Description automatically generated with medium confidenceSingle service request

Just send a few more requests by updating the JSON data in the body. and finally, use the GET call on the same URL.

A screenshot of a computer

Description automatically generated with medium confidenceGet all books

Observations –

The same instance of the service is shared among all the HTTP requests because the entire data is stored in memory and we can access it using a separate HTTP request.

Once you will restart the application then in-memory data will get lost because there will always be a new instance for each run of the application.

Example with multiple instances –

Let’s validate the Singleton service with multiple instances of same service.

Let’s create one more instance of the IBookRepository in the BooksController.

private readonly IBookRepository \_bookRepository;

private readonly IBookRepository \_bookRepository2;

/// <summary>

/// Constructor Injection

/// </summary>

/// <param name="bookRepository"></param>

/// <param name="bookRepository2"></param>

public BooksController(IBookRepository bookRepository, IBookRepository bookRepository2)

{

\_bookRepository = bookRepository;

\_bookRepository2 = bookRepository2;

}

Just for testing let’s use both the instances in the AddBook method of BooksController and this time we will perform the following two operations in this same method.

Add the new book using the first instance i.e. \_bookRepository

Get all books using the second instance i.e. \_bookRepository2

Let’s update the AddBook method of BooksController.

[HttpPost("")]

public IActionResult AddBook([FromBody] BookModel book)

{

\_bookRepository.AddBook(book); // Add book using first instance

var books = \_bookRepository2.GetAllBooks(); // Get all books using secind instance

return Ok(books);

}

Run the application again send the post request with some data. This time once you will send the POST request (to add a new book), You will receive all the books in the output.

Keep sending at least five requests with updated body JSON and every time in the output you will see all previously added books are available.

**Write the output of the HTTP requests with your thoughts in the comment section below this post.**

*I bn case you are using Asp.Net Core MVC then to test the multiple instances, you can add the books using the first instance and use the second instance to display all the books by injecting them directly in the View.cshtml*

Scoped Service lifetime in Dependency Injection –

Scoped services can be registered using AddScoped<> method.

A new instance of the service will be created for the new HTTP Request.

Example: Let’s say the controller A is using a Scoped service S two times in the same HTTP Request, then there will be only one (1) instance of this S service for this request.

Let’s register the **Scoped Dependency** in the Startup class.

public void ConfigureServices(IServiceCollection services)

{

services.AddControllers();

//services.AddSingleton<IBookRepository, BookRepository>();

services.AddScoped<IBookRepository, BookRepository>();

// Register other dependencies here

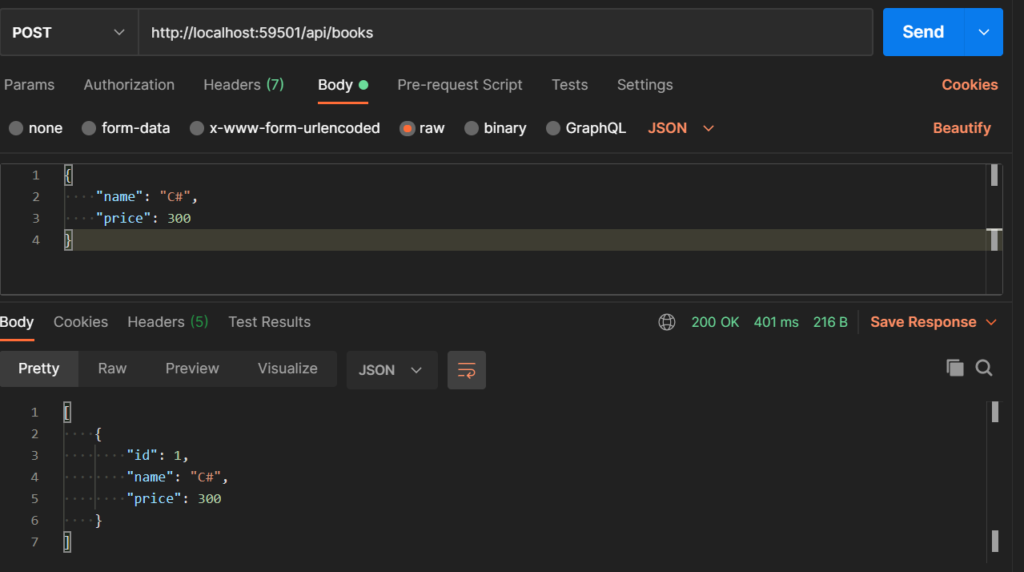
}

*Note: You can register n number of services in the ConfigureServices method.*

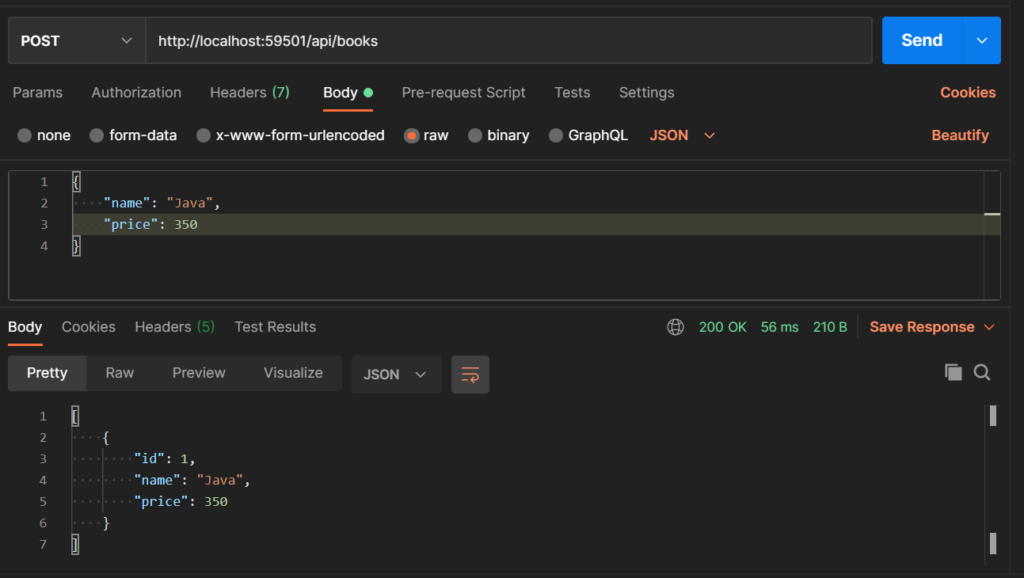
*Test the Scoped lifetime in Dependency Injection –*

*We have already setup everything, Now without making any further changes in the code let’s run the application and test the Scoped lifetime.*

*There is no change in the request also. You can send the previously (That one we were using with Singleton lifetime) request.*

Scoped lifetime in Dependency Injection

Update the JSON body and send another request.

Scoped lifetime in Dependency Injection example -2

Observations:

We are getting only the current request data in the response of the HTTP Request. It means the instances are not shared across HTTP Requests.

The instances are being shared for the same HTTP Request because we are using \_bookRepository to add the new book and \_bookRepository2 to get all the books.

**Transient Service lifetime in Dependency Injection –**

Transient services can be registered using AddTransient<> method.

A new instance of the service will be created every-time it is requested.

Example: Let’s say the Controller A is using a Transient service S 2 times in the same HTTP Request, then there will be 2 **separate instances** of this S service.

Let’s register the **Transient Dependency** in the Startup class.

public void ConfigureServices(IServiceCollection services)

{

services.AddControllers();

//services.AddSingleton<IBookRepository, BookRepository>();

//services.AddScoped<IBookRepository, BookRepository>();

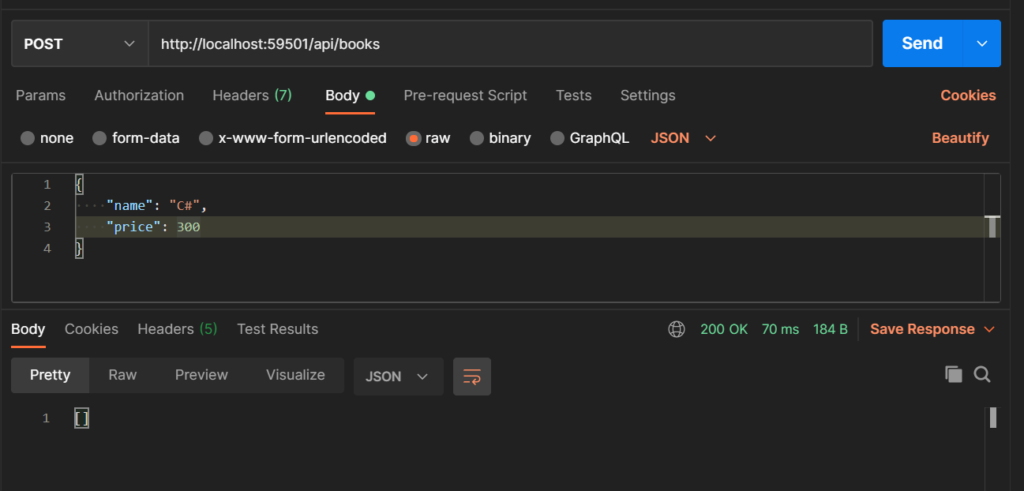
services.AddTransient<IBookRepository, BookRepository>();

// Register other dependencies here

}

Test the Scoped lifetime in Dependency Injection –

Because we have not made any change in the Controller and Service so let’s send the HTTP Request with same data.

Transient lifetime in Dependency Injection

Observations:

As per our code structure, there is no output of this HTTP Request in the Transient service. This is because we are using two separate instances of the BookRepository in the same HTTP Request. And as per the Transient service, a separate instance will be created every time it is requested.

Transient service does not share data between multiple instances hence it is a valid case in most of the scenarios. myhclm

# **Difference between SQL and NoSQL Database**

### SQL or NoSQL

[Graphical user interface, application, table, Word

Description automatically generated](https://github.com/donnemartin/system-design-primer/blob/master/images/wXGqG5f.png)  
[*Source: Transitioning from RDBMS to NoSQL*](https://www.infoq.com/articles/Transition-RDBMS-NoSQL/)

Reasons for **SQL**:

* Structured data
* Strict schema
* Relational data
* Need for complex joins
* Transactions
* Clear patterns for scaling
* More established: developers, community, code, tools, etc
* Lookups by index are very fast

Reasons for **NoSQL**:

* Semi-structured data
* Dynamic or flexible schema
* Non-relational data
* No need for complex joins
* Store many TB (or PB) of data
* Very data intensive workload
* Very high throughput for IOPS

Sample data well-suited for NoSQL:

* Rapid ingest of clickstream and log data
* Leaderboard or scoring data
* Temporary data, such as a shopping cart
* Frequently accessed ('hot') tables
* Metadata/lookup tables

When it comes to comparing among the SQL and NoSQL networks, the SQL is table-based databases, but NoSQL databases are in document forms, key-value pair, or graph databases. According to the performance, SQL requires specialist database hardware, but NoSQL can run on existing hardware.

Although both databases are excellent solutions, there are several major distinctions between them that users should consider before making a choice. The following is a comparison table showing the differences between the SQL and NoSQL databases:

| **Basis Of Comparison** | **SQL Database** | **NoSQL Database** |
| --- | --- | --- |
| **Structure** | A table-based structure is a preferable choice for programs that demand multi-row operations, such as accounting systems, or for legacy applications designed with a relational structure in mind. | Document-based structure with Key-value pairs, graph databases, and wide-column stores. |
| **Query Language** | SQL is a Structured Query Language | There is no declarative query language that NoSQL uses. It differentiates as per the different databases. |
| **Suitable** | The database is best suitable for Complex queries but not good for hierarchical data storage. | The database is not suitable for complex queries. However, it suits well for the hierarchical data storage. |
| **Scalability** | These databases are vertically scalable. So, with boosting CPU, RAM, or SSD, you may increase the demand on a single server. | NoSQL databases are horizontally scalable. This means by sharding or adding multiple servers to this database, you can handle greater traffic. |
| **Design for** | Traditional RDBMS examine and retrieve data for further analysis using SQL syntax and queries. The OLAP systems take advantage of them. | The NoSQL database system is made up of many database technologies. These were created in line with the requirements placed on recent application development. |
| **Schema** | SQL databases consists of a predefined schema | NoSQL databases comprises of the dynamic schema for unstructured data. |
| **Properties Followed** | SQL accompanies ACID properties that stand as Atomicity, Consistency, Isolation and Durability. | NoSQL accompanies Brewers CAP theorem that stands as Consistency, Availability and Partition Tolerance. |
| **Examples** | MySQL, Sqlite, MS-SQL, PostgreSQL, etc. | Big Table, MongoDB, Hbase, Cassandra, Raven DB, etc. |

Lastly, the providers provide excellent support for all SQL databases. There are also many independent consultants present to assist you with SQL databases for exceptionally large-scale deployments. However, one must still rely on support from the community for some NoSQL databases. Just a few outside professionals are accessible to design and execute your high size NoSQL deployments.

When to use SQL Database?

SQL is the finest database to employ for relational data, notably when the link among data sets is easily understandable and accessible. It’s also the greatest way to check for data security and integrity. SQL enables rising ad-hoc queries, and, in most circumstances, SQL databases are vertically expandable if you require flexibility in data access.

Some SQL databases have specific characteristics that support NoSQL workloads (for example, native JavaScript Object Notation (JSON) data types). If you don’t require the horizontal scalability of NoSQL data storage, these databases can handle a variety of non-relational applications.

Use Cases

      SQL is the simplest language used for interacting with a relational database management system.

      Understanding and modifying behavioural-related programs

      Creating unique dashboards

When to Use NoSQL Database?

For massive amounts of data or continuously updating data sets, NoSQL is the best database to employ. If you have variable database schemas or requirements that resist fitting into the relational data model. “Document databases” (e.g., CouchDB, Amazon DocumentDB, MongoDB) are a suitable choice if you’re dealing with immense quantities of unstructured data.

Use Cases

      Data that necessitates a flexible schema

      When ACID assistance isn’t required

      Data logging from a variety of source

# C# | Delegates:

A delegate is an object which refers to a method or you can say it is a reference type variable that can hold a reference to the methods. Delegates in C# are similar to the function pointer in C/C++. It provides a way which tells which method is to be called when an event is triggered.

For example, if you click on a Button on a form (Windows Form application), the program would call a specific method. In simple words, it is a type that represents references to methods with a particular parameter list and return type and then calls the method in a program for execution when it is needed.

**Important Points About Delegates:**

Provides a good way to encapsulate the methods.

Delegates are the library class in System namespace.

These are the type-safe pointer of any method.

Delegates are mainly used in implementing the call-back methods and events.

Delegates can be chained together as two or more methods can be called on a single event.

It doesn’t care about the class of the object that it references.

Delegates can also be used in “anonymous methods” invocation.

Anonymous Methods(C# 2.0) and Lambda expressions(C# 3.0) are compiled to delegate types in certain contexts. Sometimes, these features together are known as anonymous functions.

**Declaration of Delegates:**

Delegate type can be declared using the delegate keyword. Once a delegate is declared, delegate instance will refer and call those methods whose return type and parameter-list matches with the delegate declaration.

Syntax:

[modifier] delegate [return\_type] [delegate\_name] ([parameter\_list]);

modifier: It is the required modifier which defines the access of delegate and it is optional to use.

delegate: It is the keyword which is used to define the delegate.

return\_type: It is the type of value returned by the methods which the delegate will be going to call. It can be void. A method must have the same return type as the delegate.

delegate\_name: It is the user-defined name or identifier for the delegate.

parameter\_list: This contains the parameters which are required by the method when called through the delegate.

Example:

// "public" is the modifier

// "int" is return type

// "GeeksForGeeks" is delegate name

// "(int G, int F, int G)" are the parameters

public delegate int GeeksForGeeks(int G, int F, int G);

Note: A delegate will call only a method which agrees with its signature and return type. A method can be a static method associated with a class or can be an instance method associated with an object, it doesn’t matter.

**Instantiation & Invocation of Delegates:**

After declaring a delegate, a delegate object is created with the help of new keyword. Once a delegate is instantiated, a method call made to the delegate is pass by the delegate to that method. The parameters passed to the delegate by the caller are passed to the method, and the return value, if any, from the method, is returned to the caller by the delegate. This is known as invoking the delegate.

**A delegate is a class** that can hold a reference (source of information) to a method. We can say that delegate is like a pointer to a function.  
  
Every delegate object is implicitly derived from class Delegate.  
  
**Declaration of Delegate**  
A delegate can be declared using delegate keyword followed by a function signature as shown below:  
  
**Signature of a Single Cast Delegate**

*<access modifier> delegate <return type> <delegate-name>(< parameter list >)*

**Example**

1. **public** **delegate** **void** myDelegate(**string** myMessage);

Delegate class has four steps process for defining and using delegates – Declaration, Reference, Target and Invoke.  
  
**The first step** is to declare the delegate with the return type and input parameters.

1. // Delegates declaration
2. **public** **delegate** **int** myDelegate(**int** a, **int** b);
3. Which **is** having same signature **as** method below.
4. **public** **int** Sum(**int** a, **int** b)
5. {
6. **return** a + b;
7. }

**The second step** is to create a delegate reference.

1. // Create delegate reference
2. DelegateClass.myDelegate objSum = **null**;

**The third step**is to target/point the delegate reference to an object instance.

1. // Target the reference to the Sum method
2. objSum = objMyclass.Sum;

**The final step** is to invoke the delegate like invoking a regular method.

1. // Invoke the delegate
2. Console.WriteLine("Sum of two integer is = " + objSum(10, 20));
3. Console.ReadLine();

**Finally the Sample Code**

1. **namespace** DelegatesProperties
2. {
3. **class** DelegateClass
4. {
5. // Delegates declaration
6. **public** **delegate** **int** myDelegate(**int** a, **int** b);
8. // Methods to Target & called by delegate
9. **public** **int** Sum(**int** a, **int** b)
10. {
11. **return** a + b;
12. }
13. }
15. **class** Program
16. {
18. **static** **void** Main(**string**[] args)
19. {
20. DelegateClass objMyclass = **new** DelegateClass();
22. // Create delegate reference
23. DelegateClass.myDelegate objSum = **null**;
25. // Target/Point the reference to the Sum method
26. objSum = objMyclass.Sum;
28. // Invoke the delegate
29. **if** (objSum != **null**)
30. {
31. Console.WriteLine("Sum of two integer is = " + objSum(10, 20));
32. Console.ReadLine();
33. }
34. }
35. }
36. }

**Output**

*Sum of two integer is 30;*

**Let’s do it with Anonymous Method:**

1. **namespace** DelegateAnonymous
2. {
3. **class** DelegateClass
4. {
5. // Delegates declaration
6. **public** **delegate** **int** myDelegate(**int** a, **int** b);
7. }
8. **class** Program
9. {
10. **static** **void** Main(**string**[] args)
11. {
12. DelegateClass objMyclass = **new** DelegateClass();
14. // Create delegate reference
15. DelegateClass.myDelegate objSum = **null**;
17. // Point the reference to the Sum method
18. objSum = **delegate** (**int** a, **int** b) // Anonymous Method
19. {
20. **return** a + b;
21. };
23. // Invoke the delegate
24. //objSum.Invoke(20, 10);
26. **if** (objSum != **null**)
27. {
28. Console.WriteLine("Sum of two integer is = " + objSum(10, 20));
29. Console.ReadLine();
30. }
31. }
32. }
33. }

**Output**

*Sum of two integer is 30;*

Output will be the same as before, this time we have made a little bit change to point the method. Here we use an anonymous method. Let’s take a look how:

1. objSum = **delegate** (**int** a, **int** b) // Anonymous Method
2. {
3. **return** a + b;
4. };

And the Sum method no more exist in the **DelegateClass.**

1. **public** **int** Sum(**int** a, **int** b)
2. {
3. **return** a + b;
4. }

**Types of delegates**

1. Single cast delegate
2. Multi cast delegate

**Single Cast Delegate**  
A single cast delegate holds the reference of only single method. This type of delegate is derived from the *System.Delegate* class.  
  
**Note:**Our previous example is a single cast delegate  
  
**Multi Cast Delegate**  
The delegate can point to multiple methods. Class *MulticastDelegate* derives from Delegate and represents a delegate that can invoke more than one method at once.  
  
Internally, MulticastDelegate is implemented as a linked list of delegates.  
  
**Add/Remove Delegates**  
All delegate types declared in C# have implicit operators += and -=. The "+" operator adds a function to the delegate object and the "-" operator removes an existing function from a delegate object.  
  
**Sample Example:**

1. **namespace** MulticastDelegates
2. {
3. **class** DelegateClass
4. {
5. // Delegates declaration
6. **public** **delegate** **void** myDelegate(**int** a, **int** b);
8. // Methods to Target & called by delegate
9. **public** **void** Sum(**int** a, **int** b)
10. {
11. Console.WriteLine("Sum of two integer is = " + (a + b));
12. }
14. **public** **void** Divide(**int** a, **int** b)
15. {
16. Console.WriteLine("Divide of two integer is = " + (a / b));
17. }
19. **public** **void** Multiply(**int** a, **int** b)
20. {
21. Console.WriteLine("Multiply of two integer is = " + (a \* b));
22. }
23. }
24. **class** Program
25. {
26. **static** **void** Main(**string**[] args)
27. {
28. DelegateClass objMyclass = **new** DelegateClass();
30. // Create delegate reference
31. DelegateClass.myDelegate objSum = **null**;
33. // Point the reference to the Sum method
34. objSum += objMyclass.Sum;
35. objSum -= objMyclass.Divide;
36. objSum += objMyclass.Multiply;
38. // Invoke the delegate
39. **if** (objSum != **null**)
40. {
41. objSum(20, 5);
42. Console.ReadLine();
43. }
44. }
45. }
46. }

**Output**

*Sum of two integer is 25;  
Divide of two integer is 4; not showing this time.  
Multiply of two integer is 100;*

**Key Notes:**

1. Delegates are reference type.
2. Delegates are type-safe.
3. Delegates encapsulates one or more methods.
4. We can invoke all the methods the delegate is encapsulating with a single call
5. Delegates allow methods to be passed as parameters.
6. Invoking a delegate is like as invoking a regular method.
7. Delegates are used in event handling for defining callback methods.
8. Once a delegate is created, the method it is associated will never changes because delegates are immutable in nature.
9. Delegates provide a way to execute methods at run-time.
10. All delegates are implicitly derived from System.MulticastDelegate, class which is inheriting from System.Delegate class.

**What are Delegates?**  
Delegates are pointers to function. Delegates are used for implementing events and call back methods.

1. **using** System;
2. usingSystem.Collections.Generic;
3. usingSystem.Linq;
4. usingSystem.Text;
5. usingSystem.Text.RegularExpressions;
6. usingSystem.Threading.Tasks;
7. **namespace** ConsoleApplication3
8. {
9. **public** **delegate** intMyDelegate(intx, **int** y);
10. **public** **class** DelegateClass
11. {
12. **public** **static** **int** Add(**int** x, **int** y)
13. {
14. Return x + y;
15. }
16. **public** **static** intGetValue(**int** x)
17. {
18. **return**(10 + x);
19. }
20. **public** **static** **void** ShowValue(**int** x)
21. {
22. Console.WriteLine("Value" + x);
23. }
24. **public** **static** intGetResult()
25. {
26. **int** x = 30;
27. **int** y = 20;
28. **return** x \* y;
29. }
30. **public** **static** **void** ShowEmploye(intage, String name)
31. {
32. Console.WriteLine("My Name is" + name);
33. Console.WriteLine("My age is " + age);
34. }
35. **public** **static** **void** ShowMessage(String msg)
36. {
37. Console.WriteLine(msg);
38. }
39. **public** **static** **bool** IsNumeric(**object** Expression)
40. {
41. doubleretNum;
42. boolisNum = Double.TryParse(Convert.ToString(Expression), System.Globalization.NumberStyles.Any, System.Globalization.NumberFormatInfo.InvariantInfo, **out** retNum);
43. returnisNum;
44. }
45. }
46. **public** **class** MainClass
47. {
48. **public** **static** **void** Main()
49. {
50. //Assign method to delegates
51. MyDelegatedelAdd = DelegateClass.Add;
52. //Call add method using custome delegates
53. **int** sum = delAdd(1, 2);
54. Console.WriteLine(sum);
55. //You can't call other method which is having only one input parameter
56. MyDelegate del = DelegateClass.GetValue; //Compilation error since signature of delegates not matching
57. }
58. }
59. }

Func, Action and Predicate are define in C# 3.0 and these are generic inbuilt delegates. The above steps are not required, if you use these delegates.  
  
**Func Delegate**

Func is generic delegate present in System namespace. It takes one or more input parameters and returns one out parameter. The last parameter is considered as a return value.

Func delegate type can include 0 to 16 input parameters of different types. It must have one return type. So return type is mandatory but input parameter is not.  
  
**Example1:** Func delegate with two input parameters and one return value.

1. Func func1 = DelegateClass.Add;
2. **int** value = func1(10, 20);
3. TParameter = 10,20;
4. TOutput = value = 30;

**Example 2:** Func delegate with one input parameter and one return value.

1. Func func2 = DelegateClass.GetValue;
2. **int** values = func2(30);
3. TParameter = 30
4. TOutput = 40;

**Example 3:** Func delegate with zero input parameter and one return value.

1. Func func3 = DelegateClass.GetResult;
2. intresultMulti = func3();
3. TParameter = Nothing
4. TOutput = 600;
6. Func with Anonymous methods:
7. Func func4= **delegate**(intx,**int** y){ **return** (x+y); };
8. **int** result = func4(2,3);
10. Func with Lambda expression:
11. Func func5= (intx,**int** y) => { **return** (x+y); };
12. **int** xx = func4(2,3);

**Action Delegate**  
Action is a generic delegate present in System namespace. It takes one or more input parameters and returns nothing.  
  
So it does not return any value.  
  
**Example 1:** Action delegate with two input parameters.

1. Action action1=DelegateClass.ShowEmploye;
2. action1(30,"Rajesh");
3. TParameter = 30,Rajesh;
4. TOutput = Not available (No **return** value)

**Example 2:**Action delegate with one input parameter.

1. Action action2=DelegateClass.ShowMessage;
2. action2("Rajesh");
3. TParameter = “Rajesh”
4. TOutput = Not available

Action delegate with Anonymous methods:

1. Action action = **delegate**(String msg)
2. {
3. Console.WriteLine(msg);
4. };
5. action("rajesh");
6. Action **delegate** with Lambda expression: Action action = (msg) = & gt;
7. {
8. Console.WriteLine(msg)
9. };
10. action(“Rajesh”);

**Predicate Delegate**  
Predicate delegate is also inbuilt generic delegate and is present in System namespace.  
It is used to verify certain criteria of method and returns output as Boolean, either True or False.  
  
Predicate can be used with method, anonymous and lambda expression.  
  
**Example 1:** Check String value is number using Predicate delegates.  
  
Predicate predicate = DelegateClass.IsNumeric;  
bool number = predicate("1234");  
  
**Example 2:** Predicate delegate using Anonymous method.

1. Predicate predicate = **delegate**(**string** str)
2. {
3. **double** retNum;
4. **bool** isNum = Double.TryParse(Convert.ToString(str), System.Globalization.NumberStyles.Any, System.Globalization.NumberFormatInfo.InvariantInfo, **out** retNum);
5. **return** isNum;
6. };
7. **bool** found = predicate("12232");

**Example 3:**Predicate delegate using lambda expression.

1. Predicate predicate = (str) = & gt;
2. {
3. **double** retNum;
4. **bool** isNum = Double.TryParse(Convert.ToString(str), System.Globalization.NumberStyles.Any, System.Globalization.NumberFormatInfo.InvariantInfo, **out** retNum);
5. **return** isNum;
6. };
7. **bool** found = predicate("12232");

**Summary**

* Func, Action and Predicate are generic inbuilt delegates present in System namespace.
* All three can be used with method, anonymous method and lambda expression.
* Func can contains 0 to 16 input parameters and must have one return type.
* Action can contain 1 to 16 input parameters and does not have any return type.
* Predicate delegate should satisfy some criteria of method and must have one input parameter and one Boolean return type either true or false.
* Input parameters of custom delegates is fixed but Func and Actions input parameter is variable from 0 to 16 and 1 to 16 respectively.

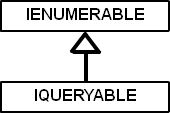
# **Below** **are some differences between the Delegates and Interfaces in C#:**

| **Delegate** | **Interface** |
| --- | --- |
| It could be a method only. | It contains both methods and properties. |
| It can be applied to one method at a time. | If a class implements an interface, then it will implement all the methods related to that interface. |
| If a delegate available in your scope you can use it. | Interface is used when your class implements that interface, otherwise not. |
| Delegates can me implemented any number of times. | Interface can be implemented only one time. |
| It is used to handling events. | It is not used for handling events. |
| It can access anonymous methods. | It can not access anonymous methods. |
| When you access the method using delegates you do not require any access to the object of the class where the method is defined. | When you access the method you need the object of the class which implemented an interface. |
| It does not support inheritance. | It supports inheritance. |
| It can wrap static methods and sealed class methods | It does not wrap static methods and sealed class methods.. |
| It created at run time. | It created at compile time. |
| It can implement any method that provides the same signature with the given delegate. | If the method of interface implemented, then the same name and signature method override. |
| It can wrap any method whose signature is similar to the delegate and does not consider which from class it belongs. | A class can implement any number of interfaces, but can only override those methods which belongs to the interfaces. |

# [**What is the difference between IQueryable<T> and IEnumerable<T>?**](https://stackoverflow.com/questions/252785/what-is-the-difference-between-iqueryablet-and-ienumerablet)

Below goes a long descriptive answer for it.

The first important point to remember is IQueryable interface inherits from IEnumerable, so whatever IEnumerable can do, IQueryable can also do.



There are many differences but let us discuss about the one big difference which makes the biggest difference. **IEnumerable** interface is useful when your collection is loaded using LINQ or Entity framework and you want to apply filter on the collection.

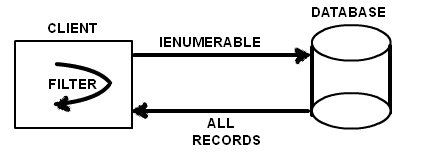
Consider the below simple code which uses IEnumerable with entity framework. It’s using a Where filter to get records whose EmpId is 2.

EmpEntities ent = new EmpEntities();

IEnumerable<Employee> emp = ent.Employees;

IEnumerable<Employee> temp = emp.Where(x => x.Empid == 2).ToList<Employee>();

This where filter is executed on the client side where the IEnumerable code is. In other words all the data is fetched from the database and then at the client its scans and gets the record with EmpId is 2.

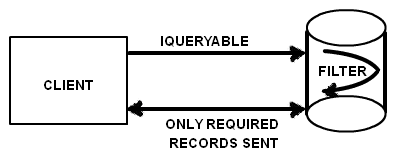


But now see the below code we have changed **IEnumerable** to **IQueryable**. It creates a SQL Query at the server side and only necessary data is sent to the client side.

EmpEntities ent = new EmpEntities();

IQueryable<Employee> emp = ent.Employees;

IQueryable<Employee> temp = emp.Where(x => x.Empid == 2).ToList<Employee>();



So the difference between IQueryable and IEnumerable is about where the filter logic is executed. One executes on the client side and the other executes on the database.

So if you working with only in-memory data collection IEnumerable is a good choice but if you want to query data collection which is connected with database `IQueryable is a better choice as it reduces network traffic and uses the power of SQL language.

What is middleware?

Middleware is just a simple class that consists of encapsulated information into an application pipeline to deal with the https request response pipeline.

Every part of this class has the option to pick whether to give the request to the next pipeline, and can play out specific activities when the following request passes in the pipeline.

In this case Request delegates are utilized to construct the request pipeline.

The request delegates handle every HTTP request.

Request delegates are designed to configure the Run, Map, and Use method on the IApplicationBuilder type that is passed into the Configure method in the Startup class. An individual request delegate can be determined in-line as a lambda expression, or it can be designed in a reusable class.

These reusable classes are middleware, or middleware parts. Each middleware part in the request pipeline is liable for invoking the next pipeline, or short circuiting the request.

Every component of middleware plays a specific role, we can mix up the role but this is not a good approach in software designed architecture.

So we should create for the specific purpose of single middleware.

For example if we see how microsoft created so much middleware for specific problems.

I will explain in just a bit about built in middleware here.

Middleware Order of Execution

The middleware Order of Execution plays a  very important role so you have to take care of it very precisely,  otherwise you may get unexpected behavior.

So suppose you have 3 middleware -  M1, M2, M3 in sequential order, then it will invoke in the same order and then respond in the reverse direction.

Lets take another example here.

1. UseAuthentication();
2. app.UseAuthorization();

Here we have set first authentication then authorization, so the order matters, because in real projects we do first authentication, then authentication.

Please refer to this image as it is taken from MS doc reference.



Create middleware using IApplicationBuilder

We can create middleware in the Configure method of the Startup class using IApplicationBuilder interface.

Here in this following example I will add a simple middleware using Run method that will return a string "Hello my first middleware," on every request.

1. **public** **class** Startup {
2. **public** Startup() {}
3. **public** **void** Configure(IApplicationBuilder app, IHostingEnvironment env, ILoggerFactory loggerFactory) {
4. // here i have configure middleware using IApplicationBuilder with Run merhod.
5. // I will explain Run method in details just a bil.
6. app.Run(async (context) => {
7. await context.Response.WriteAsync("Hello my first middleware");
8. });
9. // I have removed hereother code for the clarity..
10. }
11. }

In this example I have used Run() method. This is an extension method of IApplicationBuilder interface.

Here I have created middleware using lambda expression, but we can also create it using a private method like this,

1. **public** **class** Startup {
2. **public** Startup() {}
3. **public** **void** Configure(IApplicationBuilder app, IHostingEnvironment env) {
4. app.Run(TestMiddleware);
5. }
6. **private** Task TestMiddleware(HttpContext context) {
7. **return** context.Response.WriteAsync("Hello TestMiddleware");
8. }
9. }

Run, Use and Map method

Run() method behaves like a terminal middleware delegate to the application's request pipeline.

It will not invoke the next  one in the pipeline.

For example,

1. // Middleware 1
2. app.Run(async (context) => {
3. await context.Response.WriteAsync("Middleware 1");
4. });
5. // Middleware 2
6. app.Run(async (context) => {
7. await context.Response.WriteAsync("Middleware 2");
8. });

So in this example only // Middleware 1 will execute then after that it terminated the request.

When you right click and go to definition for Run() method you will get this signature of Run method,

public static void Run (this is IApplicationBuilder app, RequestDelegate handler)

Use() is also a function of IApplicationBuilder that is used to handle the request or call the given next function.

So as we have seen in the Run() method it doesn't invoke next function but Use  does that.

1. **public** **void** Configure(IApplicationBuilder app, IHostingEnvironment env) {
2. app.Use(async (context, next) => {
3. await context.Response.WriteAsync("Middleware 1");
4. await next();
5. });
6. app.Run(async (context) => {
7. await context.Response.WriteAsync("Middleware 2");
8. });
9. }

I use first Use method then after that Run() method, so we will get the output for both Map() methods used for the branches the request pipeline based on matches condition.

If the request path matches with the given path, the branch is executed.

1. **public** **void** Configure(IApplicationBuilder app, IHostingEnvironment env) {
2. app.Map("/maptest", HandleMapMethod);
3. }
4. **private** **static** **void** HandleMapMethod(IApplicationBuilder app) {
5. app.Run(async context => {
6. await context.Response.WriteAsync("Map method testing");
7. });
8. }

Custom middleware

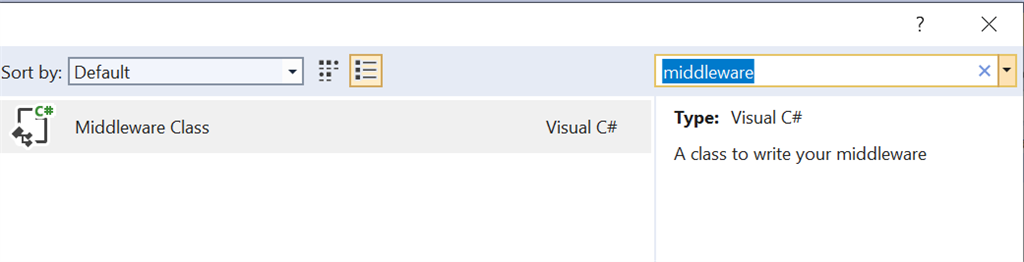
Here in this section i will explain how to create and add your own custom middleware.

Custom middleware is also  kind of the same as built in middleware but we create our own when a few requirement don't match with inbuilt middleware.  In custom middleware we should also have RequestDelegate type parameter in the constructor.

Now at this time Microsoft in Visual Studio is provided a template for Middleware.

So for that Right click on your solution project or folder where you want to add middleware class then select Add -> New Item. This will open Add the popup.

Search the word "middleware" in the top right search box and you will get middleware template class.



1. **public** **class** MyCustomMiddleware {
2. **private** **readonly** RequestDelegate \_next;
3. **public** MyCustomMiddleware(RequestDelegate next) {
4. \_next = next;
5. }
6. **public** Task Invoke(HttpContext httpContext) {
7. // you can write here whatever you want
8. **return** \_next(httpContext);
9. }
10. }
11. **public** **static** **class** MyMiddlewareExtensions {
12. **public** **static** IApplicationBuilder UseMyCustomMiddleware(**this** IApplicationBuilder builder) {
13. **return** builder.UseMiddleware < MyCustomMiddleware > ();
14. }
15. }

then you need to add your custom middleware in configure method,

1. **public** **void** Configure(IApplicationBuilder app, IHostingEnvironment env) {
2. app.UseMyCustomMiddleware();
3. app.Run(async (context) => {
4. await context.Response.WriteAsync("Hello World!");
5. });
6. }

Built-in middleware

ASP.NET core provide the following middleware components,

|  |  |
| --- | --- |
| Middleware | Description |
| Authentication | Provides authentication support. |
| CORS | Configures Cross-Origin Resource Sharing. |
| Routing | Defines for request routes. |
| Session  Static Files  Diagnostics   MVC | Provides support for user sessions.   Provides support for serving static files, and directory browsing.  Several separate middlewares that provide a developer exception page, exception handling,  status code pages, and the default web page for new apps.  Processes requests with MVC/Razor Pages. |

To whom choose between WCF or WEB API

1. Choose WCF when you want to create a service that should support special scenarios such as one way messaging, message queues, duplex communication etc.
2. Choose WCF when you want to create a service that can use fast transport channels when available, such as TCP, Named Pipes, or maybe even UDP (in WCF 4.5), and you also want to support HTTP when all other transport channels are unavailable.
3. Choose Web API when you want to create a resource-oriented services over HTTP that can use the full features of HTTP (like URIs, request/response headers, caching, versioning, various content formats).
4. Choose Web API when you want to expose your service to a broad range of clients including browsers, mobiles, iphone and tablets.

# **Improve Performance of .NET Application**

**Manage memory efficiently**

It is very important to manage memory very efficiently to improve the performance of applications. We need to keep in mind a few tips during application development.

* Always use a using block if the class implements the IDisposable interface.
* Don't create a new object always, try to use an existing object when possible. For example, for a function call, one object can be used for calling multiple functions in the same class.
* Don't forget to dispose of an unmanaged object.
* Try to not run GC.Collect(). It removes unused objects but slows down the application.
* For large session objects, try to use a different session storage mechanism, like SQL Server or state server.
* Always implement a finally block to ensure that your resource will be released, even in the worst situation.

**Multithreading in application**

Minimize thread creation and use the safe-tuning thread pool for multithreaded work. Avoid creating threads on a per–request basis; also avoid using Thread.Abort or Thread.Suspend.

Ensure that you appropriately tune the thread pool for ASP.NET applications and for Web Services.

**Try to use an Asynchronous call**

It's a new feature of C# 5.0. It may benefit client-side applications where you need to maintain user interface responsiveness. Those are the situations where we can use an asynchronous call as in the following:

* To call a web service
* To read and write a huge file from an application
* To perform heavy database operations

**Handle exception properly**

Exception objects are one of the most resource-consuming objects in applications. So try to use them with enough care. We should not use an exception in regular application logic (sometimes people throw an exception at the time of validation, ensure that it's not happening in your application). Don't throw a new exception when you want to throw it across layers. Throwing a new exception consumes the same resources as a new exception. Just use throw one if you really want to throw it.

Don't forget to implement a finally in each try-catch block.

**Choose string and StringBuilder in the right situation**

It is recommended to choose StringBuilder when there is a need to perform a huge number of string concatenations. For small concatenation purposes String performs well.

**Choose proper data type in an application**

Arrays are the fastest of all collection types, so unless you need special functionalities like a dynamic extension of the collection, sorting, and searching, you should use arrays. If you need a collection type then choose the most appropriate type based on your functionality requirements to avoid performance penalties.

* Use ArrayList to store custom object types and particularly when the data changes frequently and you perform frequent insert and delete operations.  
  Avoid using ArrayList for storing strings.
* Use a StringCollection to store strings.
* Use a Hashtable to store a large number of records and to store data that may or may not change frequently. Use Hashtable for frequently queried data such as product catalogs where a product ID is a key.
* Use a HybridDictionary to store frequently queried data when you expect the number of records to usually below with occasional increases in size.
* Use a ListDictionary to store small amounts of data (fewer than 10 items).
* Use a NameValueCollection to store strings of key-value pairs in presorted order. Use this type for data that changes frequently where you need to insert and delete items regularly and where you need to cache items for fast retrieval.
* Use a Queue when you need to access data sequentially (First In, First Out) based on priority.
* Use a Stack in scenarios where you need to process items in a Last In, First Out manner.
* Use a SortedList for fast object retrieval using an index or key. However, avoid using a SortedList for large data changes because the cost of inserting a large amount of data is high. For large data changes, use an ArrayList and then sort it by calling the Sort method. Pay attention to ADO.NET code since a large part of any project is nothing but CRUD operations, so we need to pay more attention to ADO.NET code.
* Choose the proper Data Access Layer. Think twice before using any third-party data access layer.
* Implement a transaction properly because transaction blocks database resources from being used.
* Use connection pooling and try to use a connection object efficiently.
* Don't forget to release a database object after operations on it

**Improve performance of Serialization**

Reduce the amount of data that is serialized by using XmlIgnore or NonSerialize attributes. To improve DataSet serialization, you can use column name aliasing, you can avoid serializing both the original and the updated data values, and you can reduce the number of DataTable instances that you serialize.

**Reduce the working set size**

A smaller working set produces better system performances. Fewer large assemblies rather than many smaller assemblies help reduce working-set size.

**Manage the BLOB object with special care**

Avoid moving Binary Large OBject (BLOB) data repeatedly, and consider storing pointers in the database to BLOB files that are maintained on the file system. Use Chunking to reduce the load in the server, and use chunking where network bandwidth is very limited. Use CommandBehaviour.SequencialAccess enumerator to stream BLOB data.

**Try to use DataReader**

Since nothing is faster than a DataReader, do not use a Dataset object when it is possible to use a DataReader object. DataReader is best if we want access forward-only read-only data and if we do not want to cache the data. Use a DataSet when you need to add flexibility to when you need to cache data between requests.

# **Microservice Architecture**

As the name implies, this architecture is based on services. This architecture is more than SOA architecture. Services are typically separated by either business capabilities or sub-domain. Once modules/components are defined, they can be implemented through a different set of teams. These teams would be the same or different technology stack teams. In this way, individual components can be scaled up when needed and quickly scaled down once the need is over. Let’s take a look at the Microservice architecture:

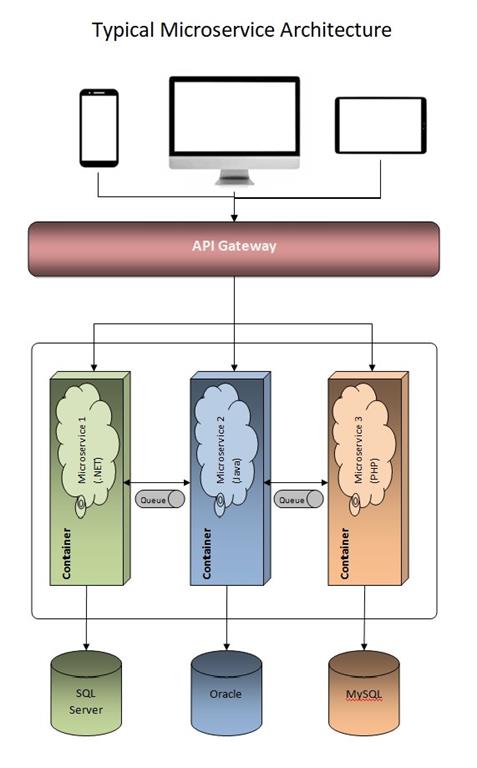


Figure 2

Benefits of Microservice Architecture

1. **A small team can be engaged and become the owner**Unlike the Monolithic approach, Microservices architecture does not require a large set of teams in a single tech stack but a small team of different tech stacks can also be engaged. So in terms of organizational cost, it leads to savings.
2. **Easy understandable code and logic**Since Microservices are small and less in code with respect to Monolithic, it’s easy to understand the code and logic written by one to another.
3. **Agility is easy**  
   Agility enables you to develop and build the product in parts. Since the entire application is broken down into small components, it’s easy to keep track of each of them. This step-by-step incremental approach helps to move fast.
4. **Introducing Resiliency**  
   Because of application is broken down based on the domain (or business capability), it is easy to maintain individually. This also reduces downtime and increase scalability.
5. **Accelerating Time to Market**  
   Since the entire complex process is broken down into smaller sub pieces, it is easy to reduce errors and shorten the development time. Any new enhancement or modification would require changes in concerned service only. Small, independently tested and deployed components lead you to push your product into market faster.
6. **Continuous delivery is possible**  
   To get all types of changes and new features, it’s possible all in the same go. It makes your business up-to-date and client happy.
7. **Extensibility is simple**  
   Whenever a new feature is required, simply add new service to the existing application architecture. No need to go back to existing code, build new features, and then a new feature can be added relatively faster because this would require new service to be introduced and won’t affect the existing code base.
8. **Replaceability anytime**  
   When needed, existing service can be replaced all together rather than maintaining them for long. This also forces us to maintain code quality, rather than modifying the existing code again and again with lots of patches.

**Advantages**

1. **Simple implementation in single technology**  
   Everyone is talking the same language and hence it’s easier. Team interaction and coordination is easy. Single repository also works perfectly where the team is enabled with easy branching and tagging.
2. **Basic setup and start is very easy**  
   Project setup with basic building blocks is easy and required only once. Further add-on features are implemented on top of it.
3. **Direct Communication**  
   Communication between Monolithic components happens within the single application boundaries. No additional strategy is required to maintain this.
4. **Easy Debugging and Testing**  
   Debugging is straightforward and easy because all components are available in a single bundle and linked together.
5. **Easy Deployment**Even we need multiple instances of an application it is easy to deploy the entire solution in multiple servers behind a load balancer. Deployment practice and steps are pretty straight forward.

**Disadvantages**

1. **Slow development when large and complex**  
   When features keep on increasing and the team is adding/modifying code, again and again, complexity increases and eventually development speed goes down.
2. **Scaling is not possible by individual components or modules**Because of a single bundle in nature, scaling is not possible by component or module. If you need to scale up, then entire application has to scale up, even when only single or few components must be scaled up.
3. **When there's a bug, the entire application may go down**  
   There is a high possibility of entire application going down on occurrence of a bug. E.g. if bug is leading to take down your app domain then entire application will go down for sure.
4. **Small changes can lead entire testing**  
   While making any change in Monolithic application, other modules are possibly impacted and hence require the entire application to be gone through with complete test cycles. This can consume a lot of time.
5. **Hard to do continuous deployment**  
   Until the entire build is ready, frequent and continuous deployment is not possible. This includes a complete test cycle, ensuring that everything is working well.
6. **Entire application is deployed when a small change**When there is a change due to any bug fix or enhancement, the entire build has to be deployed again and not the fixes or modified module. Deploying and testing the entire application is really a cumbersome task to ensure everything is working properly.
7. **Adoption of new technology is nightmare**Monolithic architecture is bound to be developed in single technology stack which actually requires relatively a big team in that technology stack. Also when migrating from one technology to another latest technology, it is very difficult and time taken.

Key Consideration while Implementing Microservices

Now you have a good overview of Microservice architecture, but having said that, practical implementation still has lot of differences compared to Monolithic. They are really not the same as traditional Monolithic architecture. We have to ensure everything is up and running effortlessly. The following are the key points which must be taken care of in this architecture,

1. *Storing Data*Each Microservice must have its own and individual database. Why? Because if we keep a single database for multiple domain/service, it defeats the purpose of having this architecture. Failing a dependent database will fail the entire system, but keeping separate databases for each service will isolate exception and the system will still up partially. E.g. in e-commerce applications, if order service is down, the user can still browse products and get details.
2. *Service Communications*Communication with services can be done using API Gateway. API Gateway is the central gate from where all requests can be translated and appropriate service can be invoked. Communication among services can be achieved using synchronous and asynchronous request/response using messaging queues.
3. *Security*Unlike the Monolithic system, the Authorization and Authentication process is different in Microservices architecture. Monolithic application is easily using session whereas Microservices uses token-based authentication.
4. *Testing*Since Microservices are completely distributed in nature, integration testing is different than a Monolithic application. Interprocess communication testing could be a challenge for a newbie.
5. *Deployment*Each Microservice should be deployed in such a way so that they are not blocking other service resources, and that’s why independent deployment recommended. Containerization should be followed to create a more efficient deployment. Independent Deploy, Update, Replace, Scale (DURS) is the beauty of Microservices and must be used.
6. Different ways of doing exception handling in apis

## A: Exception Handling in Developer Environment

**Approach 1: UseDeveloperExceptionPage**

The ASP.NET Core starup templates generate the following code,

public void Configure(IApplicationBuilder app, IWebHostEnvironment env)

{

if (env.IsDevelopment())

{

app.UseDeveloperExceptionPage();

}

else

......

}

C#

Copy

The UseDeveloperExceptionPage extension method adds middleware into the request pipeline. The Developer Exception Page is a useful tool to get detailed stack traces for server errors. It uses [DeveloperExceptionPageMiddleware](https://docs.microsoft.com/en-us/dotnet/api/microsoft.aspnetcore.diagnostics.developerexceptionpagemiddleware) to capture synchronous and asynchronous exceptions from the HTTP pipeline and to generate error responses. This helps developers in tracing errors that occur during development phase. We will demonstrate this below.

**Step 1 - Create an ASP.NET Core Web API application**

We use the current version of Visual Studio 2019 16.8 and .NET 5.0 SDK to build the app.

1. Start Visual Studio and select Create a new project.
2. In the Create a new project dialog, select ASP.NET Core Web Application > Next.
3. In the Configure your new project dialog, enter WebAPISample for Project name.
4. Select Create.
5. In the Create a new ASP.NET Core web application dialog, select,  
   1. .NET Core and ASP.NET Core 5.0 in the dropdowns.
   2. ASP.NET Core Web API
   3. Create

**Step 2 - Add Exception Code in WeatherforecastController**

#region snippet\_GetByCity

[HttpGet("{city}")]

public WeatherForecast Get(string city)

{

if (!string.Equals(city?.TrimEnd(), "Redmond", StringComparison.OrdinalIgnoreCase))

{

throw new ArgumentException(

$"We don't offer a weather forecast for {city}.", nameof(city));

}

//return GetWeather().First();

return Get().First();

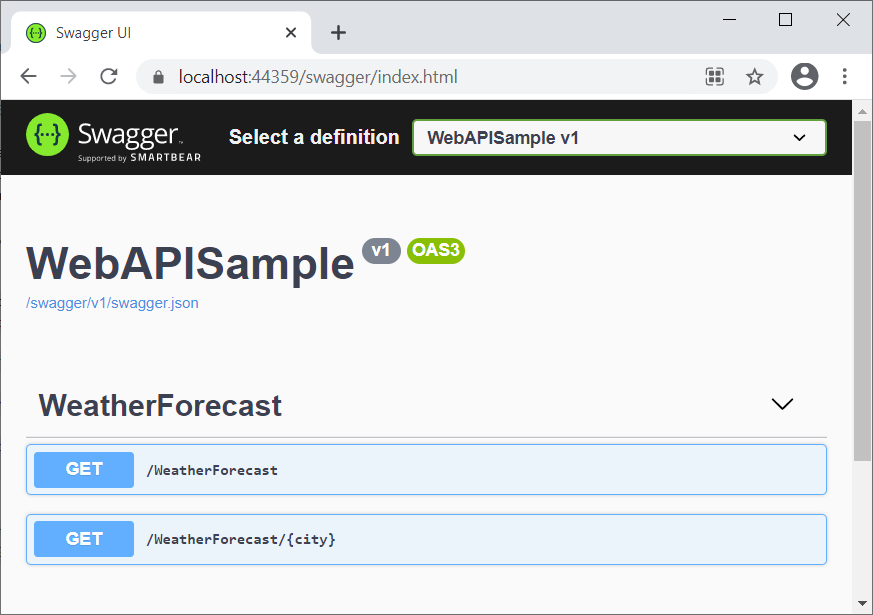
}

#endregion

C#

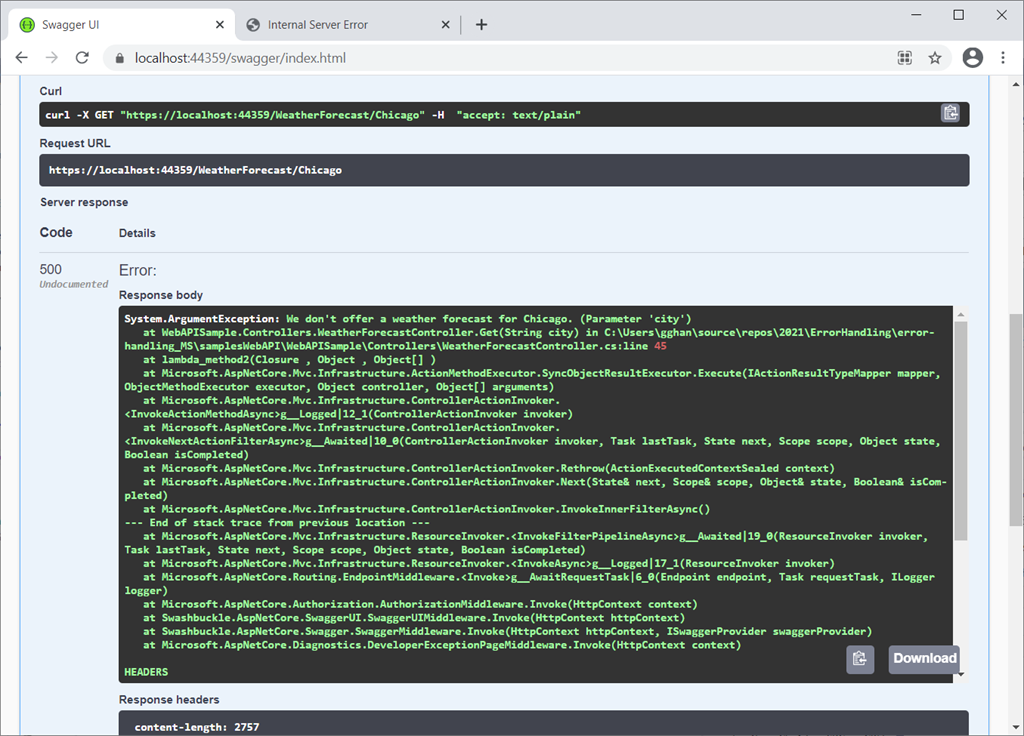
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Run the app, we will have this



**Step 3  - Trigger the Error in Three Ways**

**By Swagger**: Click GET (/WeatherForecast/{city}) > Try it out > Give City parameter as Chicago > Excute. This will trigger the exception in Step 2, and we will get



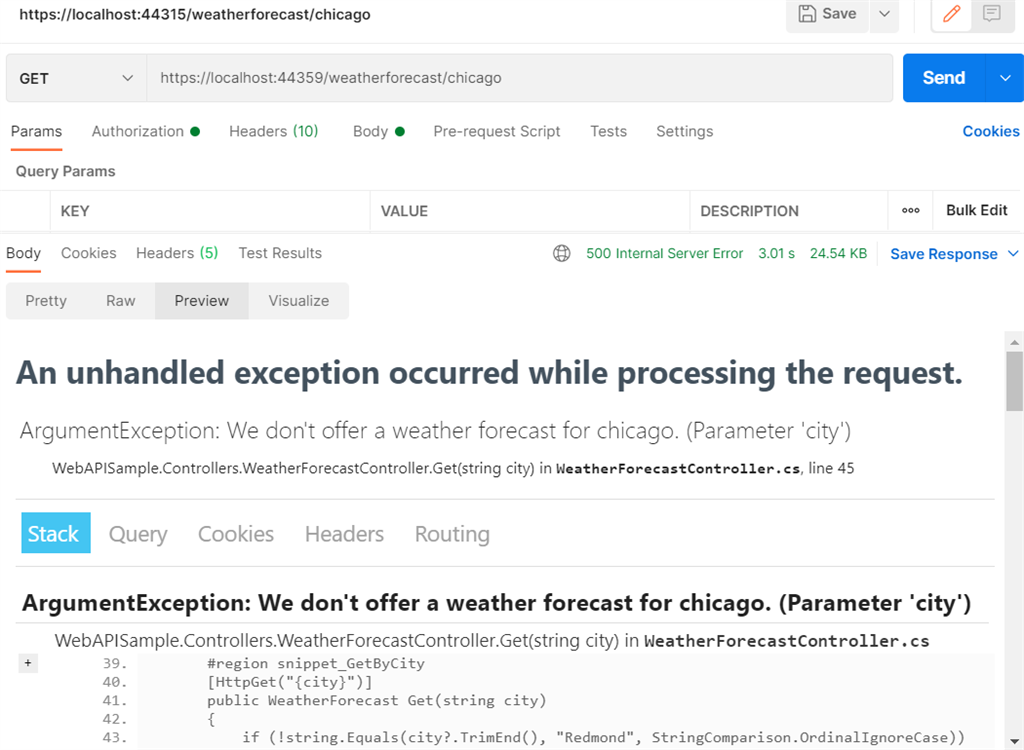
**In Browser**: Type the address https://localhost:44359/weatherforecast/chicago in Browser, we will get:



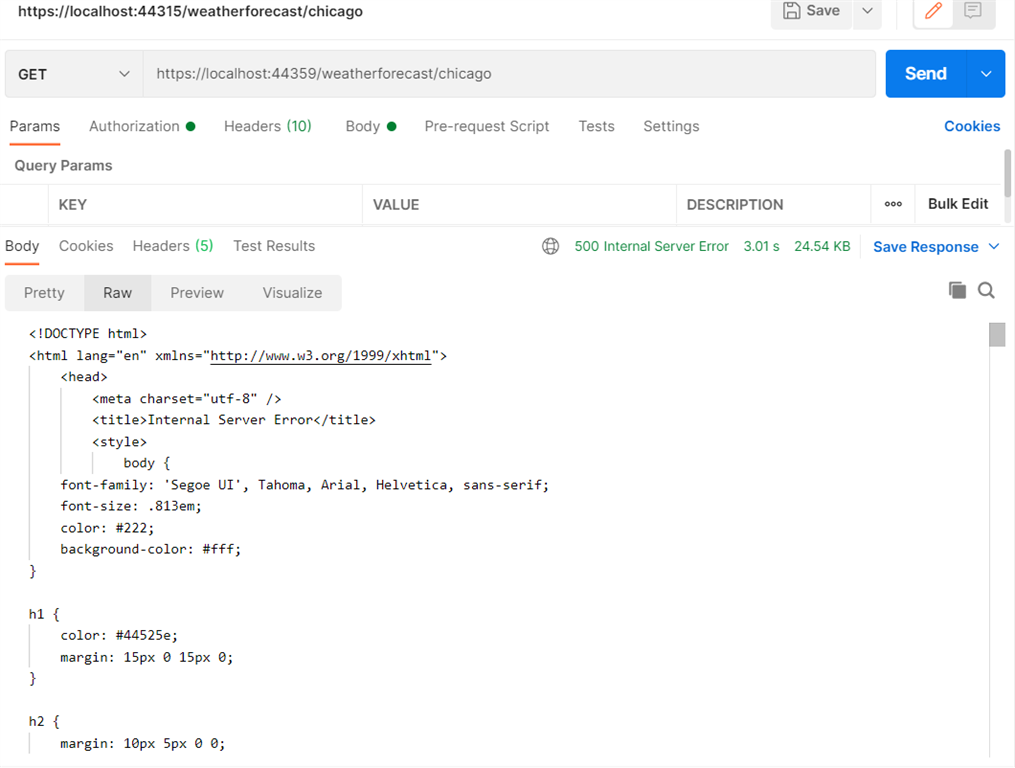
For the detailed discussion of this Developer Exception Page, we have done in the previous [article](https://www.c-sharpcorner.com/article/exception-handling-3-in-asp-net-core-mvc/).

**In Postman**: Type the address https://localhost:44359/weatherforecast/chicago in address bar, then Click **Send**Button, we will have:

Preview



 Raw Data



## Approach 2: UseExceptionHandler

Using Exception Handling Middleware is another way to provide more detailed content-negotiated output in the local development environment. Use the following steps to produce a consistent payload format across development and production environments:

**Step 1**

In Startup.Configure, register environment-specific Exception Handling Middleware instances:

public void Configure(IApplicationBuilder app, IWebHostEnvironment env)

{

if (env.IsDevelopment())

{

//app.UseDeveloperExceptionPage();

app.UseExceptionHandler("/error-local-development");

}

else

{

app.UseExceptionHandler("/error");

}

}

C#

Copy

In the preceding code, the middleware is registered with:

* A route of /error-local-development in the Development environment.
* A route of /error in environments that aren't Development that we will discuss later on.

**Step 2**

Add one empty apiController into the app, with the name as ErrorController:

* Right click Controllers > add > controller.
* In the Add New Scaffolded Item dialog, select API in the left pane, and
* API Controller - Empty > Add.
* In the Add Controller dialog, Change ErrorController for controller name > Add.

**Step 3**

Apply the following code into the controller,

public class ErrorController : ControllerBase

{

[HttpGet]

[Route("/error-local-development")]

public IActionResult ErrorLocalDevelopment(

[FromServices] IWebHostEnvironment webHostEnvironment)

{

if (webHostEnvironment.EnvironmentName != "Development")

{

throw new InvalidOperationException(

"This shouldn't be invoked in non-development environments.");

}

var context = HttpContext.Features.Get<IExceptionHandlerFeature>();

return Problem(

detail: context.Error.StackTrace,

title: context.Error.Message);

}

[HttpGet]

[Route("/error")]

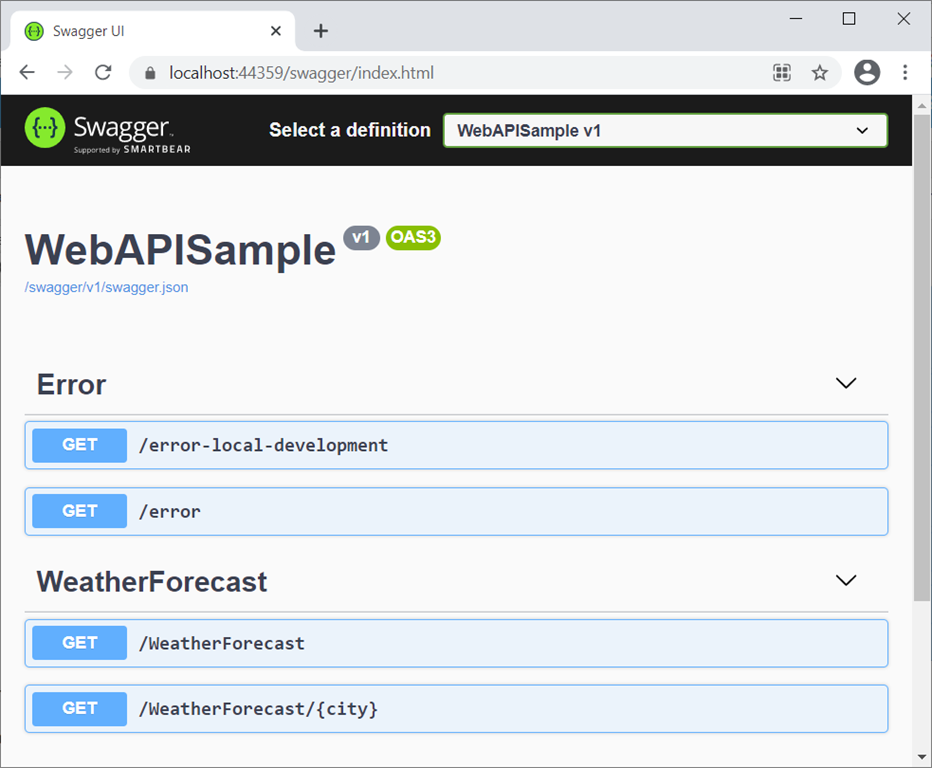
public IActionResult Error() => Problem();

}

C#

Copy

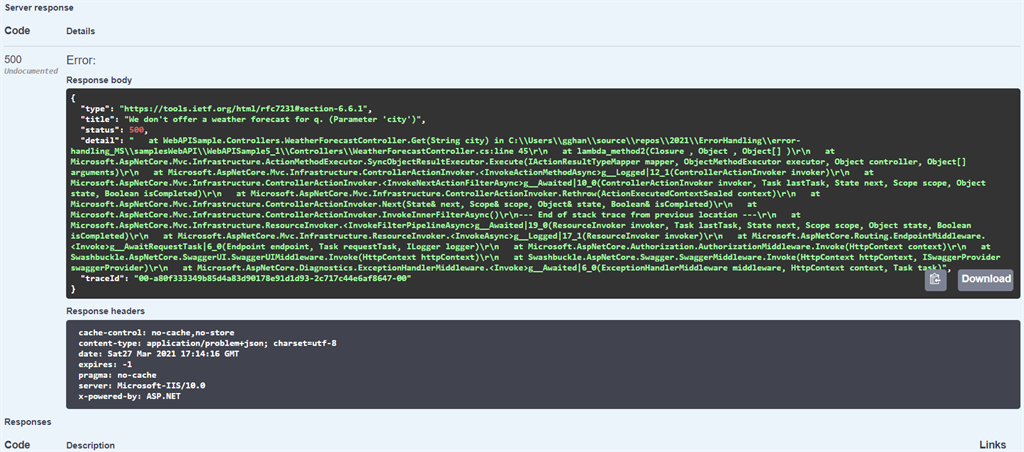
The preceding code calls [ControllerBase.Problem](https://docs.microsoft.com/en-us/dotnet/api/microsoft.aspnetcore.mvc.controllerbase.problem) to create a [ProblemDetails](https://docs.microsoft.com/en-us/dotnet/api/microsoft.aspnetcore.mvc.problemdetails) response. We will have



One can directly Click Get /error, and Get /error-local-development to test the error handling itself.

**Step 4  - Trigger the Error in Three Ways**

Trigger the Error exactly like before, we will get three different output from Swagger, Browser and Postman, the below is a demo from Swagger:



## B: Exception Handling in Production Environment

In the Section B, the  Approach 1 and 2 are quite similar to ones in the case of ASP.NET MVC module in Part ([3](https://www.c-sharpcorner.com/article/exception-handling-3-in-asp-net-core-mvc/)) of this series articles. Therefore, we will just give the input and output with only neccessary discussions,

* B: Exception Handling in Production Environment for ASP.NET Core Web API
  + Approach 1: UseExceptionHandler
    - 1: Exception Handler Page
    - 2: Exception Handler Lambda
  + Approach 2: UseStatusCodePages
    - 1: UseStatusCodePages, and with format string, and with Lambda
    - 2: UseStatusCodePagesWithRedirects
    - 3: UseStatusCodePagesWithReExecute

ASP.NET Core configures app behavior based on the [runtime environment](https://docs.microsoft.com/en-us/aspnet/core/fundamentals/environments?view=aspnetcore-5.0) that is determined in launchSettings.json file as Development, Staging or Production mode.  How to switch to production mode from development mode, we have discussed in Part ([3](https://www.c-sharpcorner.com/article/exception-handling-3-in-asp-net-core-mvc/)) of the series articles, and will skip here.

## Approach 1: UseExceptionHandler

**1: Exception Handler Page**

Switch to the production mode for the app, startup file Configure method tells us: ASP.NET Core handles exception by calling UseExceptionHandler:

public void Configure(IApplicationBuilder app, IWebHostEnvironment env)

{

if (env.IsDevelopment())

{

app.UseDeveloperExceptionPage();

}

else

{

app.UseExceptionHandler("/Error");

}

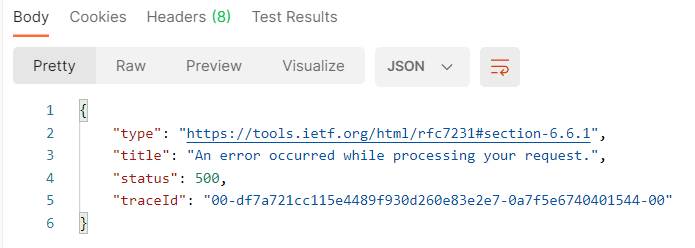
......

}

C#

Copy

Run the app, and **Trigger an exception** the same way as before, and we will get three different outputs from Swagger, Browser and Postman, the below is a demo from Postman:



**2: Exception Handler Lambda**

Replace the

        app.UseExceptionHandler("/error");

with a lambda for exception handling in startup file as below,

public void Configure(IApplicationBuilder app, IWebHostEnvironment env)

{

if (env.IsDevelopment())

{

app.UseDeveloperExceptionPage();

}

else

{

//app.UseExceptionHandler("/error");

app.UseExceptionHandler(errorApp =>

{

errorApp.Run(async context =>

{

context.Response.StatusCode = 500;

context.Response.ContentType = "text/html";

await context.Response.WriteAsync("<html lang=\"en\"><body>\r\n");

await context.Response.WriteAsync("ERROR!<br><br>\r\n");

var exceptionHandlerPathFeature =

context.Features.Get<IExceptionHandlerPathFeature>();

if (exceptionHandlerPathFeature?.Error is FileNotFoundException)

{

await context.Response.WriteAsync(

"File error thrown!<br><br>\r\n");

}

await context.Response.WriteAsync(

"<a href=\"/\">Home</a><br>\r\n");

await context.Response.WriteAsync("</body></html>\r\n");

await context.Response.WriteAsync(new string(' ', 512));

});

});

}

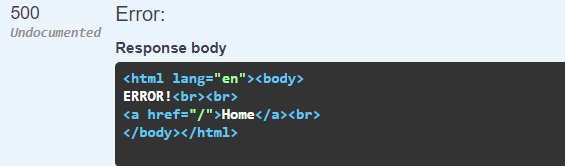
......

}

C#

Copy

We got the result from Swagger,

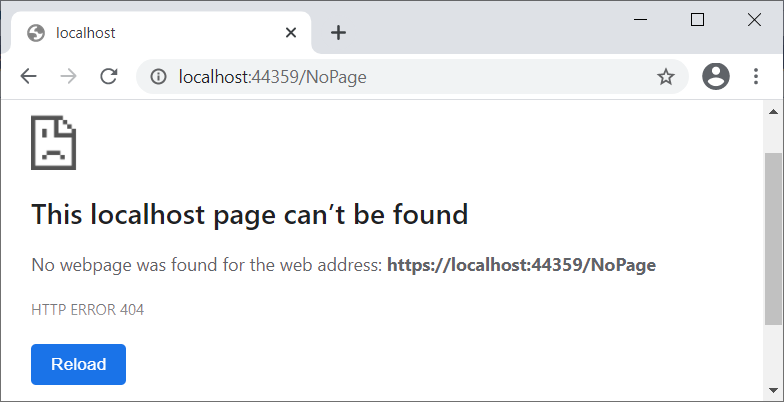


Actually, we can get rid of the HTML markup, because this is a Web API response that should be JSON format. For consistent or the sake of lazy, we just leave it as is.

## Approach 2: UseStatusCodePages

By default, an ASP.NET Core app doesn't provide a status code page for HTTP error status codes, such as 404 - Not Found. When the app encounters an HTTP 400-599 error status code that doesn't have a body, it returns the status code and an empty response body.

Request an endpoint that doesn't exist to Trigger a 404 exception:



To deal with such errors we can use UseStatusCodePages() method (status code pages middleware) to provide status code pages.

**1: Default UseStatusCodePages, or with format string, or with Lambda**

To enable default text-only handlers for common error status codes, call [UseStatusCodePages](https://docs.microsoft.com/en-us/dotnet/api/microsoft.aspnetcore.builder.statuscodepagesextensions.usestatuscodepages) in the Startup.Configure method:

public void Configure(IApplicationBuilder app, IWebHostEnvironment env)

{

if (env.IsDevelopment())

{

app.UseDeveloperExceptionPage();

}

else

{

app.UseExceptionHandler("/Home/Error");

app.UseHsts();

}

app.UseStatusCodePages();

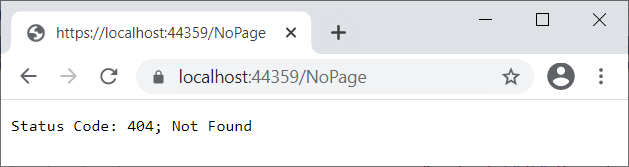
......

}

C#

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Run the app, trigger a 404 error, result will be,



Make startup file using UseStatusCodePages with format string,

public void Configure(IApplicationBuilder app, IWebHostEnvironment env)

{

if (env.IsDevelopment())

{

app.UseDeveloperExceptionPage();

}

else

{

app.UseExceptionHandler("/Home/Error");

app.UseHsts();

}

app.UseStatusCodePages("text/plain", "Status code page, status code: {0}");

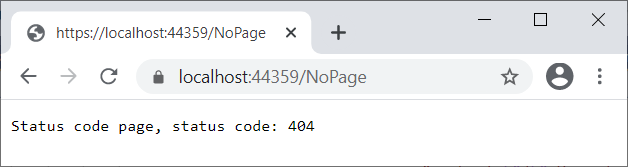
......

}

C#

Copy

Run the app, trigger a 404 error, result will be,



Make startup file using UseStatusCodePages with a lambda,

public void Configure(IApplicationBuilder app, IWebHostEnvironment env)

{

if (env.IsDevelopment())

{

app.UseDeveloperExceptionPage();

}

else

{

app.UseExceptionHandler("/Home/Error");

app.UseHsts();

}

app.UseStatusCodePages(async context =>

{

context.HttpContext.Response.ContentType = "text/plain";

await context.HttpContext.Response.WriteAsync(

"Status code lambda, status code: " +

context.HttpContext.Response.StatusCode);

});

......

}

C#

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Run the app, trigger a 404 error, result will be,

## Why Angular?

* It has a mobile support framework.
* The latest Angular version supports TypeScript and enables code optimization and modularity by employing the OOPS concept.
* It supports the changes for an increased hierarchical dependencies system.
* A developer can use various features such as syntax for type checking, Dart, TypeScript, ES5, iterators, Angular CLI, ES6, and lambda operators.
* Angular opts for semantic versioning that has a major-minor-patch arrangement.
* Amongst its best benefits is its provision for the event of simplest routing.

**Are you new to Angular? Check out the**[Angular tutorial here](https://www.simplilearn.com/tutorials/angular-tutorial/what-is-angular)**.**

## Why AngularJS?

* Its secure [MVC (Model-View-Controller)](https://www.simplilearn.com/tutorials/dot-net-tutorial/mvc-architecture) data binding makes application performance dynamic.
* A developer can easily perform unit testing or change detection at any point.
* It provides several helpful features for web developers, like declarative template language with HTML to allow them to make it more intuitive.
* The open-source framework allows well-structured front end development. It doesn't require any plugin or other platforms to work.
* The [AngularJS](https://www.simplilearn.com/nodejs-vs-angularjs-article)application runs on Android and iOS phones and tablets.

1. Api has to take different types of objects in request body, how do you do?

{

"plan\_id":"cbdemo\_free" ,

"auto\_collection":"off",

"customer": [{

"first\_name":"John",

"last\_name":"Doe",

"email":"john@user.com",

"address":{

"street": "123 Main st",

"city" : "Bellevue",

"state": "Washington",

"zip":"91789",

"country": "USA"

}

}]

}

### Difference between List and Set:

| S.No. | Basis | List | Set |
| --- | --- | --- | --- |
| 1. | Define | The List is a type of data structure to store the elements. | Sets are also a type of data structure but to stores the unique elements. |
| 2. | Sequence | A sequence of the elements is important. | The sequence doesn’t matter, it only depends upon the implementation. |
| 3. | Elements Access | Elements in the lists are accessed by using the indices of the elements in the list. | In the set, elements are the indices that can be easily accessible. |
| 4. | Interface | Systems.Collection.IList is the Interface available for the List Implementation. | Systems.Collection.ISet is the Interface available for the Set Implementation. |
| 5. | Implementation | It can be implemented using two ways:  Static List ( using Array )  Dynamic List ( using LinkedList ) | It can also be implemented using two ways:  HashSet ( Hashtable )  Sorted Set ( Red Black Tree-based ) |
| 6. | Duplicity | The list can have duplicate elements. | Set contains only unique elements. |
| 7. | Performance | List performance is not as good as Set. | Sets have good performance than List. |
| 8. | Methods | There are many methods available to apply on the List. Some of them are as :  int Add(element)  void Insert(int, element)  void Clear()  int IndexOf(element) | There are many methods available to apply on Set. Some of them are as :  bool Add(element)  bool Contains(element)  bool Remove(element)  void Clear() |

Difference compiler, interpreter, and JIT

Although there can be exceptions in general when we want to transform source code into machine code we can use:

1. **Compiler**: Takes source code and returns an executable
2. **Interpreter**: Executes the program instruction by instruction. It takes an executable segment of the source code and turns that segment into machine instructions. This process is repeated until all source code is transformed into machine instructions and executed.
3. **JIT**: Many different implementations of a JIT are possible, however a JIT is usually a combination of a compiler and an interpreter. The JIT first turn intermediary data (e.g. Java bytecode) which it receives into machine language via interpretation. A JIT can often measures when a certain part of the code is executed often and the will compile this part for faster execution.

POST vs PUT VS PATCH

* **POST** is always for creating a resource ( does not matter if it was duplicated )
* **PUT** is for checking if resource exists then update, else create new resource
* **PATCH** is always for updating a resource

What is normalization?

**Definition :** Normalization is the process of efficiently organizing data in a database. There are two goals of the normalization process: eliminating redundant data (for example, storing the same data in more than one table) and ensuring data dependencies make sense (only storing related data in a table). Both of these are worthy goals as they reduce the amount of space a database consumes and ensure that data is logically stored. There are several benefits for using Normalization in Database.

**Benefits :**

1. Eliminate data redundancy
2. Improve performance
3. Query optimization
4. Faster update due to less number of columns in one table
5. Index improvement

## Temp Table (Temporary Table)

* Temp tables are created in the runtime and these tables are ***physically***created in the ***tempdb***database.
* Temp tables are similar to normal tables and also have constraints, keys, indexes, etc. We can perform all operations in the temp table like a normal table.
* The name of the temp table can have a maximum of ***116 characters***.
* The structure of temp table can be ***altered after creating*** it.
* There are below types of temp tables
  + Local Temp Table
  + Global Temp Table

### **Local Temp Table**

* Local temp tables are only available to the ***current session*** that created them. The local temp tables are automatically deleted when the session is closed.
  + **Example:**Let's consider we are creating the temp table using query window. The temp table will only be available till query window is opened. If you close the current query window, then the temp table will be deleted. We can't access that temp table with a new query window, it will throw the error.
* If the session that we are working on has subsequent nested sessions then, the temp tables will be visible in the nested sessions.
* The local temp table name is started with a ***single hash ("#")***.

create table #Student

(

Id int,

Name nvarchar(50),

Address nvarchar(150)

)

go

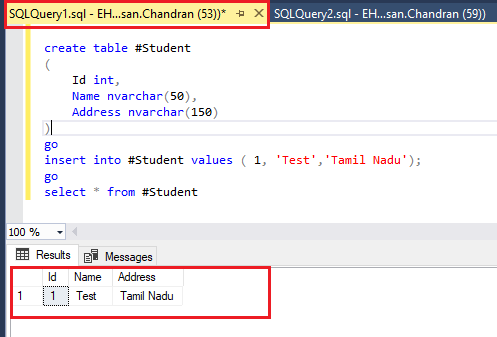
insert into #Student values ( 1, 'Test','Tamil Nadu');

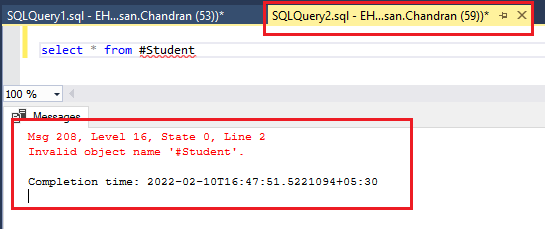
go

select \* from #Student;

SQL

Copy





**When to use Local Temp Table?**

* If the size of the temporary data is huge (more than 100 rows).
* When the user or connection which creates them alone can use it.
* If you need to create indexes or apply read lock, then go to temp table.
* You cannot use temp tables in User Defined Functions (UDF).

### **Global Temp Table**

* Global temporary tables are temporary tables that are available for ***all sessions and all users***. These can be created by any SQL Server connection user and these tables are automatically deleted when all the SQL Server connections are closed.
* The global temp table name is started with ***double hash ("##")***.

create table ##Student

(

Id int,

Name nvarchar(50),

Address nvarchar(150)

)

go

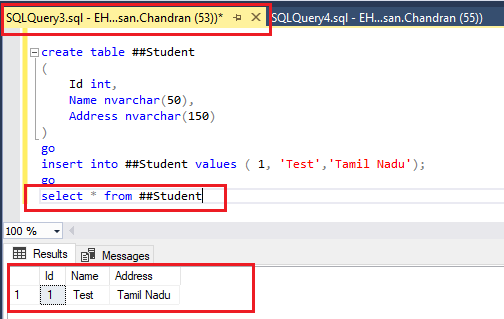
insert into ##Student values ( 1, 'Test','Tamil Nadu');

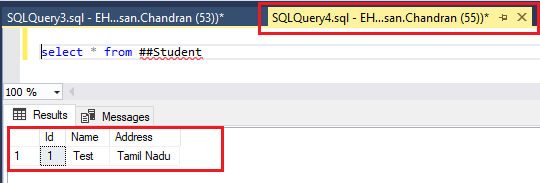
go

select \* from ##Student;

SQL

Copy





## CTE (Common Table Expression)

* It is used to hold the ***temporary result set*** or result of complex sub-query.
* The scope of CTE is ***limited to the current quer***y.
* CTE improves readability and ease in the maintenance of complex queries and sub-queries.
* CTE is created by using ***"WITH"*** statement and begin with a ***semicolon (;)***.
* ;With StudentCTE
* AS
* (
* SELECT stu.Id, stu.Name, stu.Age, Addr.Address from Student stu
* INNER JOIN Address Addr ON stu.Id = Addr.Id
* )
* SELECT \* FROM StudentCTE --Using CTE
* WHERE StudentCTE.Age > 50

ORDER BY StudentCTE.Id

SQL

Copy

* There are two types of Common Table Expression
  + Non-Recursive CTE  - It does not have any reference to itself in the CTE definition.
  + Recursive CTE - When a CTE has reference in itself, then it’s called recursive CTE.

**When to use CTE?**

* This is used to store the result of a complex subquery for further use.
* This is also used to create a recursive query.

**When to use Global Temp Table?**

* The global temp table has the same advantages over the local temp table with the feature of multiple users or sessions or connections should access to the same table.

## Temp Variable

* Temp variable is similar to temp table to use holding the data temporarily.
* Table variable is a ***special kind of data type*** and is used to ***store the result set***.
* The scope of temp variable is ***limited to the current batch***and current Stored Procedure. It will delete once comes out the batch (Ex. Stored Procedure).
* We can create a primary key, identity in the temp variable.
* We cannot create non-clustered index. It can only have indexes that are automatically created with PRIMARY KEY and UNIQUE constraints as part of the creation.
* Temp Variable is also created in the tempdb database but not the memory.
* The Temp variable name is started with ***"@"***.
* Temp Variables are created using a ***"DECLARE"*** statement.
* Declare @Student table
* (
* Id int,
* Name nvarchar(50),
* Address nvarchar(150)
* );
* -- Method 1
* insert into @Student select Id, Name, Address from Student Where id > 150;
* -- Method 2
* insert into @Student values (1000, "Test", "Test Address");

select \* from @Student;

SQL

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* We can use "insert into" statement for temp variable to store the values (Refer above examples)
* We cannot use "Select \* into” statement for temp variable to store the values. First, we have to create a temp variable and insert the values into it.
* The name of the temp variable can have a ***maximum of 128 characters***.
* Table variables can be passed as a parameter to functions and stored procedures.

**When to use** **Table Variable?**

* To store the temporary data in user-defined functions (UDF), stored procedures, and query batches.
* If the volume of data is less, say less than 100 rows.
* If you don’t want to alter the table structure after creating it.

**ACID** stands for Atomicity, Consistency, Isolation, and Durability. These are the properties of a transaction. Here is the small description of all of them:

**ATOMICITY:** The atomicity property identifies that the transaction is atomic. An **Atomic transaction** is either fully completed, or is not begun at all. If for any reason an error occurs and the transaction is unable to complete all of its steps, the then system is returned to the state it was in before the transaction was started.

**CONSISTENCY:**A transaction enforces **Consistency** in the system state by ensuring that at the end of any transaction the system is in a valid state. If the transaction completes successfully, then all changes to the system will have been properly made, and the system will be in a valid state. If any error occurs in a transaction, then any changes already made will be automatically rolled back.

**ISOLATION:**When a transaction runs in **Isolation**, it appears to be the only action that the system is carrying out at one time. If there are two transactions that are both performing the same function and are running at the same time, transaction isolation will ensure that each transaction thinks it has exclusive use of the system.

**DURABILITY:**A transaction is **Durable** in that once it has been successfully completed, all of the changes it made to the system are permanent. There are safeguards that will prevent the loss of information, even in the case of system failure.