

C# Data Manipulation

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The Stream Programming Model

- File streams can be used to access stored data.
- A stream is an object that represents a generic sequence of bytes.
- Any type of data, marked `Serializable`, can be transformed into a stream. This is called *serialisation*
- Streams can then be used to:
 - ▶ Read/Write data from/to disk.
 - ▶ Move data between machines.
- Although streams work at the byte level, programmers don't need to work with bytes.
- Reader and Writer objects are usually used to ease the use of streams.



Manual serialisation

- Writing your own serialisation function is easy, and useful in many different contexts, eg. implementing `ToString()`.
- To serialise an object of class A:
 - ▶ Serialise all value type attributes, by directly writing the data into the result buffer
 - ▶ Serialise all reference types attributes by recursively calling serialisation on them.



Naive serialisation

We implement `ToString()` for our Person/Student example as one special case of serialisation:

```
1 public string ToString0() {
2     return String.Format(
3         "Name:_{0}_{1}\tAddress:_{2}\nMatricNo:_{3}\
4         tDegree:_{4}",
5         this.GetName(),
6         this.GetlName(),
7         this.GetAddress(),
8         this.matricNo,
9         this.degree);
}
```

What's the disadvantage with this implementation?



An example of serialisation

This is a better implementation of serialisation:

```
1 public override string ToString() {
2     string base_str = base.ToString();
3     string this_str = String.Format(
4         "MatricNo:_{0}\tDegree:_{1}",
5         this.matricNo, this.degree);
6     return base_str+"\n"+this_str;
7 }
```



Accessing files using streams

- Generate a Reader/Writer object
- This internal generates a stream object
- This object directly interacts with the file
- Closing the Reader/Writer object, also closes the internal stream object



C# Support for File Streams

- C# provides a number of *abstract* classes in the `System.IO` namespace to access data in files including `Stream`, `TextWriter` and `TextReader`.
- The stream class is used to access data at the byte level.
- `TextWriter` and `TextReader` support access to readable text through using
 - ▶ `Write()` and `WriteLine()` of `TextWriter`.
 - ▶ `Read()` and `ReadLine()` of `TextReader`.
- Several classes derive from these abstract classes, and implement customised versions of reading and writing:
 - ▶ `StreamReader` and `StreamWriter` for text data
 - ▶ `BinaryReader` and `BinaryWriter` for binary data



Example: Accessing a File

```
1 using System;
2 using System.IO;
3
4 public class FileReadWrite{
5     public static void Main(){
6         // Write to a file
7         StreamWriter sw = new StreamWriter("test.txt");
8         sw.Write("Hello World!");
9         sw.Close();
10
11        // Reading from a file
12        StreamReader sr = new StreamReader("test.txt");
13        Console.WriteLine(sr.ReadLine());
14        sr.Close();
15    }
16 }
```



More on File Access

Reading from a file line-by-line:

```
1 StreamReader sr = new StreamReader("test.txt");
2 string inValue = "";
3 while((inValue = sr.ReadLine()) != null)
4     Console.WriteLine(inValue);
```



Handling file access problems with exceptions

```
1 try { Body that is executed
2     StreamWriter sw = new StreamWriter("test.txt");
3     sw.Write("Hello World!");
4     sw.Close();
5 } catch(IOException ex) {
6     Console.WriteLine(ex.Message);
7 } Catch block, executed if IOException was raised
```



Another common pattern

```
1 using (StreamReader sr = new StreamReader(infile)) {
2     // open file
3     using (StreamWriter sw = new StreamWriter(outfile))
4     {
5         string str = ""; Read line-by-line
6         string str0 = "";
7         while ((str = sr.ReadLine()) != null) // iterate
8             over lines
9         {
10            str0 = ""; Remove punctuation
11            foreach (char c in str) {
12                if (Char.IsPunctuation(c)) {
13                    // nothing
14                } else {
15                    str0 += c;
16                }
17            }
18            Write to different file
19            sw.WriteLine(str0.ToLower());
20        }
21    }
22 }
```



Summary

- Stream programming in general deals with serialising and transferring data
- One example is reading/writing from/to files
- Other examples are transferring data over a network or a persistent storage
- The basic interface for file access is provide by the System.IO namespace through StreamReader and StreamWriter

