Programming Languages and Tools: Programming with C++ CS:3210:0003

Lecture/Lab #9

Streams

- A sequence of bytes that can be accessed sequentially
- Over time, may produce/consume unlimited amounts of data

iostream

- Input/output stream library

- 4 standard streams in C++:
  1. cin: tied to the standard input (typically keyboard)
  2. cout: tied to the standard output (typically monitor)
  3. cerr: tied to the standard error (typically monitor), with unbuffered output
  4. clog: tied to the standard error (typically monitor), with buffered output

std::cout - Character Output

- Send data to the console to be printed as text

- <<, the insertion operator
  - Use cout with << to send data to console
  - Polymorphic - works with multiple types
  - Doesn't seem to work with arrays
  - Can print literals or values within variables

std::cout is Buffered

- Outputs to be printed to the console are added to a buffer
- When the buffer is flushed, these outputs are printed on the console
- Writing to console is slower than writing to buffer
- For newline, use:
  1. std::endl
  2. Character literal '\n'
  3. String literal "\n"
- endl moves to a newline and flushes the output buffer, so literal is usually faster

std::cin - Character Input

- Read input from keyboard using extraction operator >>
  - Input must be stored in a variable
  - Polymorphic
  - Buffered

- We can also input space separated input with cin:

```
int x = 0, y = 0;
cin >> x >> y;
```

Stream Manipulators

- Used to modify stream
- Invoked by passing to stream
- Some useful stream manipulators/functions:

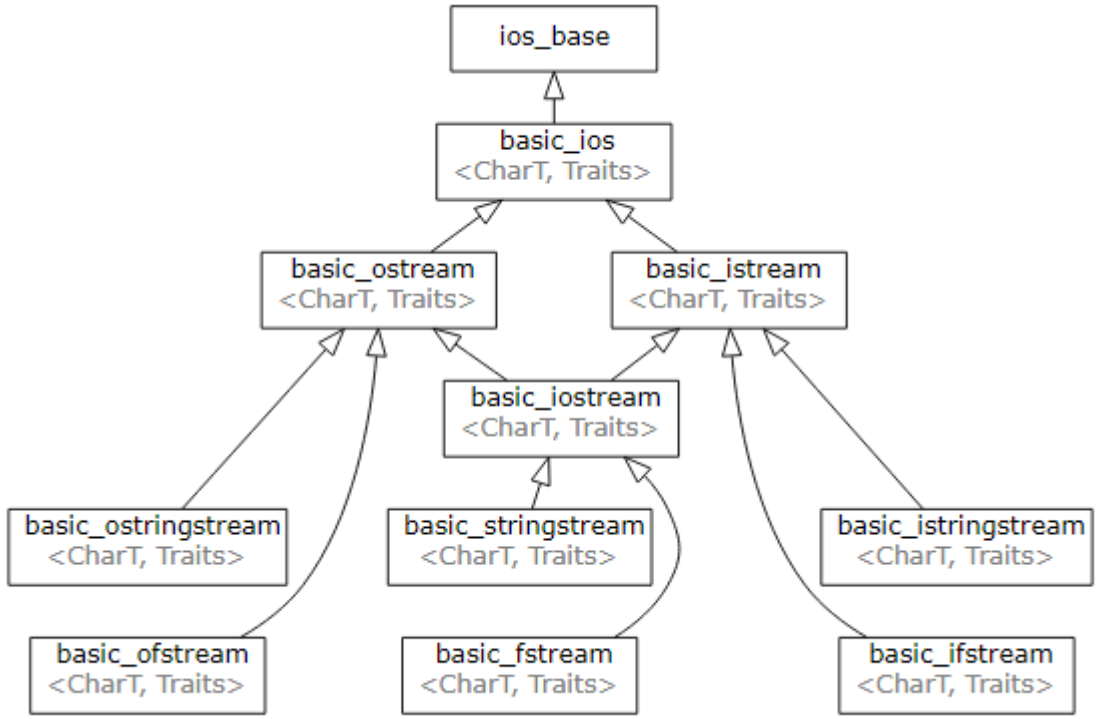
Manipulator	Function
std::endl	Print newline and flush buffered output
std::setw(int n)	Limit no. of chars read from stream
std::ignore()	Discard first char in stream
std::peek()	Read char without removing it from stream
std::unget()	Returns last character read to stream so it can be read again by the next call

I/O Formatting

- Manipulators – objects placed in stream to effect I/O
- Flags – bits that can be turned on/off to effect I/O
- Use setf() and unsetf() to turn flags on/off

C++ Streams

- OOP-style stream-based I/O library
- Implemented within a class hierarchy
- Organized around abstract input/output devices
- Streams for
  - I/O devices
  - Strings
  - Files



Streams for File I/O

- File I/O classes: ifstream, ofstream, and fstream
- Need to set up a file stream corresponding to a file
- Use insertion (<<) and extraction (>>) to read and write from stream
- >> breaks on whitespace
- Use getline() to read by line

Activity

Write a program bintests.cpp that:
- Initializes a 16 x 4 multidimensional array of Booleans called bits
- Prints to screen the array:

```
0000
0000
...
0000
```

Activity

Now modify bintests.cpp so that the arrays have the 4-bit binary values from 0 to 15 sequentially

Binary	Hex	Decimal
0000	0	0
0001	1	1
0010	2	2
0011	3	3
0100	4	4
0101	5	5
0110	6	6
0111	7	7
1000	8	8
1001	9	9
1010	A	10
1011	B	11
1100	C	12
1101	D	13
1110	E	14
1111	F	15

Activity

Modify bintests.cpp to print all 16 values (separated by newlines) to a file called bintests

File Output is Buffered

- Output is written to file when stream is flushed
- Stream is flushed when file is closed
- Manually flush stream by
  - Calling flush() on the stream, or
  - Sending std::flush to the output stream

File Modes

- Open file with a mode for corresponding operation

Ios file mode	Meaning
app	Opens the file in append mode
ate	Seeks to the end of the file before reading/writing
binary	Opens the file in binary mode (instead of text mode)
in	Opens the file in read mode (default for ifstream)
out	Opens the file in write mode (default for ofstream)
trunc	Erases the file if it already exists