SIS – SoftUni Information Services

SIS is a combination of a Web Server and a MVC Framework. Ultimately it is designed to mimic Microsoft's IIS and ASP.NET Core. Following several Lab documents you will build all components of the SIS.

SIS: Handmade HTTP Server

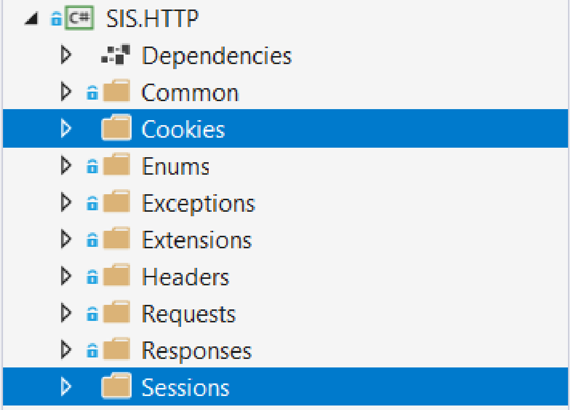
Problems for exercises and homework for the "C# Web Development Basics" course @ SoftUni.

Following to the end this document will help you to create your own very simple HTTP Server. We will eventually build a MVC Framework, with which we can build MVC Web Applications which will be hosted on the Handmade HTTP Server.

State management

In this lab you will configure the Server to be stateful. This means that we will add a few classes for Cookies and Sessions, in order to maintain states about our clients.

Start by **adding** the following **2 namespaces** to the **`SIS.HTTP`** project.



And now let's get to the main thing...

1. Cookies

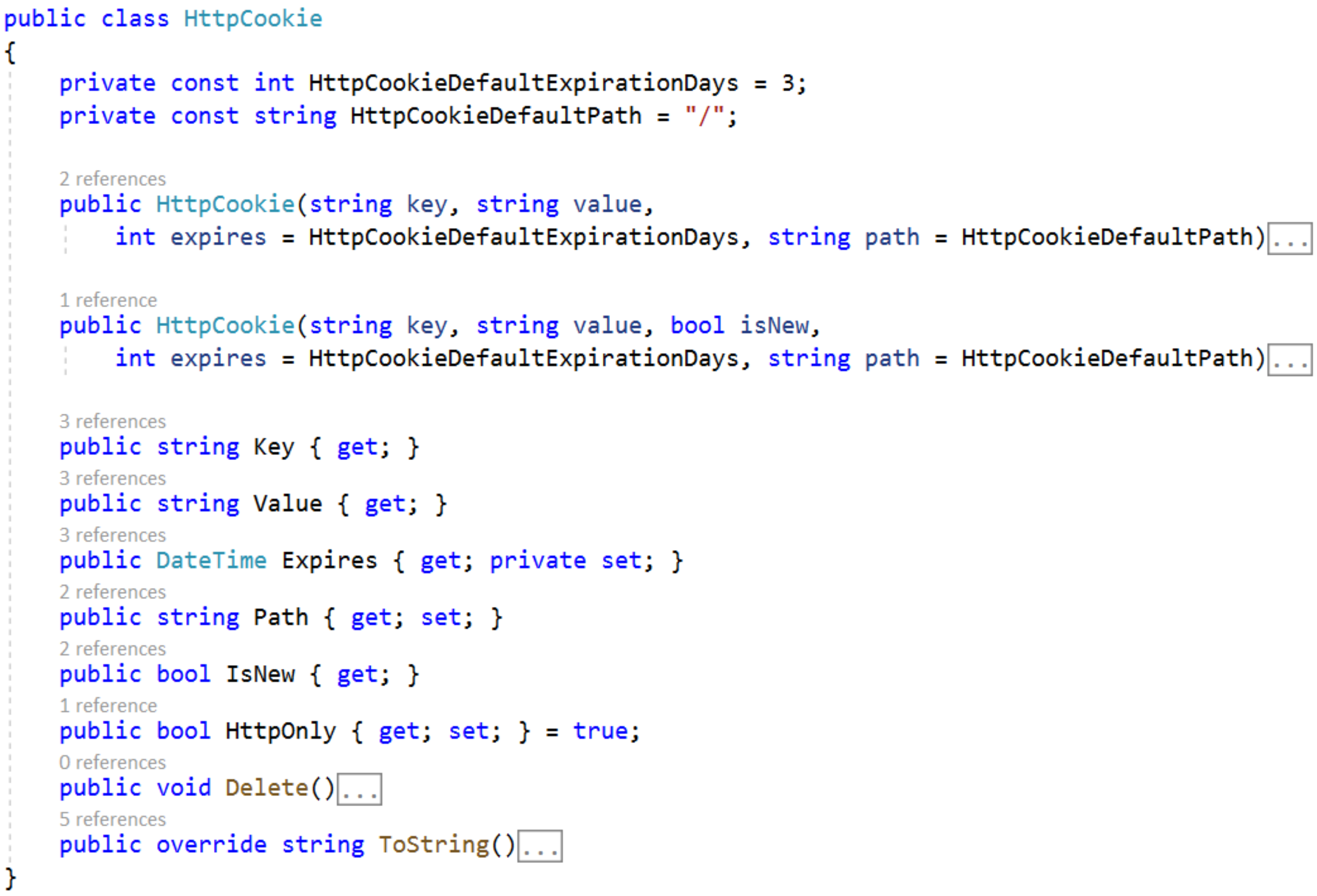
HttpCookie Class

The first thing we need to do is add the functionality for the **Cookies**, they will be the most **primitive element** to our **State Management**.

Create a class, called **`HttpCookie`**, in the **`Cookies`** namespace. The class should have the following properties:

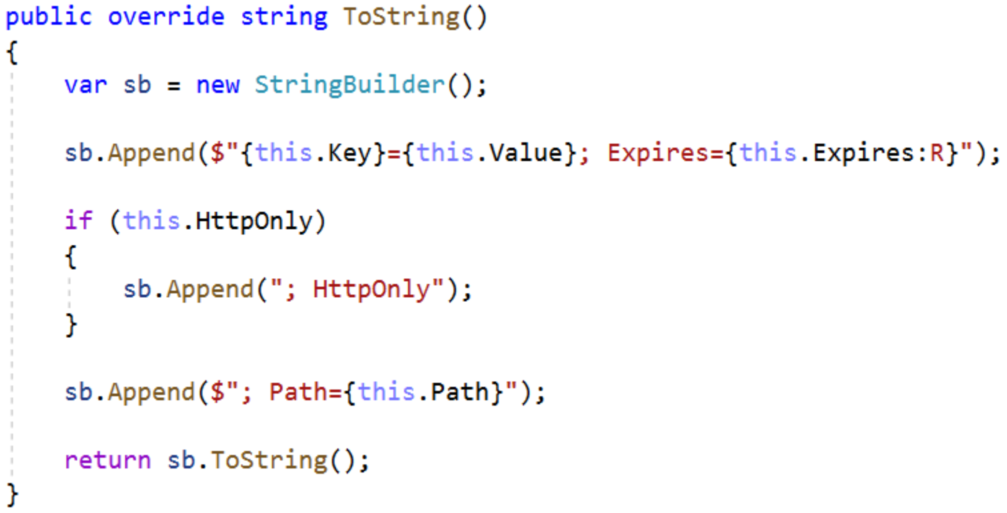
- **`Key`** – a **string**, representing the **key** (or the **name**) of the **Cookie**.
- **`Value`** – a **string**, representing the **value** (or the **content**) of the **Cookie**.
- **`Expires`** – a **DateTime**, representing the **expiration time** of the **Cookie**.
  - This **property** will be initialized with an **integer**, which will represent **DAYS**, from the **current moment**.
- **`Path`** - a **string**, representing the default **path** of the **Cookie**.

- **`IsNew`** – a **boolean**, which will be used to **define** if the **Cookie** is **freshly created**. This way we will know if the **Server** has **created** the **Cookie** (for example when the **Client logs in**) or the **Cookie** comes from the **Client**.
- **`HttpOnly`** - a **boolean** representing if the **Cookie** has HttpOnly flag, by default **true**.



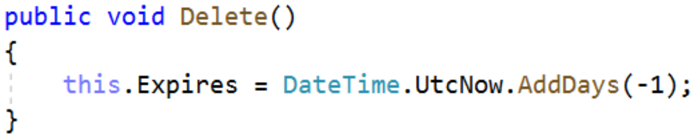
```
public class HttpCookie
{
    private const int HttpCookieDefaultExpirationDays = 3;
    private const string HttpCookieDefaultPath = "/";

    2 references
    public HttpCookie(string key, string value,
        int expires = HttpCookieDefaultExpirationDays, string path = HttpCookieDefaultPath)...

    1 reference
    public HttpCookie(string key, string value, bool isNew,
        int expires = HttpCookieDefaultExpirationDays, string path = HttpCookieDefaultPath)...

    3 references
    public string Key { get; }
    3 references
    public string Value { get; }
    3 references
    public DateTime Expires { get; private set; }
    2 references
    public string Path { get; set; }
    2 references
    public bool IsNew { get; }
    1 reference
    public bool HttpOnly { get; set; } = true;
    0 references
    public void Delete()...
    5 references
    public override string ToString()...
}
```

The **`ToString()`** method formats the **Cookie parameters** in **Web-ready format**.



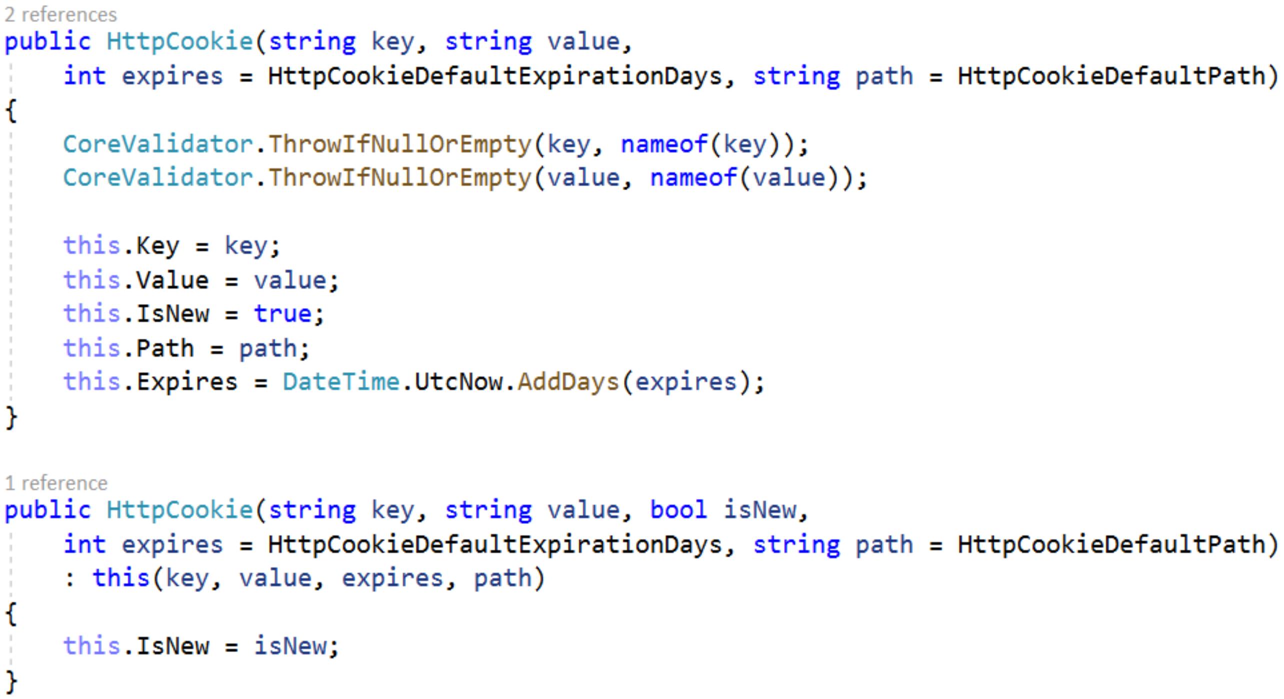
```
public override string ToString()
{
    var sb = new StringBuilder();

    sb.Append($"{this.Key}={this.Value}; Expires={this.Expires:R}");

    if (this.HttpOnly)
    {
        sb.Append("; HttpOnly");
    }

    sb.Append($"; Path={this.Path}");

    return sb.ToString();
}
```

Delete() method deletes the Cookie.



```
public void Delete()
{
    this.Expires = DateTime.UtcNow.AddDays(-1);
}
```

There are **2 constructors** which control the way the **IsNew** property is **initialized**, due to its behaviour:

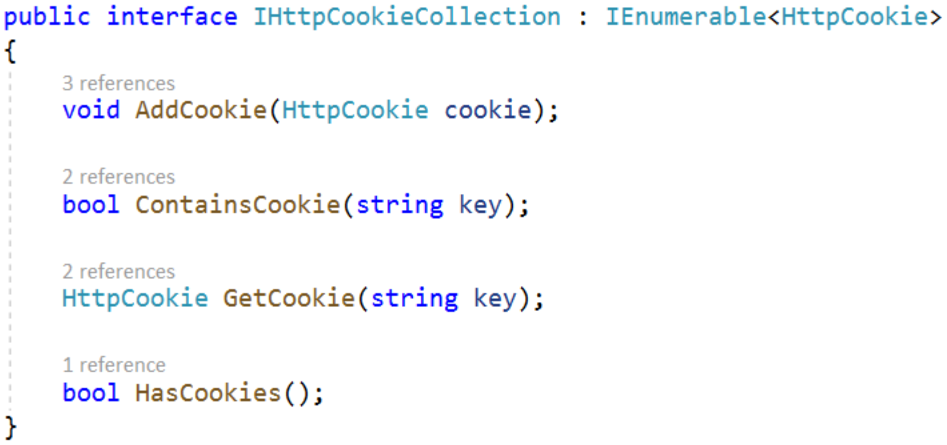


```
2 references
public HttpCookie(string key, string value,
    int expires = HttpCookieDefaultExpirationDays, string path = HttpCookieDefaultPath)
{
    CoreValidator.ThrowIfNullOrEmpty(key, nameof(key));
    CoreValidator.ThrowIfNullOrEmpty(value, nameof(value));

    this.Key = key;
    this.Value = value;
    this.IsNew = true;
    this.Path = path;
    this.Expires = DateTime.UtcNow.AddDays(expires);
}

1 reference
public HttpCookie(string key, string value, bool isNew,
    int expires = HttpCookieDefaultExpirationDays, string path = HttpCookieDefaultPath)
    : this(key, value, expires, path)
{
    this.IsNew = isNew;
}
```

And with this we have completed our **HttpCookie** class. Now it's time to create a **Repository-like** class for it.

HttpCookieCollection Class

Create an interface, called **IHttpCookieCollection** in the **Cookies** namespace. It should look like this.



```
public interface IHttpCookieCollection : IEnumerable<HttpCookie>
{
    3 references
    void AddCookie(HttpCookie cookie);

    2 references
    bool ContainsCookie(string key);

    2 references
    HttpCookie GetCookie(string key);

    1 reference
    bool HasCookies();
}
```

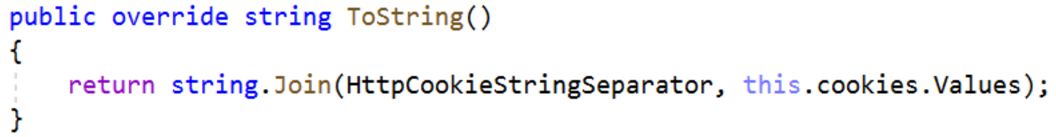
The classes that implement the interface and its methods should have the following functionality:

- **AddCookie()** – **adds** the given **Cookie** to a **collection** of **HttpCookies**.
- **ContainsCookie()** – returns a **boolean** result, on whether the **given key** is **contained** in the **HttpCookie** collection.
- **GetCookie()** – **extracts**, form the **HttpCookie** collection, the **Cookie** with the **given key**, and **returns it**.

- **`HasCookies()`** – returns a **boolean** result, on **whether** there are **ANY cookies** in the **`HttpCookie`** collection.

The class is yours to implement. :)

The HttpCookieCollection class should also have a **`ToString()`** override method, that should format the Cookies in Web-Ready format:

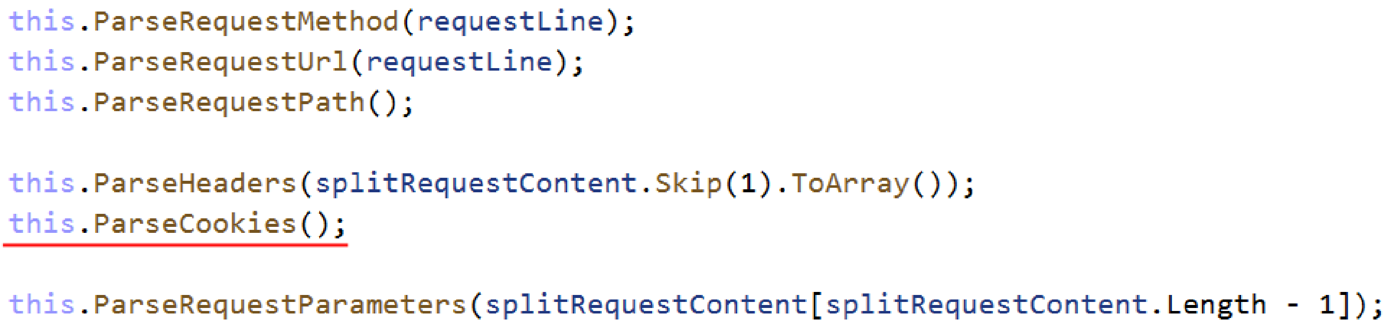


```
public override string ToString()
{
    return string.Join(HttpCookieStringSeparator, this.cookies.Values);
}
```

Now let's add the Cookies to our main communication classes – The **`HttpRequest`** & **`HttpResponse`**.

HttpRequest

Add an **`IHttpCookieCollection`** property to the **`HttpRequest`** class. Intiialize it from the constructor. Write a method **`ParseCookies()`**, which checks the **`HttpHeadersCollection`** for a **Header** with name "**`Cookie`**" and if there is, extracts its **string value**, **formats** it, **parses** it and **adds** it to the **`HttpCookieCollection`**.

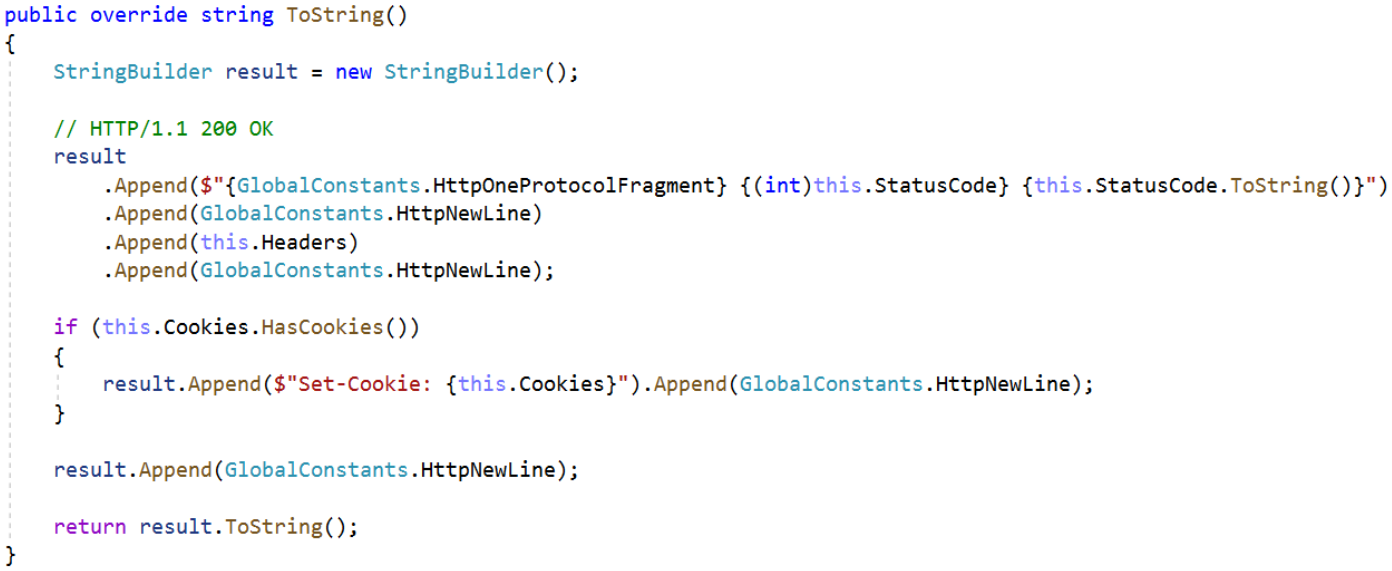


```
this.ParseRequestMethod(requestLine);
this.ParseRequestUrl(requestLine);
this.ParseRequestPath();

this.ParseHeaders(splitRequestContent.Skip(1).ToArray());
this.ParseCookies();

this.ParseRequestParameters(splitRequestContent[splitRequestContent.Length - 1]);
```

HttpResponse

Add an **`IHttpCookieCollection`** property to the **`HttpResponse`** class. Intiialize it from the constructor. Write a public method **`AddCookie()`**, which **adds** the **given `Cookie`** to the **`HttpCookieCollection`**.

Reformat the **`ToString()`** method so that it includes the **`Cookies`**, if there are any, with a "**`Set-Cookie`**" **name**, and **values** – separated by a **semi colon** and a **space**.



```
public override string ToString()
{
    StringBuilder result = new StringBuilder();

    // HTTP/1.1 200 OK
    result
        .Append($"{GlobalConstants.HttpOneProtocolFragment} {(int)this.StatusCode} {this.StatusCode.ToString()}")
        .Append(GlobalConstants.HttpNewLine)
        .Append(this.Headers)
        .Append(GlobalConstants.HttpNewLine);

    if (this.Cookies.HasCookies())
    {
        result.Append($"Set-Cookie: {this.Cookies}").Append(GlobalConstants.HttpNewLine);
    }

    result.Append(GlobalConstants.HttpNewLine);

    return result.ToString();
}
```

And with this we are done with the Cookies' implementation in our HTTP Server. This will be enough for now. As the time passes by, we will obviously refactor them, extend them, optimize them and manipulate them in many ways, but let's be patient.

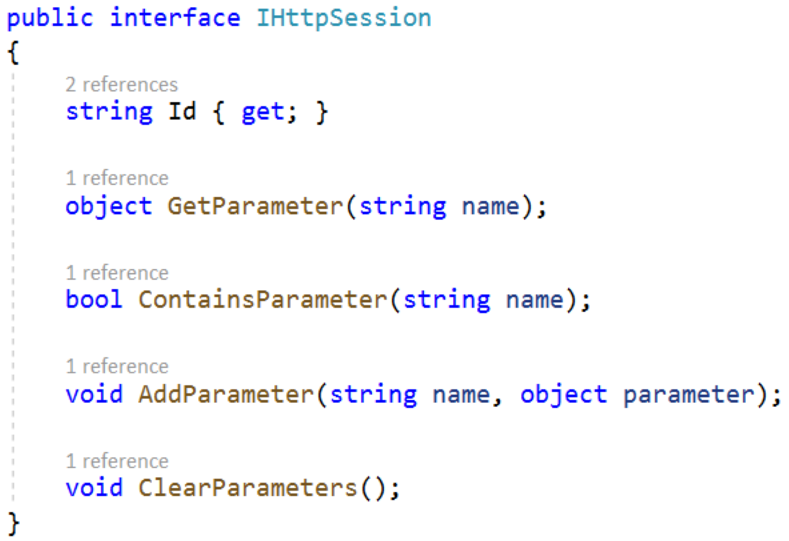
NOTE: Each of the **public methods** and **properties** you've **added** should **be also added** to the **interfaces** of the **corresponding classes**.

2. Sessions

The next big thing we need to implement is the **`Sessions`**. They are **Server-side State Management** mechanism, and are the most important element of the Stateful functionality.

IHttpSession

Let's start with the interface. Create an interface, called **`IHttpSession`**, in the **`Sessions`** namespace. The **`HttpSession`** should have a **collection** of **parameters** and a **`Id`** which is a **string**. The interface should look like this:



```
public interface IHttpSession
{
    2 references
    string Id { get; }

    1 reference
    object GetParameter(string name);

    1 reference
    bool ContainsParameter(string name);

    1 reference
    void AddParameter(string name, object parameter);

    1 reference
    void ClearParameters();
}
```

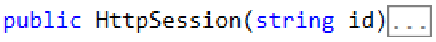
As you can see there are **several methods** for **accessing** the **collection** of **parameters**, as it will be **private**. This is everything we need as public behaviour.

The classes that implement the **interface** and its **methods** should have the following functionality:

- **`Id`** – just a **property** with a **getter**.
- **`GetParameter()`** – **extracts**, form the **parameter collection**, the **parameter** with the **given name**, and **returns it**.
- **`ContainsParameter()`** – returns a **boolean** result, on whether a **parameter** with **given name** is **contained** in the collection.
- **`AddParameter()`** – **adds** the given **`parameter`** with the **given name** to a **key-value-pair collection** of **parameters**.
- **`ClearParameters()`** – **clears** the **collection**, emptying it.

The class is yours to implement. :)

Note: The **constructor** of the **class** should **initialize** the **collection** and the **`Id`**. Here's a hint on how it should look:



```
public HttpSession(string id)...
```

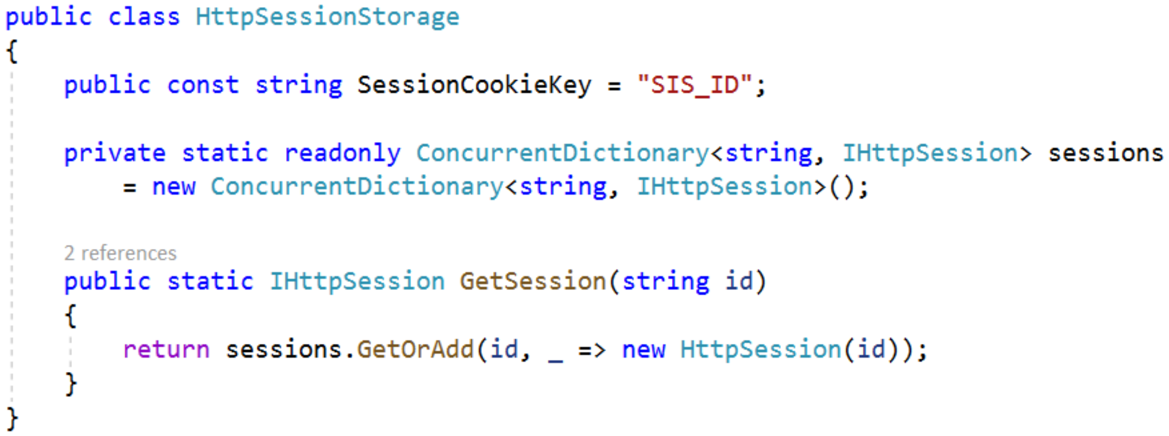
The **`HttpSessions`** are implemented, but there is something missing. The **Server** needs to store the **`Sessions`** somewhere.

HttpSessionStorage

Create a class named **HttpSessionStorage**, in the **Sessions** namespace. We will use this **class** to **store** our **sessions**, in a **Dictionary-like** collection. But our **Server** will work with **many Clients parallelly**, which means that the collection must be **async-friendly**, or **thread-safe**.

Well, there is a collection that just does the trick.

We would also need a **Session Key**, something with which our **Session** will be sent as a **Cookie** to the **Client**. Let's call it "**SIS_ID**". This will be the **SIS**'s **Session Key**.



```
public class HttpSessionStorage
{
    public const string SessionCookieKey = "SIS_ID";

    private static readonly ConcurrentDictionary<string, IHttpSession> sessions
        = new ConcurrentDictionary<string, IHttpSession>();

    2 references
    public static IHttpSession GetSession(string id)
    {
        return sessions.GetOrAdd(id, _ => new HttpSession(id));
    }
}
```

The **GetSession()** method **retrieves** a **Session** from the **Session Storage collection** if it **exists**, or **adds** it and **then retrieves** it, if it **does NOT exist**.

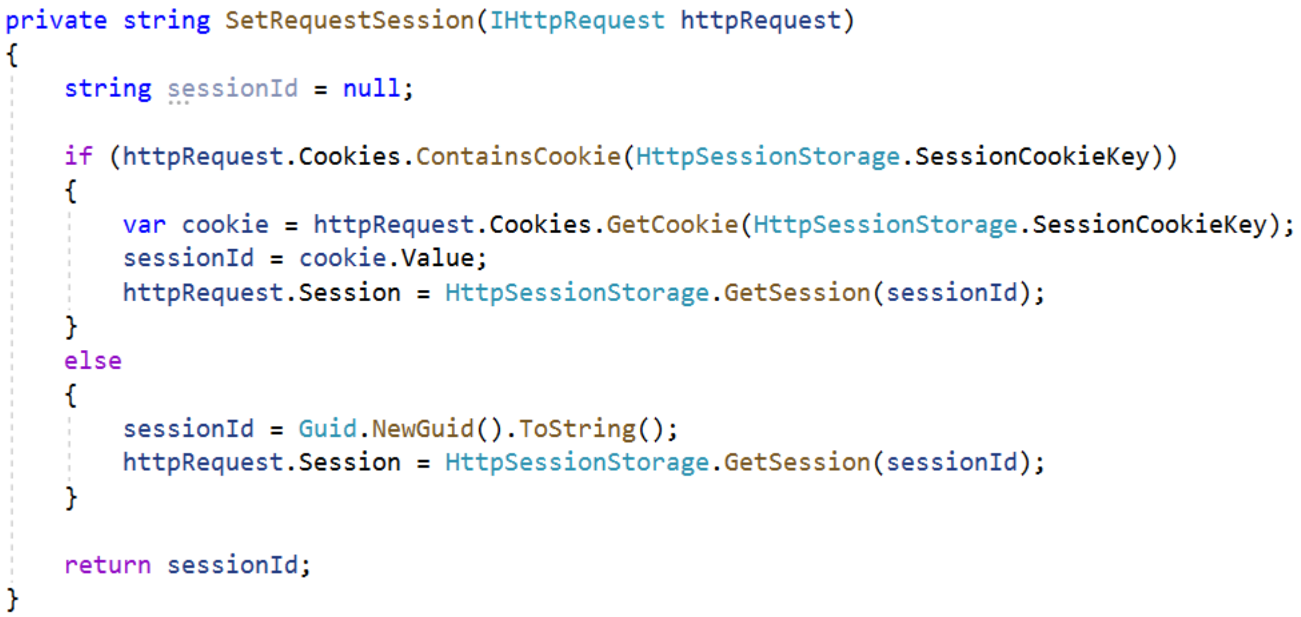
And with this we are ready with our **HttpSessionStorage**. Now it's time to include all we've created so far in the main business logic of our **Server**.

3. Server

We have to add the **Sessions** functionality to our **ConnectionHandler**, in order for it to be linked with the **Client**.

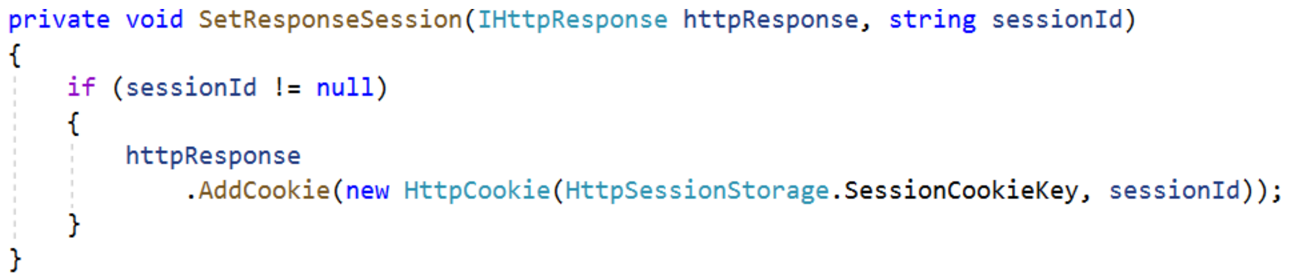
The following things must be included in our logic:

- **Initialize** the **Request Session** – **Check** if the **Request** contains a **Cookie** with the **SIS Session Key**.
  - If **there is**:
    - **Extract** the **value** of the **Cookie** (which will be the **id** of the **Session**).
    - **Use** the **id** to **extract** the **Session** from the **Session storage**.
    - **Set** it to the **Request**'s **Session** property.
  - If **there isn't**:
    - **Generate** a **new GuID**, create a **new Session** with it.
    - **Add** the new **Session** to the **Session storage**.
    - **Set** it to the **Request**'s **Session** property.
  - This should be achieved by **adding** the **following method** to the **ConnectionHandler** class:



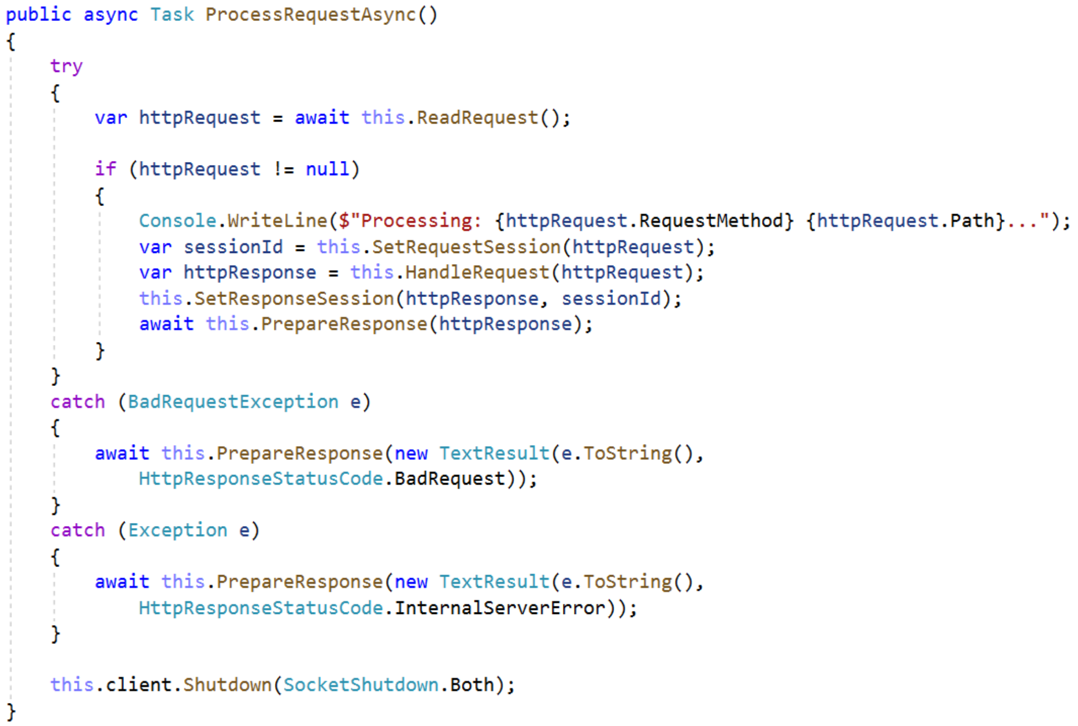
```
private string SetRequestSession(IHttpRequest httpRequest)
{
    string sessionId = null;

    if (httpRequest.Cookies.ContainsCookie(HttpSessionStorage.SessionCookieKey))
    {
        var cookie = httpRequest.Cookies.GetCookie(HttpSessionStorage.SessionCookieKey);
        sessionId = cookie.Value;
        httpRequest.Session = HttpSessionStorage.GetSession(sessionId);
    }
    else
    {
        sessionId = Guid.NewGuid().ToString();
        httpRequest.Session = HttpSessionStorage.GetSession(sessionId);
    }

    return sessionId;
}
```

- **Initialize** the **Response Session** – **Add** a **Cookie** with the **SIS Session Key** as **Cookie key**, and the **Request**'s **session id**, as **Cookie value**
  - This should be achieved by **adding** the **following method** to the **ConnectionHandler** class:



```
private void SetResponseSession(IHttpResponse httpResponse, string sessionId)
{
    if (sessionId != null)
    {
        httpResponse
            .AddCookie(new HttpCookie(HttpSessionStorage.SessionCookieKey, sessionId));
    }
}
```

The **invocation** of these methods should be **performed** while **processing** the **Request**. Modify the **ProcessRequest()** method like this:

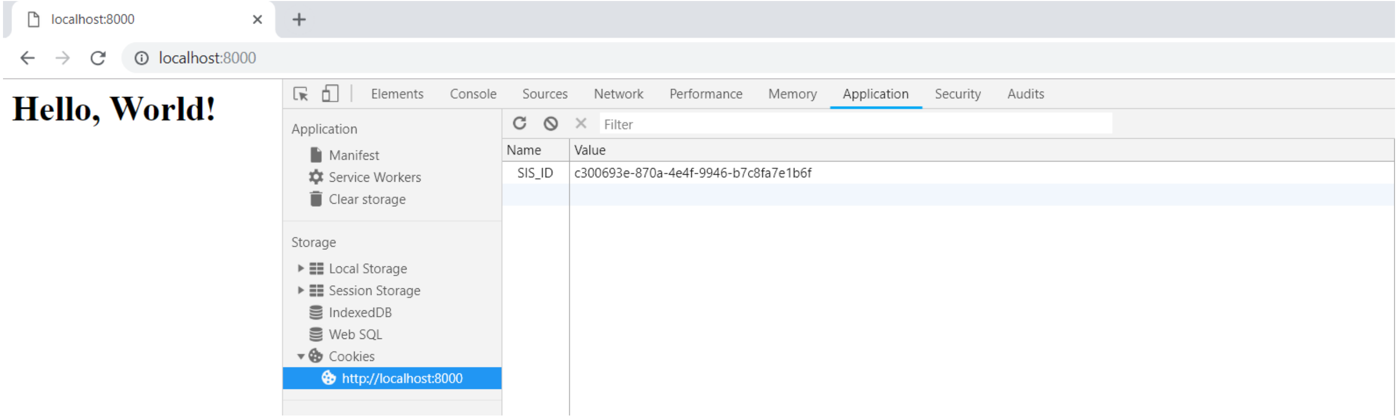


```
public async Task ProcessRequestAsync()
{
    try
    {
        var httpRequest = await this.ReadRequest();

        if (httpRequest != null)
        {
            Console.WriteLine($"Processing: {httpRequest.RequestMethod} {httpRequest.Path}...");
            var sessionId = this.SetRequestSession(httpRequest);
            var httpResponse = this.HandleRequest(httpRequest);
            this.SetResponseSession(httpResponse, sessionId);
            await this.PrepareResponse(httpResponse);
        }
    }
    catch (BadRequestException e)
    {
        await this.PrepareResponse(new TextResult(e.ToString(),
            HttpResponseStatusCode.BadRequest));
    }
    catch (Exception e)
    {
        await this.PrepareResponse(new TextResult(e.ToString(),
            HttpResponseStatusCode.InternalServerError));
    }

    this.client.Shutdown(SocketShutdown.Both);
}
```

And this should do for now. We have **implemented** a very simple **State Management** mechanism in our **SIS**'s **HTTP Server**.

As the Server is implement, currently, it generates a **`Session`** for every connected client. That **`Session`** however is **manipulatable**, and we can **add parameters** to it. **Parameters** such as **`username`** for example. Such parameters may be used to **indicate** if the **Client** is **logged in**, or what are his **permissions** ot our application.

4. Test it out



Name	Value
SIS_ID	c300693e-870a-4e4f-9946-b7c8fa7e1b6f