Binary!

$$1209_{[10]} = 1\times10^3 + 2\times10^2 + 0\times10^1 + 9\times10^0$$

$$100101_{[2]} = 1\times2^5 + 0\times2^4 + 0\times2^3 + 1\times2^2 + 0\times2^1 + 1\times2^0$$

$$(b_{n-1}b_{n-2}\ldots b_1b_0)_{[2]} = b_{n-1}\times2^{n-1} + b_{n-2}\times2^{n-2} + \ldots$$
$$+ b_2\times2^2 + b_1\times2^1 + b_0\times2^0$$

$$= 2\times(b_{n-1}\times2^{n-2} + b_{n-2}\times2^{n-3} + \ldots + b_2\times2^1 + b_1\times2^0) + b_0$$

$$= 2\times(2\times(b_{n-1}\times2^{n-3} + b_{n-2}\times2^{n-4} + \ldots + b_2\times2^0) + b_1) + b_0$$

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

Hexadecimal!

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

Hexadecimal!

```
      0*16 + C = 12
     12*16 + 0 = 192
    192*16 + F = 3087
   3087*16 + A = 49402
  49402*16 + C = 790444
 790444*16 + E = 12647119
```

Hexadecimal!

```
0*16 + C = 12
12*16 + 0 = 192
192*16 + F = 3087
3087*16 + A = 49402
49402*16 + C = 790444
790444*16 + E = 12647119
```

```
--> 0xC0FACE
12647118 (int)
--> int2hex(12647118);
"00C0FACE" (string)
```

Modular arithmetic

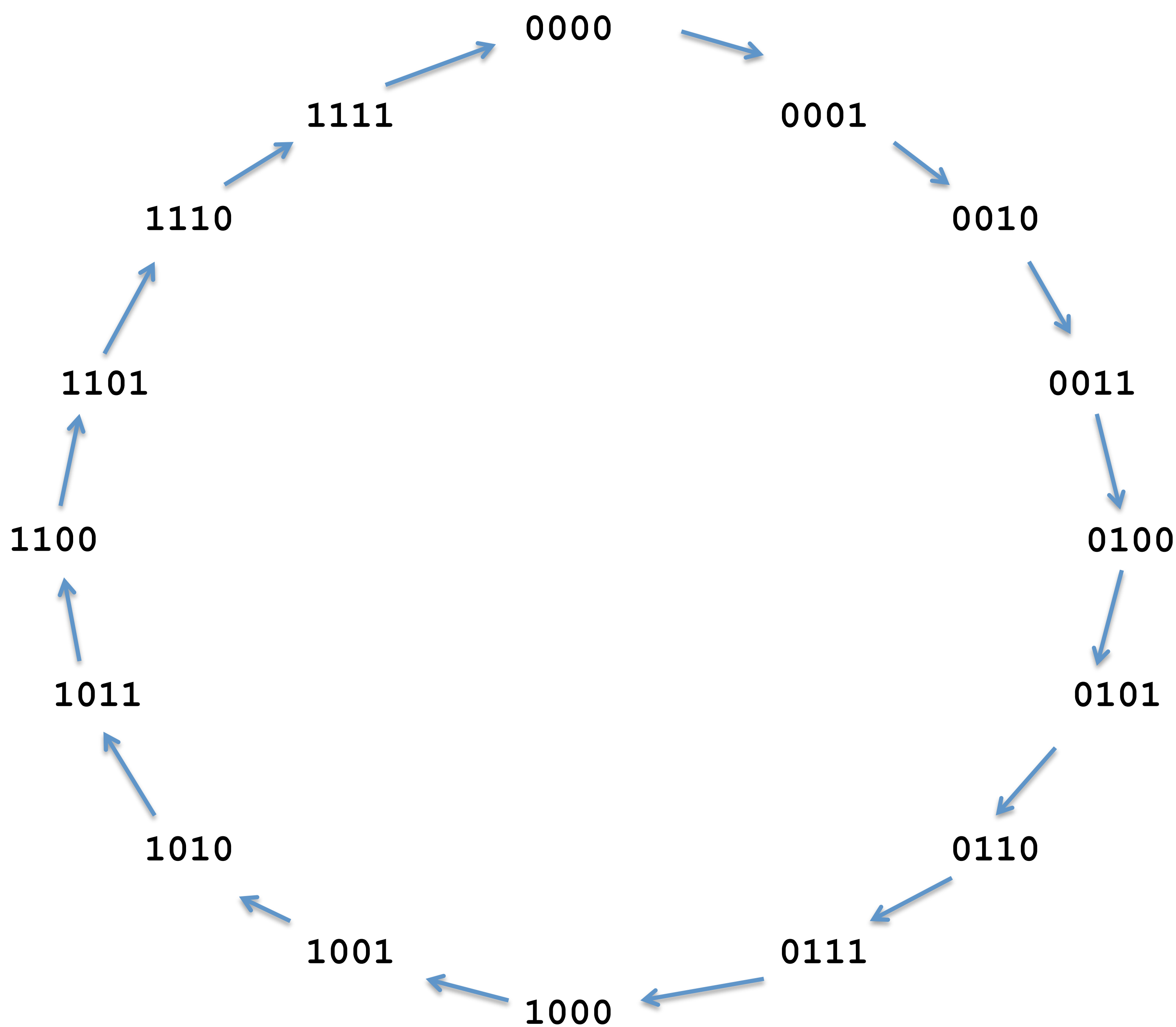
```
   11 1 1
   01101010   (106)
 + 10101010   (170)
 ----------
  100010100   (276)
```

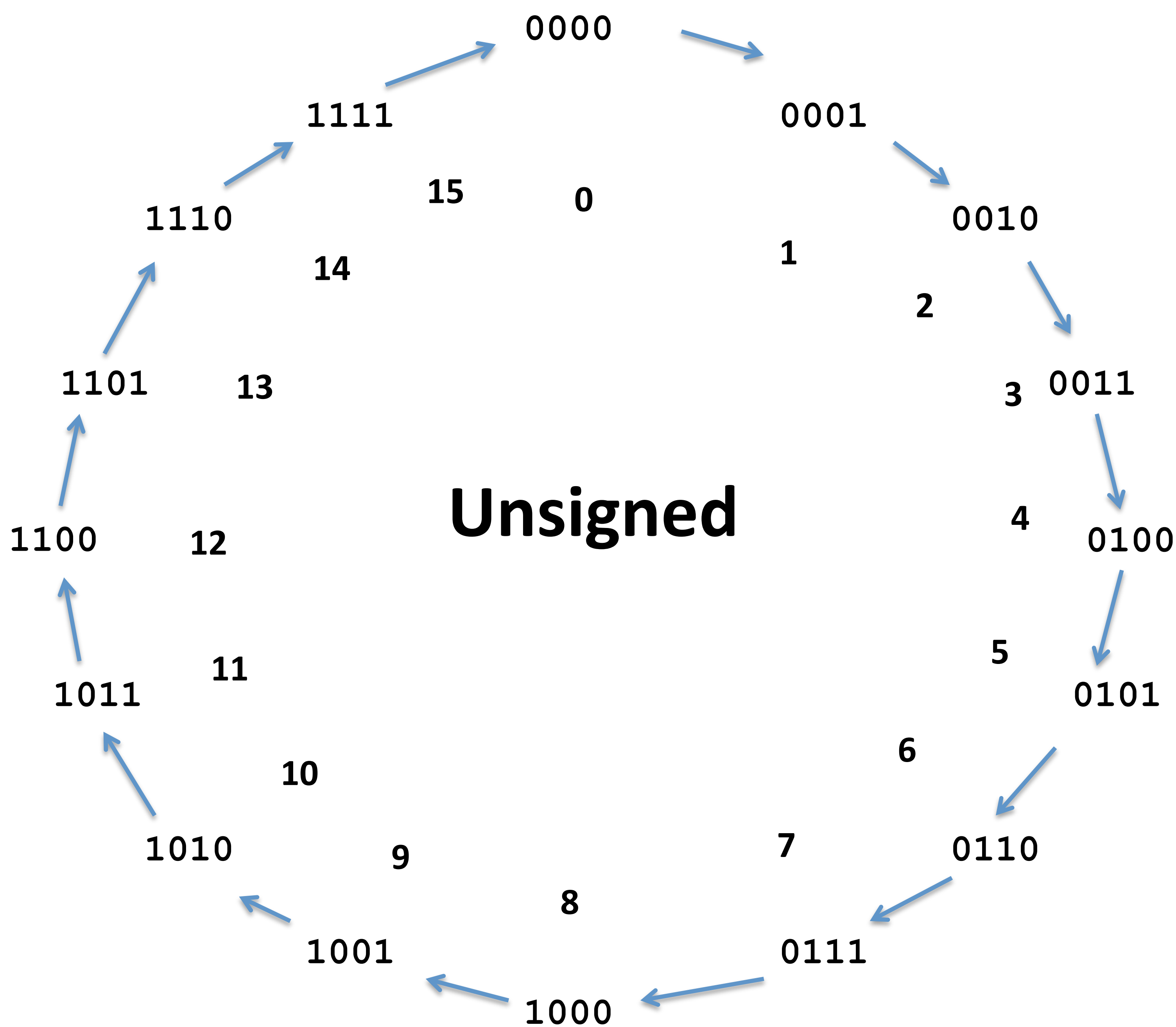
```
                01101010   (106)
              x 10101010   (170)
 -----------------------
                00000000
               01101010
              00000000
             01101010
            00000000
           01101010
          00000000
 +       01101010
 -----------------------
   1000110011001 00        
```

Modular arithmetic

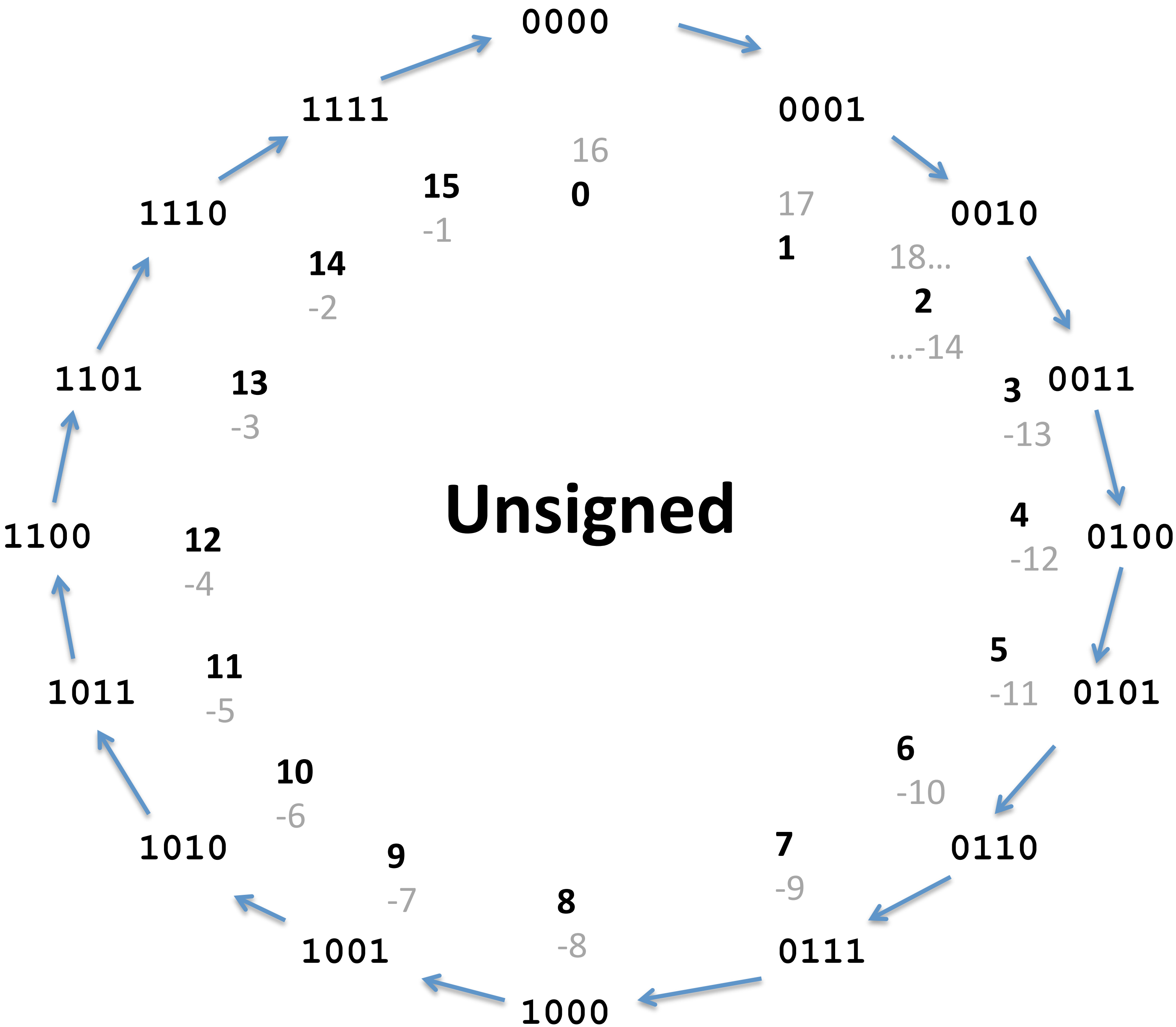
```
   11 1 1
   01101010  (106)
 + 10101010  (170)
 ----------
  100010100  (276)

   00010100   (20)
```

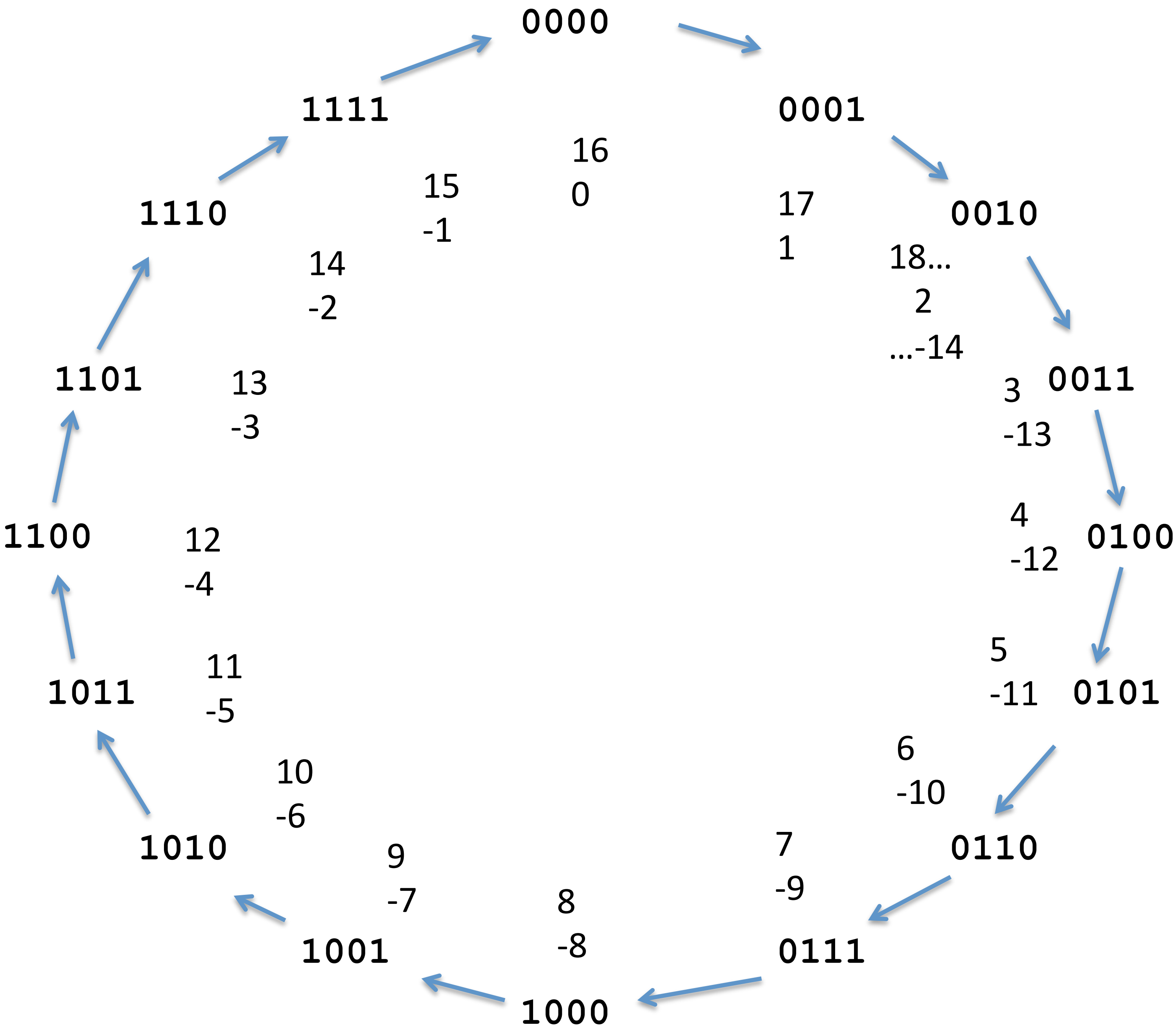
```
           01101010  (106)
         x 10101010  (170)
 ------------------
           00000000
          01101010
         00000000
        01101010
       00000000
      01101010
     00000000
 + 01101010
 ------------------
    100011001100100  (18020)

           01100100  (100)
```

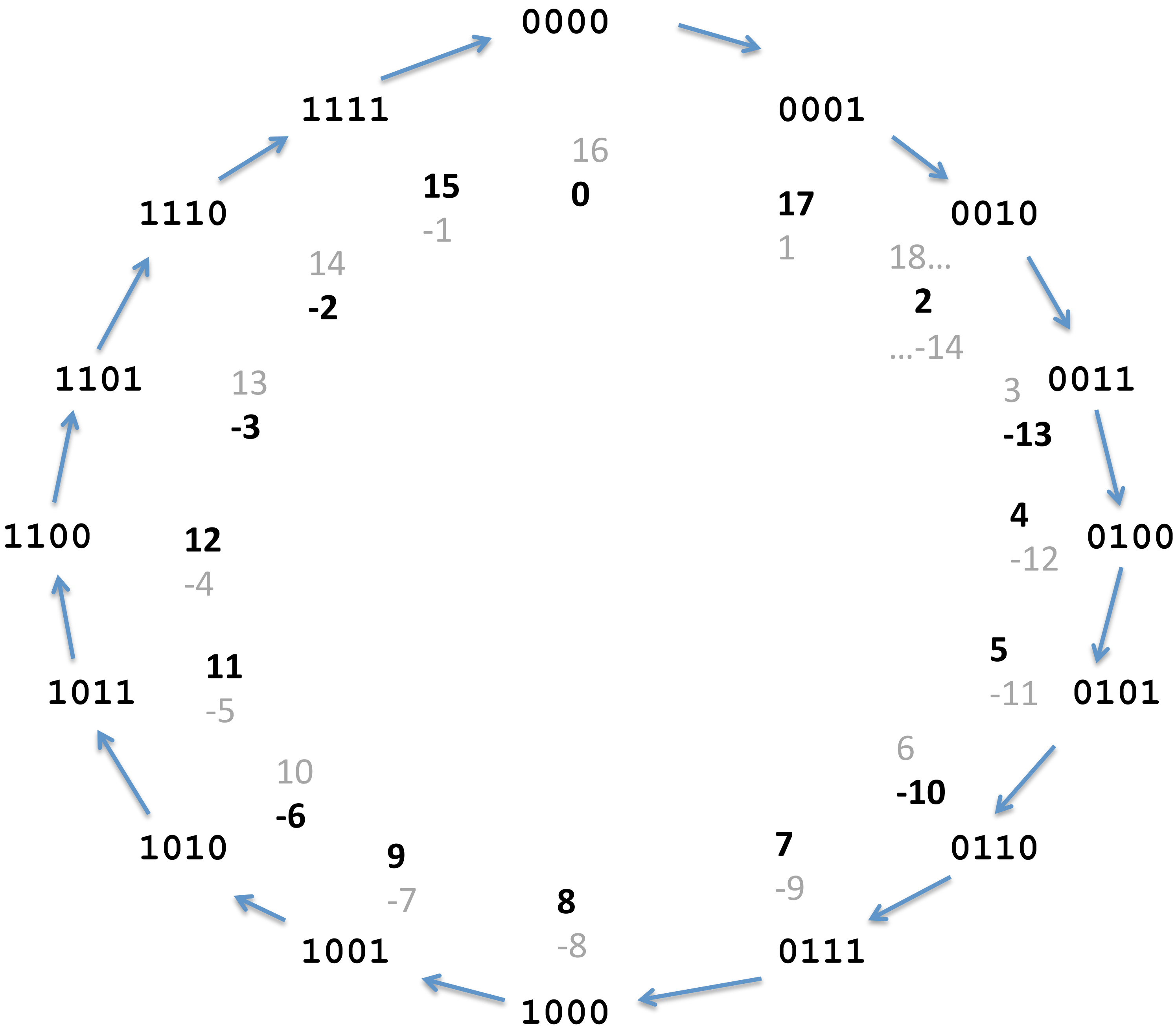

0000
0001
0010
0011
0100
0101
0110
0111
1000
1001
1010
1011
1100
1101
1110
1111

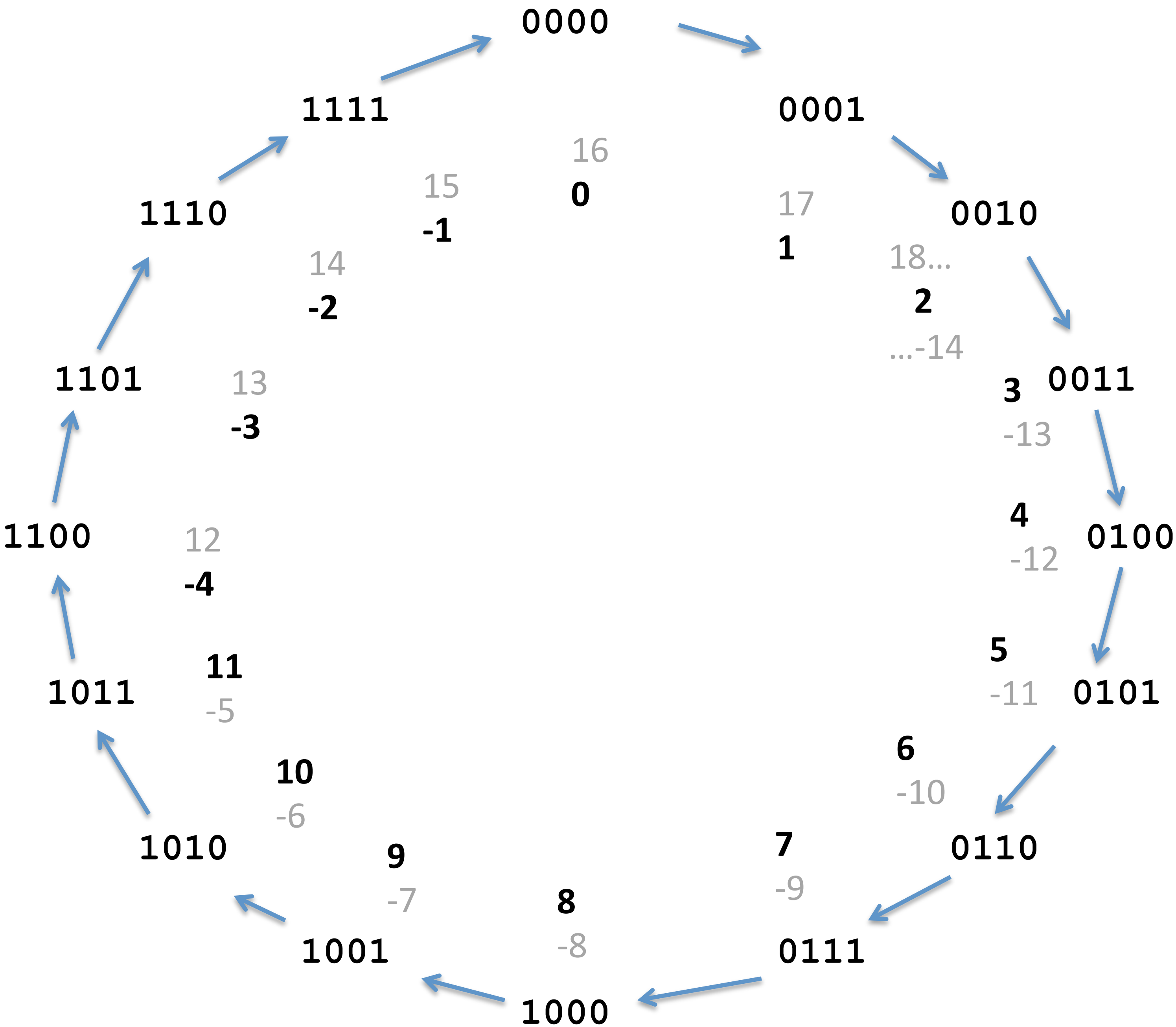


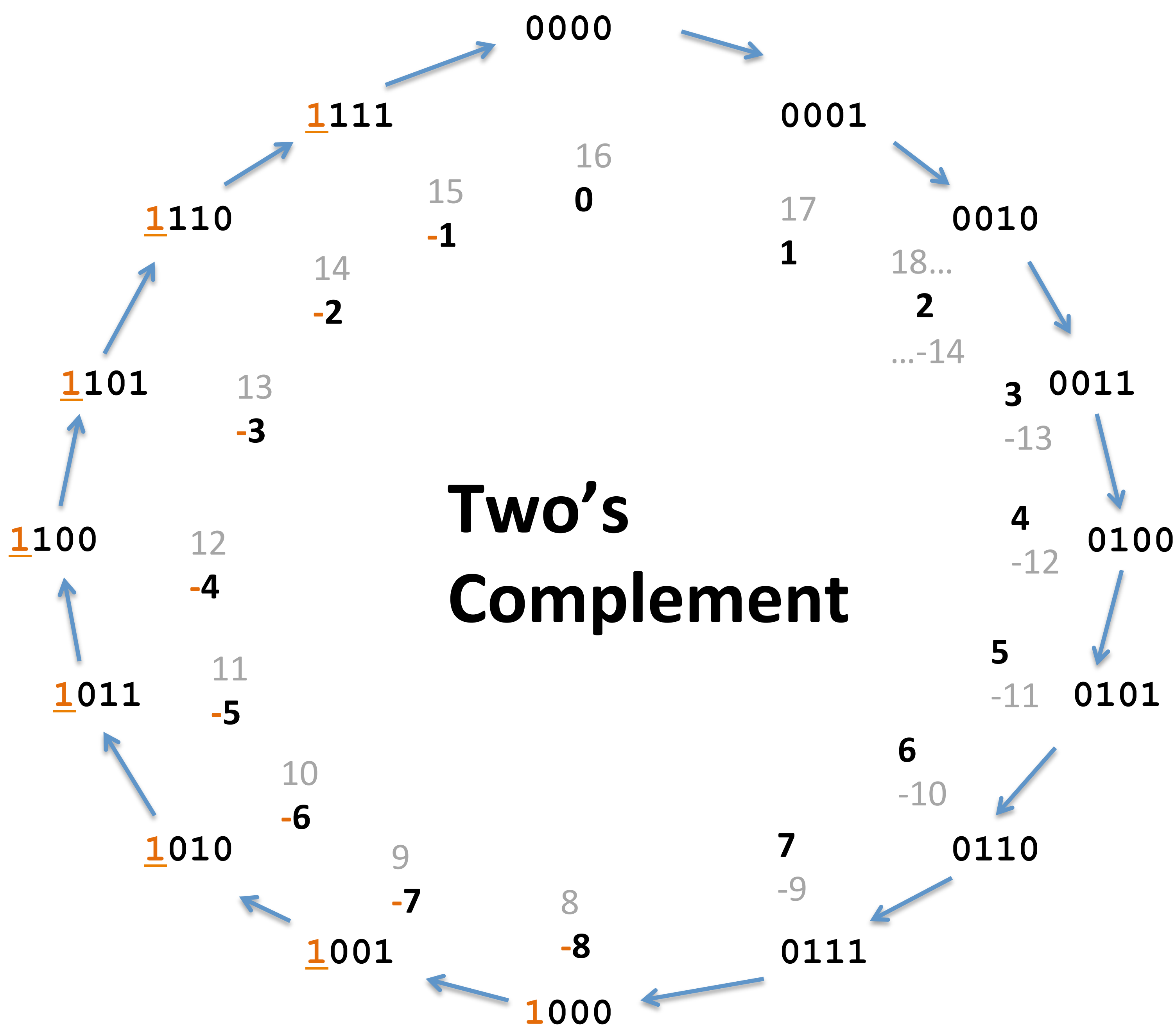
Unsigned
0000
0001
0010
0011
0100
0101
0110
0111
1000
1001
1010
1011
1100
1101
1110
1111
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15


Unsigned
0000
0001
0010
0011
0100
0101
0110
0111
1000
1001
1010
1011
1100
1101
1110
1111
16
0
17
1
18…
2
…-14
3
-13
4
-12
5
-11
6
-10
7
-9
8
-8
9
-7
10
-6
11
-5
12
-4
13
-3
14
-2
15
-1

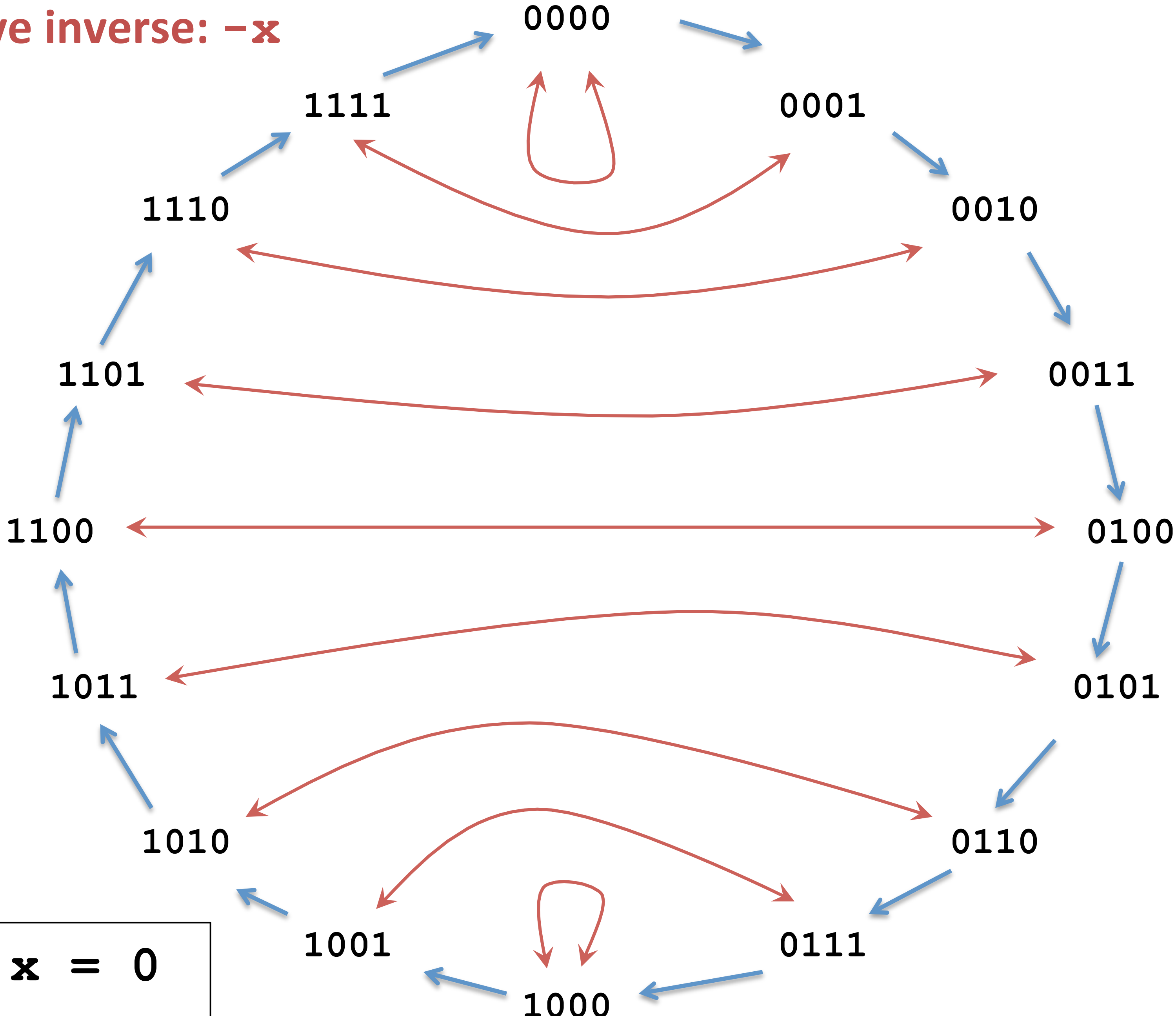

0000
0001
0010
0011
0100
0101
0110
0111
1000
1001
1010
1011
1100
1101
1110
1111
16
0
17
1
18...
2
...-14
3
-13
4
-12
5
-11
6
-10
7
-9
8
-8
9
-7
10
-6
11
-5
12
-4
13
-3
14
-2
15
-1


0000
16
0
0001
17
1
0010
18...
2
...-14
0011
3
-13
0100
4
-12
0101
5
-11
0110
6
-10
0111
7
-9
1000
8
-8
1001
9
-7
1010
10
-6
1011
11
-5
1100
12
-4
1101
13
-3
1110
14
-2
1111
15
-1


0000
0001
0010
0011
0100
0101
0110
0111
1000
1001
1010
1011
1100
1101
1110
1111
16
0
17
1
18...
2
...-14
3
-13
4
-12
5
-11
6
-10
7
-9
8
-8
9
-7
10
-6
11
-5
12
-4
13
-3
14
-2
15
-1

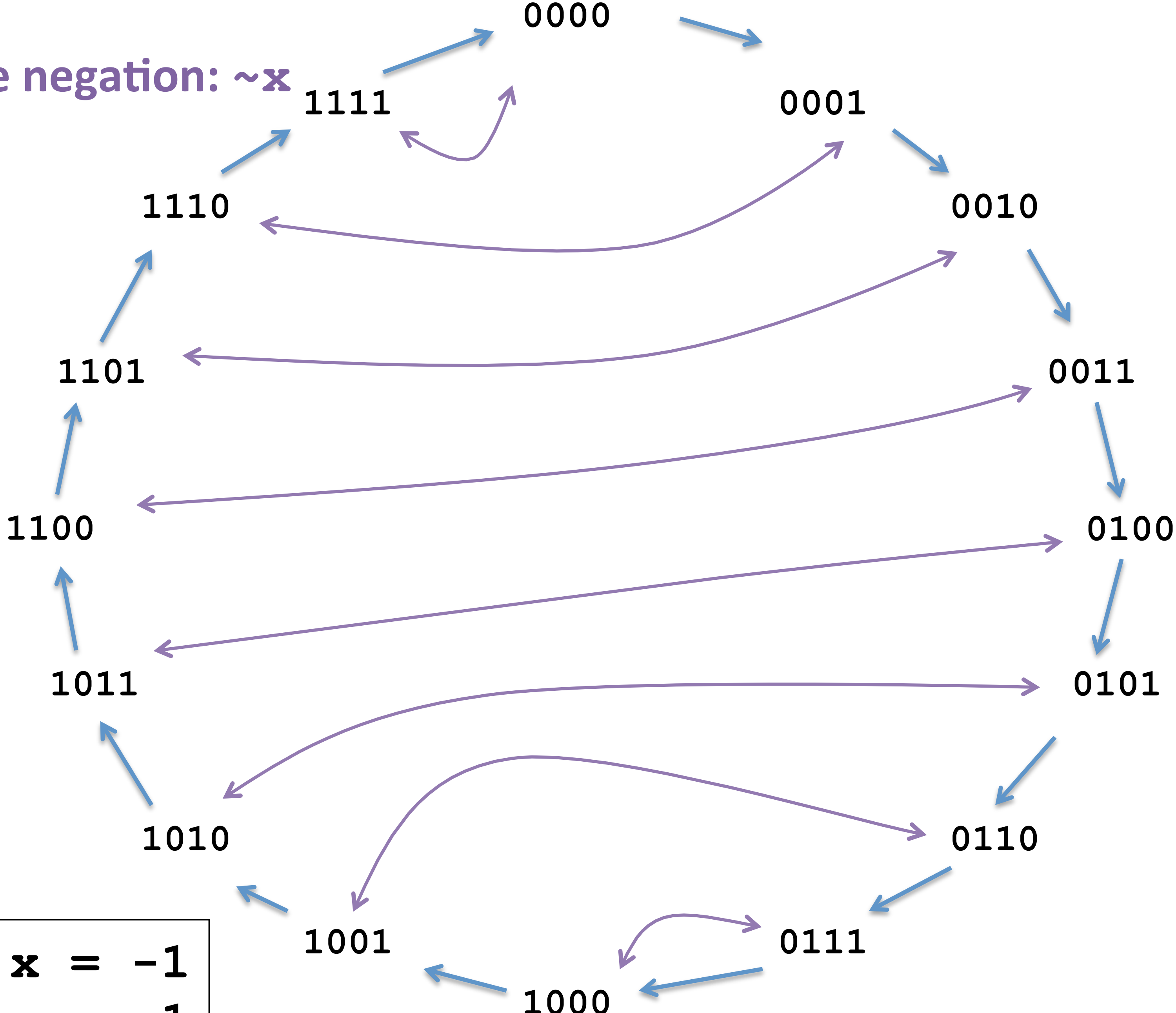

Two's Complement
0000
16
0
0001
17
1
0010
18...
2
...-14
0011
3
-13
0100
4
-12
0101
5
-11
0110
6
-10
0111
7
-9
1000
8
-8
1001
9
-7
1010
10
-6
1011
11
-5
1100
12
-4
1101
13
-3
1110
14
-2
1111
15
-1

Additive inverse: $-x$



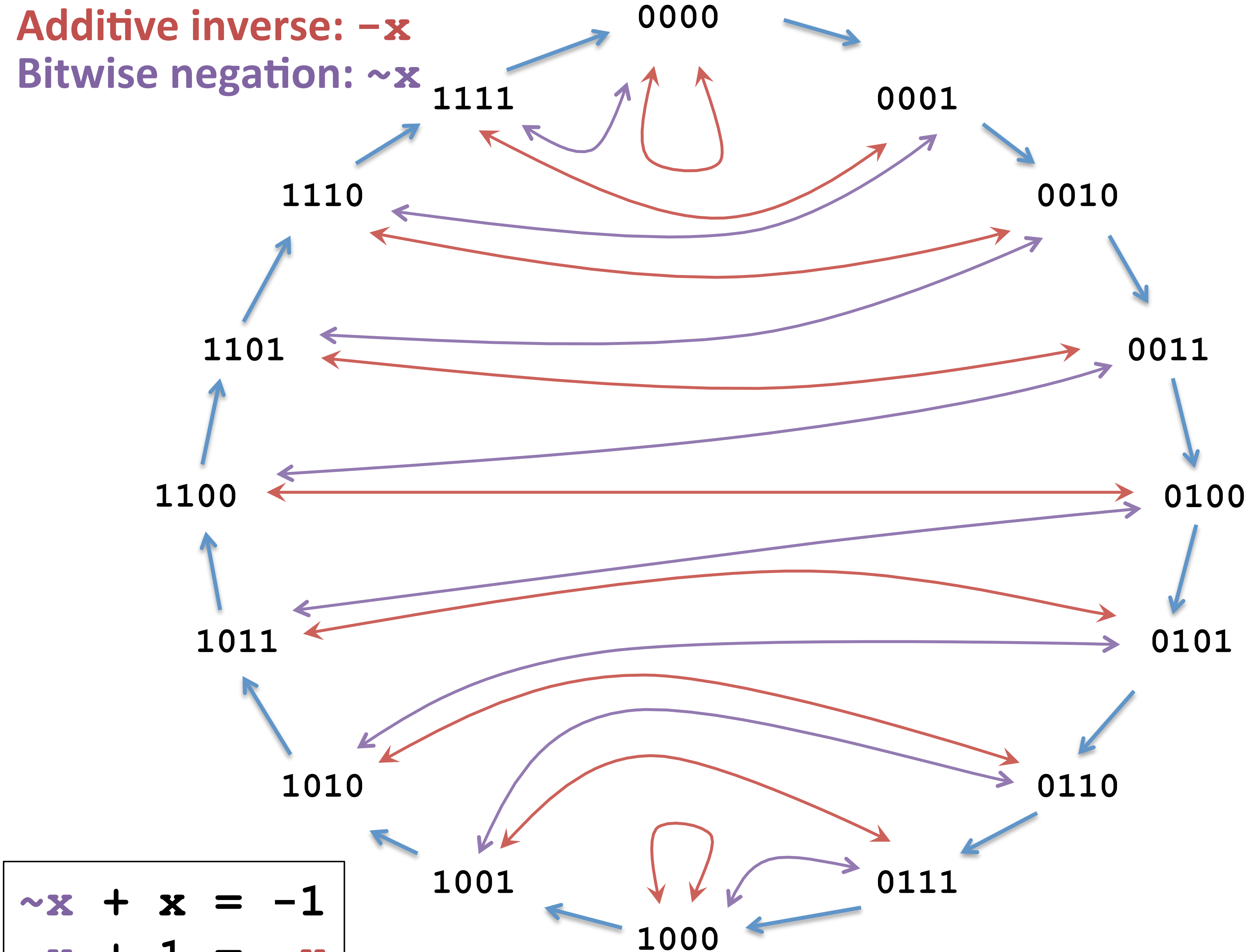
$$-x + x = 0$$

Bitwise negation: ~x



~x + x = -1

~x | x = -1



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