Chapter 2
Computer Arithmetic (Part 1)

Arithmetic in various Number Systems

- Addition of numbers in any number system
  - Add numbers starting at the least significant digit.
  - Perform addition on numbers of the same number base.
- Subtraction of numbers
  - Must use complements

Binary Addition

- To add binary numbers: (X + Y)
  - Get the SCR of the negative numbers
  - Add the two numbers
  - If the SCR used is:
    - 2's C: Discard end carry
    - 1's C: Add the end carry to the sum

Example: Binary Addition

- Add the following numbers. Use 8 bits to represent each number.
  - 6 + 13
  - 6 + (–13)
  - (–6) + 13
  - (–6) + (–13)

Example: Binary Addition

- 6 + 13 = 19

Example: Binary Addition

- 6 + 13 = 19

  0 0000110

Example: Binary Addition

- 6 + 13 = 19

```
  0 0000110
+ 0 0001101
-----------
```

Example: Binary Addition

- 6 + 13 = 19

$$
\begin{array}{r}
0\ 0000110 \\
+\ 0\ 0001101 \\
\hline
0\ 0010011
\end{array}
$$

Example: Binary Addition

- $6 + 13 = 19$

$$
\begin{array}{r}
0\ 0000110 \\
+\ 0\ 0001101 \\
\hline
0\ 0010011
\end{array}
$$

- $6 + (-13) = -7$

Example: Binary Addition

- $6 + 13 = 19$

$$
\begin{array}{r}
0\ 0000110 \\
+\ 0\ 0001101 \\
\hline
0\ 0010011
\end{array}
$$

- $6 + (-13) = -7$

$$0\ 0000110$$

Example: Binary Addition

- $6 + 13 = 19$

$$
\begin{array}{r}
0\ 0000110 \\
+\ 0\ 0001101 \\
\hline
0\ 0010011
\end{array}
$$

- $6 + (-13) = -7$

$$0\ 0000110$$

(1's)

Example: Binary Addition

- $6 + 13 = 19$

$$\begin{array}{r} 0\ 0000110 \\ +\ 0\ 0001101 \\ \hline 0\ 0010011 \end{array}$$

- $6 + (-13) = -7$

$$\begin{array}{r} 0\ 0000110 \\ +\ 1\ 1110010 \text{ (1's)} \\ \hline \end{array}$$

Example: Binary Addition

- $6 + 13 = 19$

$$\begin{array}{r} 0\ 0000110 \\ +\ 0\ 0001101 \\ \hline 0\ 0010011 \end{array}$$

- $6 + (-13) = -7$

$$\begin{array}{r} 0\ 0000110 \\ +\ 1\ 1110010 \quad \text{(1's)} \\ \hline 1\ 1111000 \end{array}$$

Example: Binary Addition

- (–6) + 13 = 7

  1 1111010 (2's)

Example: Binary Addition

- (–6) + 13 = 7

1 1111010 (2's)

+ 0 0001101

Example: Binary Addition

- (–6) + 13 = 7

$$\begin{array}{r} 1\ 1111010 \quad (2\text{'s}) \\ +\ 0\ 0001101 \\ \hline 10\ 0000111 \end{array}$$

Example: Binary Addition

- $(-6) + 13 = 7$

$$
\begin{array}{r}
1\ 1111010 \quad (2\text{'s}) \\
+\ 0\ 0001101 \\
\hline
10\ 0000111
\end{array}
$$

Example: Binary Addition

- $(-6) + 13 = 7$

$$\begin{array}{r} 1\ 1111010 \quad (2\text{'s}) \\ +\ 0\ 0001101 \\ \hline 10\ 0000111 \end{array}$$

- $(-6)+(-13) = -19$

Example: Binary Addition

- $(-6) + 13 = 7$

$$
\begin{array}{r}
1\ 1111010 \quad (2\text{'s}) \\
+\ 0\ 0001101 \\
\hline
10\ 0000111
\end{array}
$$

- $(-6)+(-13) = -19$

$$
1\ 1111010 \quad (2\text{'s})
$$

Example: Binary Addition

- $(-6) + 13 = 7$

$$\begin{array}{rl} & 1\ 1111010 \quad (2\text{'s}) \\ + & 0\ 0001101 \\ \hline & 10\ 0000111 \end{array}$$

- $(-6)+(-13) = -19$

$$\begin{array}{rl} & 1\ 1111010 \quad (2\text{'s}) \\ + & 1\ 1110011 \quad (2\text{'s}) \\ \hline & \end{array}$$

Example: Binary Addition

- $(-6) + 13 = 7$

$$\begin{array}{r} 1\ 1111010 \quad (2\text{'s}) \\ +\ 0\ 0001101 \\ \hline 10\ 0000111 \end{array}$$

- $(-6)+(-13) = -19$

$$\begin{array}{r} 1\ 1111010 \quad (2\text{'s}) \\ +\ 1\ 1110011 \quad (2\text{'s}) \\ \hline 11\ 1101101 \end{array}$$

Example: Binary Addition

- $(-6) + 13 = 7$

$$\begin{array}{r} 1\ 1111010 \quad (2\text{'s}) \\ +\ 0\ 0001101 \\ \hline \cancel{1}0\ 0000111 \end{array}$$

- $(-6)+(-13) = -19$

$$\begin{array}{r} 1\ 1111010 \quad (2\text{'s}) \\ +\ 1\ 1110011 \quad (2\text{'s}) \\ \hline \cancel{1}1\ 1101101 \end{array}$$

Examples: Addition

- $(999.5 + 281.6)_{10}$

$$\begin{array}{r} {\scriptstyle 1\ \ 1\ \ 1\ \ } \\ 999.5 \\ +\ \ 281.6 \\ \hline 1281.1 \end{array}$$

Examples: Addition

- $(999.5 + 281.6)_{10}$

```
  1 1 1
   999.5
+  281.6
-------
  1281.1
```

- $(110.11 + 1010.11)_2$

```
   110.11
+ 1010.11
---------
 10001.10
```

Examples: Addition

- $(355.4 + 240.61)_8$

$$\begin{array}{rr} & 355.4 \\ + & 240.61 \\ \hline \end{array}$$

Examples: Addition

- $(355.4 + 240.61)_8$

$$\begin{array}{rr} & 355.4 \\ + & 240.61 \\ \hline & 616.21 \end{array}$$

Examples: Addition

- $(355.4 + 240.61)_8$

$$\begin{array}{r} 355.4 \\ +\ 240.61 \\ \hline 616.21 \end{array}$$

- $(A0C.D + E72.9)_{16}$

$$\begin{array}{r} A0C.D \\ +\ E72.9 \\ \hline \end{array}$$

Examples: Addition

- $(355.4 + 240.61)_8$

$$\begin{array}{r} 355.4 \\ +\ 240.61 \\ \hline 616.21 \end{array}$$

- $(A0C.D + E72.9)_{16}$

$$\begin{array}{r} A0C.D \\ +\ E72.9 \\ \hline 187F.6 \end{array}$$