# Unsigned Addition

```
unsigned char a = 255;
unsigned char b = 1;

unsigned char c = a + b;
printf("c=%d", c)
```

运行结果:

c = 0

# Unsigned Addition

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For x and y $0 \leq x < 2^w,\ 0 \leq y < 2^w$

$$x +_w^u y = \begin{cases} x + y, & x + y < 2^w \\ x + y - 2^w, & 2^w \leq x + y < 2^{w+1} \end{cases}$$

## Detecting Overflow of Unsigned Addition

```
int uadd_ok(unsigned x, unsigned y)
{
    unsigned sum = x + y;

    if(sum >= x)
        return 1;
    else
        return 0;
}
```

## Detecting Overflow of Unsigned Addition

```
int uadd_ok(unsigned x, unsigned y)
{
    unsigned sum = x + y;

    if(sum >= x)
        return 1;
    else
        return 0;
}
```

return sum >= x;

$0 \le x < 2^w, 0 \le y < 2^w$

$x + y \ge x, \quad x + y \ge y$

sum

overflow: x + y $-2^w$

$y - 2^w < 0$

$x + y - 2^w < x$

# Two's Complement Addition

For x and y $-2^{w-1} \le x < 2^{w-1} - 1,\ -2^{w-1} \le y < 2^{w-1} - 1$

$$x +_w^t y = \begin{cases} x + y - 2^w, & 2^{w-1} \le x + y \quad \text{Positive overflow} \\ x + y, & -2^{w-1} \le x + y < 2^{w-1} \\ x + y + 2^w, & x + y < -2^{w-1} \quad \text{Negative overflow} \end{cases}$$

# Overflow

$(1) x \ge 0, \quad y \ge 0$

x + y < 0 Positive Overflow

$(2) x \le 0, \quad y \le 0$

x + y > 0 Negative Overflow

# Additive Inverse

For x, $0 \le x < 2^w$

$$x + x' = x' + x = 0$$

$$y - x \longrightarrow y + x'$$

For x, x' $0 \le x < 2^w, 0 \le x' < 2^w$

$$x + x' = 2^w = 0$$

$$-_w^u x = \begin{cases} x, & x = 0 \\ 2^w - x, & x \ge 0 \end{cases}$$

## Two's-Complement Negation

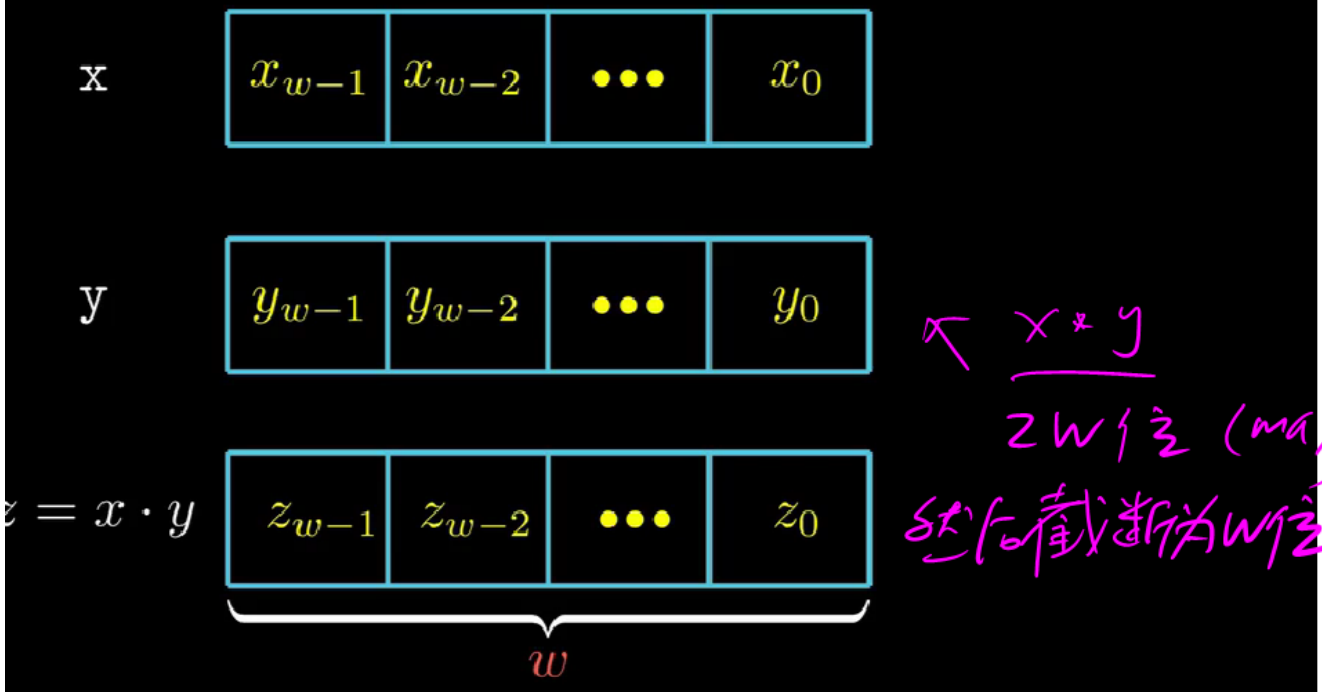
For x, $-2^{w-1} \leq x < 2^{w-1} - 1$

$$-_w^t x = \begin{cases} -x, & x > TMin_w \\ TMin_w, & x = TMin_w \end{cases}$$

$$Tmin_w + Tmin_w = -2^{w-1} + (-2^{w-1}) = -2^w$$

$$Tmin_w +_w^t Tmin_w = -2^w + 2^w = 0$$

## Unsigned Multiplication




x * y

2w位 (max)

然后截断为w位