Input/output

Victor Eijkhout, Harika Gurram,
Je'aime Powell, Charley Dey

Fall 2018

Formatted output

Formatted output

- `cout` uses default formatting
- Possible: pad a number, use limited precision, format as hex/base2, etc
- Many of these output modifiers need

```
#include <iomanip>
```

Default unformatted output

Code:

```
for (int i=1; i<200000000; i*=10)
  cout << "Number: " << i << endl;
cout << endl;
```

Output:

```
Number: 1
Number: 10
Number: 100
Number: 1000
Number: 10000
Number: 100000
Number: 1000000
Number: 10000000
Number: 100000000
```

Reserve space

You can specify the number of positions, and the output is right aligned in that space by default:

Code:

```
 cout << "Width is 6:" << endl;
 for (int i=1; i<200000000; i*=10)
   cout << "Number: "
<< setw(6) << i << endl;
 cout << endl;
 cout << "Width is 6:" << endl;
 cout << setw(6) << 1 << 2 << 3 << endl;
 cout << endl;
```

Output:

```
Width is 6:
Number:      1
Number:     10
Number:    100
Number:   1000
Number:  10000
Number: 100000
Number: 1000000
Number: 10000000
Number: 100000000

Width is 6:
     123
```

Padding character

Normally, padding is done with spaces, but you can specify other characters:

Code:

```
#include <iomanip>
using std::setfill;
using std::setw;
//codesnippet formatpad
  /* ... */

int main() {

  //codesnippet formatpad
  /* ... */
  for (int i=1; i<200000000; i*=10)
    cout << "Number: "
         << setfill('.') << setw(6) << i
 << endl;
```

Output:

```
Number: .....1
Number: ....10
Number: ...100
Number: ..1000
Number: .10000
Number: 100000
Number: 1000000
Number: 10000000
Number: 100000000
```

Note: single quotes denote characters, double quotes denote strings.

Left alignment

Instead of right alignment you can do left:

Code:

```
#include <iomanip>
using std::left;
using std::setfill;
using std::setw;
  /* ... */
  for (int i=1; i<200000000; i*=10)
    cout << "Number: "
         << left << setfill('.') << setw(6)
 << i << endl;
```

Output:

```
Number: 1.....
Number: 10....
Number: 100...
Number: 1000..
Number: 10000.
Number: 100000
Number: 1000000
Number: 10000000
Number: 100000000
```

Number base

Finally, you can print in different number bases than 10:

Code:

```
#include <iomanip>
using std::setbase;
using std::setfill;
  /* ... */
  cout << setbase(16) << setfill(' ');
  for (int i=0; i<16; i++) {
    for (int j=0; j<16; j++)
      cout << i*16+j << " " ;
    cout << endl;
  }
```

Output:

```
0 1 2 3 4 5 6 7 8 9 a b c d e f
10 11 12 13 14 15 16 17 18 19 1a 1b 1c 1d 1e 1f
20 21 22 23 24 25 26 27 28 29 2a 2b 2c 2d 2e 2f
30 31 32 33 34 35 36 37 38 39 3a 3b 3c 3d 3e 3f
40 41 42 43 44 45 46 47 48 49 4a 4b 4c 4d 4e 4f
50 51 52 53 54 55 56 57 58 59 5a 5b 5c 5d 5e 5f
60 61 62 63 64 65 66 67 68 69 6a 6b 6c 6d 6e 6f
70 71 72 73 74 75 76 77 78 79 7a 7b 7c 7d 7e 7f
80 81 82 83 84 85 86 87 88 89 8a 8b 8c 8d 8e 8f
90 91 92 93 94 95 96 97 98 99 9a 9b 9c 9d 9e 9f
a0 a1 a2 a3 a4 a5 a6 a7 a8 a9 aa ab ac ad ae af
b0 b1 b2 b3 b4 b5 b6 b7 b8 b9 ba bb bc bd be bf
c0 c1 c2 c3 c4 c5 c6 c7 c8 c9 ca cb cc cd ce cf
d0 d1 d2 d3 d4 d5 d6 d7 d8 d9 da db dc dd de df
e0 e1 e2 e3 e4 e5 e6 e7 e8 e9 ea eb ec ed ee ef
f0 f1 f2 f3 f4 f5 f6 f7 f8 f9 fa fb fc fd fe ff
```

Exercise 1

Code:

```
#include <iomanip>
using std::right;
using std::setbase;
using std::setfill;
using std::setw;
  /* ... */
  cout << setbase(16) << setfill('0') << right ;
  for (int i=0; i<16; i++) {
    for (int j=0; j<16; j++)
      cout << setw(2) << i*16+j << " " ;
    cout << endl;
  }
```

Output:

```
Block16:
00 01 02 03 04 05 06 07 08 09 0a 0b 0c 0d 0e 0f
10 11 12 13 14 15 16 17 18 19 1a 1b 1c 1d 1e 1f
20 21 22 23 24 25 26 27 28 29 2a 2b 2c 2d 2e 2f
30 31 32 33 34 35 36 37 38 39 3a 3b 3c 3d 3e 3f
40 41 42 43 44 45 46 47 48 49 4a 4b 4c 4d 4e 4f
50 51 52 53 54 55 56 57 58 59 5a 5b 5c 5d 5e 5f
60 61 62 63 64 65 66 67 68 69 6a 6b 6c 6d 6e 6f
70 71 72 73 74 75 76 77 78 79 7a 7b 7c 7d 7e 7f
80 81 82 83 84 85 86 87 88 89 8a 8b 8c 8d 8e 8f
90 91 92 93 94 95 96 97 98 99 9a 9b 9c 9d 9e 9f
a0 a1 a2 a3 a4 a5 a6 a7 a8 a9 aa ab ac ad ae af
b0 b1 b2 b3 b4 b5 b6 b7 b8 b9 ba bb bc bd be bf
c0 c1 c2 c3 c4 c5 c6 c7 c8 c9 ca cb cc cd ce cf
d0 d1 d2 d3 d4 d5 d6 d7 d8 d9 da db dc dd de df
e0 e1 e2 e3 e4 e5 e6 e7 e8 e9 ea eb ec ed ee ef
f0 f1 f2 f3 f4 f5 f6 f7 f8 f9 fa fb fc fd fe ff
```

Exercise 2

Use integer output to print fixed point numbers aligned on the decimal:

```
  1.345
 23.789
456.1234
```

Use four spaces for both the integer and fractional part.

Hexadecimal

Hex output is useful for pointers (chapter **??**):

```
int i;
cout << "address of i, decimal: "
     << (long)&i << endl;
cout << "address if i, hex    : "
     << std::hex << &i << endl;
```

Back to decimal:

```
cout << hex << i << dec << j;
```

Floating point formatting

Floating point precision

Use `setprecision` to set the number of digits before and after decimal point:

Code:

```
#include <iomanip>
using std::left;
using std::setfill;
using std::setw;
using std::setprecision;
  /* ... */
  x = 1.234567;
  for (int i=0; i<10; i++) {
    cout << setprecision(4) << x << endl;
    x *= 10;
  }
```

Output:

```
1.235
12.35
123.5
1235
1.235e+04
1.235e+05
1.235e+06
1.235e+07
1.235e+08
1.235e+09
```

(Notice the rounding)

Output

```
1.235
12.35
123.5
1235
1.235e+04
1.235e+05
1.235e+06
1.235e+07
1.235e+08
1.235e+09
```

(Notice the rounding)

Fixed point precision

Fixed precision applies to fractional part:

Code:

```
x = 1.234567;
cout << fixed;
for (int i=0; i<10; i++) {
  cout << setprecision(4) << x << endl;
  x *= 10;
}
```

Output:

```
1.2346
12.3457
123.4567
1234.5670
12345.6700
123456.7000
1234567.0000
12345670.0000
123456700.0000
1234567000.0000
```

Aligned fixed point output

Combine width and precision:

Code:

```
x = 1.234567;
cout << fixed;
for (int i=0; i<10; i++) {
  cout << setw(10) << setprecision(4) << x
<< endl;
  x *= 10;
}
```

Output:

```
    1.2346
   12.3457
  123.4567
 1234.5670
12345.6700
123456.7000
1234567.0000
12345670.0000
123456700.0000
1234567000.0000
```

Scientific notation

```
cout << "Combine width and precision:" << endl;
x = 1.234567;
cout << scientific;
for (int i=0; i<10; i++) {
  cout << setw(10) << setprecision(4) << x << endl;
  x *= 10;
}
```

Output

```
Combine width and precision:
1.2346e+00
1.2346e+01
1.2346e+02
1.2346e+03
1.2346e+04
1.2346e+05
1.2346e+06
1.2346e+07
1.2346e+08
1.2346e+09
```

File output

Text output to file

Streams are general: work the same for console out and file out.

```
#include <fstream>
```

Use:

```
#include <fstream>
using std::ofstream;
  /* ... */
  ofstream file_out;
  file_out.open("fio_example.out");
  /* ... */
  file_out << number << endl;
  file_out.close();
```

Binary output

```
ofstream file_out;
file_out.open
  ("fio_binary.out",ios::binary);
/* ... */
file_out.write( (char*)(&number),4);
```