

Introduction to Std C++ File I/O



C++ Object Oriented Programming
Pei-yih Ting
NTOU CS

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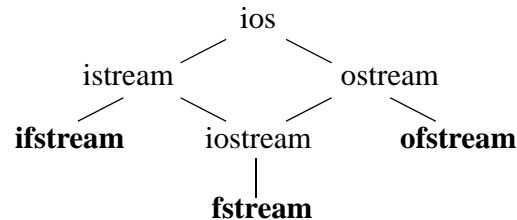
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Class Hierarchy

- ❖ File classes are *inherited* from console classes

#include <fstream>
using namespace std;



- ❖ Why inheritance?
 - * All operations for the console classes are available in exactly the same form for file processing
 - * More device-independent than their counterparts in C
- ❖ Formatted and unformatted I/O
 - * Console data is always in formatted form, i.e. ASCII printable integers, strings, floats...
 - * File I/O can be formatted or unformatted (raw bytes)

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Basic File I/O Operations

- ❖ Reading characters from a file and printing to the screen

```
char cBuf;  
ifstream myFile("testFile"); // open the file implicitly  
if (!myFile) { // check for correct opening or !myFile.is_open()  
    cerr << "File can't be opened";  
    return;  
}  
while (myFile.get(cBuf)) cout << cBuf;
```

& operator
not required

- * operator ! is overloaded in class **ios** to return false if the failbit or badbit has been set after attempting to open the file
- * get() will return false when EOF is reached, otherwise it will return the file stream object
- ❖ Explicitly open or close of a file if you plan to reuse the ifstream obj

```
ifstream myFile;  
myFile.open("testFile");  
...  
myFile.close(); // this will also be invoked in inherited destructor
```

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Basic File I/O Operations (cont'd)

❖ Writing characters to a file

```
ofstream myFile("testFile"); // creates the file with this name
char *string = "test output string";
if (!myFile) {
    cerr << "File can't be created\n";
    return;
}
for (i=0; i<strlen(string); i++)
    myFile.put(string[i]);
```

* You could also put a letter to the console window: cout.put('A');

❖ File modes:

```
ios::out           // open the file and erase the contents, default
ofstream myFile("testFile", ios::out);
ios::app           // append data to the end of the file
ios::nocreate      // open fails if the file doesn't exist
ios::noreplace     // open fails if the file exists
```

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Insertion and Extraction operators

❖ File objects have the same interface as console objects: >>, <<

```
int number1 = 10;
int number2 = 20;
int number3 = 30;
ofstream myFile("numberData.txt");
if (!myFile) {
    cerr << "File can't be created\n";
    return;
}
myFile << number1 << ' ' << number2 << ' ' << number3 << endl;
```

Output is a text file:
10 20 30

* << and >> are for formatted I/O, the codes converts the internal formats of the built-in types to printed characters

```
int number;
ifstream myFile("numberData.txt");
while (myFile >> number)
    cout << number;
```

* The operator << of ifstream class will return false when EOF is reached

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Unformatted File I/O

❖ Unformatted files store data as raw bytes

❖ Using member functions read() and write()

```
int array[SIZE], newArray[SIZE];
ofstream outputFile("binaryData.dat", "std::ofstream::binary");
if (!outputFile) {
    cerr << "File can't be created\n";
    return;
}
for (i=0; i<SIZE; i++) array[i] = i;
outputFile.write((char *)array, sizeof(int)*SIZE);
outputFile.close();
ifstream inputFile("binaryData.dat", "std::ifstream::binary");
if (!inputFile) {
    cerr << "File can't be opened\n";
    return;
}
inputFile.read((char *)newArray, sizeof(int)*SIZE);
for (i=0; i<SIZE; i++) cout << newArray[i];
```

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Random Access Files

❖ Simultaneous input and output ios::in | ios::out

❖ Absolute file positioning

seekg(offset) // seek get, used with input streams, relative to file beginning

seekp(offset) // seek put, used with output streams

❖ Relative file positioning functions

seekg(offset, ios::beg)

seekg(offset, ios::cur)

seekg(offset, ios::end) // offset must be negative

seekp(offset, ios::beg)

seekp(offset, ios::cur)

seekp(offset, ios::end)

❖ tellg() returns the current file position as a long integer

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Using Random Access File

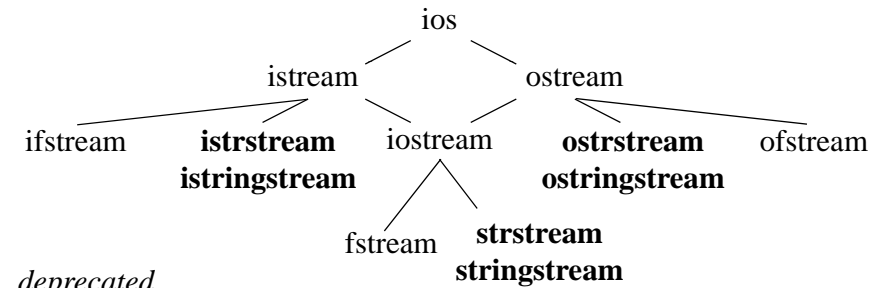
◇ Ex.

```
int data[SIZE];
fstream fileStream("data.dat", ios::in | ios::out);
if (!fileStream) {
    cerr << "File can't be opened\n";
    return;
}
for (i=0; i<100; i++)
    fileStream.write((char *)data, sizeof(data));
...
index = 70;
fileStream.seekp(sizeof(data)*index);
fileStream.write((char *)data, sizeof(data));
...
index = 20;
fileStream.seekg(sizeof(data)*index);
inputFile.read((char *)newArray, sizeof(int)*SIZE);
```

String Stream Processing

◇ Counterparts of scanf(), sprintf() in stdio library

- ★ Take advantage of the console formatting library to construct strings



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

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

ostringstream

◇ Create a simple formatted string

```
ostringstream outputStream;
char *result;
outputStream.precision(18);
outputStream << "The value of pi to a precision of 18 is " << pi << ends;
result = outputStream.str();
cout << result;
outputStream.freeze(false);
```

Output on the console is:
The value of pi to a precision of 18 is 3.14159265358979324

- ★ The manipulator **ends** inserts the null terminator
- ★ The address of the internal buffer is returned by str()
- ★ Once str() is invoked, no additional data can be added (the buffer is frozen)
- ★ The client program owns the buffer and is responsible for deleting the buffer
- ★ The client program should call freeze(false) after str() is called to unfreeze the buffer

ostringstream (cont'd)

◇ The following usage causes an error

```
result = outputStream.str(); // buffer frozen
outputStream << "more data";
if (outputStream.fail()) // This will be true
    cout << "failure";
```

String not properly terminated

- ◇ The data is dynamically allocated within the ostream object.
- ◇ ostream has a second overloaded constructor whereby the client supplies a fixed-size character array to be used as the buffer.

```
const int cSize=12;
char buffer[cSize], *result;
ostringstream outputStream(buffer, cSize);
outputStream.precision(18);
outputStream << "The value of pi to a precision of 18 is " << pi << ends;
result = outputStream.str();
cout << result << "\n[" << result[11] << "]" << "\n";
if (outputStream.fail()) cout << "failure"; // failbit will be set
```

Output:
The value of π
[f]

istream

- ◇ An istream object contains a character array from which formatted data can be extracted

◇ Ex.

```
const int cBufSize = 100;
const int cStrSize = 50;
void main()
{
    char buffer[cBufSize] = "pi is 3.14159";
    istream inputStream(buffer, cBufSize);
    char string1[cStrSize], string2[cStrSize];
    double value;
    inputStream >> string1 >> string2 >> value;
    cout << string1 << ' ' << string2 << ' ' << value;
}
```

- * Note: istream's failbit is NOT turned on till the end of the buffer in VC6.
The null character in the buffer does not terminate the stream.

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ostringstream

- ◇ #include <sstream>
using namespace std;
 - ◇ The internal implementation is string object instead of C char array
- ```
#include <string> // std::string
#include <iostream> // std::cout
#include <sstream> // std::stringstream, std::stringbuf
void main () {
 std::stringstream ss;
 ss.str("123456789x123456789y123456789z1234567890");
 // initialize the buffer of the stringstream
 ss << "Overwriting the initial string"; // no need for ends
 std::string s = ss.str(); // obtaining a copy of the internal buffer of stringstream
 std::cout << s << "\n";
}
```

Output:

Overwriting the initial string1234567890

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## istringstream

- ◇ #include <sstream>  
using namespace std;

◇ Example

```
#include <string> // std::string
#include <iostream> // std::cout
#include <sstream> // std::istringstream
```

```
void main () {
 std::istringstream iss;
 std::string strvalues = "32 240 2 1450";
 iss.str(strvalues);
 for (int n=0; n<4; n++) {
 int val;
 iss >> val;
 std::cout << val << "\n";
 }
 std::cout << "Finished writing the numbers in: ";
 std::cout << iss.str() << "\n";
}
```

```
32
240
2
1450
Finished writing the numbers in: 32 240 2 1450
```

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## User-defined types

- ◇ Overload the << and >> operators for a class
  - ◇ Ex. Overloaded operators for CComplex
- ```
ostream &operator<<(ostream &os, CComplex number) {
    os << number.m_real << "+" << number.m_imaginary << "i";
    return os;
}
istream &operator>>(istream &is, CComplex &number) {
    char dummy;
    is >> number.m_real >> dummy >> number.m_imaginary >> dummy;
    return is;
}
...
CComplex number(-5, -2);
ofstream outputFile("outputFile.txt");
outputFile << number;
```

Note: An ofstream object is a fstream object.

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