Introduction to Scientific Programming with C++

Session 4: Input, output and text manipulation

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Writing to a file

Let's say we wanted to gift someone with an ASCII caterpillar, here's how:

```
#include <iostream>
#include <fstream>

int main () {
  std::ofstream myFile("caterpillar.txt");
  myFile << "Here, have a caterpillar:\n\n";
  myFile << "\\ \n";
  myFile << " '-.__.-' \n";
  myFile << " /oo |--.--,--,--. \n";
  myFile << " \\_.-'._i__i__i_.' \n";
  myFile << "        \"\"\"\"\"\"\"\"\" \n";
  if(myFile.is_open())
    myFile.close();
  return 0;
}
```

../code/4_io/lectures/simple_output.cpp

Doesn't look like much does it? That's because I've had to use escape characters to print some of the symbols: \ is \\ and " is \" [1]

[1] For full list see `http://en.cppreference.com/w/cpp/language/escape`

Introduction to ofstream

Output file stream

All of the action happens with the ofstream object. Let's have a closer look.

Constructing ofstream

```
ofstream();
ofstream(const char * filename, ios_base::openmode mode =
    ios_base::out);
```

Two ways to construct an ofstream. Second is equivalent to:

```
std::ofstream myFile;
myFile.open(filename, std::ios_base::out);
```

The openmode tells ofstream how you want to open the file[2].

[2] See http://en.cppreference.com/w/cpp/io/ios_base/openmode for a full list.

Introduction to ofstream

Opening a file stream

```
void open(const char * filename, ios_base::openmode mode
    = ios_base::out);
```

Does what it says on the tin: opens a file called `filename` with mode `mode`.

Writing to a file: the insertion operator

```
ostream & operator <<(/*..stuff..*);
```

Use this to operator to insert text, numbers, strings and other things[3] into a file.

[3] See `http://en.cppreference.com/w/cpp/io/basic_ostream/operator_ltlt` for full list.

Introduction to ofstream

Closing a file

```
void close();
```

Tells the operating system to close the file because we no longer need it.

Warning!

- You do not need to close files, the fstream destructor will do it for you when you leave the current scope.
- If you want to close a file manually check to see if the file is open before trying to close it:

```
if(myFile.is_open()){
  myFile.close();
}
```

Calling close on a file that is not open is an error!

Reading from a file

Reading from a text file is relatively easy. Let's dive in:

```
#include <iostream>
#include <fstream>
#include <string>

int main () {
  std::string line;
  std::ifstream
       myFile("caterpillar.txt");

  if(myFile.is_open())
  {
    while(myFile.good())
    {
      std::getline(myFile, line);
      std::cout << line << std::endl;
    }
    myFile.close();
  }
  else
    std::cout << "Unable to open";

  return 0;
}
```

../code/4_io/lectures/simple_input.cpp

Output:

```
Here, have a caterpillar:

    \
     '-.__.-'
     /oo |--.--,--,--.
     \_.-'._i__i__i_.'
            """""""""
```

Introduction to `ifstream`

The `ifstream` (input file stream) class is where most of the magic happened. Let's take a closer look:

Constructing ifstream

```
ifstream();
ifstream(const char * filename, ios_base::openmode mode =
    ios_base::in);
```

To create one we give it a file name. Second argument tells `ifstream` how to open the file.

Checking if the file is ready to be read from

```
bool good() const;
```

If there has been an error or the end of file has been reached, this will be false, otherwise true.

```
while(myFile.good())
```

Introduction to `ifstream`

Reading a line from the file

```
ifstream & getline(istream & is, string & str, char delim);
ifstream & getline(istream & is, string & str);
```

This function reads characters from an input stream (`is`) until a delimiter (`delim`) is found. The result is placed in the string `str`. If you call it again it will continue from where it left off.
The overloaded version with no third parameters assumes the delimiter to be `\n` (i.e. the new line character).
This is *not* part of `ifstream`, it's actually in `<string>`.

```
std::getline(myFile, line);
```

These are just some of the many things `ifstream` can do, see [4] for a complete look at the class.

[4] `http://www.cplusplus.com/reference/iostream/ifstream/`

Input

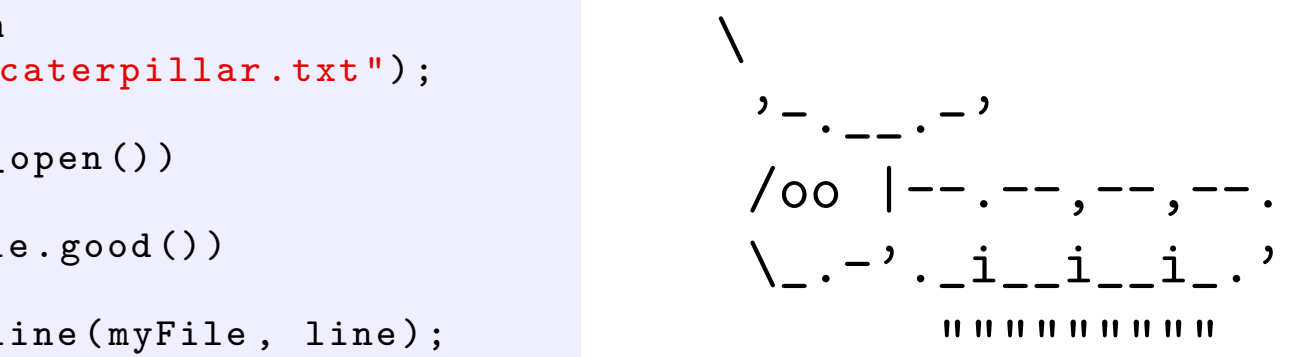
Reading from a file

Let's have another look:

```
#include <iostream>
#include <fstream>
#include <string>

int main () {
  std::string line;
  std::ifstream
       myFile("caterpillar.txt");

  if(myFile.is_open())
  {
    while(myFile.good())
    {
      std::getline(myFile, line);
      std::cout << line << std::endl;
    }
    myFile.close();
  }
  else
    std::cout << "Unable to open";

  return 0;
}
```

Output:

Here, have a caterpillar:



Strings revisited

How long is a piece of string? myString.length() of course

`strings` that we saw earlier are actually classes. There are many useful things we can do with strings. Here are a couple:

Get the length

```
size_t size();
size_t length();
```

Get the number of characters in a string. `size_t` is a special type that roughly corresponds to an unsigned integer.

Find content in the string

```
size_t find(const string & str, size_t pos = 0) const;
```

Search for `str` within the current string, optionally starting after position `pos`, returning the position of the first occurrence in the string. If `str` is not found `string::npos` is returned.

Splitting up a strings

Step 1

Say we have a string made up of a series of numbers:

```
const std::string line("3.51 9.23 1.25 4.51");
```

How do we get the numbers out so we can deal with them as `double`s and, say, calculate their sum?
By using the ever handy `stringstream` class:

Step 1: Split the string up using space as a delimiter

```
const std::string line("3.51 9.23 1.25 4.51");
std::string numString;
std::stringstream stream(line);

double num, sum = 0.0;
while(std::getline(stream, numString, ' '))
{
```

Splitting up a strings

Step 2

Step 2: Convert each number string to a double

```
{
  std::stringstream numStream(numString);
  if(!(numStream >> num)){
    num = 0.0;
  }
  sum += num;
}
```

Here we're using the extraction operator (>>) to extract a `double` type from the `stringstream`.
We can check if it failed by using the not operator (`!`). Remember because this is a class operator we could write:

```
numStream.operator >>(num);
```

To use the `stringstream` class make just include the `<sstream>` header.

Splitting up a string

```
#include <iostream>
#include <string>
#include <sstream>

int main()
{
  const std::string line("3.51 9.23 1.25 4.51");
  std::string numString;
  std::stringstream stream(line);

  double num, sum = 0.0;
  while(std::getline(stream, numString, ' '))
  {
    std::stringstream numStream(numString);
    if(!(numStream >> num)){
      num = 0.0;
    }
    sum += num;
  }
  std::cout << "Sum is: " << sum << "\n";

  return 0;
}
```

Output:

```
Sum is:  18.5
```

../code/4_io/lectures/parse_numbers.cpp