Streams II

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Quick Recap

- Streams are a general way to handle I/O
- Most frequent ways to access data are getline, >>, <<, and get
- Can be an istream, ostream, or iostream

Today

- Stream Internals
- Stream Shortcuts
- Stream Manipulators

ostream Internals

- We glossed over using ostreams last time
- It turns out ostreams also have an internal sequence of data!

Stream Buffers

- The internal sequence of data stored in a stream is called a **buffer**
- istreams use them to store data we haven’t used yet
- ostreams use them to store data they haven’t passed along yet
    - Depends on the implementation used

Flushing

If you want to force the buffer to get used, you **flush** the stream:

- `stream.flush()`
  - Use by default
- `stream << flush`
  - Use if you're already printing on that line without a newline
- `flush(stream)`
  - Just don't use this
- `stream << endl`
  - Use if you're printing a newline

stream.fail()

What exactly does stream.fail() actually tell us?

Stream Bits

Has four bits:

- Good bit - No errors, the stream is good to go
- EOF bit - End-of-file was reached during a previous operation
- Fail bit - Logical error on a previous operation
- Bad bit - Likely unrecoverable error on previous operation

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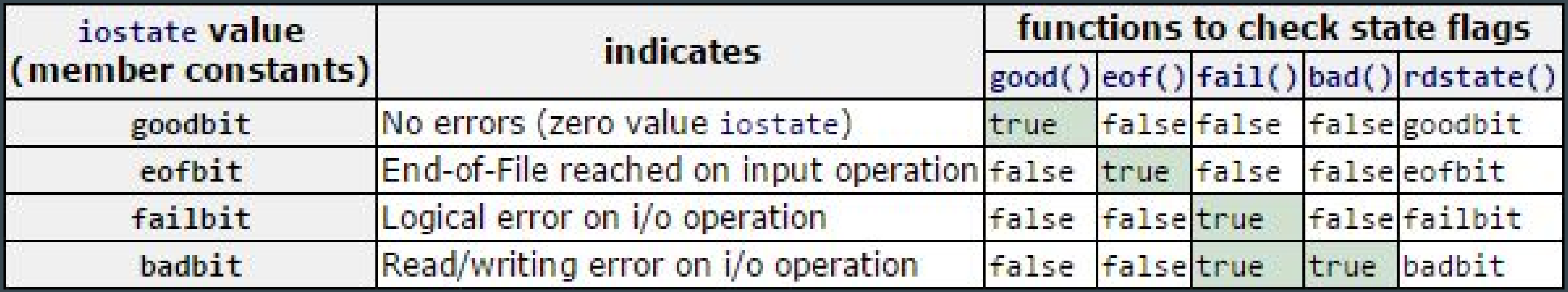

iostate value (member constants)	indicates	functions to check state flags				
		good()	eof()	fail()	bad()	rdstate()
goodbit	No errors (zero value iostate)	true	false	false	false	goodbit
eofbit	End-of-File reached on input operation	false	true	false	false	eofbit
failbit	Logical error on i/o operation	false	false	true	false	failbit
badbit	Read/writing error on i/o operation	false	false	true	true	badbit

Which Bit is Best?

1. Read data
2. Check if data is valid, if not, break
3. Use data
4. Go back to step 1

Which Bit is Best?

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```
while(true) {

    stream >> temp;

    if (stream.fail()) break;

    foo(temp);

}
```

Clear

- `stream.clear()` sets the stream's bit to `goodbit`
- You must do this if you want to continue using a stream that isn't in a good state

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Chaining << and >>

We’ve been writing code like:

```
    cout << “Hello World!” << endl;
```

Why can we chain together multiple << operators?

Operator Returns

C++ treats operators as functions, and they thus have return types

What are the return types for the following?

- int + int
- int / double
- ostream << int

Chaining << and >>

If we take our hello world line and parenthesize it, we get the equivalent:

```
(cout << “Hello World!”) << endl;
```

Chaining << and >>

If we take our hello world line and parenthesize it, we get the equivalent:

```
    (cout) << endl;
```

Converting the Stream

```
int x = 0;

double y = x;  // Converted to a double implicitly
```

Converting the Stream to a …bool?

```
int x = 0;

double y = x;  // Converted to a double implicitly

bool z = cout; // Converted to a bool implicitly
```

Converting the Stream to a …bool?

```
int x = 0;

double y = x;  // Converted to a double implicitly

bool z = cout; // Converted to a bool implicitly

bool isGood = !cout.fail(); // Equivalent to the above line
```

Using Our New Tools

1. Read data
2. Check if data is valid, if not, break
3. Use data
4. Go back to step 1

```
while(true) {

    stream >> temp;

    if (stream.fail()) break;

    foo(temp);

}
```

Using Our New Tools

1. Read data
2. Check if data is valid, if not, break
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```
while(true) {

    stream >> temp;

    if (!stream) break;

    foo(temp);

}
```

Using Our New Tools

1. Read data
2. Check if data is valid, if not, break
3. Use data
4. Go back to step 1

```
while(true) {

    bool isGood = stream >> temp;

    if (!isGood) break;

    foo(temp);

}
```

Using Our New Tools

1. Read data
2. Check if data is valid, if not, break
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```
while(stream >> temp) {

    foo(temp);

}
```

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How Does endl Work?

- A brief overview:
  - endl is actually something called a **stream manipulator**
  - If you check the type of endl, it’s actually a function

`stream << endl` is equivalent to `endl(stream)`

Mixing >> and getline

```
int age;
string name;
cin >> age;
getline(cin, name);
```

Doesn’t do what we want!

Mixing >> and getline

```
int age;
string name;
cin >> age >> ws;
getline(cin, name);
```

Does do what we want!

Common Stream Manipulators

- endl: inserts a newline and flushes the stream
- ws: skips all currently available whitespace
- boolalpha: prints “true” and “false” for bools
- Numeric:
  - hex: prints numbers in hex
  - setprecision: adjusts the precision numbers print with
- Padding:
  - setw
  - setfill

Padding Example

```
cout << “[“ << setw(10) << “Hi!” << “]” << endl;
```

outputs

```
[       Hi!]
```

Padding Example

```
cout << “[“ << right << setw(10) << “Hi!” << “]” << endl;
```

outputs

```
[Hi!       ]
```

Padding Example

```
cout << “[“ << right << setfill(‘!’) << setw(10)
     << “Hi!” << “]”  << endl;
```

outputs

```
[Hi!!!!!!!!!]
```

Numeric Example

```
cout << hex << 10; //prints a
cout << oct << 10; //prints 12
cout << dec << 10; //prints 10
```

Stream Manipulators Recap

- Stream manipulators are things you can pass into streams to change how they behave
- They have a variety of uses, and if you'd like to format something differently, there's probably a manipulator for it
- The most important are probably `endl` and `ws`
- You can find a list of the most common at http://www.cplusplus.com/reference/library/manipulators/