Industrial Programming

Lecture 6: C# Data Manipulation

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.

Naïve serialisation

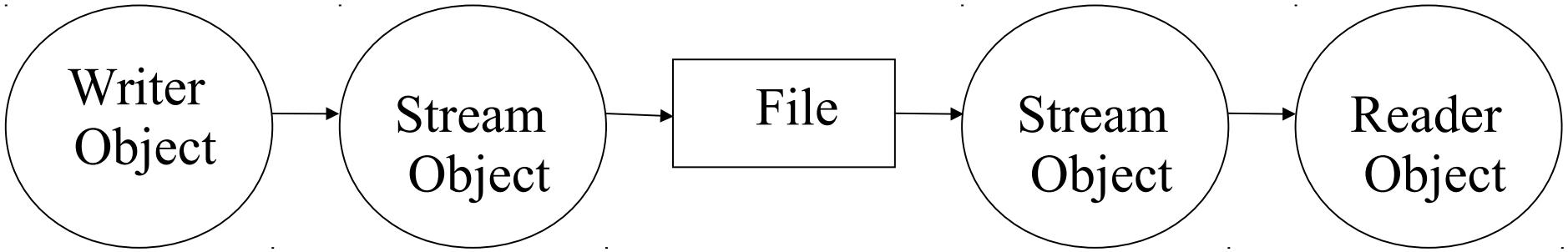
- We implement `ToString()` for our Person/Student example as one special case of serialisation:

```
public string ToString0() {
  return String.Format(
     "Name: {0} {1}\tAddress:
{2}\nMatricNo: {3}\tDegree: {4}",
          this.GetfName(),
          this.GetlName(),
          this.GetAddress(),
          this.matricNo,
          this.degree);
}
```

An example of serialisation

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

Accessing Files Using Streams



C# Support for File Streams

- C# provides a number of 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*.

Accessing a File: Writing

- Open a file (a `FileStream` object is created).
  - A new file could be created.
  - Or an existing file opened for data to be appended to its content.
- Use a `StreamWriter` object to write text to the file.
- Close the stream.

Accessing a File: Reading

- Open a file (a `FileStream` object is created).
- Use a `StreamReader` object to read text from the file.
- Close the stream.

Example: Accessing a File

```
using System;
using System.IO;

public class FileReadWrite{
   public static void Main(){
   // Write to a file
   StreamWriter sw = new StreamWriter(“test.txt”);
   sw.Write("Hello World!");
   sw.Close();

   // Reading from a file
   StreamReader sr = new StreamReader(“test.txt");
   Console.WriteLine(sr.ReadLine());
   sr.Close();
   }
 }
```

More on File Access

- Reading more than one line from a file

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

- Handling file access problems with exceptions

```
try{
   StreamWriter sw = new StreamWriter(“test.txt”);
   sw.Write("Hello World!");
   sw.Close();
}
catch(IOException ex){
   Console.WriteLine(ex.Message); }
```

Another common pattern

```
using (StreamReader sr = new StreamReader(infile)) { // open file
    using (StreamWriter sw = new StreamWriter(outfile)) {
        string str = "";
        string str0  = "";
        while ((str = sr.ReadLine()) != null)// iterate over lines
        {
           str0 = "";
           foreach (char c in str) {
             if (Char.IsPunctuation(c)) {
               // nothing
             } else {
               str0 += c;
             }
           }
           sw.WriteLine(str0.ToLower());
        }
    }
}
```

C# Database Access

- C# supports database access through the ActiveX Data Objects (ADO.NET) technology.
- The ADO.NET architecture supports different databases through using *data providers* for:
  - Microsoft SQL Server *(System.Data.SqlClient)*
  - Oracle *(System.Data.OracleClient)*
  - OLE DB *(System.Data.OleDb)*
  - ODBC *(System.Data.Odbc)*

ADO.NET Data Providers

- Each provider contains a collection of classes:
  - *Connection*: setup a connection with a data source.
  - *Command:* execute an SQL statement to retrieve data from a data source.
  - *DataReader:* sequential access of data.
  - *DataAdapter:* update the database.

Creating a Connection Object

- To connect to a database hosted by SQL Server, an *SqlConnection* object need to be created.
- The *SqlConnection* constructor is used to create the object as follows:

SqlConnection conn = new SqlConnection(

“Data Source = (local);Initial Catalog=TestDatabase;
User ID=myId;Password=myPassword”);

Cont. Creating a Connection Object

- The *SqlConnection* constructor takes a *string* argument which includes the following parts:
  - Data Source: identifying the server hosting the database, could be a local machine, domain name or an IP address.
  - Initial Catalog: identifying the database name.
  - User ID and Password.

Using the Connection

- We have already instantiated an *SqlConnection* object.
- We are going now to:
  - Open the connection.
  - Perform SQL operations.
  - Close the connection.

Example

```
using System;
using System.Data;
using System.Data.SqlClient;

class DatabaseConnExample{
  public static Main(){
       SqlConnection conn = new SqlConnection(
    “Data Source= (local);Initial Catalog=TestDatabase;User ID

       =myId;Password=myPassword”);
     SqlDataReader dr = null;
     try{
        conn.open(); //open connection
              // pass the connection to a command object
        SqlCommand cmd = new SqlCommand(“Select * from
           Students”, conn);
        //get query results
        dr = cmd.ExecuteReader();
```

Example (cont'd)

```
        while(dr.Read()){Console.WriteLine(dr[0]);}
    }
    finally{
        if(dr != null){dr.Close();}
        if(conn != null){conn.Close();} // Close
                                        // connection
    }
    }
}
```

Example Explained

- The connection is opened using the *open()* function of the *SqlConnection* instance *(conn).*
- The *SqlCommand* object uses *conn* to perform a query on the *students* table.
- The result set is returned in a *SqlDataReader.*
- The while loop reads the value of the first field in each row of the result set.
- The *close()* function of *conn* is called to ensure that the connection is closed.

LINQ

- The Language Integrated Query (LINQ) components makes access to databases easier.
- It provides uniform access to a range of databases and data formats (e.g. XML).
- The commands are similar to SQL commands.
- When querying a database, tables can be treated like classes and columns like members.
- It makes use of advanced language features such as anonymous types, implicitly typed variables, and lambda expressions.
- From C# 3.0 onwards this is the preferred way of working with large sets of data.