Intermediate Programming

Day 25

Outline

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

Exercise 24

Populate **counters** so that each entry has a key which is a word collected and the corresponding value is the number of times that word appears in the file.

main.cpp

```
…
void main( void )
{
        …
        string word;
        while( cin >> word ) counters[word]++;
        …
}
…
```

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



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

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

	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 then compare the implementations.

sort.cpp

```
…
#include <algorithm>

void sort( std::vector< int > *values );

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)

- 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, 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)

- 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, 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!
>>
```

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

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

- we can insert and extract data from a **stringstream**
- If we define operators "<<" (resp. ">>“) operators for inserting (resp. extracting) a new class to an **ostream** (resp. **istream**) these are can be used to insert into (resp. extract from) a **stringstream**.

main.cpp

```
#include <iostream>
#include <sstream>
#include <vector>
using namespace std;
ostream& operator<<( ostream& os , const vector<int>& vec)
{
        for( size_t i=0 ; i<vec.size() ; i++ ) os << vec[i] << ' ';
        return os;
}
istream& operator>>( istream& is , vector<int>& vec )
{
        int i;
        while( is>>i ) vec.push_back(i);
        return is;
}
int main( void )
{
        stringstream ss( "1 2 3 4 5" );
        vector<int> vec;
        ss >> vec;
        cout << vec << endl;
        return 0;
}
```

```
>> ./a.out
1 2 3 4 5
>>
```

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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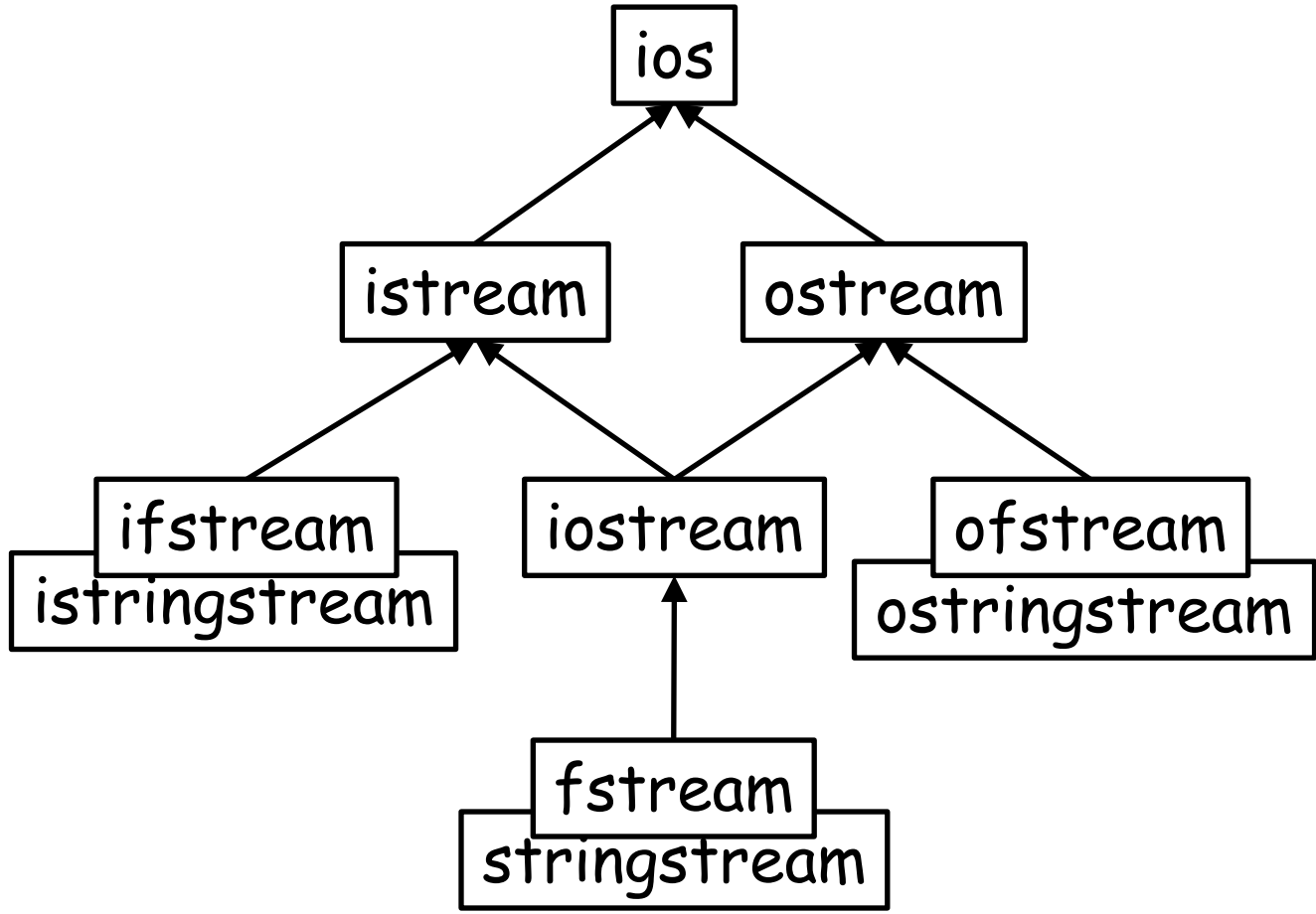
Object Oriented Programming

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

- Functionality for acting on the `class`'s data
- 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, with arrows indicating who inherits from whom ("is-a" relationship).



C++ stream class hierarchy

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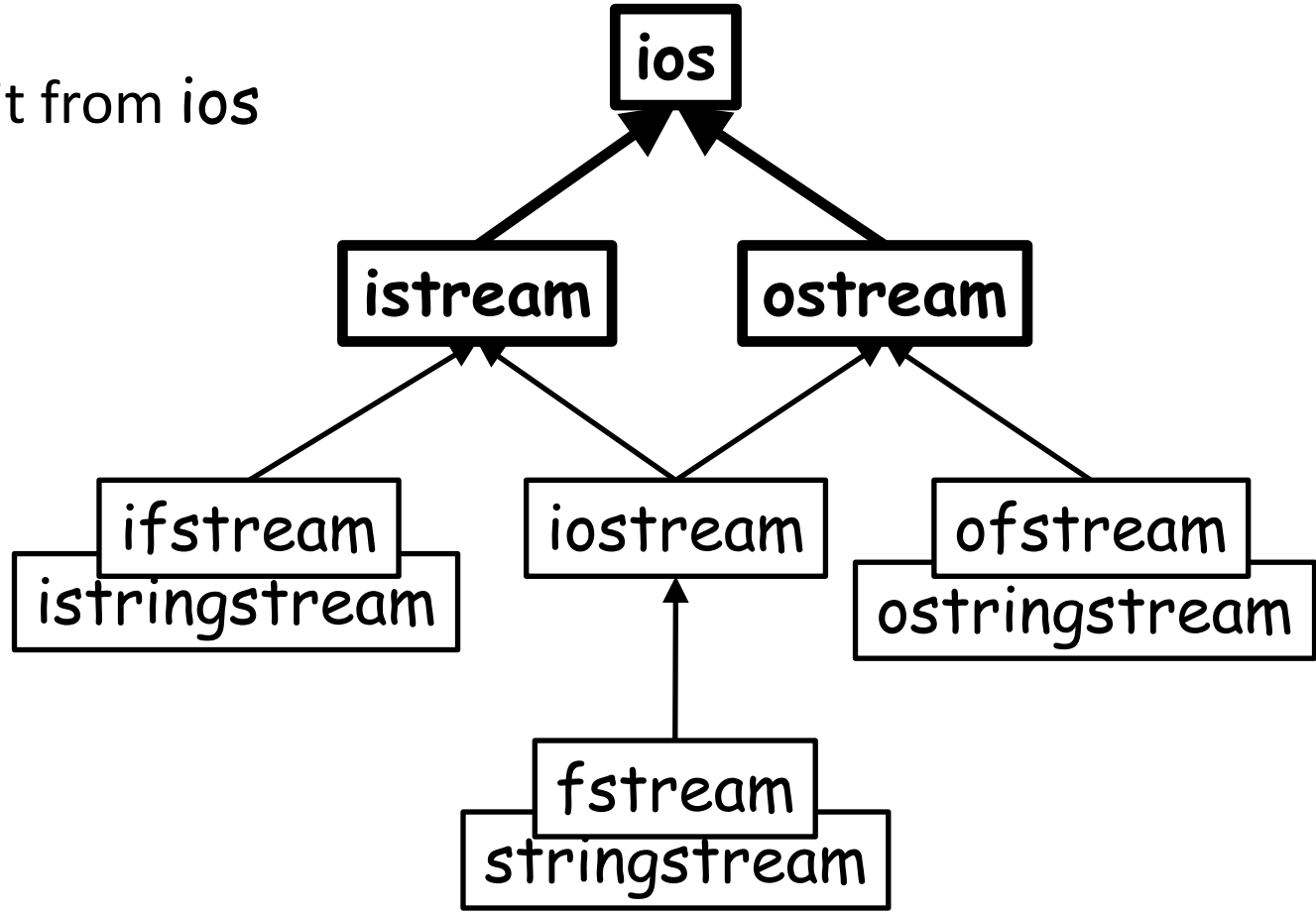
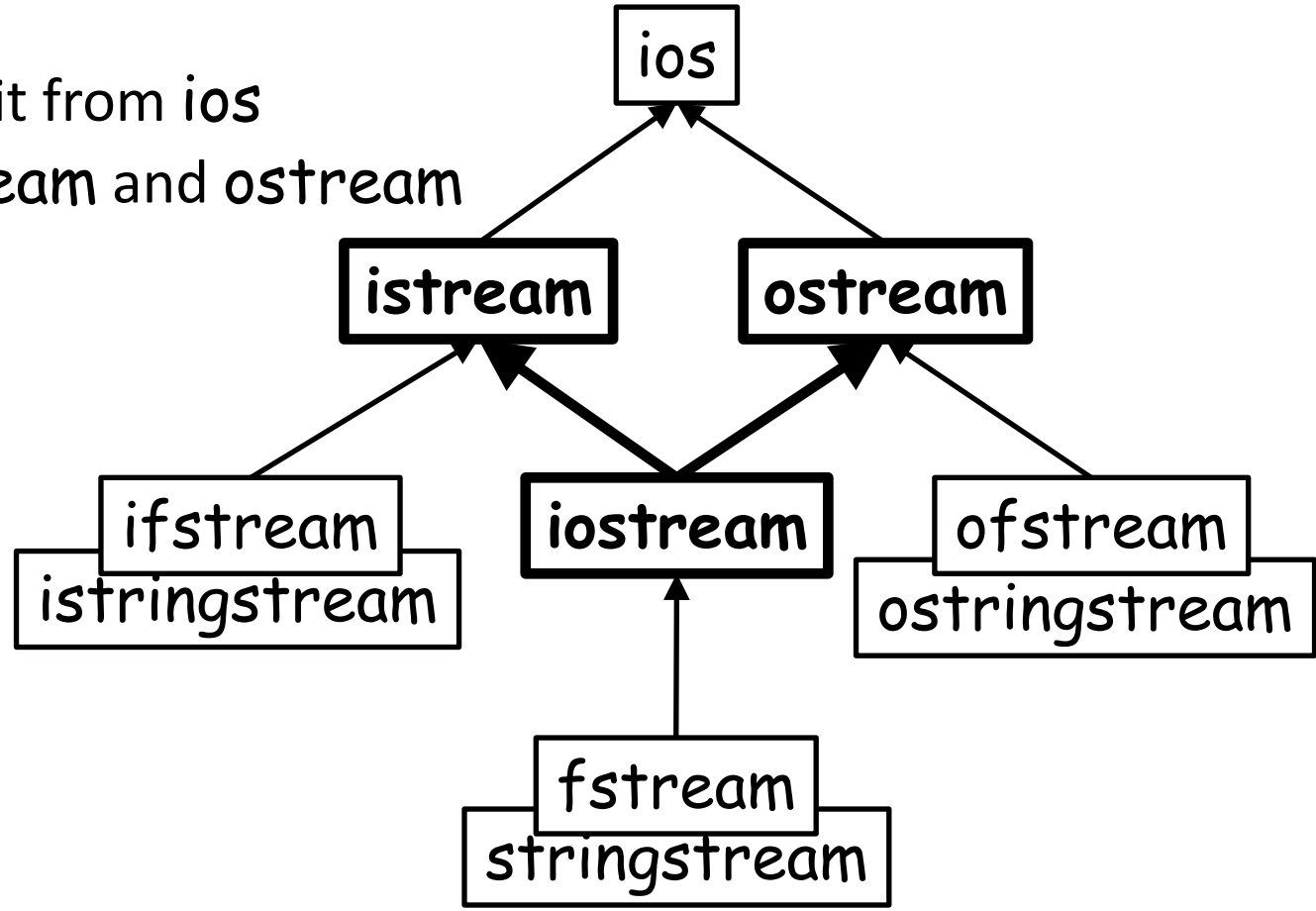
- **istream** and **ostream** both inherit from **ios**



C++ stream class hierarchy

Inheritance diagram for streams, with arrows indicating who inherits from whom ("is-a" relationship).

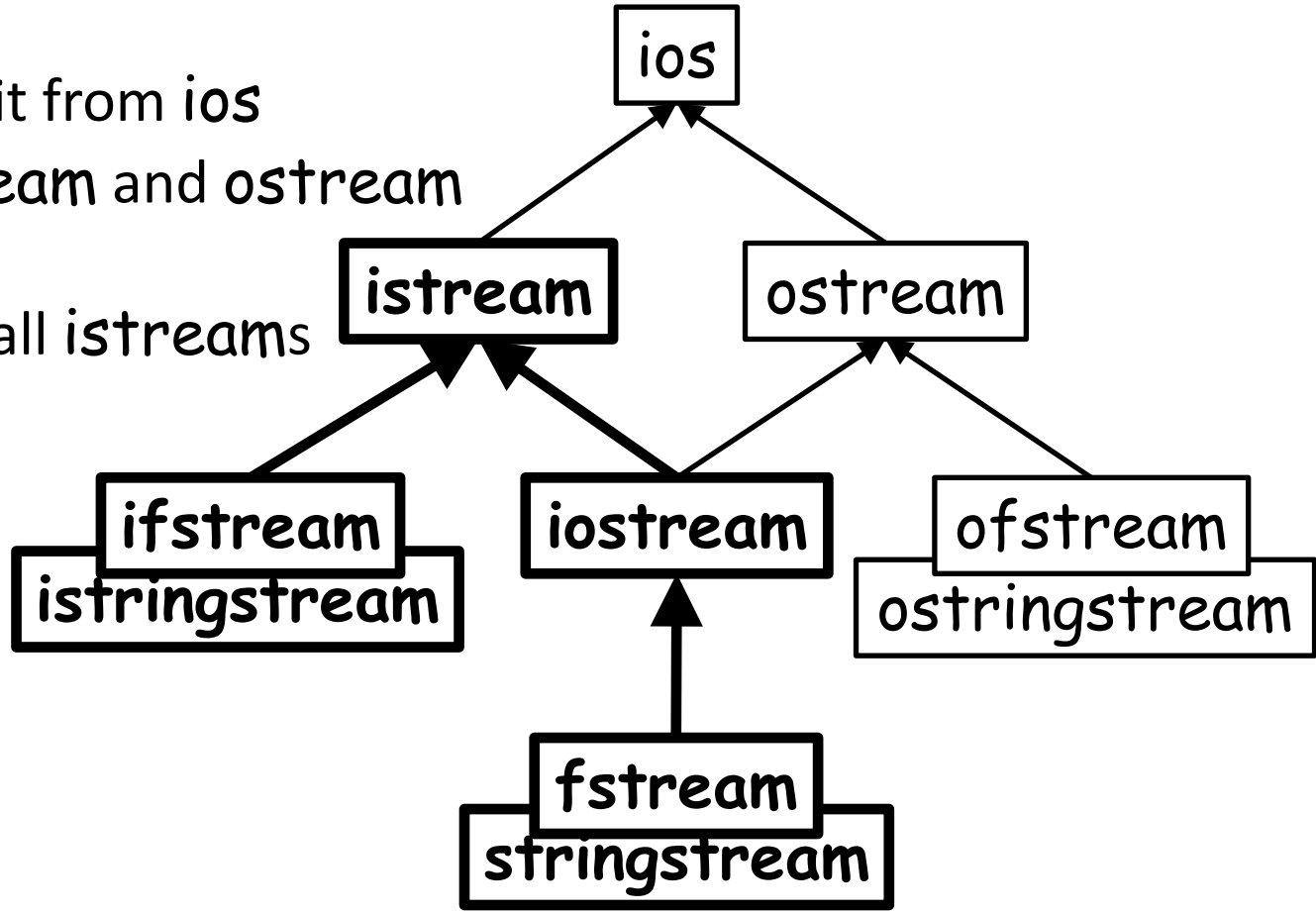
- **istream** and **ostream** both inherit from **ios**
- **iostream** inherits from both **istream** and **ostream**
  - multiple inheritance is allowed



C++ stream class hierarchy

Inheritance diagram for streams, with arrows indicating 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
- Stream extraction (>>) defined for all istreams



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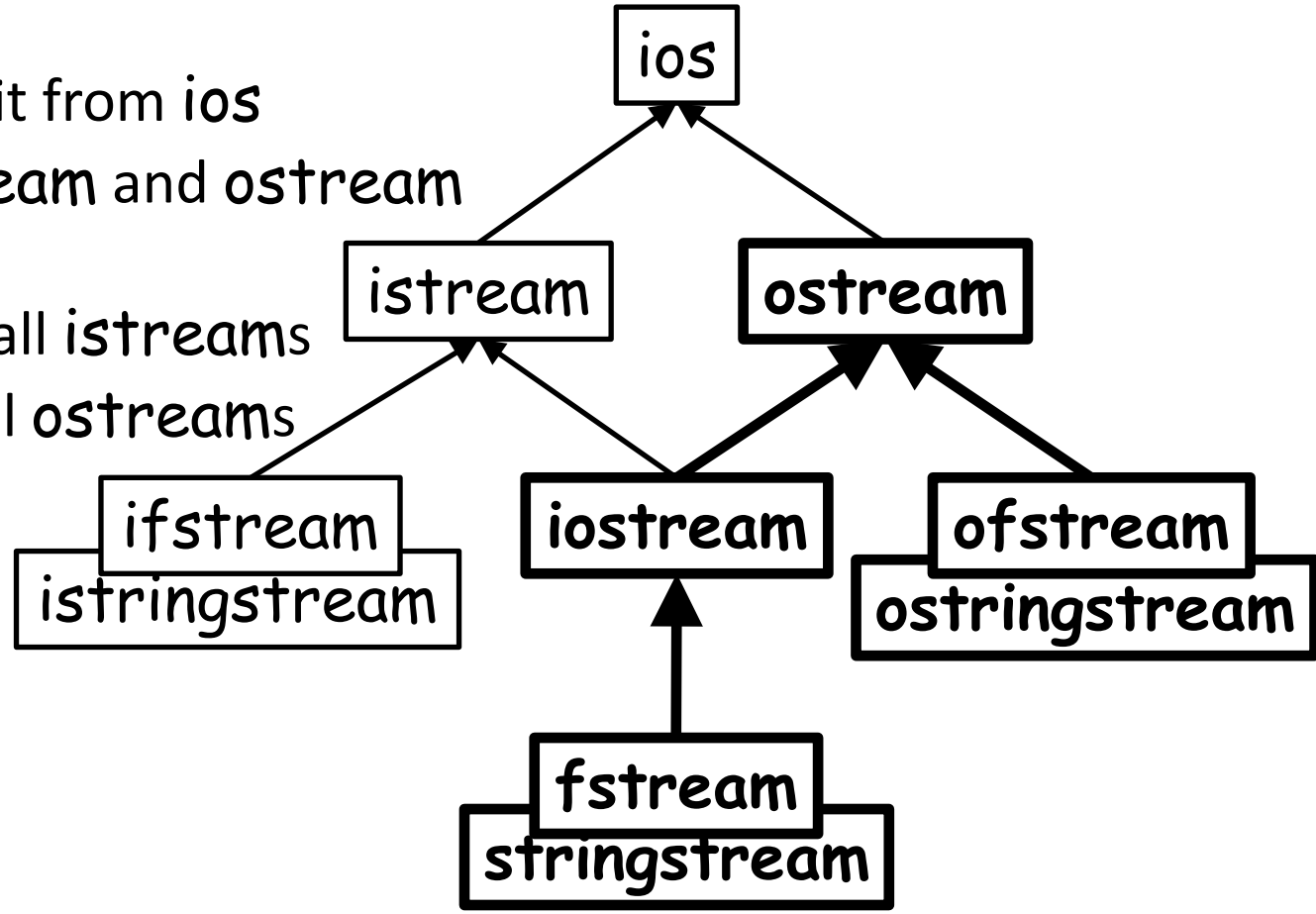
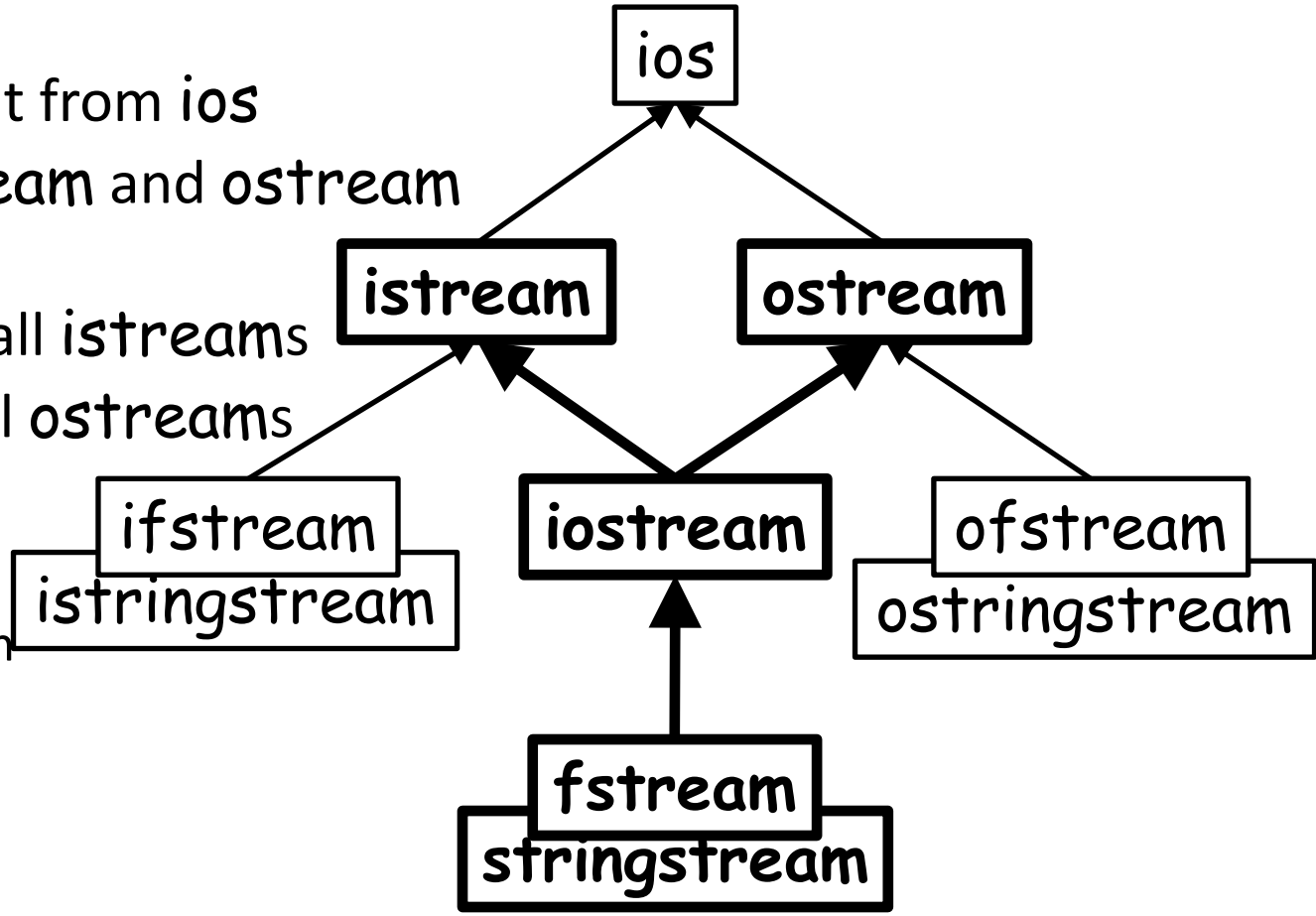


C++ stream class hierarchy

Inheritance diagram for streams, with arrows indicating 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
- Stream extraction (>>) defined for all **istreams**
- Stream insertion (<<) defined for all **ostreams**
- **fstream** and **stringstream** both inherit from **iostream**
  - Both support insertion and extraction



Exercise 25

- Website -> Course Materials -> Exercise 25