Chapter 6

I/O Streams as an Introduction to Objects and Classes

Overview

6.1 Streams and Basic File I/O

6.2 Tools for Stream I/O

6.3 Character I/O

6.1

Streams and Basic File I/O

I/O Streams

- I/O refers to program input and output
  - Input is delivered to your program via a stream object
  - Input can be from
    - The keyboard
    - A file
  - Output is delivered to the output device via a stream object
  - Output can be to
    - The screen
    - A file

Objects

- Objects are special variables that
  - Have their own special-purpose functions
  - Set C++ apart from earlier programming languages

Streams and Basic File I/O

- Files for I/O are the same type of files used to store programs
- A stream is a flow of data.
  - Input stream: Data flows into the program
    - If input stream flows from keyboard, the program will accept data from the keyboard
    - If input stream flows from a file, the program will accept data from the file
  - Output stream: Data flows out of the program
    - To the screen
    - To a file

cin And cout Streams

- cin
  - Input stream connected to the keyboard
- cout
  - Output stream connected to the screen
- cin and cout defined in the iostream library
  - Use include directive: #include <iostream>
- You can declare your own streams to use with files.

File I/O

- Reading from a file
  - Taking input from a file
  - Done from beginning to the end (for now)
    - No backing up to read something again (OK to start over)
    - Just as done from the keyboard
- Writing to a file
  - Sending output to a file
  - Done from beginning to end (for now)
    - No backing up to write something again (OK to start over)
    - Just as done to the screen

Stream Variables

- Like other variables, a stream variable…
  - Must be declared before it can be used
  - Must be initialized before it contains valid data
    - Initializing a stream means connecting it to a file
    - The value of the stream variable can be thought of as the file it is connected to
  - Can have its value changed
    - Changing a stream value means disconnecting from one file and connecting to another

Declaring An Input-file Stream Object

- Input-file streams are of type ifstream
- Type ifstream is defined in the fstream library
  - You must use the include and using directives

```
#include <fstream>
using namespace std;
```

- Declare an input-file stream variable using

```
ifstream    in_stream;
```

Declaring An Output-file Stream Variable

- Ouput-file streams of are type ofstream
- Type ofstream is defined in the fstream library
  - You must use these include and using directives

```
#include <fstream>
using namespace std;
```

- Declare an output-file stream variable using

```
ofstream    out_stream;
```

Connecting To A File

- Once a stream object is declared, connect it to a file
  - Connecting a stream to a file is opening the file
  - Use the open function of the stream object

```
in_stream.open("infile.dat");
```

Period

File name on the disk

Double quotes

Using The Input Stream

- Once connected to a file, the input-stream variable can be used to produce input just as you would use cin with the extraction operator
  - Example:

```
int one_number, another_number;
in_stream >> one_number
          >> another_number;
```

Using The Output Stream

- An output-stream works similarly to the input-stream

```
ofstream out_stream;
out_stream.open("outfile.dat");

out_stream << "one number = "
           << one_number
           << "another number = "
           << another_number;
```

External File Names

- An External File Name…
  - Is the name for a file that the operating system uses
    - infile.dat and outfile.dat used in the previous examples
  - Is the "real", on-the-disk, name for a file
  - Needs to match the naming conventions on your system
  - Usually only used in the stream's open statement
  - Once open, referred to using the name of the stream connected to it.

Closing a File

- After using a file, it should be closed
  - This disconnects the stream from the file
  - Close files to reduce the chance of a file being corrupted if the program terminates abnormally
- It is important to close an output file if your program later needs to read input from the output file
- The system will automatically close files if you forget as long as your program ends normally

Display 6.1

Display 6.1

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Simple File Input/Output

```
//Reads three numbers from the file infile.dat, sums the numbers,
//and writes the sum to the file outfile.dat.
//(A better version of this program will be given in Display 5.2.)
#include <fstream>

int main( )
{
    using namespace std;
    ifstream in_stream;
    ofstream out_stream;

    in_stream.open("infile.dat");
    out_stream.open("outfile.dat");

    int first, second, third;
    in_stream >> first >> second >> third;
    out_stream << "The sum of the first 3\n"
               << "numbers in infile.dat\n"
               << "is " << (first + second + third)
               << endl;

    in_stream.close( );
    out_stream.close( );

    return 0;
}
```

infile.dat
(Not changed by program.)

```
1
2
3
4
```

outfile.dat
(After program is run.)

```
The sum of the first 3
numbers in infile.dat
is 6
```

There is no output to the screen and no input from the keyboard.

Objects

- An object is a variable that has functions and data associated with it
  - in_stream and out_stream each have a function named open associated with them
  - in_stream and out_stream use different versions of a function named open
    - One version of open is for input files
    - A different version of open is for output files

Member Functions

- A member function is a function associated with an object
  - The open function is a member function of in_stream in the previous examples
  - A different open function is a member function of out_stream in the previous examples

Classes

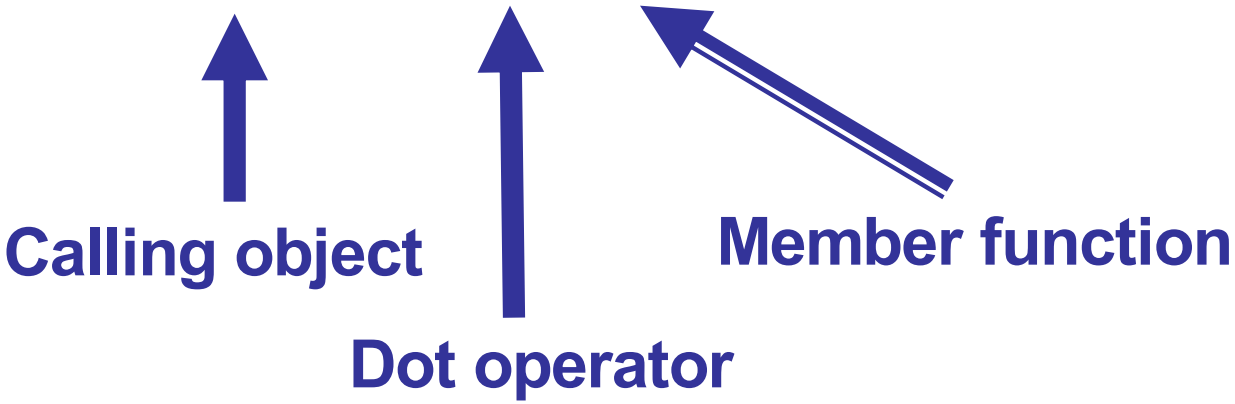
- A type whose variables are objects, is a class
  - ifstream is the type of the in_stream variable (object)
  - ifstream is a class
  - The class of an object determines its member functions
  - Example:

```
ifstream in_stream1, in_stream2;
```

    - in_stream1.open and in_stream2.open are the same function but might have different arguments

Calling a Member Function

- Calling a member function requires specifying the object containing the function
- The calling object is separated from the member function by the dot operator
- Example: `in_stream.open("infile.dat");`



Errors On Opening Files

- Opening a file could fail for several reasons
  - Common reasons for open to fail include
    - The file might not exist
    - The name might be typed incorrectly
- May be no error message if the call to open fails
  - Program execution continues!

Catching Stream Errors

- Member function fail, can be used to test the success of a stream operation
  - fail returns a boolean type (true or false)
  - fail returns true if the stream operation failed

Halting Execution

- When a stream open function fails, it is generally best to stop the program
- The function exit, halts a program
  - exit returns its argument to the operating system
  - exit causes program execution to stop
  - exit is NOT a member function
  - exit requires an int argument, which is the error returned to the OS. The convention is zero indicating a normal exit, while a non-zero, such as 1, indicating an abnormal exit.

Using fail and exit

- Immediately following the call to open, check that the operation was successful:

```
#include <iostream>      // for cout
#include <fstream>       // for file I/O
using namespace std;
 …
in_stream.open("stuff.dat");
if (in_stream.fail( ))
  {
        cout << "Input file opening failed.\n";
        exit(1) ;
   }
```

Display 6.2

Appending Data (optional)

- Output examples so far create new files
  - If the output file already contains data, that data is lost
- To append new output to the end an existing file
  - use the constant ios::app defined in the iostream library:

    outStream.open("important.txt", *ios::app*);

  - If the file does not exist, a new file will be created

Display 6.3

File Names as Input (optional)

- Program users can enter the name of a file to use for input or for output
- Program must use a variable that can hold multiple characters
  - A sequence of characters is called a string
  - Declaring a variable to hold a string of characters:

```
char   file_name[16];
```

    - file_name is the name of a variable
    - Brackets enclose the maximum number of characters + 1
    - The variable file_name contains up to 15 characters

Using A Character String

```
char file_name[16];
cout << "Enter the file_name ";
cin >> file_name;
ifstream in_stream;
in_stream.open(file_name);
if (in_stream.fail( ))
{
        cout << "Input file opening failed.\n";
        exit(1);
}
```

Display 6.4 (1)

Display 6.4 (2)

Section 6.1 Conclusion

- Can you
  - Write a program that uses a stream called fin which will be connected to an input file and a stream called fout which will be connected to an output file? How do you declare fin and fout? What include directive, if any, do you nee to place in your program file?
  - Name at least three member functions of an iostream object and give examples of usage of each?

6.2

Tools for Streams I/O

Tools for Stream I/O

- To control the format of the program's output
  - We use commands that determine such details as:
    - The spaces between items
    - The number of digits after a decimal point
    - The numeric style: scientific notation for fixed point
    - Showing digits after a decimal point even if they are zeroes
    - Showing plus signs in front of positive numbers
    - Left or right justifying numbers in a given space

Formatting Real Numbers

- Real numbers (type double) produce a variety of outputs

```
double price = 78.5;
cout << "The price is $" << price << endl;
```

  - The output could be any of these:

    The price is $78.5
    The price is $78.500000
    The price is $7.850000e01

  - The most unlikely output is:

    The price is $78.50

Showing Decimal Places

- cout includes tools, i.e., member functions, to specify the output of type double

- To specify fixed point notation
  - setf(ios::fixed)
- To specify that the decimal point will always be shown
  - setf(ios::showpoint)
- To specify that two decimal places will always be shown
  - precision(2)

- Example:

```
cout.setf(ios::fixed);
cout.setf(ios::showpoint);
cout.precision(2);
cout    << "The price is "
        << price << endl;
```

- Shows 78.50

Formatting Output to Files

- Format output to the screen with:

```
cout.setf(ios::fixed);
cout.setf(ios::showpoint);
cout.precision(2);
```

- Format output to a file using the out-file stream named out_stream with:

```
out_stream.setf(ios::fixed);
out_stream.setf(ios::showpoint);
out_stream.precision(2);
```

out_stream.precision(2);

- precision is a member function of output streams
  - After out_stream.precision(2);
    Output of numbers with decimal points…
    - will show 2 digits after the decimal point

      23.56 2.26e7 2.21 0.69 0.69e-4
- Calls to precision apply only to the stream named in the call

setf(ios::fixed);

- setf is a member function of output streams
  - setf is an abbreviation for set flag
    - A flag is an instruction to do one of two options
    - ios::fixed is a flag
  - After out_stream.setf(ios::fixed);
    All further output of floating point numbers…
    - Will be written in fixed-point notation, the way we normally expect to see numbers
- Calls to setf apply only to the stream named in the call

setf(ios::showpoint);

- After out_stream.setf(ios::showpoint);

  Output of floating point numbers…

  - Will show the decimal point even if all digits after the decimal point are zeroes

Display 6.5

Display 6.5

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Formatting Flags for `setf`

Flag	Meaning	Default
`ios::fixed`	If this flag is set, floating-point numbers are not written in e-notation. (Setting this flag automatically unsets the flag `ios::scientific`.)	Not set
`ios::scientific`	If this flag is set, floating-point numbers are written in e-notation. (Setting this flag automatically unsets the flag `ios::fixed`.) If neither `ios::fixed` nor `ios::scientific` is set, then the system decides how to output each number.	Not set
`ios::showpoint`	If this flag is set, a decimal point and trailing zeros are always shown for floating-point numbers. If it is not set, a number with all zeros after the decimal point might be output without the decimal point and following zeros.	Not set
`ios::showpos`	If this flag is set, a plus sign is output before positive integer values.	Not set
`ios::right`	If this flag is set and some field-width value is given with a call to the member function `width`, then the next item output will be at the right end of the space specified by `width`. In other words, any extra blanks are placed *before* the item output. (Setting this flag automatically unsets the flag `ios::left`.)	Set
`ios::left`	If this flag is set and some field-width value is given with a call to the member function `width`, then the next item output will be at the left end of the space specified by `width`. In other words, any extra blanks are placed *after* the item output. (Setting this flag automatically unsets the flag `ios::right`.)	Not set

Creating Space in Output

- The width function specifies the number of spaces for the next item
  - Applies only to the next item of output (*non-sticky*)
- Example: To print the digit 7 in four spaces use

```
out_stream.width(4);
out_stream << 7 << endl;
```

  - Three of the spaces will be blank

(ios::right)

(ios::left)

Not Enough Width?

- What if the argument for width is too small?
  - Such as specifying

    cout.width(3);

    when the value to print is 3456.45
- The entire item is always output
  - If too few spaces are specified, as many more spaces as needed are used

Unsetting Flags

- Any flag that is set, may be unset
- Use the unsetf function
  - Example:

```
cout.unsetf(ios::showpos);
```

causes the program to stop printing plus signs on positive numbers

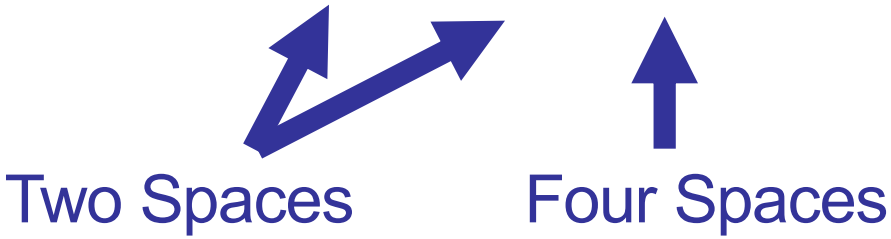
Manipulators

- A manipulator is a function called in a nontraditional way
  - Manipulators in turn call member functions
  - Manipulators may or may not have arguments
  - Used after the insertion operator (<<) as if the manipulator function call is an output item

The setw Manipulator

- setw does the same task as the member function width
  - setw calls the width function to set spaces for output
- Example: cout << "Start" << setw(4) << 10
  << setw(4) << 20 << setw(6) << 30;

produces: `Start  10  20    30`



The setprecision Manipulator

- setprecision does the same task as the member function precision

- Example:

```
cout.setf(ios::fixed | ios::showpoint);
cout << "$" << setprecision(2)
        << 10.3  << endl
        << "$" << 20.5 << endl;
```

produces:

```
$10.30
$20.50
```

  - setprecision setting stays in effect until changed, i.e., *sticky*

Manipulator Definitions

- The manipulators setw and setprecision are defined in the iomanip library
  - To use these manipulators, add these lines

```
#include <iomanip>
using namespace std;
```

Stream Names as Arguments

- Streams can be arguments to a function
  - The function's formal parameter for the stream must be call-by-reference

- Example:

```
void make_neat(ifstream& messy_file,
               ofstream&  neat_file);
```

The End of The File

- Input files used by a program may vary in length
  - Programs may not be able to assume the number of items in the file
- A way to know the end of the file is reached:
  - The boolean expression (in_stream >> next)
    - Reads a value from in_stream and stores it in next
    - True if a value can be read and stored in next
    - False if there is not a value to be read (the end of the file)

End of File Example

- To calculate the average of the numbers in a file
  -
```
double next, sum = 0;
int count = 0;
while (in_stream >> next)
{
        sum = sum + next;
        count++;
}

double average = sum / count;
```

Stream Arguments and Namespaces

- using directives have been local to function definitions in the examples so far
- When parameter type names are in a namespace
  - A using directive must be outside the function so C++ will understand the parameter type names such as ifstream
- Easy solution is to place the using directive at the beginning of the file
  - Many experts do not approve as this does not allow using multiple namespaces with names in common

Program Example

- The program in Display 6.6…
  - Takes input from rawdata.dat
  - Writes output to the screen and to neat.dat
    - Formatting instructions are used to create a neater layout
    - Numbers are written one per line in a field width of 12
    - Each number is written with 5 digits after the decimal point
    - Each number is written with a plus or minus sign
  - Uses function make_neat that has formal parameters for the input-file stream and output-file stream

Display 6.6 (1) Display 6.6 (2) Display 6.6 (3)

Display 6.6 (1/3)

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Formatting Output (*part 1 of 3*)

```
//Illustrates output formatting instructions.
//Reads all the numbers in the file rawdata.dat and writes the numbers
//to the screen and to the file neat.dat in a neatly formatted way.
#include <iostream>
#include <fstream>
#include <cstdlib>
#include <iomanip>
using namespace std;

void make_neat(ifstream& messy_file, ofstream& neat_file,
             int number_after_decimalpoint, int field_width);
//Precondition: The streams messy_file and neat_file have been connected
//to files using the function open.
//Postcondition: The numbers in the file connected to messy_file have been
//written to the screen and to the file connected to the stream neat_file.
//The numbers are written one per line, in fixed-point notation (that is, not in
//e-notation), with number_after_decimalpoint digits after the decimal point;
//each number is preceded by a plus or minus sign and each number is in a field of
//width field_width. (This function does not close the file.)

int main( )
{
    ifstream fin;
    ofstream fout;

    fin.open("rawdata.dat");
    if (fin.fail( ))
    {
        cout << "Input file opening failed.\n";
        exit(1);
    }

    fout.open("neat.dat");
    if (fout.fail( ))
    {
        cout << "Output file opening failed.\n";
        exit(1);
    }
```

Needed for setw

Stream parameters must be call-by-reference.

Formatting Output (*part 2 of 3*)

Display 6.6 (2/3)

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```
    make_neat(fin, fout, 5, 12);

    fin.close( );
    fout.close( );

    cout << "End of program.\n";
    return 0;
}


//Uses iostream, fstream, and iomanip:
void make_neat(ifstream& messy_file, ofstream& neat_file,
               int number_after_decimalpoint, int field_width)
{
    neat_file.setf(ios::fixed);          Not in e-notation
    neat_file.setf(ios::showpoint);      Show decimal point
    neat_file.setf(ios::showpos);        Show + sign
    neat_file.precision(number_after_decimalpoint);
    cout.setf(ios::fixed);
    cout.setf(ios::showpoint);
    cout.setf(ios::showpos);
    cout.precision(number_after_decimalpoint);

    double next;
    while (messy_file >> next)           Satisfied if there is a next number to read
    {
        cout << setw(field_width) << next << endl;
        neat_file << setw(field_width) << next << endl;
    }
}
```

Display 6.6 (3/3)

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Formatting Output (*part 3 of 3*)

rawdata.dat
(Not changed by program.)

```
10.37      -9.89897
2.313    -8.950   15.0

  7.33333    92.8765
-1.237568432e2
```

neat.dat
(After program is run.)

```
 +10.37000
  -9.89897
  +2.31300
  -8.95000
 +15.00000
  +7.33333
 +92.87650
-123.75684
```

Screen Output

```
 +10.37000
  -9.89897
  +2.31300
  -8.95000
 +15.00000
  +7.33333
 +92.87650
-123.75684
End of program.
```

Section 6.2 Conclusion

- Can you
  - Show the output produced when the following line
    is executed?

    ```
    cout << "*" << setw(3) << 12345 << "*" endl;
    ```

  - Describe the effect of each of these flags?

Ios::fixed	ios::scientific	ios::showpoint
ios::right	ios::right	ios::showpos

6.3

Character I/O

Character I/O

- All data is input and output as characters
  - Output of the number 10 is two characters '1' and '0'
  - Input of the number 10 is also done as '1' and '0'
  - Interpretation of 10 as the number 10 or as characters depends on the program
  - Conversion between characters and numbers is usually automatic
  - Or if you read in a character array with digits, you can call atoi() to convert the array to a number

```
char array[10] = “55”;
int num = atoi(array);
```

Low Level Character I/O

- Low level C++ functions for character I/O
  - Perform character input and output
  - Do not perform automatic conversions
  - Allow you to do input and output in anyway you can devise

Member Function get

- Function get
  - Member function of every input stream
  - Reads one character from an input stream
  - Stores the character read in a variable of type char, the single argument the function takes
  - Does not use the extraction operator (>>) which performs some automatic work
  - <u>Does not skip blanks</u>

Using get

- These lines use get to read a character and store it in the variable next_symbol

```
char next_symbol;
cin.get(next_symbol);
```

  - Any character will be read with these statements
    - Blank spaces too!
    - '\n' too! (The newline character)

  - End of line character(s) can be represented by
    - LF (linefeed): '\n', 0x0A
    - CR (carriage-return): '\r', 0x0D
    - Unix/Linux: LF
    - MS Windows: CR+LF

get Syntax

- input_stream.get(char_variable);

- Examples:

```
char  next_symbol;
cin.get(next_symbol);

ifstream  in_stream;
in_stream.open("infile.dat");
in_stream.get(next_symbol);
```

More About get

- Given this code:

```
char c1, c2, c3, c4;
cin.get(c1);
cin.get(c2);
cin.get(c3);
cin.get(c4);
```

and this input:

```
AB
CD
```

- c1 = 'A' c2 = 'B' c3 = '\n'
- On Linux: c4='C',
- On Windows (Notepad): c3='\r', c4='\n'
- `cin >> c1 >> c2 >> c3;` would place 'C' in c3 (the ">>" operator skips the newline character)

The End of The Line

- To read and echo a line of input
  - Look for '\n' at the end of the input line:

```
cout<<"Enter a line of input and I will "
        << "echo it.\n";
char symbol;
 do
 {
     cin.get(symbol);
     cout << symbol;
 } while (symbol != '\n');
```

  - All characters, including '\n' will be output

'\n ' vs "\n "

- '\n'
  - A value of type char
  - Can be stored in a variable of type char
- "\n"
  - A string containing only one character
  - Cannot be stored in a variable of type char

- In a cout statement they produce the same result

Member Function put

- Function put
  - Member function of every output stream
  - Requires one argument of type char
  - Places its argument of type char in the output stream
  - Does not allow you to do more than previous output with the insertion operator and cout

put Syntax

- output_stream.put(char_expression);

- Examples:

```
cout.put(next_symbol);
cout.put('a');

ofstream out_stream;
out_stream.open("outfile.dat");
out_stream.put('Z');
```

Member Function putback

- The putback member function places a character in the input stream
  - putback is a member function of every input stream
  - Useful when input continues until a specific character is read, but you do not want to process the character
  - Places its argument of type char in the input stream
  - Character placed in the stream does not have to be a character read from the stream
  - Putting more than one character back to the input stream does not work

putback Example

- The following code reads up to the first blank in the input stream fin, and writes the characters to the file connected to the output stream fout
  - ```
    fin.get(next);
    while (next != ' ')
    {
        fout.put(next);
        fin.get(next);
    }
    fin.putback(next);
    ```
  - The blank space read to end the loop is put back into the input stream
    ```

Program Example
Checking Input

- Incorrect input can produce worthless output
- Use input functions that allow the user to re-enter input until it is correct, such as
  - Echoing the input and asking the user if it is correct
  - If the input is not correct, allow the user to enter the data again

Checking Input: get_int

- The get_int function seen in Display 6.7 obtains an integer value from the user
  - get_int prompts the user, reads the input, and displays the input
  - After displaying the input, get_int asks the user to confirm the number and reads the user's response using a variable of type character
  - The process is repeated until the user indicates with a 'Y' or 'y' that the number entered is correct

Checking Input: new_line

- The new_line function seen in Display 6.7 is called by the get_int function
  - new_line reads all the characters remaining in the input line but does nothing with them, essentially discarding them
  - new_line is used to discard what follows the first character of the the user's response to get_line's "Is that correct? (yes/no)"
    - The newline character is discarded as well

Display 6.7 (1)

Display 6.7 (2)

Checking Input (*part 1 of 2*)

Display 6.7 (1/2)

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```
//Program to demonstrate the functions new_line and get_input.
#include <iostream>
using namespace std;

void new_line( );
//Discards all the input remaining on the current input line.
//Also discards the '\n' at the end of the line.
//This version only works for input from the keyboard.

void get_int(int& number);
//Postcondition: The variable number has been
//given a value that the user approves of.


int main( )
{
    int n;

    get_int(n);
    cout << "Final value read in = " << n << endl
         << "End of demonstration.\n";
    return 0;
}


//Uses iostream:
void new_line( )
{
    char symbol;
    do
    {
        cin.get(symbol);
    } while (symbol != '\n');
}
```

Skipping characters until new line

Display 6.7 (2/2)

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Checking Input (*part 2 of 2*)

```
//Uses iostream:
void get_int(int& number)
{
    char ans;
    do
    {
        cout << "Enter input number: ";
        cin >> number;
        cout << "You entered " << number
             << " Is that correct? (yes/no): ";
        cin >> ans;
        new_line( );
    } while ((ans != 'Y') && (ans != 'y'));
}
```

Sample Dialogue

```
Enter input number: 57
You entered 57 Is that correct? (yes/no): No
Enter input number: 75
You entered 75 Is that correct? (yes/no): yes
Final value read in = 75
End of demonstration.
```

Inheritance and Output

- ostream is the class of all output streams
  - cout is of type ostream
- ofstream is the class of output-file streams
  - The ofstream class is a **child** class of ostream
  - More about this in Chapter 10
  - This function can be called with ostream or ofstream arguments

```
void say_hello(ostream& any_out_stream)
{
        any_out_stream << "Hello";
}
```

Program Example: Another new_line Function

- The new_line function from Display 6.7 only works with cin
- This version works for any input stream

```
void new_line(istream& in_stream)
{
        char symbol;
        do
        {
            in_stream.get(symbol);
        } while (symbol != '\n');
}
```

Program Example: Calling new_line

- The new version of new_line can be called with cin as the argument

```
new_line(cin);
```

  - If the original version of new_line is kept in the program, this call produces the same result

```
new_line( );
```

- New_line can also be called with an input-file stream fin as an argument

```
new_line(fin);
```

Default Arguments

- It is not necessary to have two versions of the new_line function
  - A default value can be specified in the parameter list
  - The default value is selected if no argument is available for the parameter
- The new_line header can be written as

  new_line (istream & in_stream = cin)

  - If new_line is called without an argument, cin is used

Multiple Default Arguments

- When some formal parameters have default values and others do not
  - All formal parameters with default values must be at the end of the parameter list
  - Arguments are applied to the all formal parameters in order just as we have seen before
  - The function call must provide at least as many arguments as there are parameters without default values

Default Argument Example

- void default_args(int arg1, int arg2 = -3)
  {
  cout << arg1 << ' ' << arg2 << endl;
  }
- default_args can be called with one or two parameters

```
default_args(5);       //output is   5   -3
default_args(5, 6);    //output is   5   6
```

Mixing cin >> and cin.get

- Be sure to deal with the '\n' that ends each input line if using cin >> and cin.get
  - "cin >>" reads up to the '\n'
  - The '\n' remains in the input stream
  - Using cin.get next will read the '\n'
  - The new_line function from Display 6.7 can be used to clear the '\n'

'\n' Example

- The Code:

```
cout << "Enter a number:\n";
int number;
cin >> number;
cout << "Now enter a letter:\n";
char symbol;
cin.get(symbol);
```

The Dialogue:

Enter a number:
21
Now enter a letter:
A

The Result:

number = 21

symbol = '\n'

A Fix To Remove '\n'

- ```
  cout << "Enter a number:\n";
  int number;
  cin >> number;
  cout << "Now enter a letter:\n";
  char symbol;
  cin >>symbol;
  ```
  ```

Another '\n' Fix

- ```
  cout << "Enter a number:\n";
  int number;
  cin >> number;
  new_line( ); // From Display 6.7
  cout << "Now enter a letter:\n";
  char symbol;
  cin.get(symbol);
  ```
  ```

Detecting the End of a File

- Member function eof detects the end of a file
  - Member function of every input-file stream
  - eof stands for end of file
  - eof returns a boolean value
    - True when the end of the file has been reached
    - False when there is more data to read
  - Normally used to determine when we are NOT at the end of the file
    - Example: `if ( ! in_stream.eof( ) )`

Using eof

- This loop reads each character, and writes it to the screen
-

```
in_stream.get(next);
while (! in_stream.eof( ) )
{
        cout << next;
        in_stream.get(next);
}
```

- (! in_stream.eof( )) becomes false when the program reads past the last character in the file

The End Of File Character

- End of a file is indicated by a special character
- in_stream.eof( ) is false after the last character of data is read
- in_stream.eof( ) becomes true when the special end of file character is read

How To Test End of File

- We have seen two methods
  - while (in_stream >> next)
  - while (! in_stream.eof( ))
- Which should be used?
  - In general, use eof when input is treated as text and using a member function get to read input
  - In general, use the extraction operator (>>) method when processing numeric data

Program Example: Editing a Text File

- The program of Display 6.8…
  - Reads every character of file cad.dat and copies it to file cplusad.dat except that every 'C' is changed to "C++" in cplusad.dat
  - Preserves line breaks in cad.dat
    - get is used for input as the extraction operator would skip line breaks
    - get is used to preserve spaces as well
  - Uses eof to test for end of file

Display 6.8 (1)

Display 6.8 (2)

Character Functions

- Several predefined functions exist to facilitate working with characters
- The cctype library is required
  - #include <cctype>
    using namespace std;

The toupper Function

- toupper returns the argument's upper case character
  - toupper('a') returns 'A'
  - toupper('A') return 'A'

The isspace Function

- isspace returns true if the argument is whitespace
  - Whitespace is spaces ‘ ‘, tabs ‘\t’, and newlines ‘\n’
  - isspace(' ') returns true
  - Example:

```
if (isspace(next) )
    cout << '-';
else
    cout << next;
```

  - Prints a '-' if next contains a space, tab, or newline character
- See more character functions in

Display 6.9 (1)

Display 6.9 (2)

Display 6.9 (2/2)

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Some Predefined Character Functions in cctype (*part 2 of 2*)

Function	Description	Example

`isupper(Char_Exp)`	Returns *true* provided *Char_Exp* is an uppercase letter; otherwise, returns *false*.	`if (isupper(c))`
		`  cout << c << " is uppercase.";`
		`else`
		`  cout << c`
		`  << " is not uppercase.";`

`islower(Char_Exp)`	Returns *true* provided *Char_Exp* is a lowercase letter; otherwise, returns *false*.	`char c = 'a';`
		`if (islower(c))`
		`  cout << c << " is lowercase.";`
		`Outputs: a is lowercase.`

`isalpha(Char_Exp)`	Returns *true* provided *Char_Exp* is a letter of the alphabet; otherwise, returns *false*.	`char c = '$';`
		`if (isalpha(c))`
		`  cout << c << " is a letter.";`
		`else`
		`  cout << c`
		`  << " is not a letter.";`
		`Outputs: $ is not a letter.`

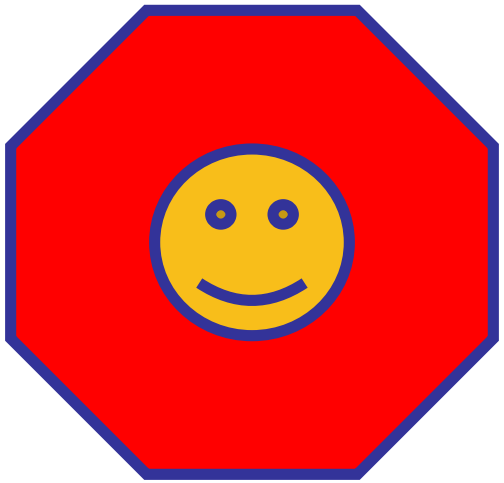
`isdigit(Char_Exp)`	Returns *true* provided *Char_Exp* is one of the digits '0' through '9'; otherwise, returns *false*.	`if (isdigit('3'))`
		`  cout << "It's a digit.";`
		`else`
		`  cout << "It's not a digit.";`
		`Outputs: It's a digit.`

`isspace(Char_Exp)`	Returns *true* provided *Char_Exp* is a whitespace character, such as the blank or newline symbol; otherwise, returns *false*.	`//Skips over one "word" and`
		`//sets c equal to the first`
		`//whitespace character after`
		`//the "word":`
		`do`
		`{`
		`  cin.get(c);`
		`} while (! isspace(c));`

Section 6.3 Conclusion

- Can you
  - Write code that will read a line of text and echo the line with all the uppercase letters deleted?
  - Describe two methods to detect the end of an input file:
  - Describe whitespace?

Chapter 6 -- End



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File I/O with Checks on open

```
//Reads three numbers from the file infile.dat, sums the numbers,
//and writes the sum to the file outfile.dat.
#include <fstream>
#include <iostream>
#include <cstdlib>

int main( )
{
    using namespace std;
    ifstream in_stream;
    ofstream out_stream;

    in_stream.open("infile.dat");
    if (in_stream.fail( ))
    {
        cout << "Input file opening failed.\n";
        exit(1);
    }

    out_stream.open("outfile.dat");
    if (out_stream.fail( ))
    {
        cout << "Output file opening failed.\n";
        exit(1);
    }

    int first, second, third;
    in_stream >> first >> second >> third;
    out_stream << "The sum of the first 3\n"
               << "numbers in infile.dat\n"
               << "is " << (first + second + third)
               << endl;

    in_stream.close( );
    out_stream.close( );

    return 0;
}
```

Screen Output (If the file `infile.dat` does not exist)

```
Input file opening failed.
```

Appending to a File (*Optional*)

```
//Appends data to the end of the file data.txt.
#include <fstream>
#include <iostream>

int main( )
{
    using namespace std;

    cout << "Opening data.txt for appending.\n";
    ofstream fout;
    fout.open("data.txt", ios::app);
    if (fout.fail( ))
    {
        cout << "Input file opening failed.\n";
        exit(1);
    }

    fout << "5 6 pick up sticks.\n"
         << "7 8 ain't C++ great!\n";

    fout.close( );
    cout << "End of appending to file.\n";

   return 0;
}
```

Sample Dialogue

data.txt
(Before program is run.)

```
1 2 bucket my shoe.
3 4 shut the door.
```

data.txt
(After program is run.)

```
1 2 bucket my shoe.
3 4 shut the door.
5 6 pick up sticks.
7 8 ain't C++ great!
```

Screen Output

```
Opening data.txt for appending.
End of appending to file.
```

Display 6.3

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Display 6.4 (1/2)

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Inputting a File Name (*Optional*) (*part 1 of 2*)

```
//Reads three numbers from the file specified by the user, sums the numbers,
//and writes the sum to another file specified by the user.
#include <fstream>
#include <iostream>
#include <cstdlib>

int main( )
{
    using namespace std;
    char in_file_name[16], out_file_name[16];
    ifstream in_stream;
    ofstream out_stream;

    cout << "I will sum three numbers taken from an input\n"
         << "file and write the sum to an output file.\n";
    cout << "Enter the input file name (maximum of 15 characters):\n";
    cin >> in_file_name;
    cout << "Enter the output file name (maximum of 15 characters):\n";
    cin >> out_file_name;
    cout << "I will read numbers from the file "
         << in_file_name << " and\n"
         << "place the sum in the file "
         << out_file_name << endl;

    in_stream.open(in_file_name);
    if (in_stream.fail( ))
    {
        cout << "Input file opening failed.\n";
        exit(1);
    }

    out_stream.open(out_file_name);
    if (out_stream.fail( ))
    {
        cout << "Output file opening failed.\n";
        exit(1);
    }
```

Display 6.4 (2/2)

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Inputting a File Name (*Optional*) (*part 2 of 2*)

```
    int first, second, third;
    in_stream >> first >> second >> third;
    out_stream << "The sum of the first 3\n"
               << "numbers in " << in_file_name << endl
               << "is " << (first + second + third)
               << endl;

    in_stream.close( );
    out_stream.close( );

    cout << "End of Program.\n";
    return 0;
}
```

numbers.dat
(Not changed by program.)

```
1
2
3
4
```

sum.dat
(After program is run.)

```
The sum of the first 3
numbers in numbers.dat
is 6
```

Sample Dialogue

```
I will sum three numbers taken from an input
file and write the sum to an output file.
Enter the input file name (maximum of 15 characters):
numbers.dat
Enter the output file name (maximum of 15 characters):
sum.dat
I will read numbers from the file numbers.dat and
place the sum in the file sum.dat
End of Program.
```

Editing a File of Text (*part 1 of 2*)

Display 6.8 (1/2)

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```
//Program to create a file called cplusad.dat that is identical to the file
//cad.dat, except that all occurrences of 'C' are replaced by "C++".
//Assumes that the uppercase letter 'C' does not occur in cad.dat except
//as the name of the C programming language.

#include <fstream>
#include <iostream>
#include <cstdlib>
using namespace std;

void add_plus_plus(ifstream& in_stream, ofstream& out_stream);
//Precondition: in_stream has been connected to an input file with open.
//out_stream has been connected to an output file with open.
//Postcondition: The contents of the file connected to in_stream have been
//copied into the file connected to out_stream, but with each 'C' replaced
//by "C++". (The files are not closed by this function.)

int main( )
{
    ifstream fin;
    ofstream fout;

    cout << "Begin editing files.\n";

    fin.open("cad.dat");
    if (fin.fail( ))
    {
        cout << "Input file opening failed.\n";
        exit(1);
    }

    fout.open("cplusad.dat");
    if (fout.fail( ))
    {
        cout << "Output file opening failed.\n";
        exit(1);
    }

    add_plus_plus(fin, fout);
```

Display 6.8 (2/2)

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Editing a File of Text (*part 2 of 2*)

```
    fin.close( );
    fout.close( );

    cout << "End of editing files.\n";
    return 0;
}

void add_plus_plus(ifstream& in_stream, ofstream& out_stream)
{
    char next;

    in_stream.get(next);
    while (! in_stream.eof( ))
    {
        if (next == 'C')
            out_stream << "C++";
        else
            out_stream << next;

        in_stream.get(next);
    }
}
```

cad.dat

(Not changed by program.)

```
C is one of the world's most modern
programming languages. There is no
language as versatile as C, and C
is fun to use.
```

cplusad.dat

(After program is run.)

```
C++ is one of the world's most modern
programming languages. There is no
language as versatile as C++, and C++
is fun to use.
```

Screen Output

```
Begin editing files.
End of editing files.
```

Display 6.9 (1/2)

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Some Predefined Character Functions in `cctype` (*part 1 of 2*)

Function	Description	Example

`toupper(`*Char_Exp*`)`	Returns the upper-case version of *Char_Exp*.	`char c = toupper('a');`
		`cout << c;`
		Outputs: A

`tolower(`*Char_Exp*`)`	Returns the lower-case version of *Char_Exp*.	`char c = tolower('A');`
		`cout << c;`
		Outputs: a