CS2311 Computer Programming

LT12: File I/O

Outline

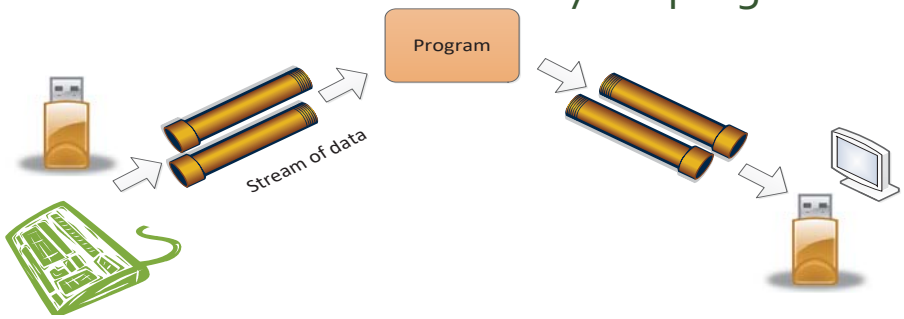
- Stream
- Open File
- File I/O
- Error Handling

File I/O vs. Console I/O

- "**Console**" refers to "**keyboard** + **screen**"
- Keyboard input and screen output are volatile
- Input file can be used again and again
- Useful for debugging especially when volume of data is huge
- Allow off-line processing
- Output file retains the results after execution

Basic I/O – Keyboard and Screen

- Program read input from keyboard (**console**) or disk storage (**file**) and write data to screen (console) or disk storage(file)
- Sequence of inputs is conceptually treated as an object called "**Stream**"
- Stream – a flow (sequence) of data
- Input stream – a flow of data into your program
- Output stream – a flow of data out of your program



Streams

- Predefined console streams in C++

  #include <iostream>

  cin : input stream physically linked to the keyboard

  cout : output stream physically linked to the screen

- File streams class in C++

  #include <fstream>

  ifstream : stream class for file input

  ofstream : stream class for file output

- To declare an objects of class **ifstream** or **ofstream**, use

```
ifstream fin;          // fin is the variable name
ofstream fout;         // fout is the variable name
```


ifstream

- To declare an **ifsteam** object

```
ifstream fin;
```

- To open a file for reading

```
fin.open("infile.dat");
```

- To read the file content

```
fin >> x;        //x is a variable
```

- To close the file

```
fin.close();
```

ofstream

- To declare an **ofsteam** object

  ofstream fout;
- To open a file for writing

  fout.open("myfile.dat") ;
- To write something to the file

  fout << x; //x is a variable
- To close the file

  fout.close();
- PS: **fin.open()** and **fout.open()** refer to different functions

Examples

```
#include <fstream>
using namespace std;

int main() {
    ifstream fin;
    ofstream fout;
    int x,y,z;

    fin.open("input.txt");
    fout.open("output.txt");
    fin >> x >> y >> z;
    fout << "The sum is "<< x + y + z;
    fin.close();
    fout.close();
    return 0;
}
```

3 4 7

The sum is 14

Open a file

- An open file is represented within a program by a stream (i.e. an object of **ifstream** or **ofstream**), and any I/O performed on this stream object will be applied to the file associated with it.
- To open a file, use the member function **open** with the stream object: **open(filename, mode);**

  filename : a string

  mode : optional

Modes for file I/O

ios::in	Open for input operations.
ios::out	Open for output operations.
ios::binary	Open in binary mode.
ios::ate	Set the initial position at the end of the file. If this flag is not set, the initial position is the beginning of the file.
ios::app	All output operations are performed at the end of the file, appending the content to the current content of the file.
ios::trunc	If the file is opened for output operations and it already existed, its previous content is deleted and replaced by the new one.

Example:

```
ofstream   fout;
fout.open (image_filename, ios::binary);
```

Detecting I/O failures

- Member function **fail()** returns true if and only if the previous I/O operation on that stream fails
  - E.g. file not exists when opening an input stream
  - PS: one may call function **exit()** when an I/O operation fails to abort the program execution.
  - the argument in **exit()** is returned to the calling party – usually the OS

Examples

```
#include <iostream>
#include <fstream>
using namespace std;

int main() {
    ifstream in1, in2;
    in1.open("infile1.dat");
    in2.open("infile2.dat");
    if (in1.fail()) {
        cout << "Input file 1 opening failed." << endl;
        exit(1);    // 1 stands for error
    }
    ...
    return 0;
}
```

Detecting end-of-file (EOF)

- Member function **eof** returns true if and only if we reach the end of the input file (no more data)
  - Only for objects of class **ifstream**
    - e.g. **fin >> x;**
      if (!fin.eof()) …
- The expression **fin >> x** has value **0** if fin has no more data
  - e.g. **while (fin>> x)**
    {…}

Examples: file dump (integer only)

```
#include <iostream>
#include <fstream>
using namespace std;

int main() {
    ifstream fin;
    int x;
    fin.open("input.txt");
    while (!fin.eof()) {
        fin >> x;
        cout << x << " ";
    }
    return 0;
}
```

Text files

- When **ios::binary** is **not** set, the file is treated as a **text file**.
  - All input/output is assumed to be text, and may suffer formatting transformations.
- I/O for text files is similar to I/O for console, i.e. through the input/output operators **>>** and **<<**
- Read:

  fin.get() : get a single character

  fin.getline(char str[], size) : read the file line by line

Binary files

- When **ios::binary** is set, all I/O is performed on a binary basis.
  - The byte values are directly used independent of formatting considerations.
- Input/output operators may not be efficient for binary files, unless you want to read/write in text format.
  - Specific functions can be used.

  fin.read(char* target, int num)

  fin.write(const char* source, int num)

Binary files

fin.read(char* target, int num)

- **target**
  - a pointer to char (1 byte). It represents the address of an array of bytes (a memory block) where the data can be stored.
- **num**
  - the integer size of the memory block (how many bytes)

An Example of Binary File I/O

```
1  // slide 18
2  #include <iostream>
3  #include <fstream>
4  using namespace std;
5
6  const int LineLen = 128;
7
8  int main() {
9
10     char ibuffer[LineLen];
11     ifstream myfile("data.bin", ios::in | ios::binary);
12
13     myfile.read(ibuffer, LineLen);
14     if (!myfile) {
15         cerr << "Error reading from data.bin, ony " << myfile.gcount()
16             << " bytes read. " << endl;
17         myfile.clear();
18     }
19
20     return 0;
21 }
```

```
Error reading from data.bin, ony 0 bytes read.
```

Examples: file dump (integer only)

```
#include <iostream>
#include <fstream>
using namespace std;

int main() {
    ifstream fin;
    int x;
    fin.open("input.txt");
    while (fin >> x) {
        cout << x << " ";
    }
    return 0;
}
```

return 0 if fin has no more data

Reference Only: I/O Re-directions

- A facility offered by many OS's
- Allows the program input and output to be redirected from/to specified files
  - e.g. suppose you have an executable file **hello.exe**. If you type:

    hello > outfile1.dat
  - in the **MSDOS** prompt, the output is written to the file **outfile1.dat** instead of the screen
- Similarly, **hello < infile1.dat** specifies that the input is from **infile1.dat** instead keyboard