File Streams

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- A stream of cars waiting to enter RMNP
- One at a time
- Buy/show pass

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- One at a time
- Buy/show pass
- Eventually, no more cars

Reading and Writing Files

- The C++ input/output library is based on the concept of *streams*.
- An *input stream* is a source of data.
- An *output stream* is a destination for data.

- The most common sources and destinations for data are the files on your hard disk.
  - You need to know how to read/write disk files to work with large amounts of data that are common in business, administrative, graphics, audio, and science/math programs

Streams

```
This is a stream of characters. It could be from the
keyboard  or  from a file. Each of these is just a
character - even these:  3  -23.73 which, when input,
can be converted to: ints or doubles or whatever type
you like.
(that was a  '\n'  at the end  of the last line)
&*@&^#!%#$ (No, that was -not- a curse!!!!!!!!!!
¥1,0000,0000 (price of a cup of coffee in Tokyo)
Notice that all of this text is very plain -  No
bold or green of italics - just characters - and
whitespace (TABs, NEWLINES and, of course... the
other one you can't see: the space character:
(another '\n')
(&& another)
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    Aren't you x-STREAM-ly glad this stream is over?
                    And there were no sound effects!!!
```
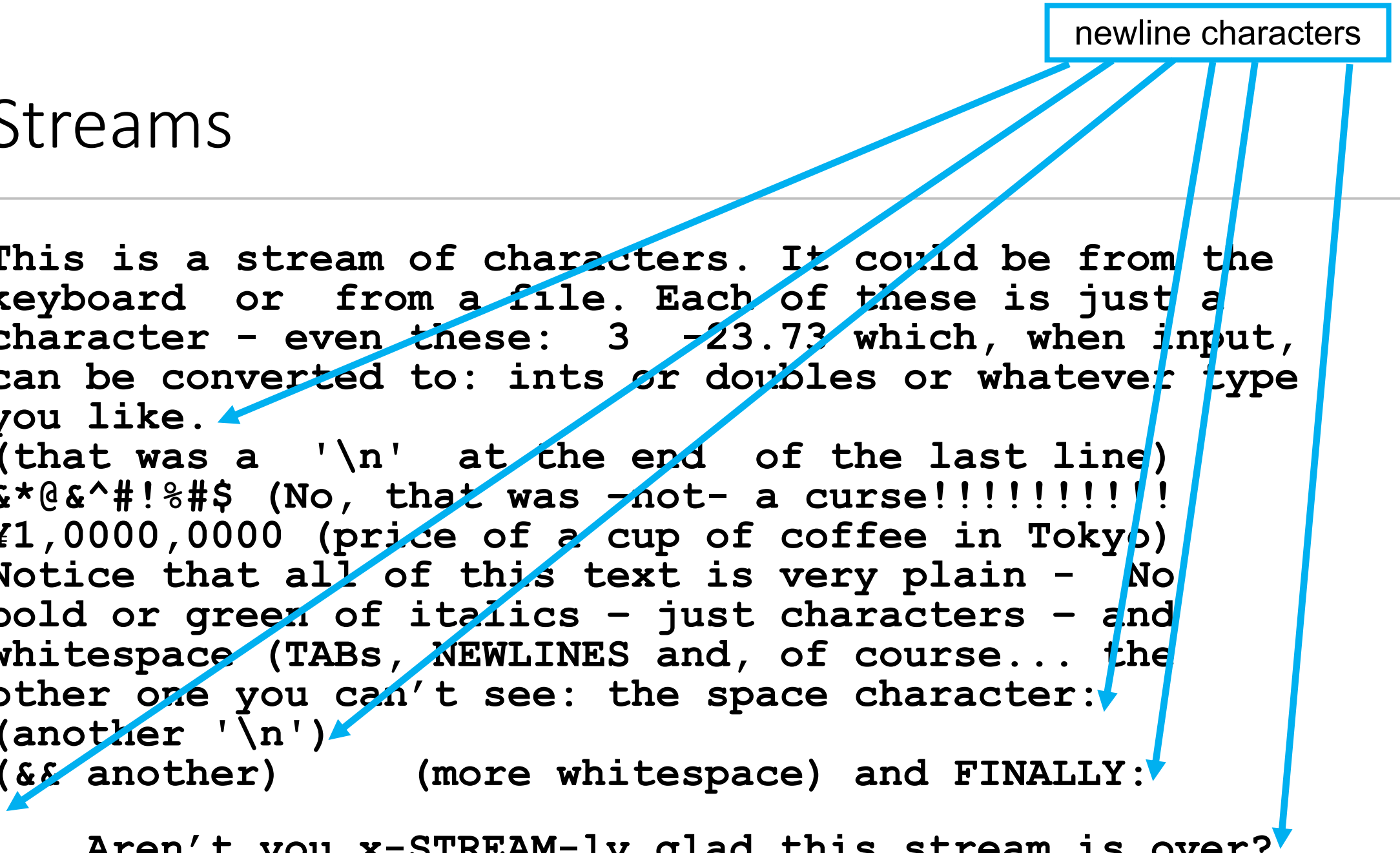

Streams

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other one you can't see: the space character:
(another '\n')
(&& another)      (more whitespace) and FINALLY:

    Aren't you x-STREAM-ly glad this stream is over?
                And there were no sound effects!!!
```

Reading and Writing Streams

- The stream you just saw is a plain text file.
- No formatting, no colors, no video or music (or sound effects).

- A program can read these sorts of plain text streams of characters from the keyboard, as has been done so far with `cin`.

Reading and Writing Disk Files

You can also read and write files stored on your hard disk:

- plain text files
- binary information (a binary file)
  - Such as images or audio recording

To read/write files, you use *variables* of the stream types:

`ifstream` for input from plain text files.
`ofstream` for output to plain text files.
`fstream` for input and output from binary files.

You must `#include <fstream>`

Opening a Stream

- To read anything from a file stream, you need to *open* the stream. (The same for writing.)
- *Opening a stream* means associating your stream variable with the disk file.
- The first step in opening a file is having the stream variable ready.

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- To read anything from a file stream, you need to *open* the stream. (The same for writing.)
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- The first step in opening a file is having the stream variable ready.

Here's the definition of an input stream variable named **`in_file`**:

```
ifstream in_file;
```

Looks suspiciously like every other variable definition you've done – it is!
Only the type name is new to you.

Code for opening a stream

```
ifstream in_file;
in_file.open("input.txt"); //filename is input.txt
```

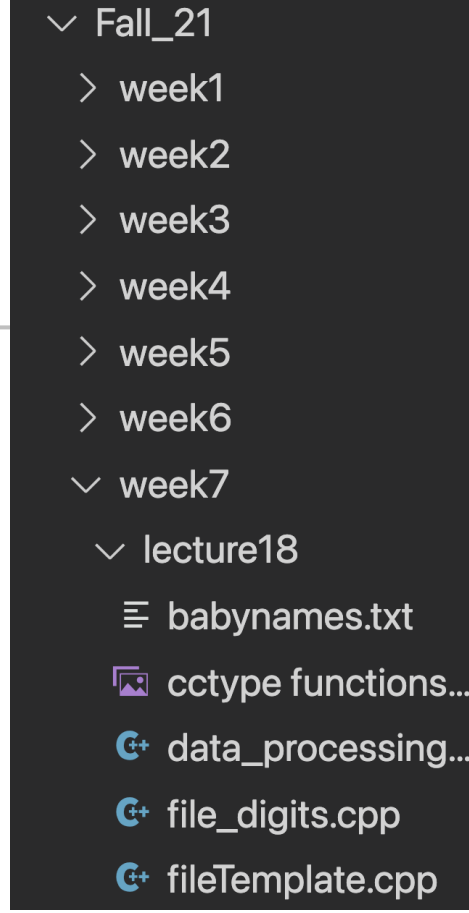
An alternative shorthand syntax combines the 2 statements:

```
ifstream in_file(“input.txt”);
```

- As your program runs and tries to find this file, it WILL ONLY LOOK IN THE DIRECTORY (FOLDER) IT IS LOCATED IN!

- This is a common source of errors. If the desired file is not in the executing program’s folder, the full file path must be specified.

File Path Names



File names can contain directory path information, such as:

UNIX
```
in_file.open("~/nicework/input.dat");
```

Windows
```
in_file.open("c:\\nicework\\input.dat");
```

When you specify the file name as a string literal, and the name contains backslash characters (as in Windows), you must **supply each backslash *twice*** to avoid having unintended *escape characters* in the string.

\\ becomes a single \ when processed by the compiler.

Failing to open

- The **`open`** method also sets a “not failed” condition
- It is a good idea to test for failure immediately:

```
in_file.open(filename);

// Check for failure after opening
if (in_file.fail())
{
     return 0;
}
```

or

```
if(!in_file.is_open())
{
     return 0;
}
```

Closing a Stream

- When the program ends, all streams that you have opened will be automatically closed.
- You *can* manually close a stream with the **close** member function:

```
in_file.close();
```

1. Create variable
2. Open file (provide filename)
3. Check if file opened successfully
4. Read from file
5. Close file

Reading from a stream

If you have the following stored in a file:

```
CSCI 1300
```

You already know how to read and write using files.

Yes you do:

```
string name;
int number;
```

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in_file >> name >> number;
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```

cin? **in_file**?

No difference when it comes to reading using **>>**.

Reading from a stream

- The **>>** operator returns a “not failed” condition, allowing you to combine an input statement and a test.
- A “failed” read yields a **`false`** and a “not failed” read yields a **`true`**.

```
if (in_file >> name >> number)
{
   // Process input
}
```

Reading from a stream

- You can even read ALL the data from a file because running out of things to read causes that same “failed state” test to be returned:

```
while (in_file >> name >> number)
{
   // Process input
}
```

Reading from a stream - alternate

- You can read ALL the data from a file until we have reached end of file: eof()

```
while (!in_file.eof())
{
    // Process input
}
```

Reading Words and Characters

What really happens when reading a `string`?

```
string word;
in_file >> word;
```

1. Any whitespace is skipped (whitespace is: `'\t' '\n' ' '`).
2. The first character that is not white space is added to the string `word`. More characters are added until either another white space character occurs, or the end of the file has been reached.

Reading A Whole Line: `getline`

- The function **`getline()`** reads a whole line up to the next '\n', into a C++ string.

- The '\n' is then deleted, and NOT saved into the string.

```
string line;
ifstream in_file("myfile.txt");

getline(in_file, line);
```

Reading A Whole Line in a Loop: `getline`

- The **`getline`** function, like the others we've seen, returns the "not failed" condition.
- To process a whole file line by line:

```
string line;
while( getline(in_file, line)) //reads whole file
{
   // Process line
}
```

Reading Words and Characters

You can read a single character, including whitespace, using `get()`:

```
char ch;
in_file.get(ch);
```

The `get` method returns the "not failed" condition so:

```
//reads entire file, char by char
while (in_file.get(ch))
{
   // Process the character ch
}
```

Reading a Number Only If It Is a Number

- You can look at a character after reading it and then put it back.
- This is called *one-character lookahead*. A typical usage: check for numbers before reading them so that a failed read won't happen:

```
char ch;
int n=0; //for reading an entire int
in_file.get(ch);

if (isdigit(ch)) // Is this a number?
{
   // Put the digit back so that it will be part of the number we read
   in_file.unget();

   in_file >> n; // Read integer starting with ch

}
```

Functions in <cctype> (Handy for Lookahead)

Function	Accepted Characters
isdigit	0 ... 9
isalpha	a ... z, A ... Z
islower	a ... z
isupper	A ... Z
isalnum	a ... z, A ... Z, 0 ... 9
isspace	White space (space, tab, newline, and the rarely used carriage return, form feed, and vertical tab)

Writing to a Stream

Here's everything:

1. create output stream variable
2. open the file
3. write to file
4. close file!

```
ofstream out_file;
out_file.open("output.txt");
if (in_file.fail()) { return 0; }
out_file << name << " " << value << endl;
out_file << "CONGRATULATIONS!!!" << endl;
```

Working with File Streams