Intermediate Programming

Day 25

Outline

- Exercise 24
- File I/O
- std::stringstream
- Object Oriented Programming
- Review Questions

Exercise 24

main.cpp

```
…
void main( void )
{
        typedef map< string , int > s2i;
        typedef s2i::const_iterator s2i_citer;
        s2i counters;
        …
        string word;
        while( cin >> word ) counters[word]++;
        …
}
```

Populate **counters** so that each entry has:

- Key: collected words
- Value: the number of times that word appears in the file

Exercise 24

Rearrange so that each entry in the new map has an integer key, and an entire vector of strings as its value.

main.cpp

```
…
void main( void )
{
        typedef map< string , int > s2i;
        typedef s2i::const_iterator s2i_citer;
        s2i counters;
        …
        string word;
        while( cin >> word ) counters[word]++;
        …
        typedef map< int , vector< string > > i2v;
        typedef i2v::const_iterator i2v_citer;

        i2v words_by_freq;
        for( s2i_citer it=counters.cbegin() ; it!=counters.cend() ; it++ )
                words_by_freq[ it->second ].push_back( it->first );
        …
}
```

Exercise 24

Output the new map's contents.

main.cpp

```
...
void main( void )
{
	typedef map< string , int > s2i;
	typedef s2i::const_iterator s2i_citer;
	s2i counters;
	...
	string word;
	while( cin >> word ) counters[word]++;
	...
	typedef map< int , vector< string > > i2v;
	typedef i2v::const_iterator i2v_citer;

	i2v words_by_freq;
	for( s2i_citer it=counters.cbegin() ; it!=counters.cend() ; it++ )
		words_by_freq[ it->second ].push_back( it->first );

	typedef vector< string >::const_iterator v_citer;
	for( i2v_citer it=words_by_freq.cbegin() ; it!=words_by_freq.cend() ; it++ )
	{
		std::cout << "Frequency: " << it->first << std::endl;
		for( v_citer _it=it->second.cbegin() ; _it!=it->second.cend() ; _it ++ )
			std::cout << *_it << std::endl;
	}
	...
}
```

Exercise 24

Invoke **std::sort** from the STL to sort the contents of **vec2** and compare the implementations.

sort.cpp

```
…
#include <algorithm>
…
void main( void )
{
        …
        std::sort( vec2.begin() , vec2.end() );
        …
}
…
```

```
>>  ./sort
Enter the count: 100000
Your sort time = 223(ms)
STL's sort time = 57(ms)
>>
```

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File I/O

Recall that in C++ we write/read to/from the command with handles:

- `std::cout`
- `std::cin`

using the (overloaded) insertion and extraction operators:

- `<<`
- `>>`

File I/O

- In C, `printf` wrote to `stdout` and `scanf` read from `stdin`
  - `fprintf` and `fscanf` were their counterparts for files
- In C++, we have `std::cout` and `std::cin`
  - `std::ofstream` and `std::ifstream` are their counterparts for files
  - These are declared in the file-stream header

    ```
    #include <fstream>
    ```

    which declares classes:
    - `ofstream`: for writing to a file (inherits* from `ostream`)
    - `ifstream`: for reading from a file (inherits* from `istream`)
    - `fstream`: for reading **and** writing to/from a file (inherits* from `ostream` and `istream`)
  - The class `ostream` (resp. `istream`) defines the extraction (resp. insertion) operator `<<` (resp. `>>`) so `ofstream` (resp. `ifstream`) inherits* it.
  - Since `fstream` derives* from both `ostream` and `istream`, it inherits* both.

File I/O (**std::ofstream**)

main.cpp

```
#include <iostream>
#include <fstream>
int main( void )
{
        std::ofstream ofile( "hello.txt" );
        ofile << "Hello, World!" << std::endl;
        return 0;
}
```

```
>> ./a.out
>> cat hello.txt
Hello, World!
>>
```

File I/O (**std::ofstream**)

- **ofstream** has a constructor* taking a **string** specifying the filename
  - Calling the constructor with a filename string is like calling **fopen** with the filename using a "**w**" flag

main.cpp

```
#include <iostream>
#include <fstream>
int main( void )
{
        std::ofstream ofile( "hello.txt" );
        ofile << "Hello, World!" << std::endl;
        return 0;
}
```

```
>> ./a.out
>> cat hello.txt
Hello, World!
>>
```

File I/O (std::ofstream)

- ofstream has a constructor* taking a string specifying the filename
  - Calling the constructor with a filename string is like calling fopen with the filename using a "w" flag
- Since ofstream inherits* from ostream, anything we can "<<" to an ostream, we can "<<" to the ofstream

main.cpp

```
#include <iostream>
#include <fstream>
int main( void )
{
        std::ofstream ofile( "hello.txt" );
        ofile << "Hello, World!" << std::endl;
        return 0;
}
```

```
>> ./a.out
>> cat hello.txt
Hello, World!
>>
```

File I/O (std::ofstream)

- ofstream has a constructor* taking a string specifying the filename
  - Calling the constructor with a filename string is like calling fopen with the filename using a "w" flag
- Since ofstream inherits* from ostream, anything we can "<<" to an ostream, we can "<<" to the ofstream
- ofstream has a destructor* that closes the file
  - When an ofstream object goes out of scope (or is deleted), it automatically closes itself

main.cpp

```
#include <iostream>
#include <fstream>
int main( void )
{
        std::ofstream ofile( "hello.txt" );
        ofile << "Hello, World!" << std::endl;
        return 0;
}
```

```
>> ./a.out
>> cat hello.txt
Hello, World!
>>
```

File I/O (**std::ifstream**)

main.cpp

```
#include <iostream>
#include <fstream>
#include <string>
int main( void )
{
	std::ifstream ifile( "hello.txt" );
	std::string word;
	while( ifile>>word ) std::cout << word << ' ';
	std::cout << std::endl;
	return 0;
}
```

```
>> ./a.out
Hello, World!
>>
```

File I/O (std::ifstream)

- ifstream has a constructor* taking a string specifying the filename
  - Calling the constructor with a filename string is like calling fopen with the filename using a "r" flag

main.cpp

```
#include <iostream>
#include <fstream>
#include <string>
int main( void )
{
	std::ifstream ifile( "hello.txt" );
	std::string word;
	while( ifile>>word ) std::cout << word << ' ';
	std::cout << std::endl;
	return 0;
}
```

```
>> ./a.out
Hello, World!
>>
```

File I/O (std::ifstream)

- ifstream has a constructor* taking a string specifying the filename
  - Calling the constructor with a filename string is like calling fopen with the filename using a "r" flag
- Since ifstream inherits* from istream, anything we can ">>" to an istream, we can ">>" to the ifstream

main.cpp

```
#include <iostream>
#include <fstream>
#include <string>
int main( void )
{
	std::ifstream ifile( "hello.txt" );
	std::string word;
	while( ifile>>word ) std::cout << word << ' ';
	std::cout << std::endl;
	return 0;
}
```

```
>> ./a.out
Hello, World!
>>
```

File I/O (std::ifstream)

- ifstream has a constructor* taking a string specifying the filename
  - Calling the constructor with a filename string is like calling fopen with the filename using a "r" flag
- Since ifstream inherits* from istream, anything we can ">>" to an istream, we can ">>" to the ifstream
- ifstream has a destructor* that closes the file
  - When an ifstream object goes out of scope (or is deleted), it automatically closes itself

main.cpp

```
#include <iostream>
#include <fstream>
#include <string>
int main( void )
{
	std::ifstream ifile( "hello.txt" );
	std::string word;
	while( ifile>>word ) std::cout << word << ' ';
	std::cout << std::endl;
	return 0;
}
```

```
>> ./a.out
Hello, World!
>>
```

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std::stringstream

- Instead of reading or writing to console, it reads and writes to a temporary string (“buffer”) stored inside

main.cpp

```
#include <iostream>
#include <sstream>
int main( void )
{
        std::stringstream ss;
        ss << "Hello, world!" << std::endl;
        std::cout << ss.str();
        return 0;
}
```

std::stringstream

- Instead of reading or writing to console, it reads and writes to a temporary string (“buffer”) stored inside
  - The string buffer can be accessed with the member function:
    string stringstream::str(void)

main.cpp

```
#include <iostream>
#include <sstream>
int main( void )
{
        std::stringstream ss;
        ss << "Hello, world!" << std::endl;
        std::cout << ss.str();
        return 0;
}
```

```
>> ./a.out
Hello, world!
>>
```

std::stringstream

Since it inherits from both **istream** and **ostream**

- we can insert and extract data from a **stringstream**

main.cpp

```
#include <string>
#include <iostream>
#include <sstream>
int main( void )
{
        std::stringstream ss;
        ss << "Hello" << ' ' << 35 << " world";
        std::string word1, word2;
        int num;
        ss >> word1 >> num >> word2;
        std::cout << word1 << ", " << word2 << '!' << std::endl;
        return 0;
}
```

```
>> ./a.out
Hello, world!
>>
```

std::stringstream

- Like the file-stream, the string-stream also comes in flavors that only do reading or writing:
  - istringstream ↔ ifstream
  - ostringstream ↔ ostream

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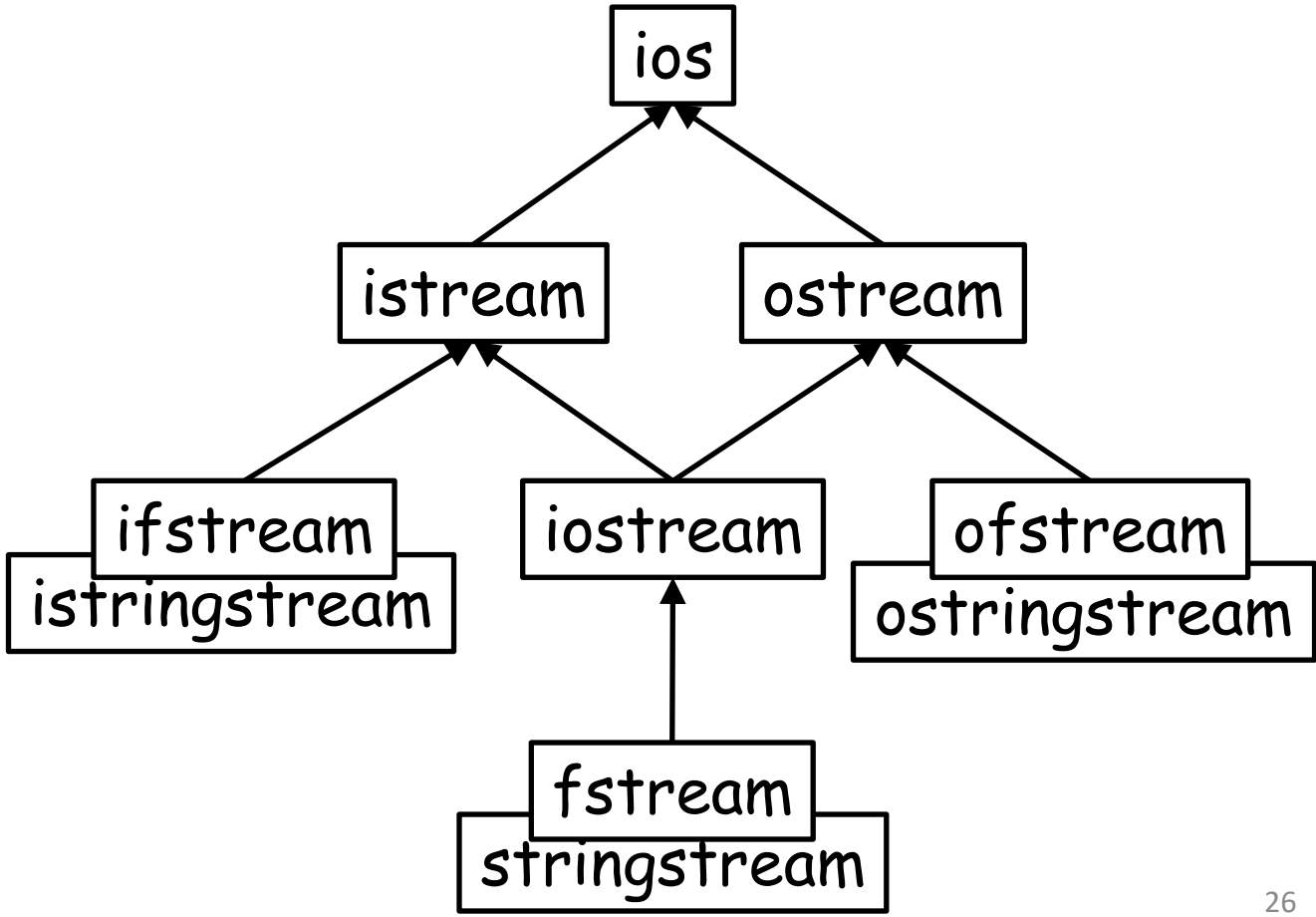
Object Oriented Programming

In C++ `class`es are similar to `struct`s in C, but additionally support:

- Functionality for acting on the `class`'s data
  - E.g. An `ofstream` object not only stores information about the output file stream but also provides functionality for opening/closing the file handle
- Field protection for controlling who has access to a `class`'s data.
  (By default, only the class itself has access.)
- Special functions called *constructors* which are invoked when an object of a particular `class` is created.
- Special functions called *destructors* which are invoked when an object of a particular `class` goes out of scope or is destroyed.
- Inheritance.

C++ stream class hierarchy

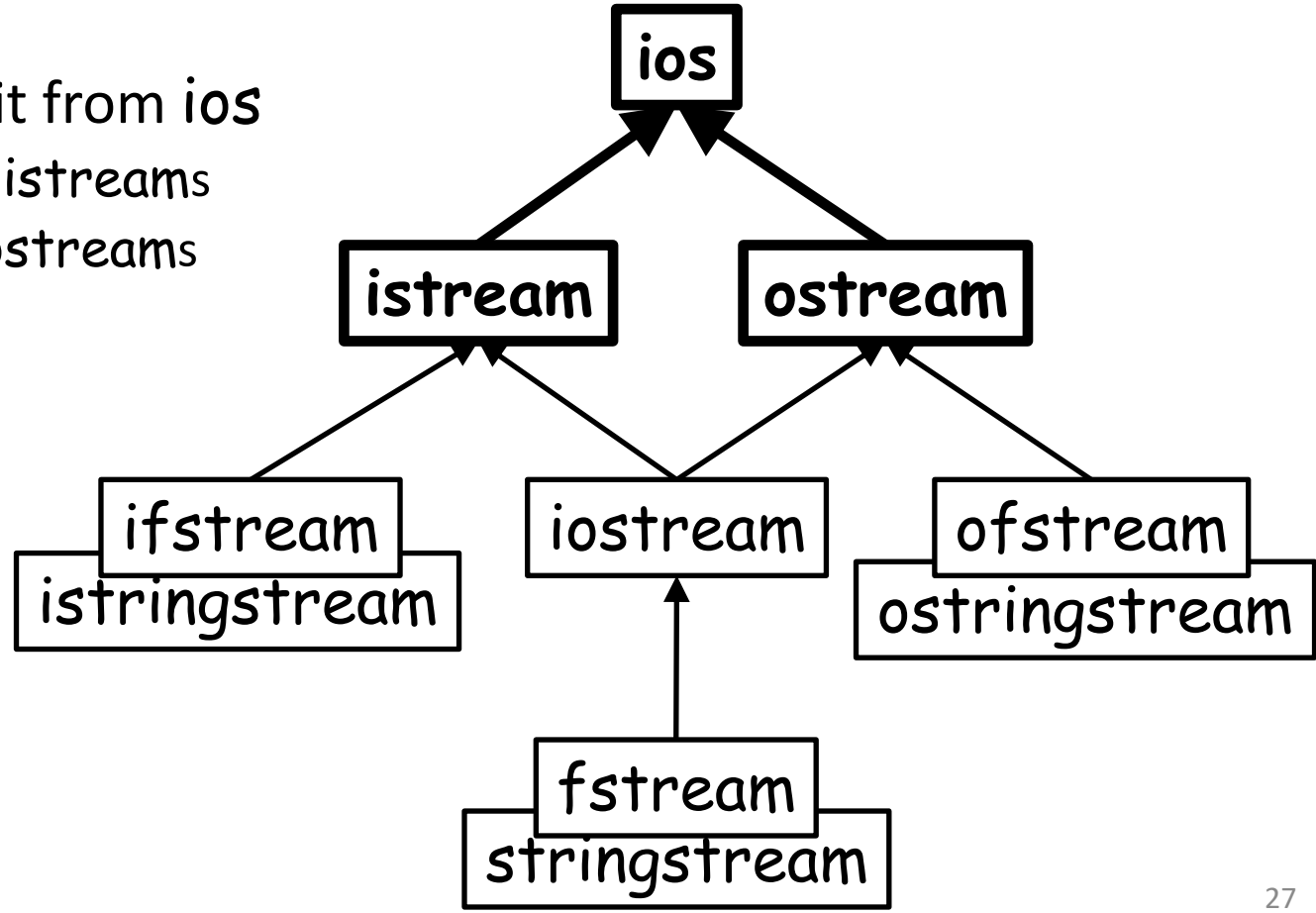
Inheritance diagram for streams – arrows indicate who inherits from whom ("is-a" relationship).



C++ stream class hierarchy

Inheritance diagram for streams – arrows indicate who inherits from whom ("is-a" relationship).

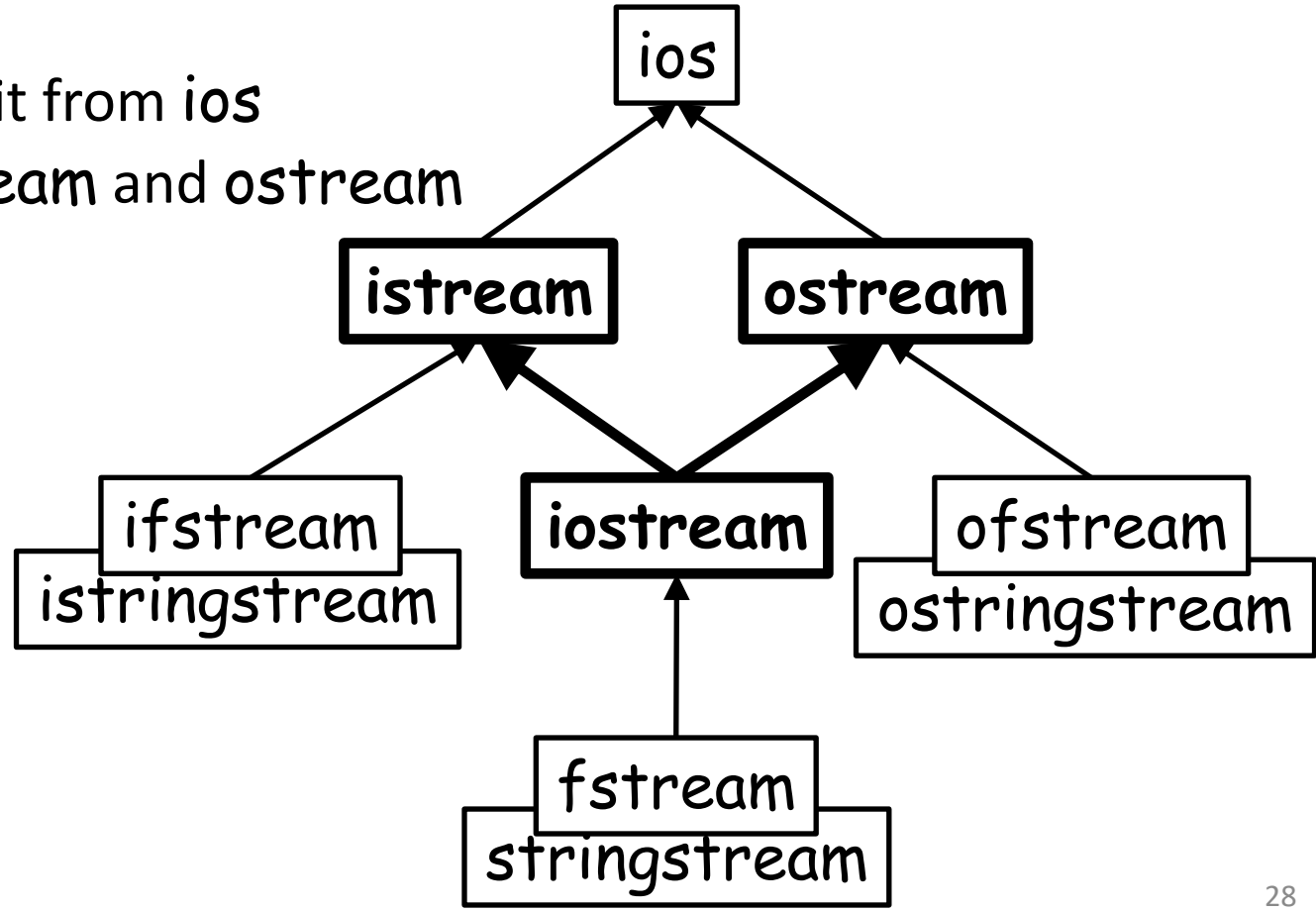
- **istream** and **ostream** both inherit from **ios**
  - Stream extraction (>>) defined for all **istream**s
  - Stream insertion (<<) defined for all **ostream**s



C++ stream class hierarchy

Inheritance diagram for streams – arrows indicate who inherits from whom ("is-a" relationship).

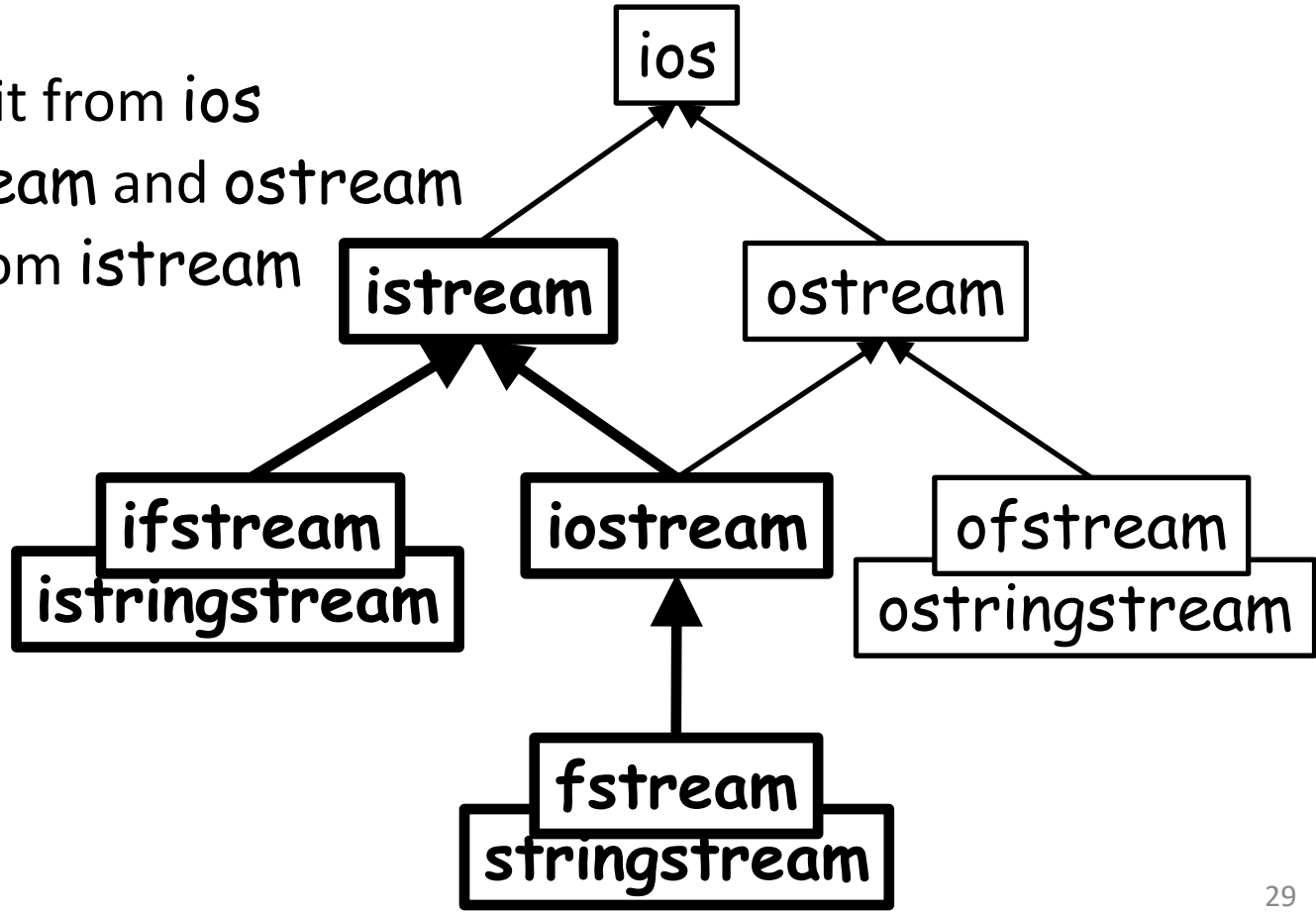
- **istream** and **ostream** both inherit from **ios**
- **iostream** inherits from both **istream** and **ostream**
  - multiple inheritance is allowed



C++ stream class hierarchy

Inheritance diagram for streams – arrows indicate who inherits from whom ("is-a" relationship).

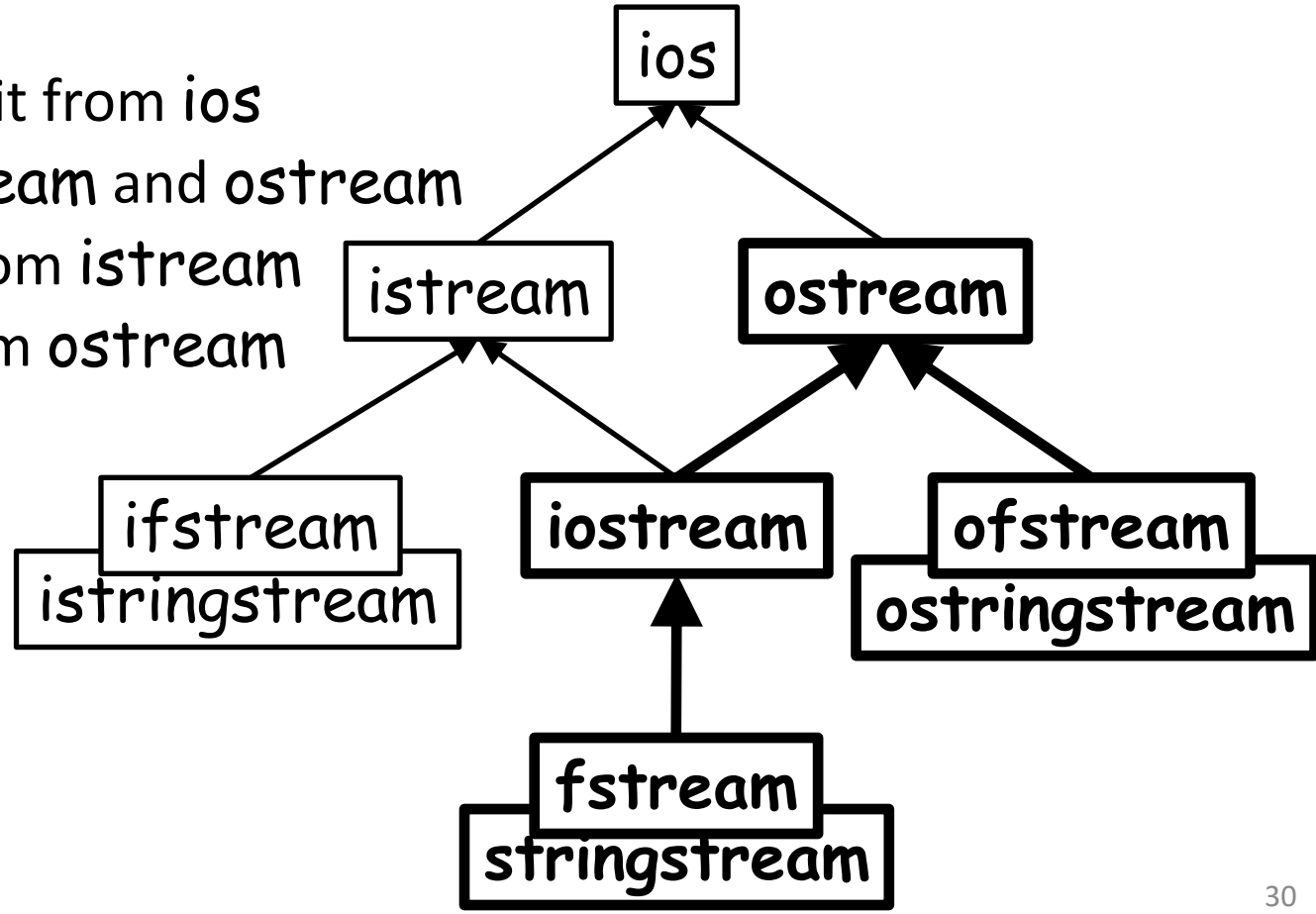
- **istream** and **ostream** both inherit from **ios**
- **iostream** inherits from both **istream** and **ostream**
- Stream extraction (>>) inherited from **istream**



C++ stream class hierarchy

Inheritance diagram for streams – arrows indicate who inherits from whom ("is-a" relationship).

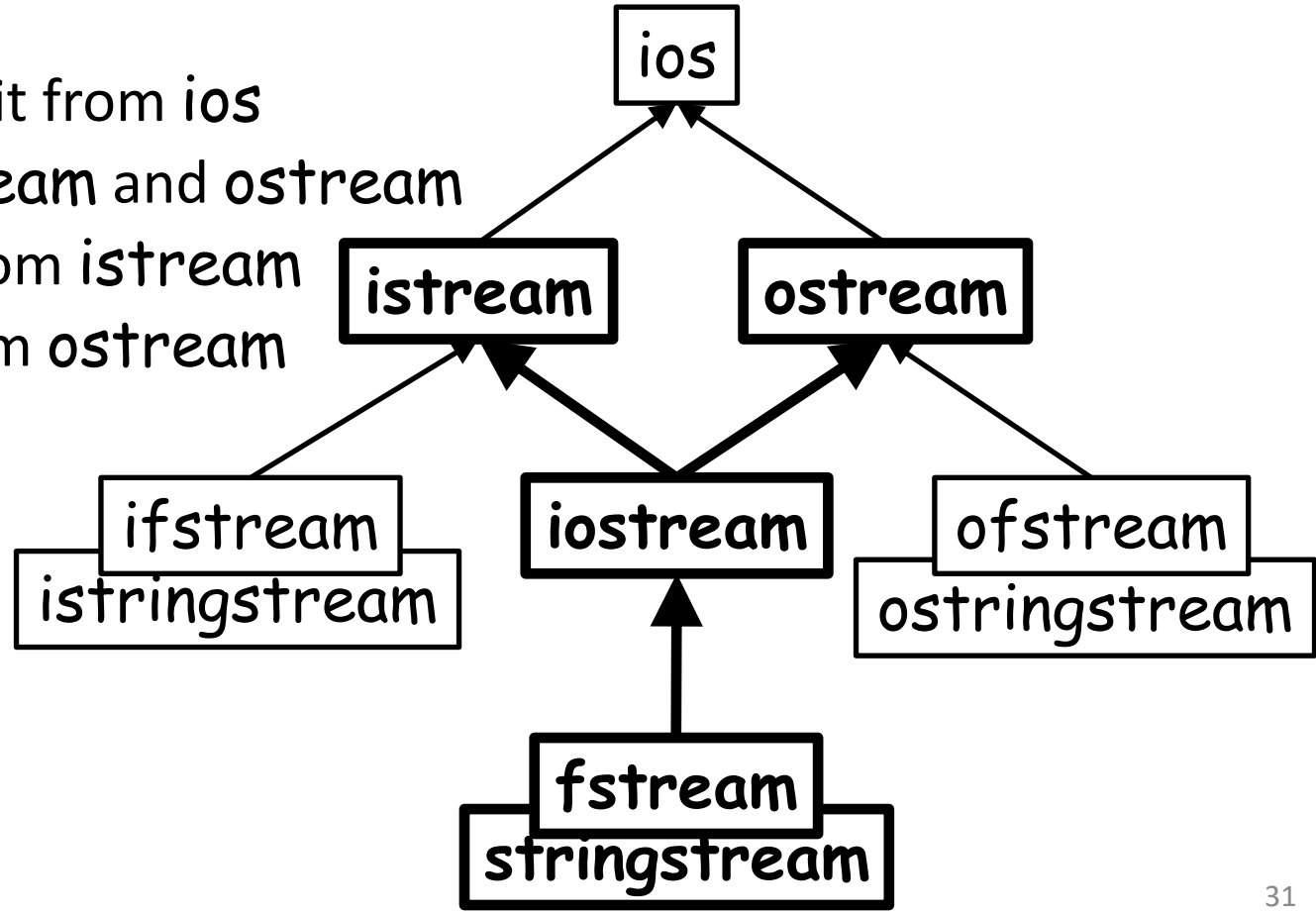
- **istream** and **ostream** both inherit from **ios**
- **iostream** inherits from both **istream** and **ostream**
- Stream extraction (>>) inherited from **istream**
- Stream insertion (<<) inherited from **ostream**



C++ stream class hierarchy

Inheritance diagram for streams – arrows indicate who inherits from whom ("is-a" relationship).

- istream and ostream both inherit from ios
- iostream inherits from both istream and ostream
- Stream extraction (>>) inherited from istream
- Stream insertion (<<) inherited from ostream
- fstream and stringstream both inherit from iostream



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Review questions

1. How do you read/write files in C++?

Create input / output filestreams

```
std::ifstream ifile( "hello.txt" );
std::ofstream ofile( "hello.txt" );
```

and insert into / extract from the files

```
ifile >> str1 >> str2;
ofile << "Hello, World!" << std::endl;
```

Review questions

2. What is a **stringstream** in C++?

A stream supporting insertion/extraction, which keeps its data buffered in a **std::string**.

Review questions

3. How do you extract the contents of a `stringstream`?

Either use the stream extraction operator "`>>`", or use the `str( void )` member function.

Review questions

4. What does a constructor do?

Initializes the resources associated with a class

Review questions

5. What does a destructor do?

Releases/deallocates the resources associated with a class

Exercise 25

- Website -> Course Materials -> Exercise 25