CS 376 Exercise 1:
Making a simpler serializer

Overview

In this assignment, you'll write a serializer for a simplified subset of the Unity object system. We're serializing to a text file in a format similar to JSON, so you'll be able to read it.

We've provided:

- Simplified versions of `GameObject`, `Component`, `Transform`, `CircleCollider2D`, and `SpriteRenderer`. They'll give you a sense of how to the different objects fit together.
- A `Serializer` and `Deserializer` class. To serialize an object *o*, one creates a `Serializer` and then calls its `WriteObject` method on *o*. Since *o* likely has pointers to other objects, we're really serializing a whole tree or graph of objects. Similarly, to deserialize, you make a `Deserializer` and then call its `ReadObject` method. Again, this is likely to end up reading in a whole graph of objects.
    - There's a built-in static method, `Serializer.Serialize()` that does those steps for you. It takes an object and gives you back the serialized string.
    - There's a built-in static method, `Deserializer.Deserialize()` that takes a serialized string and gives you back the object, or rather an equivalent object.
- A set of useful methods in a static class called `Utilities` that lets you
    - Find out all the fields in an object, the names (strings) of those fields and their values
    - Take an object, the name of a field, and a new value for the field, and update that field to have that value
    - Create a new object given the name (a string) of its class.
- Code to serialize and deserialize
    - Primitive types like int, float, and string
    - Sequence types like arrays and lists
- Unit tests that run inside Visual Studio and display their status

You need to fill in the missing code in the code in `Serialization/Serializer.cs` and `Serialization/Deserializer.cs` to:

- Write a complex object (a class instance). This needs to write out a serial number for the object, and if it hasn't already been written out, its type, and all its fields.
- Write an arbitrary object. This needs to check the object to see what type it is and call the appropriate code to write it.
- Read a complex object. This needs to read the serial number and possibly the data for the object if that object hasn't already been read in.
- Read an arbitrary object. This needs to read the first character of the description, decide what kind of object it's looking at, and call the appropriate code to read it.

Serialization format

The format we'll use is a variant of JSON. It looks like this:

- Whitespace is ignored, so you can generate newlines as you like
- Floats and ints print as normal decimal numbers: 1.5, 1, etc.
- Strings print with double quotes: "this is a string"
- Booleans print as "True" or "False"
- Lists and arrays print with square brackets. Inside the brackets are the elements of the list, separated by commas
- Complex objects containing their own fields which have not already been serialzed, should print as:

  #id { type: *typename*, *fieldname*: *value*, … }

  where
  - *id* is the serial number assigned to this object
  - *typename* is the name of the type of the object. You can get the type of an object by calling its GetType() method, and you can get a type's name by looking at its .Name field.
  - *Fieldname*s are the names of the different fields in the object and *value*s are their respective values. We've given you a method that will tell you what all the field names and values are for a given object
- Complex objects that have already been serialized should be printed just as the *#id*, since all the other data has already been put into the serialization stream.

Example serialized data structure

Here's the serialization produced by my solution set for the GameObject graph used in the tests. That graph has a gameobject, parent, which two gameobjects in it, the first of which has its own child object inside it. All gameobjects have transform components, but the two children of the parent game object also have other components in them. Here's the serialization:

```
#0{
    type: "GameObject",
    name: "test",
    components: [
        #1{
            type: "Transform",
            X: 0,
            Y: 0,
            parent: null,
            children: [
                #2{
                    type: "Transform",
                    X: 100,
                    Y: 100,
                    parent: #1,
                    children: [
                        #3{
                            type: "Transform",
```

```
            X: 0,
            Y: 0,
            parent: #2,
            children: [ ],
            gameObject: #4{
                type: "GameObject",
                name: "child 2",
                components: [
                    #3
                 ]
            }
        }
     ],
    gameObject: #5{
        type: "GameObject",
        name: "child 1",
        components: [
            #2, #6{
                type: "CircleCollider2D",
                Radius: 10,
                gameObject: #5
            }, #7{
                type: "SpriteRenderer",
                FileName: "circle.jpg",
                gameObject: #5
            }
         ]
    }
}, #8{
    type: "Transform",
    X: 500,
    Y: 550,
    parent: #1,
    children: [ ],
    gameObject: #9{
        type: "GameObject",
        name: "child 3",
        components: [
            #8, #10{
                type: "CircleCollider2D",
                Radius: 200,
                gameObject: #9
            }, #11{
                type: "SpriteRenderer",
                FileName: "circle.jpg",
                gameObject: #9
            }
         ]
    }
}
```

```
            ],
            gameObject: #0
        }
    ]
}
```

Notice that the serialization starts with "`#0`", meaning "here comes object #0!" and ends with "`gameObject: #0`", which means "the value of the `gameObject` field of this object is object #0." Since object 0 has already been serialized, we don't have to include another copy of it here (and shouldn't!).

Unit Testing

This assignment does not run inside of Unity. It's a standalone C# project, which means it can use the standard C# unit testing framework. We've included a set of unit tests, so you don't have to write your own.

When you start the assignment most or all of the tests will fail. As you implement parts of the assignment, more tests will succeed. When all the tests succeed, you're done.

Getting started

Start by doing a pull on GitHub to make sure you have the most recent version of the repo. Then open the file `Serializer.sln`. This will launch Visual Studio and open the assignment. It contains two "projects", the serializer itself, called "Serializer", and the unit tests, called "SerializerTests". Inside of Serializer, are two folders, `FakeUnity`, which has a classes that implement fake versions of some of the important Unity classes, like GameObject, Transform, and Component, and Serialization, which has the code for the serializer and deserializer.

Familiarizing yourself with the code

Reading other people's code is one of the most important skills for you as a programmer. So begin by reading all the code we've provided. Your goal here isn't to memorize the code, just to see what classes and methods are there so that when you need a method to do something we've already implemented, you know where to go looking for it.

IMPORTANT: the code in Utilities.cs uses the reflection features of C#, which we haven't talked about, and which aren't central to this class. So while I'm happy to answer any questions about it, don't feel you need to understand how those methods work. You just need to understand what they do.

Running unit tests

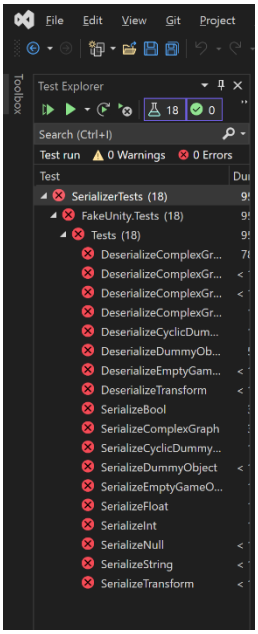
To run the unit tests, open the test window (called "test explorer"). In windows, go to the **Test** menu and choose **Test explorer**. On Mac, go to the **View** menu and choose **Tests**.

Running all tests

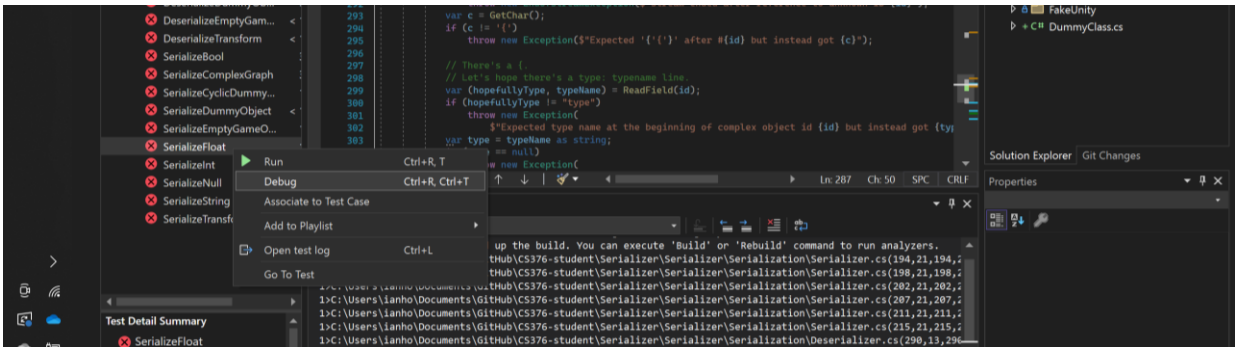
Press the button to run all tests. On windows, this looks like:

On mac, it looks like:

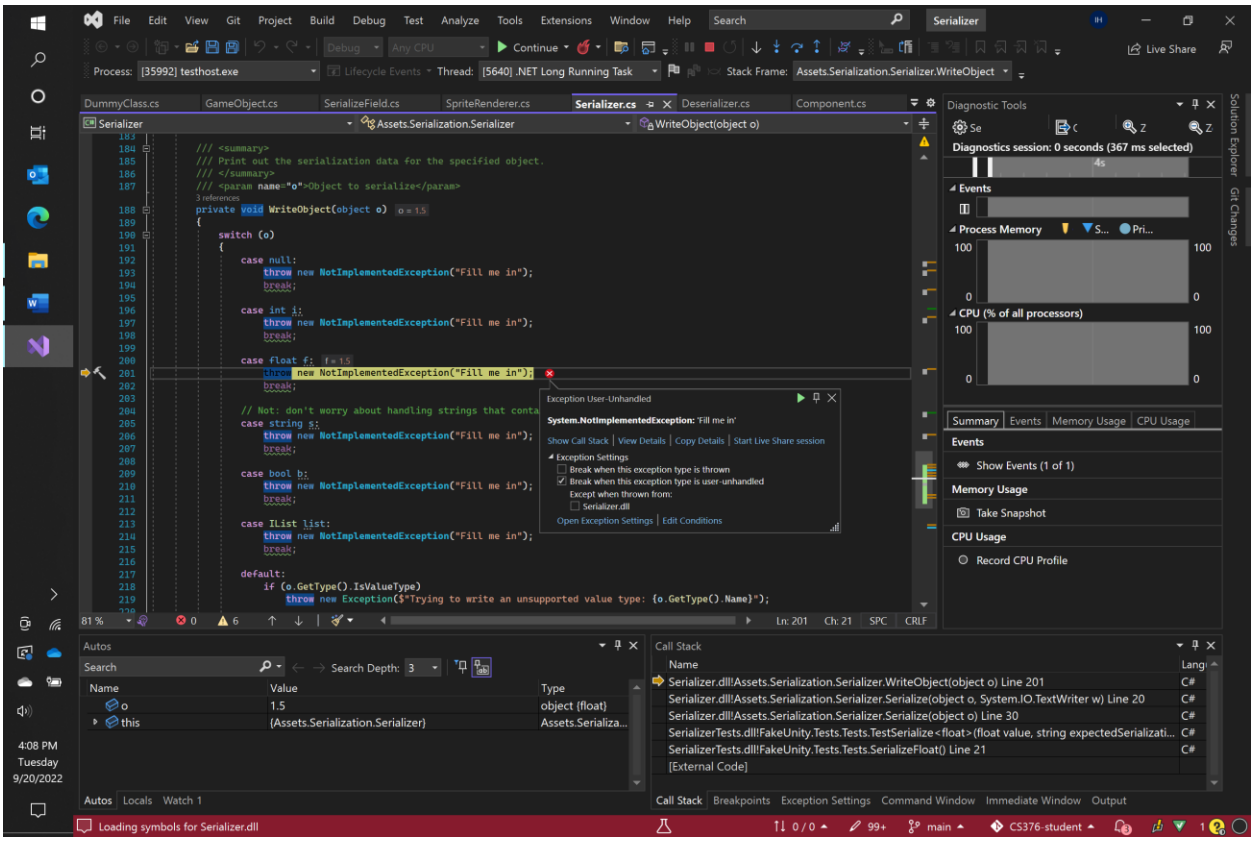
You'll see green check marks next to the tests that worked and red Xs next to those that failed. Initially, they'll all be red:



You'll primarily do this assignment by filling in bits of code that say "`throw new NotImplementedException("Fill me in!")`". As you fill those in, the red tests should start turning green. However, if you can't get one to work, then select it in the test window. Right click and select Debug:



It will run just that one test with debugging enabled, so you'll be able to set breakpoints, look at the call stack, and so on. Since we haven't set any breakpoints, this will just run until the point where it throws the exception:



Pressing the stop button in the toolbar or selecting **Stop Debugging** from the **Debug** menu will stop the debugger and let you go back to editing.

Writing the serializer

You'll be filling in methods in the files Serializer.cs and Deserializer.cs.

Important: do not modify any of the other files. When we test your code, we will only use your Serializer.cs and Deserializer.cs files. So if they depend on changes you made to other files, your code will fail when it is being graded.

Writing simple objects

Now go to the `WriteObject()` method in Serializer.cs. `WriteObject` is mostly doing a case analysis of the different kinds of objects that might be passed to it. Fill in the code for each of those cases. We've put in lines that say "`throw new NotImplementedException("Fill me in!");`" everywhere you need to add code. Replace these lines with the right code to write out the object o in the correct format. Note that strings should be written with " marks before and after them.

After you fill in each case in `WriteObject()`, try rerunning the tests, and you should see them gradually start passing.

Writing complex objects

Once you finish filling in `WriteObject()`, you'll need to fill in `WriteComplexObject()`. This is the method that gets called to serialize objects that have fields in them. You will need to assign the object a

serial number, if you haven't already, and remember that serial number in a hash table (use the `Dictionary<object,int>` data type; search for "C# Dictionary class" for documentation). If there's already a serial number assigned to the object, then you've already written the object once in this serialization, so just write out a # followed by the number. If you haven't already assigned a number, assign one, remember it, write out # followed by the number, and the write { }s with the type and fields written inside, separated by commas.

Writing the Deserializer

Now you'll do the same thing but for the deserializer. We won't make you fill in the `ReadObject()` method, but you should fill in the blanks in `ReadComplexObject()`. Again, save your file and try the game to see if your tests are succeeding.

Important: If you want to add any additional methods or fields to the Deserializer class, include them inside Deserializer.cs.

Turning it in

When you're finished, save all your files, rerun the tests to make sure they work, and make sure your code compiles without issuing warnings. Once everything works smoothly, make a zip file consisting of just your Serializer.cs and Deserializer.cs files and upload it to Canvas.