

Binary!

$$1209_{[10]} = 1 \times 10^3 + 2 \times 10^2 + 0 \times 10^1 + 9 \times 10^0$$

$$100101_{[2]} = 1 \times 2^5 + 0 \times 2^4 + 0 \times 2^3 + 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0$$

$$(b_{n-1} b_{n-2} \dots b_1 b_0)_{[2]} = b_{n-1} \times 2^{n-1} + b_{n-2} \times 2^{n-2} + \dots \\ + b_2 \times 2^2 + b_1 \times 2^1 + b_0 \times 2^0$$

$$= 2 \times (b_{n-1} \times 2^{n-2} + b_{n-2} \times 2^{n-3} + \dots + b_2 \times 2^1 + b_1 \times 2^0) + b_0$$

$$= 2 \times (2 \times (b_{n-1} \times 2^{n-3} + b_{n-2} \times 2^{n-4} + \dots + b_2 \times 2^0) + b_1) + b_0$$

$$= 2 \times (2 \times (2 \times (\dots (2 \times b_{n-1} + b_{n-2}) + \dots) + b_2) + b_1) + b_0$$

Modular arithmetic

$$\begin{array}{r} 11\ 1\ 1 \\ 01101010 \\ + 10101010 \\ \hline 100010100 \end{array} \quad \begin{array}{l} (106) \\ (170) \\ (276) \end{array}$$

$$\begin{array}{r} 01101010 \\ \times 10101010 \\ \hline 00000000 \\ 01101010 \\ 00000000 \\ 01101010 \\ 00000000 \\ 01101010 \\ 00000000 \\ + 01101010 \\ \hline 100011001100100 \end{array} \quad \begin{array}{l} (106) \\ (170) \\ \\ \\ \\ \\ \\ \\ \\ (18020) \end{array}$$

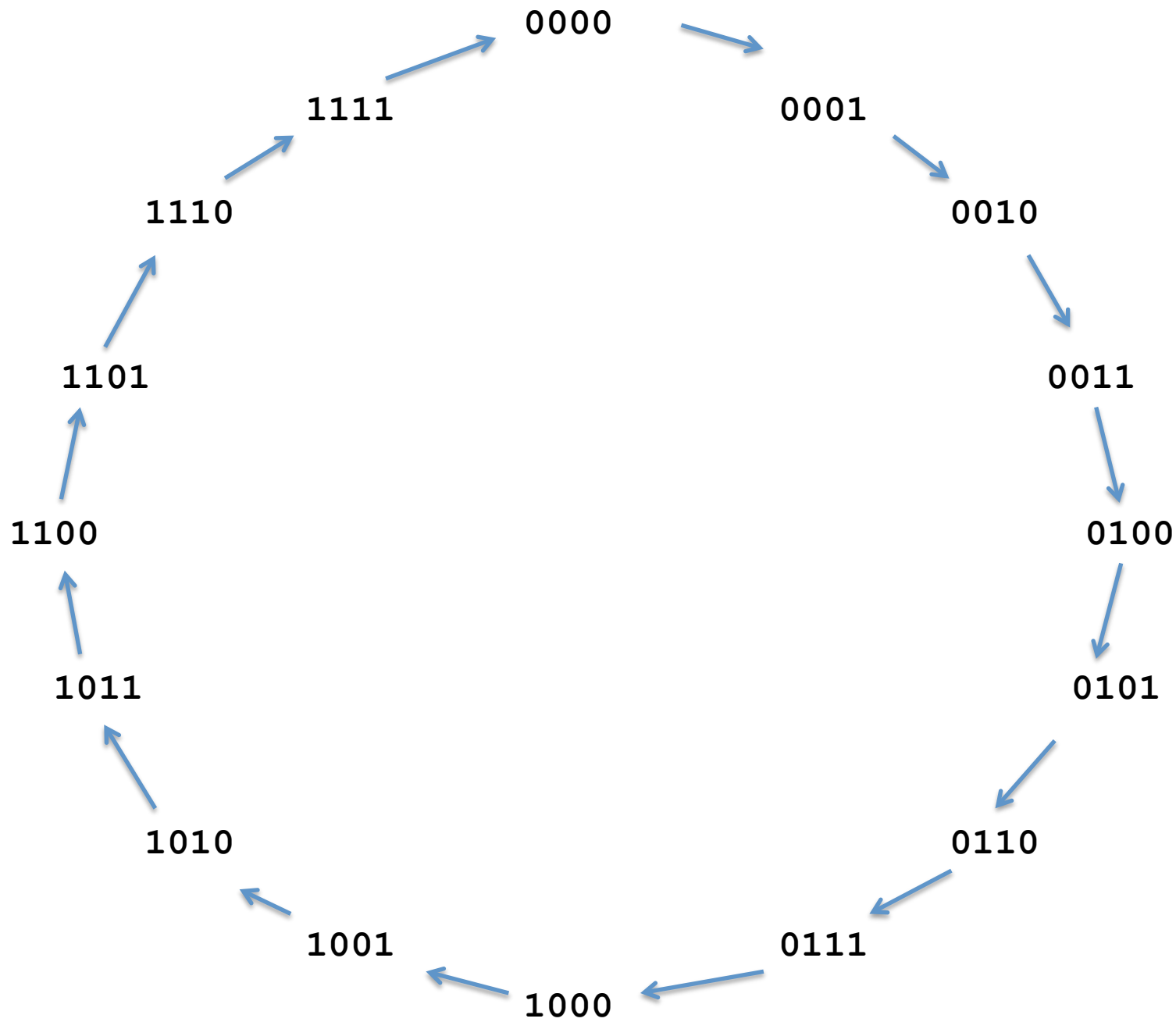
Modular arithmetic

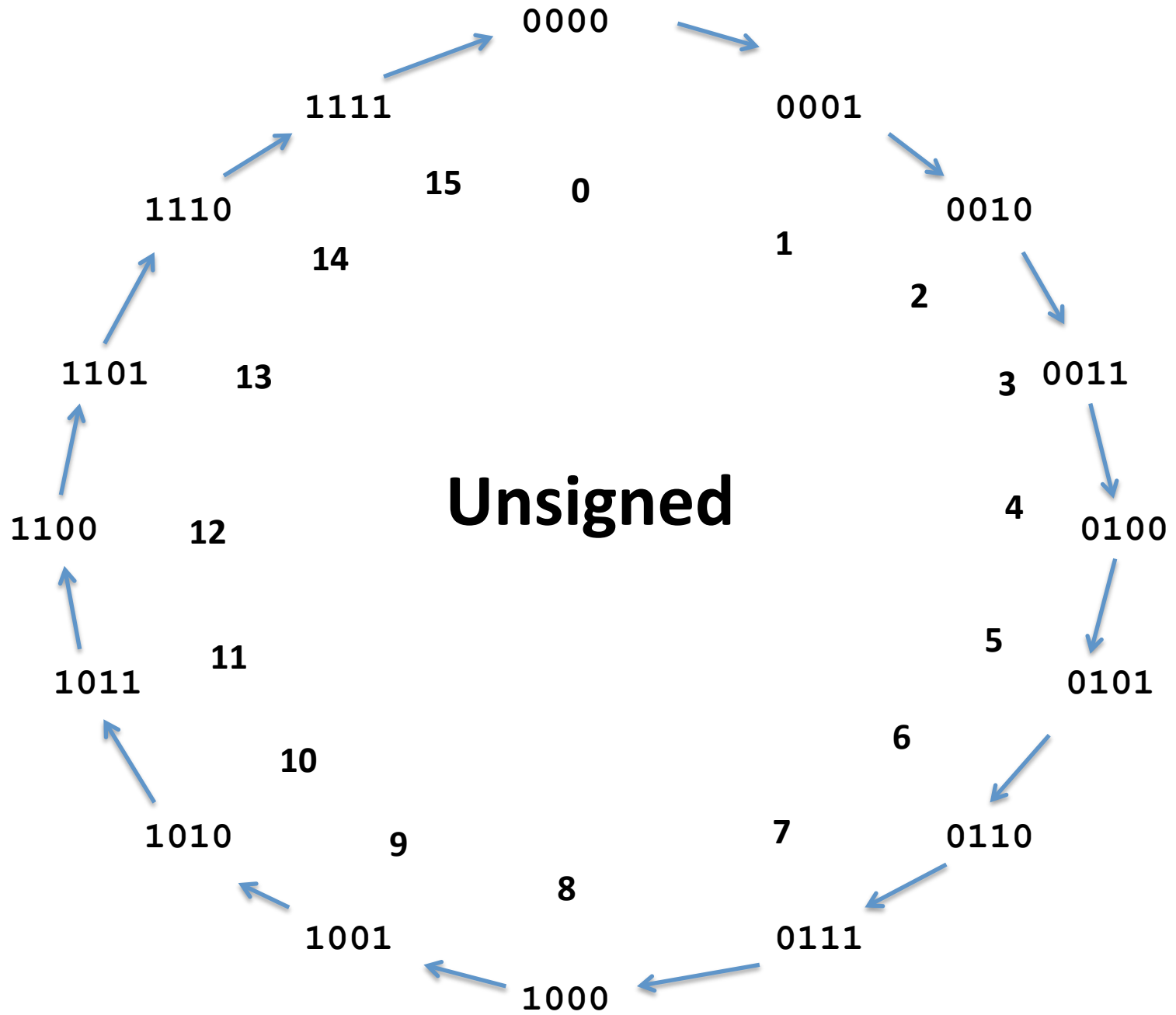
$$\begin{array}{r}
 11\ 1\ 1 \\
 01101010 \quad (106) \\
 + 10101010 \quad (170) \\
 \hline
 100010100 \quad (276)
 \end{array}$$

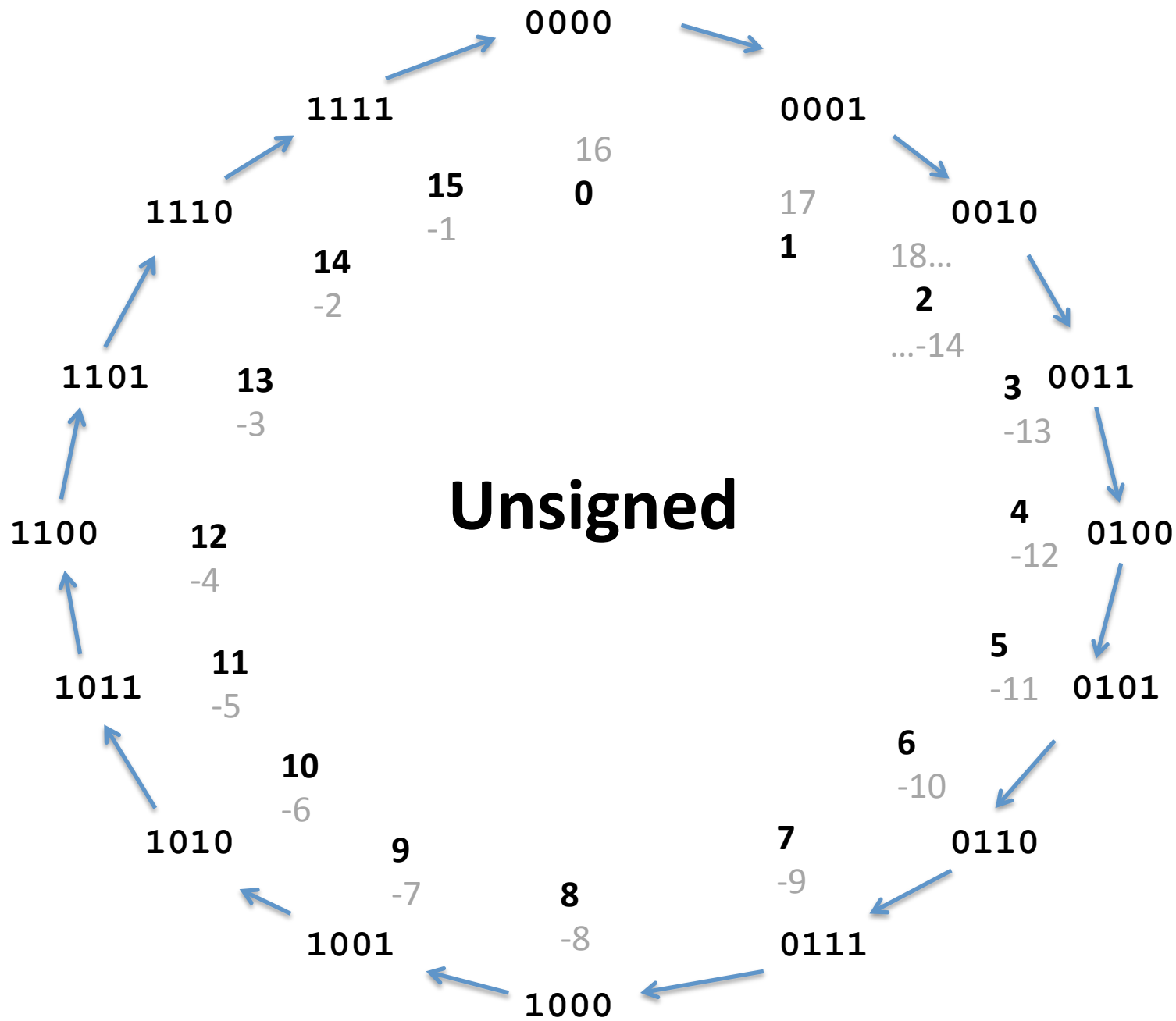
$$00010100 \quad (20)$$

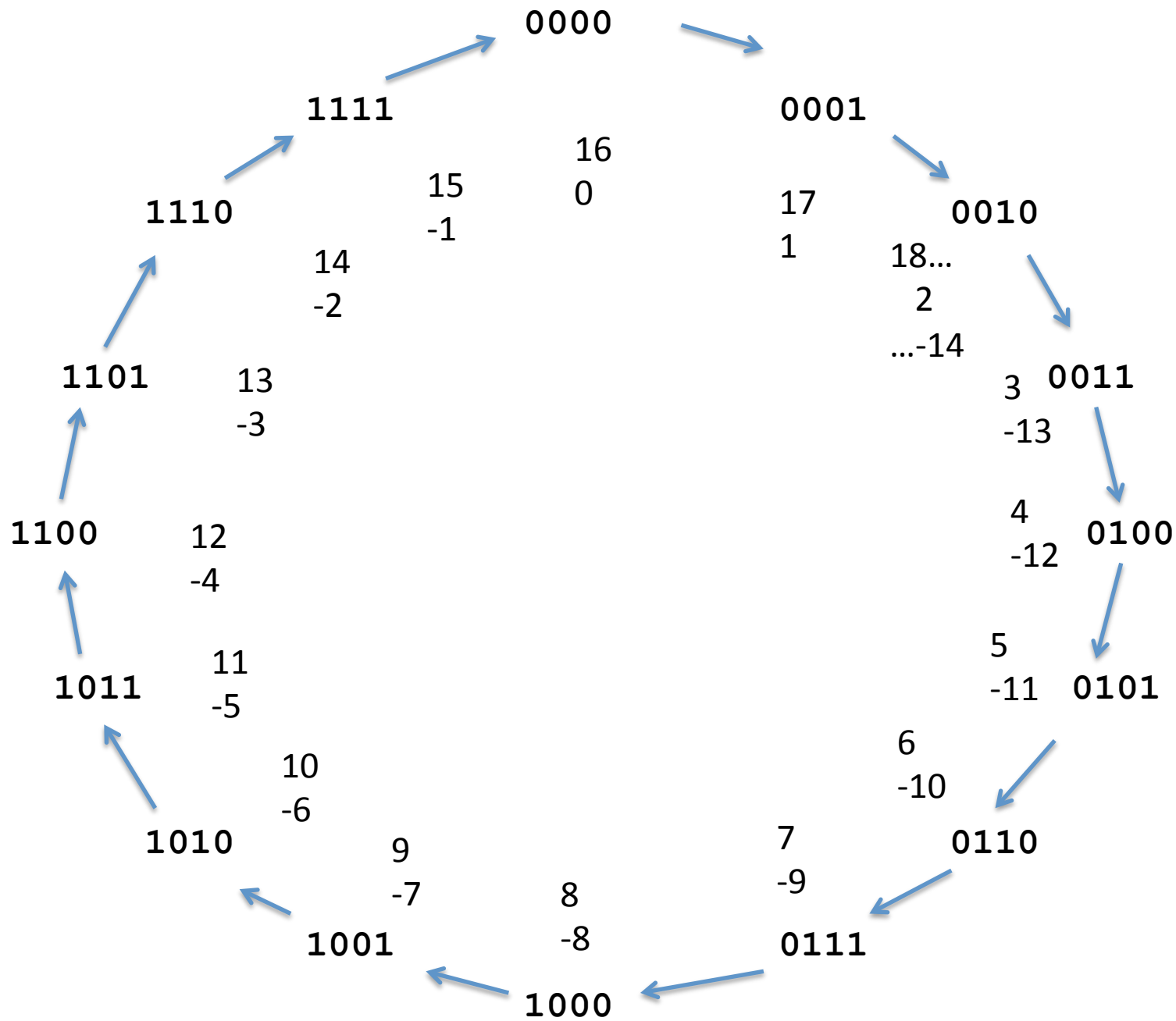
$$\begin{array}{r}
 01101010 \quad (106) \\
 \times 10101010 \quad (170) \\
 \hline
 00000000 \\
 01101010 \\
 00000000 \\
 01101010 \\
 00000000 \\
 01101010 \\
 00000000 \\
 + 01101010 \\
 \hline
 100011001100100 \quad (18020)
 \end{array}$$

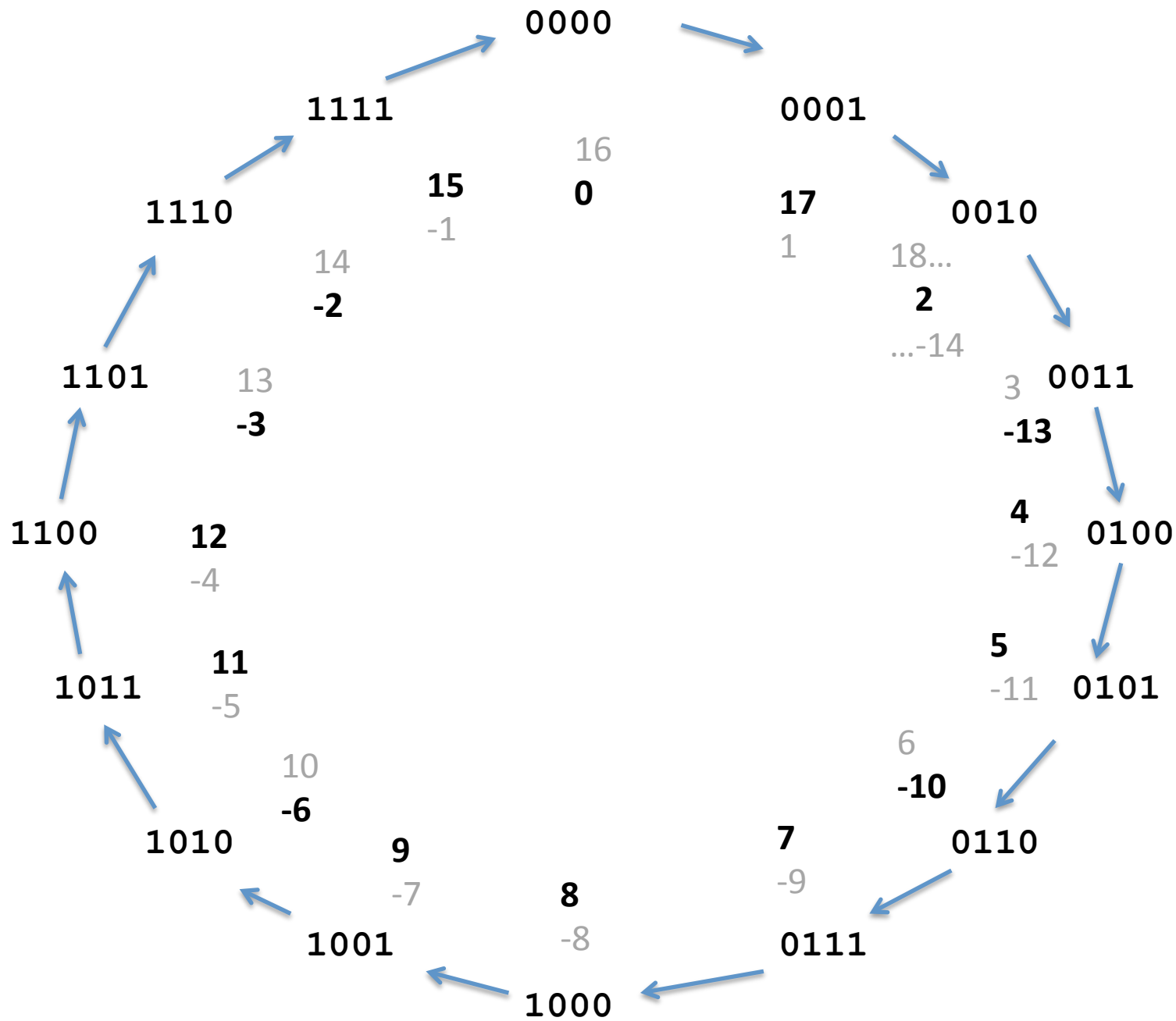
$$01100100 \quad (100)$$

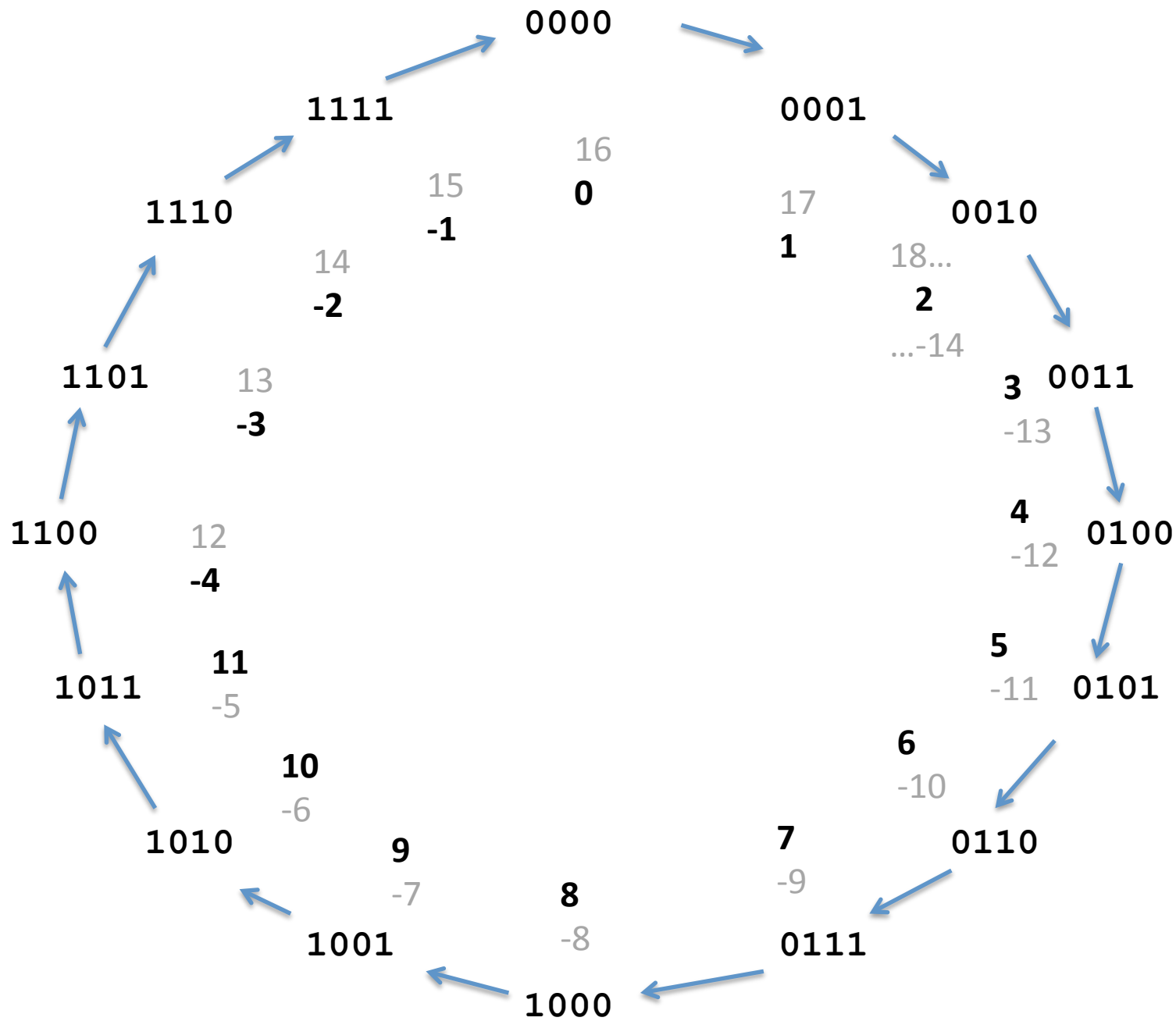




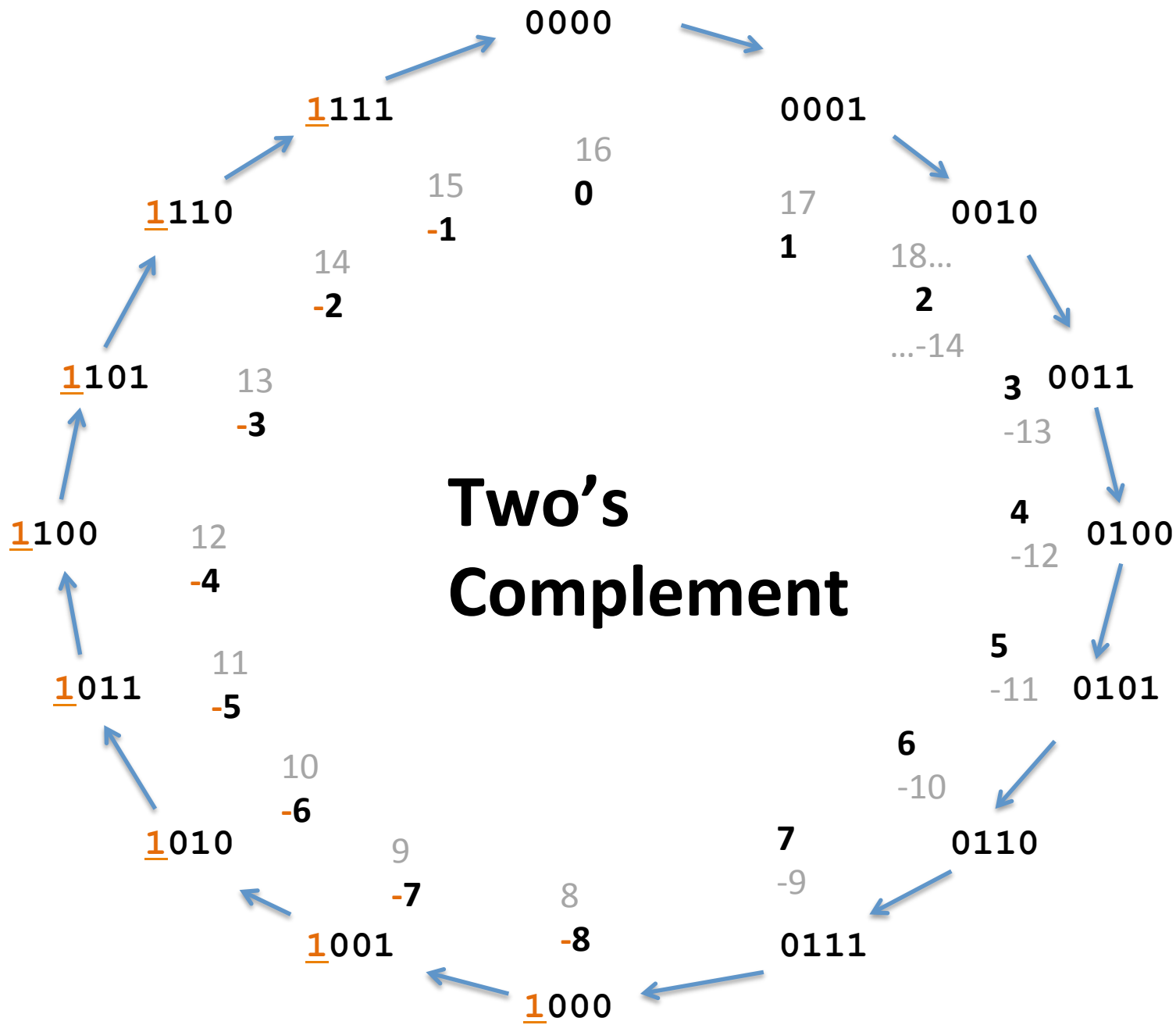








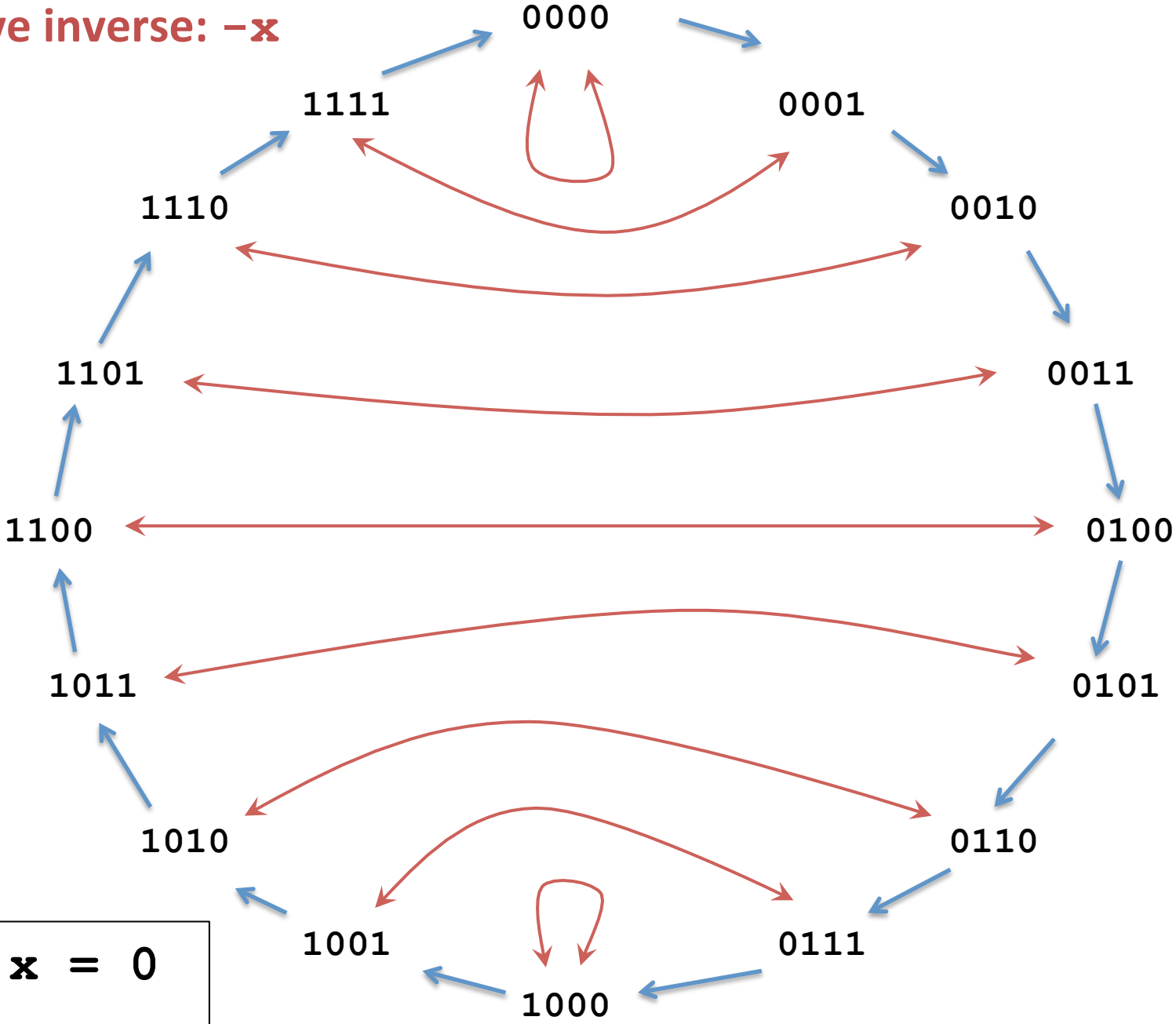
Two's Complement



Hexadecimal!

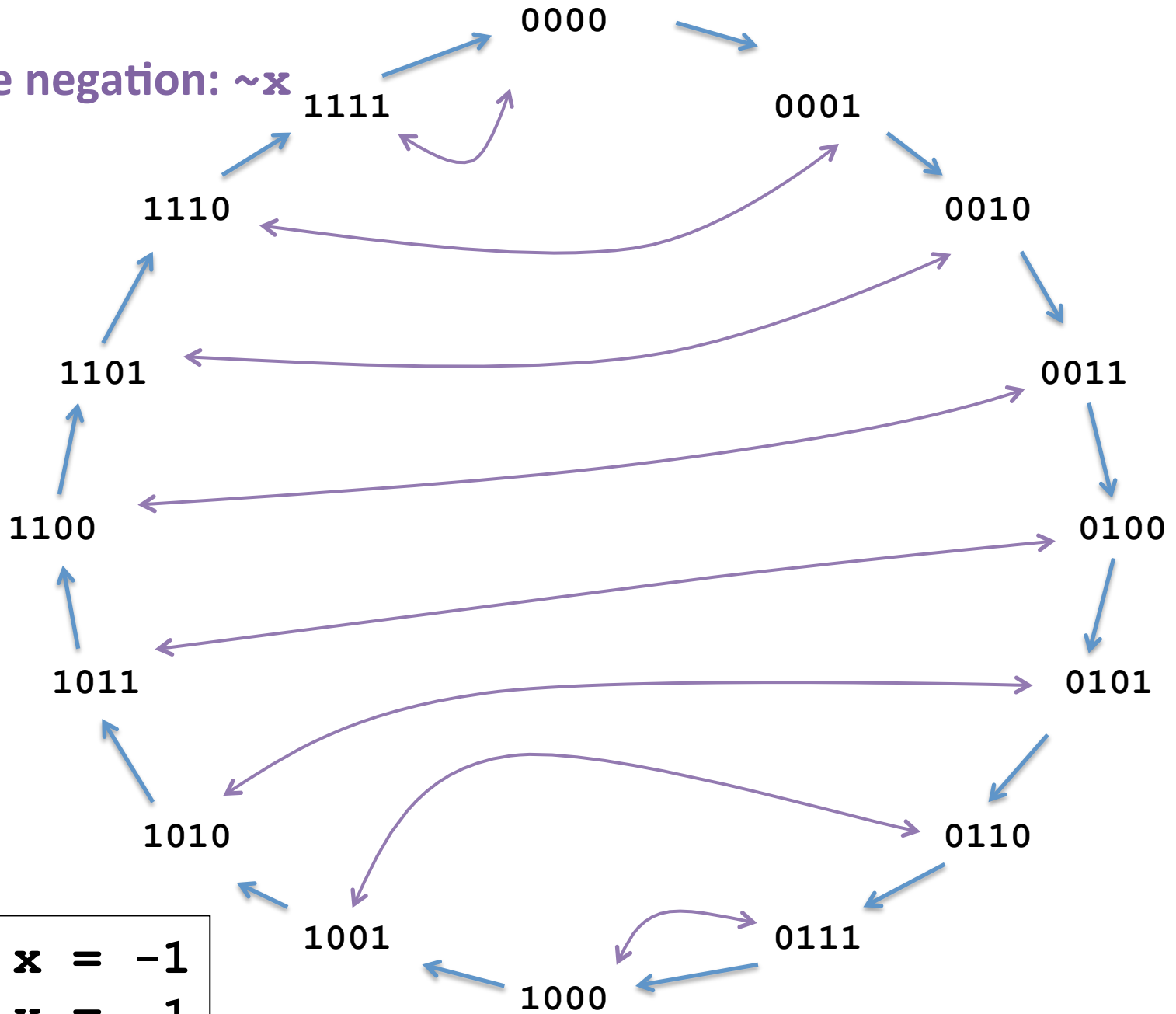
- $0_{[16]}$ $0000_{[2]}$ $0_{[10]}$
- $1_{[16]}$ $0001_{[2]}$ $1_{[10]}$
- $2_{[16]}$ $0010_{[2]}$ $2_{[10]}$
- $3_{[16]}$ $0011_{[2]}$ $3_{[10]}$
- $4_{[16]}$ $0100_{[2]}$ $4_{[10]}$
- $5_{[16]}$ $0101_{[2]}$ $5_{[10]}$
- $6_{[16]}$ $0110_{[2]}$ $6_{[10]}$
- $7_{[16]}$ $0111_{[2]}$ $7_{[10]}$
- $8_{[16]}$ $1000_{[2]}$ $8_{[10]}$
- $9_{[16]}$ $1001_{[2]}$ $9_{[10]}$
- $A_{[16]}$ $1010_{[2]}$ $10_{[10]}$
- $B_{[16]}$ $1011_{[2]}$ $11_{[10]}$
- $C_{[16]}$ $1100_{[2]}$ $12_{[10]}$
- $D_{[16]}$ $1101_{[2]}$ $13_{[10]}$
- $E_{[16]}$ $1110_{[2]}$ $14_{[10]}$
- $F_{[16]}$ $1111_{[2]}$ $15_{[10]}$

Additive inverse: $-x$



$-x + x = 0$

Bitwise negation: $\sim x$

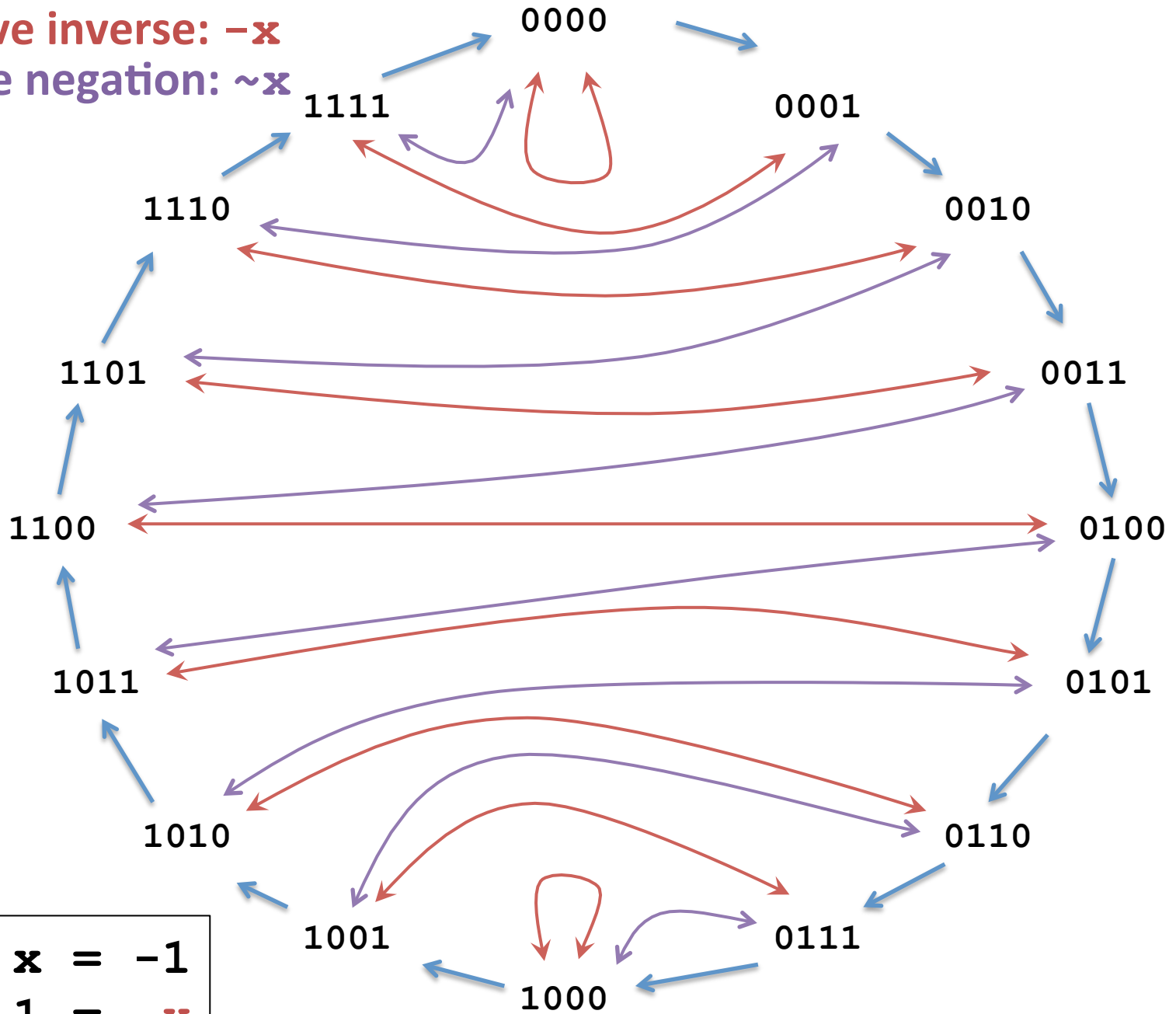


$$\sim x + x = -1$$

$$\sim x | x = -1$$

Additive inverse: $-x$

Bitwise negation: $\sim x$



$$\sim x + x = -1$$

$$\sim x + 1 = -x$$