Ch.5 Formulas and operator

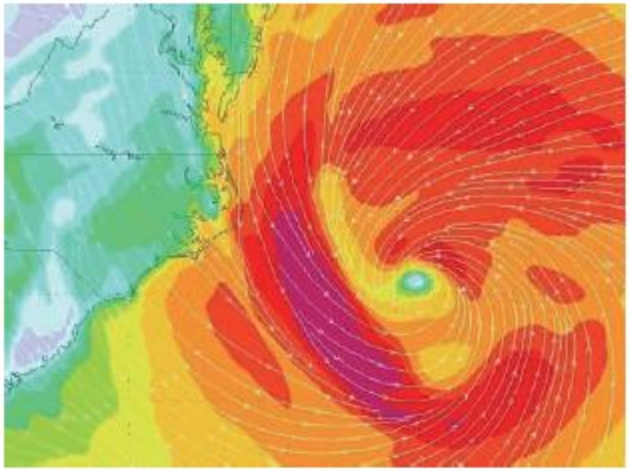
What you will learn in this chapter

* What are formulas and operators ?
* Assignment operation
* Arithmetic operations
* Logical operations
* Relational operations
* Priority and associativity rules

In this chapter, we will look at formulas and operators .

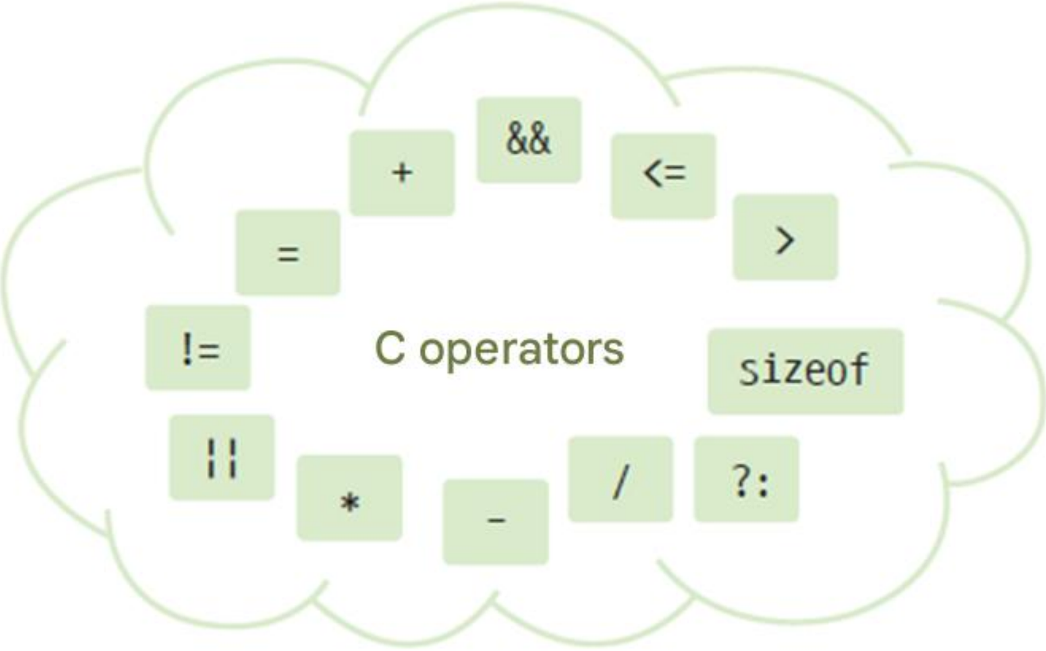
A computer is fundamentally a calculating machine.

The Korea Meteorological Administration uses supercomputers to calculate the weather .

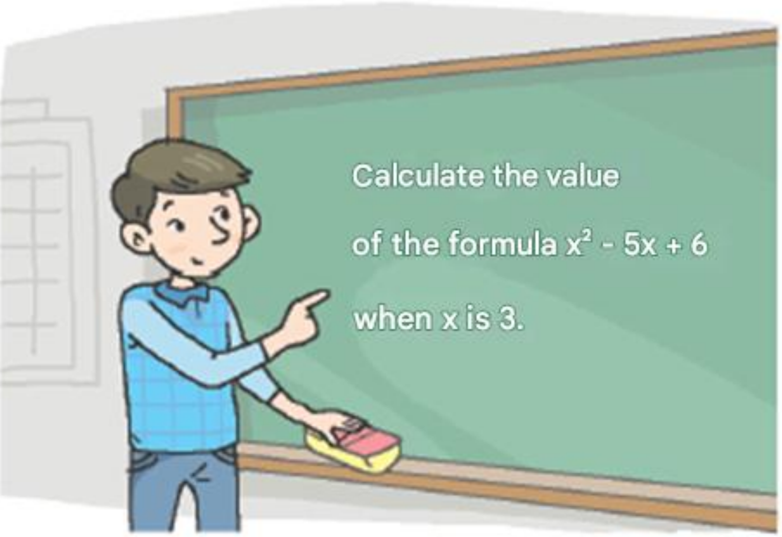


Operators in the C language

- The de facto industry standard
- Modern languages such as Java , C++, Python , and JavaScript use C language operators almost as they are.



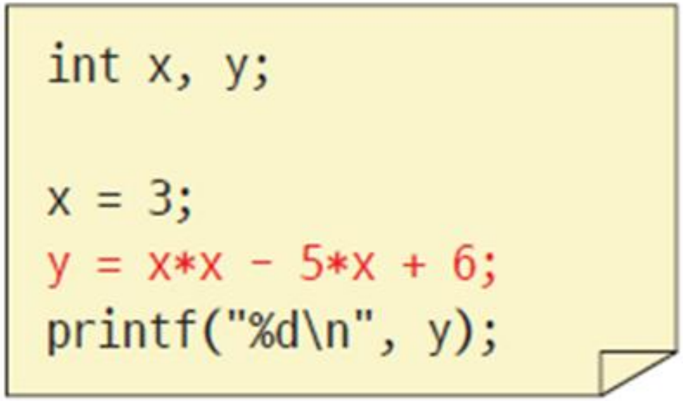
Example of a formula



Calculate the value

of the formula $x^2 - 5x + 6$

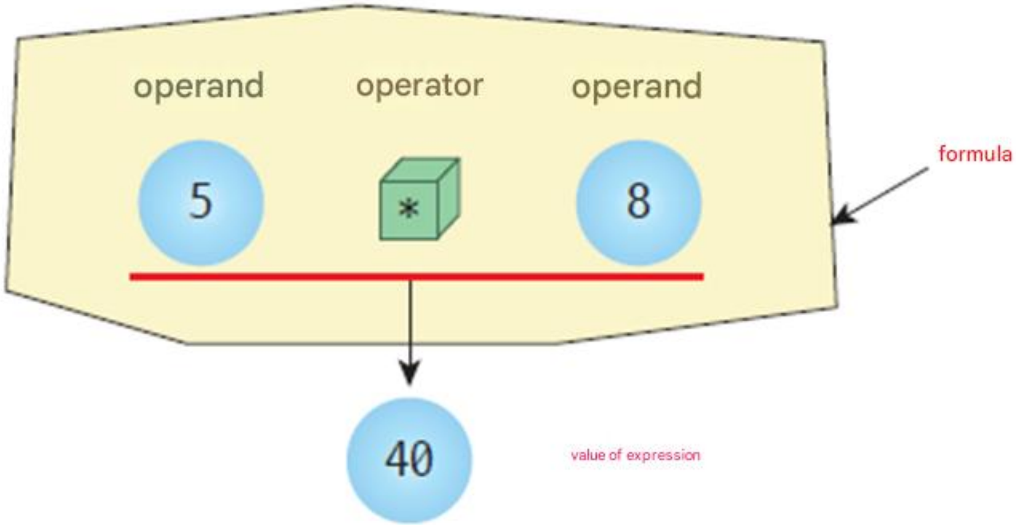
when x is 3.



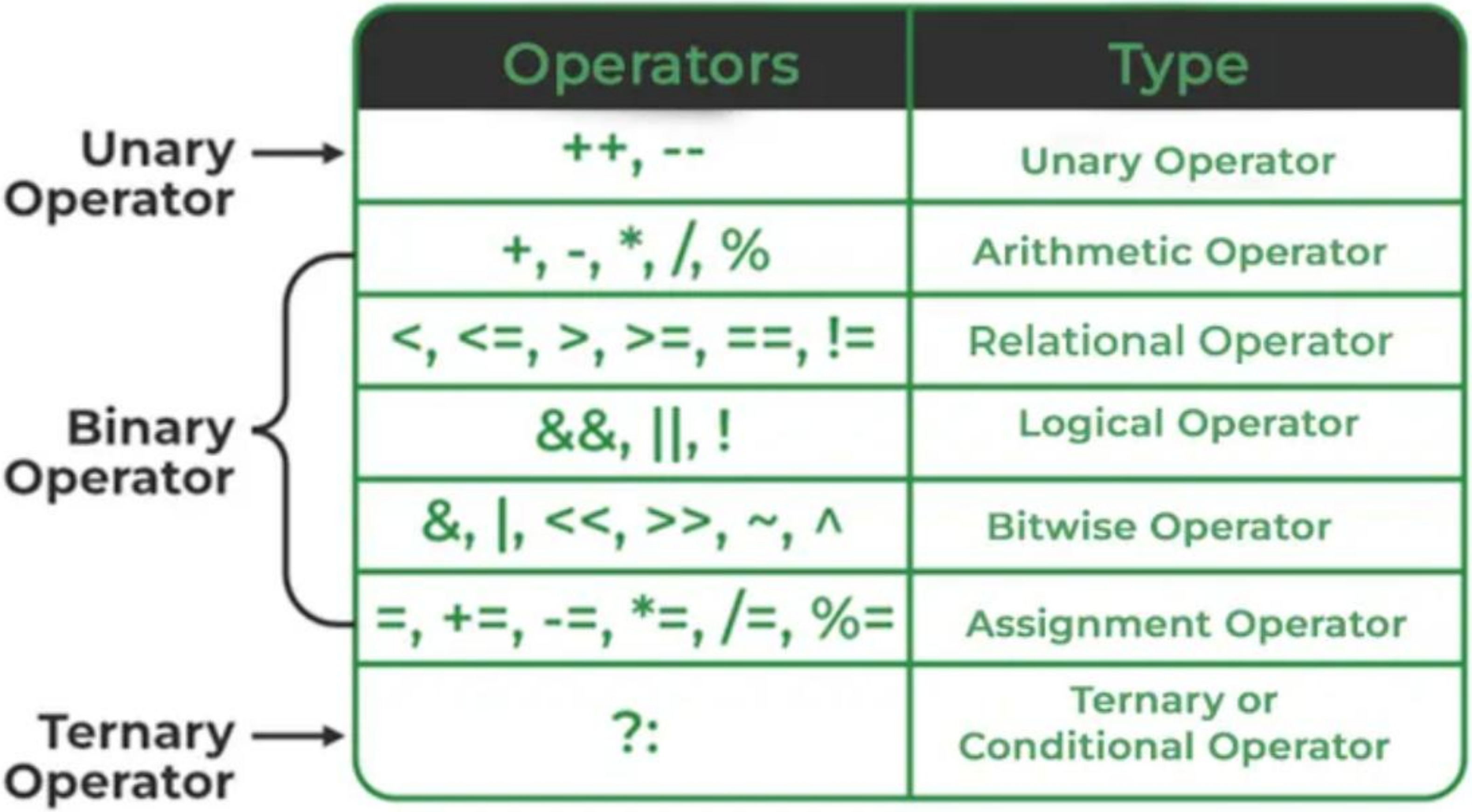
```
int x, y;

x = 3;
y = x*x - 5*x + 6;
printf("%d\n", y);
```

formula

- expression
  - constants , variables , and operators
  - It is divided into operators and operands .



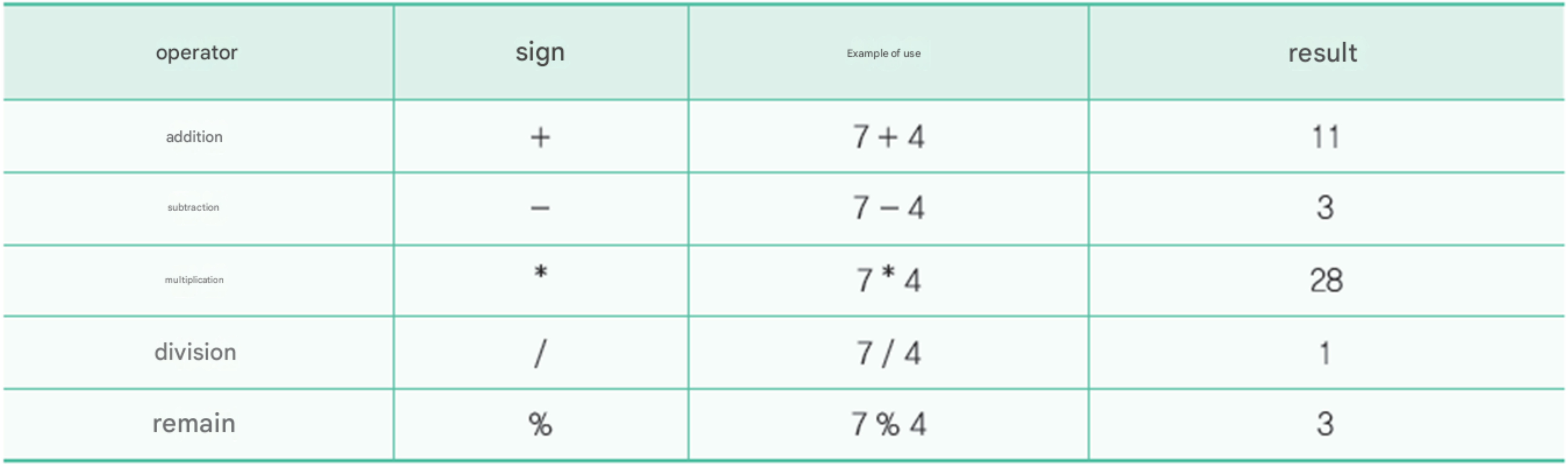
Classification of operators by function



	Operators	Type
Unary Operator	++, --	Unary Operator
Binary Operator	+, -, *, /, %	Arithmetic Operator
	<, <=, >, >=, ==, !=	Relational Operator
	&&, ||, !	Logical Operator
	&, |, <<, >>, ~, ^	Bitwise Operator
	=, +=, -=, *=, /=, %=	Assignment Operator
Ternary Operator	?:	Ternary or Conditional Operator

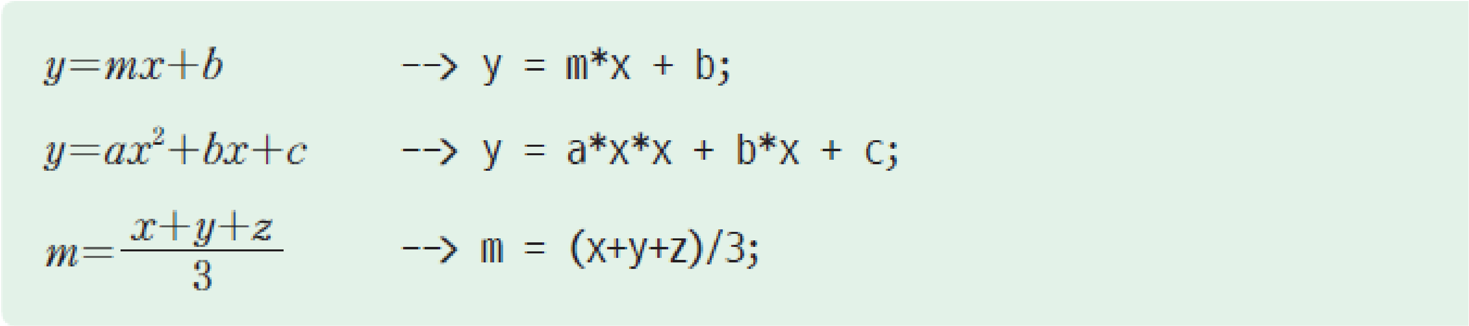
Arithmetic Operators

- Arithmetic Operations : The Most Basic Operations on a Computer
- Operators that perform basic arithmetic operations such as addition , subtraction , multiplication , and division.



operator	sign	Example of use	result
addition	+	7 + 4	11
subtraction	–	7 – 4	3
multiplication	*	7 * 4	28
division	/	7 / 4	1
remain	%	7 % 4	3

Examples of arithmetic operators



$y=mx+b$ --> `y = m*x + b;`

$y=ax^2+bx+c$ --> `y = a*x*x + b*x + c;`

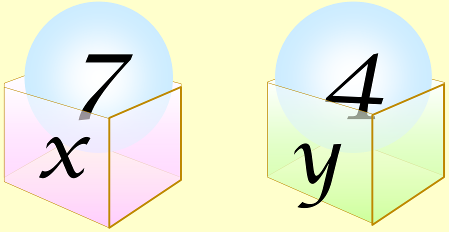
$m=\frac{x+y+z}{3}$ --> `m = (x+y+z)/3;`

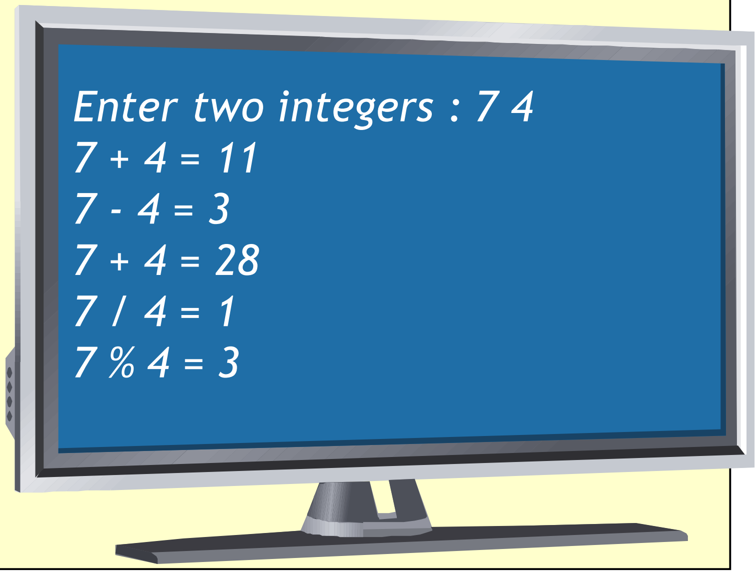
(Note) What is the exponentiation operator ?

C does not have an operator for exponentiation .
Simply multiply the variable twice, like x * x .

Integer arithmetic operations

```
#include < stdio.h >

int main(void)
{
       int x, y, result;
       printf ( " Enter two integers : ");
       scanf( "%d %d" , &x, &y);

      result = x + y;
      printf( "%d + %d = %d" , x, y, result);

      result = x - y; // subtraction
      printf( "%d - %d = %d" , x, y, result);
      result = x * y; // multiplication
      printf( "%d + %d = %d" , x, y, result);
      result = x / y; // division
      printf( "%d / %d = %d" , x, y, result);
      result = x % y; // remainder
      printf( "%d %% %d = %d" , x, y, result);
       return 0;
}
```

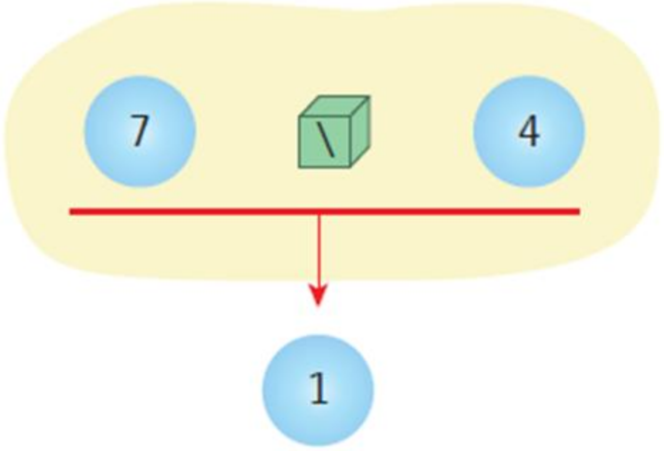




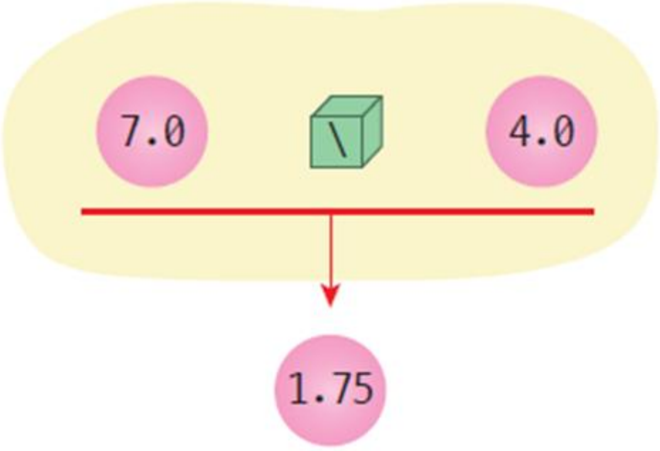
```
Enter two integers : 7 4
7 + 4 = 11
7 - 4 = 3
7 + 4 = 28
7 / 4 = 1
7 % 4 = 3
```

Division operator

- Division between integers produces an integer result, and division between floating-point numbers produces a floating-point value.
- In division between integers, the decimal places are discarded.



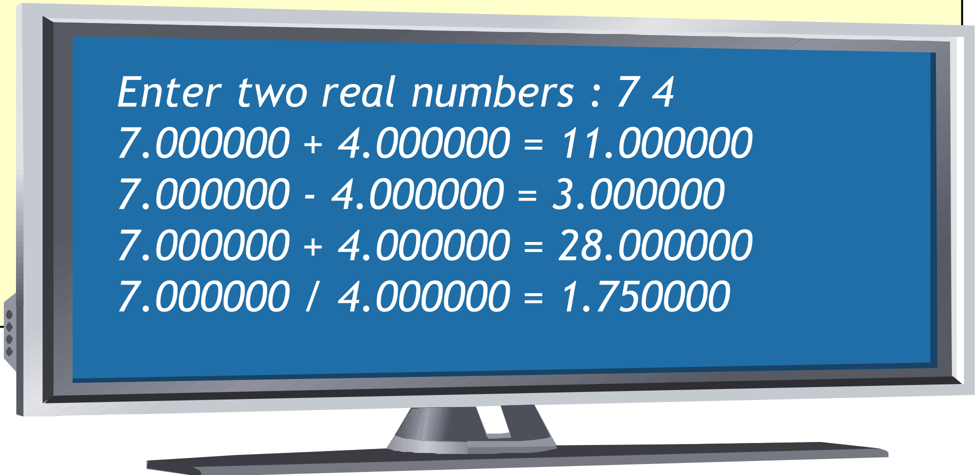
Division of integers



Division of real numbers and real numbers

Real number Arithmetic operations

```
#include < stdio.h >

int main()
{
     double x, y, result;

     printf ( " Enter two real numbers : ");
     scanf( "%lf %lf" , &x, &y);

     result = x + y; // Perform addition operation and assign the result to result
     printf( "%f / %f = %f" , x, y, result);

        ...
     result = x / y;
     printf( "%f / %f = %f" , x, y, result);

     return 0;
}
```



```
Enter two real numbers : 7 4
7.000000 + 4.000000 = 11.000000
7.000000 - 4.000000 = 3.000000
7.000000 + 4.000000 = 28.000000
7.000000 / 4.000000 = 1.750000
```

Remainder operator

- The modulus operator calculates the remainder when the first operand is divided by the second operand.
  - 10 % 2 is 0 .
  - 5 % 7 is 5 .
  - 30 % 9 is 3 .

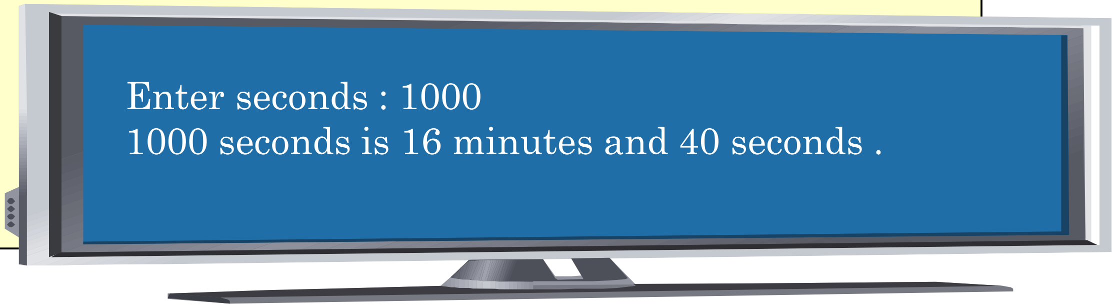
- (Example) Distinguishing between even and odd numbers using the remainder operator
  - Even if x % 2 is 0

- (Example) Determining multiples of 3 using the remainder op erator
  - x % 3 is 0, then it is a multiple of 3.

Remainder operator

```
// Remainder operator program
#include < stdio.h >
#define SEC_PER_MINUTE 60 // 1 minute is 60 seconds

int main( void )
{
      int input, minute, second;

      printf (  "  Please enter seconds : " );
      scanf ( "%d" , &input); // Read the time in seconds .

      minute = input / SEC_PER_MINUTE; // how many minutes
      second = input % SEC_PER_MINUTE; // how many seconds

      printf ( "%d seconds are %d minutes %d seconds . \n" , input, minute, second);
      return 0;
}
```

70
input
1
minute
10
second

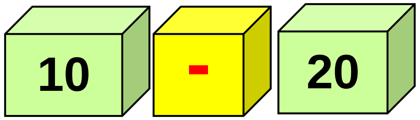


```
Enter seconds : 1000
1000 seconds is 16 minutes and 40 seconds .
```

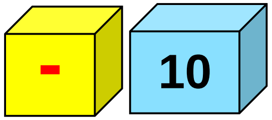
Sign operator

- Change the sign of a variable or constant

```
x = -10;
y = -x; // The value of variable y becomes 10 .
```



Binary operator

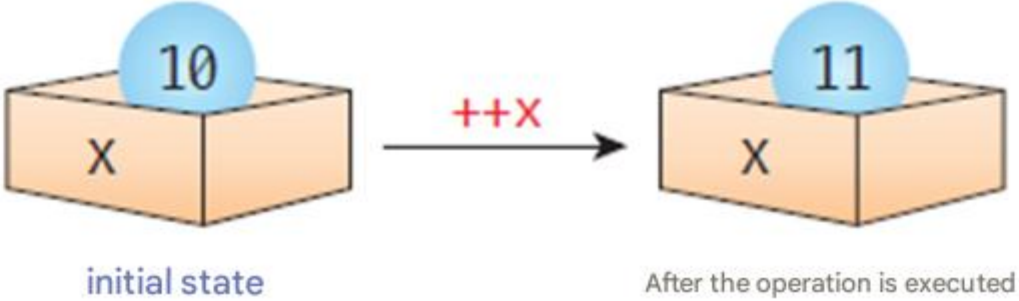


Unary operator

- is both a binary operator and a unary operator.

Increment/decrement operator

- Increment/decrement operators : ++, --
- Operator that increases or decreases the value of a variable by one.
- (Example) ++x, --x;



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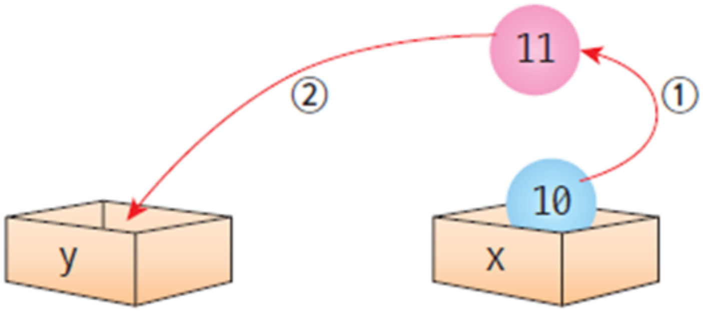
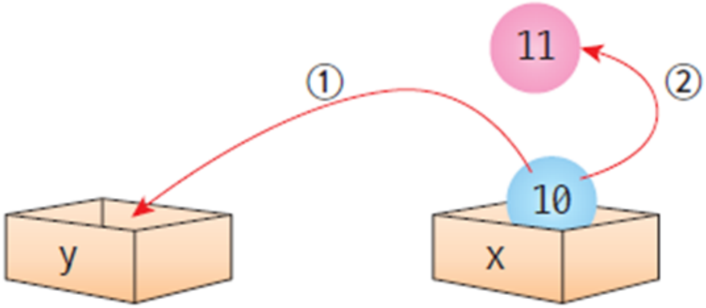
Difference between ++x and x++

```
y=++x;
```



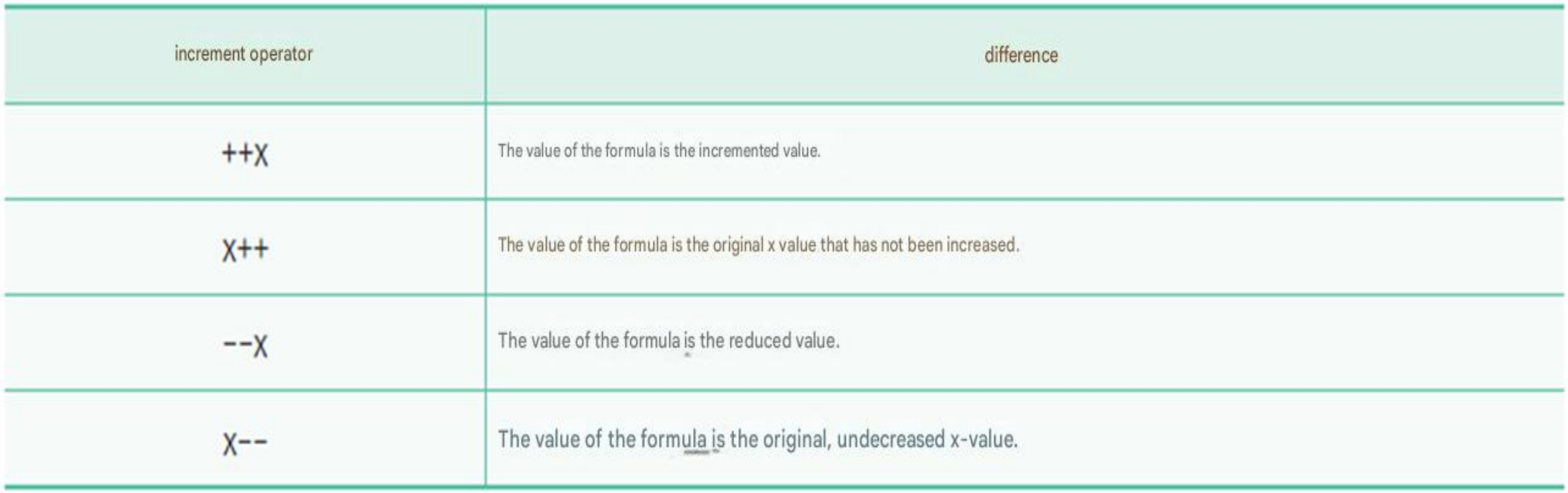
The increased value of x is assigned to y.

```
y=x++;
```



Substitute first, then increase later.

Increment/decrement operator summary



increment operator	difference
++X	The value of the formula is the incremented value.
X++	The value of the formula is the original x value that has not been increased.
--X	The value of the formula is the reduced value.
X--	The value of the formula is the original, undecreased x-value.

Examples of increment and decrement operators

```
y = (1 + x++) + 10; // Even if there are parentheses, the increase
in the value of x is executed last .
```

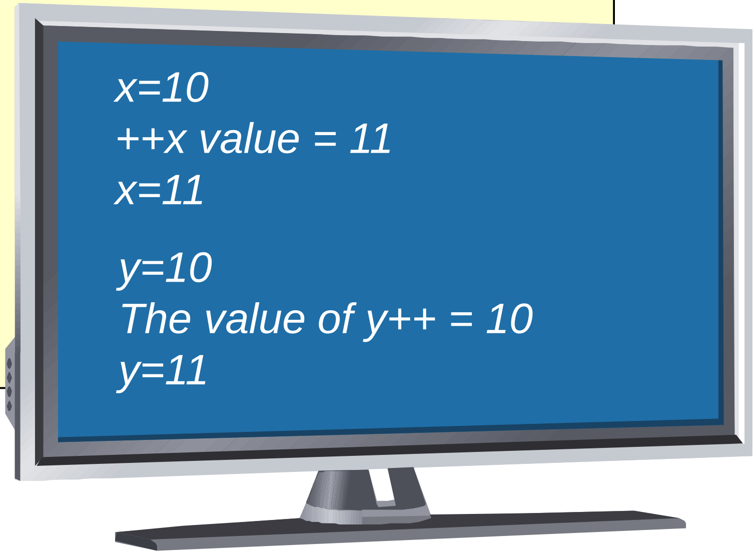
```
x = 10++; // Cannot be applied to constants .
y = (x+1)++; // Cannot be applied to formulas .
```

Example : Increment/decrement operator

```
#include < stdio.h >
int main( void )
{
    int x=10, y=10;

    printf ( "x=%d\n" , x);
    printf ( "++x value =%d\n" , ++x);
    printf ( "x=%d\n\n" , x);

    printf ( "y=%d\n" , y);
    printf ( " value of y++ =%d\n" , y++);
    printf ( "y=%d\n" , y);

    return 0;
}
```

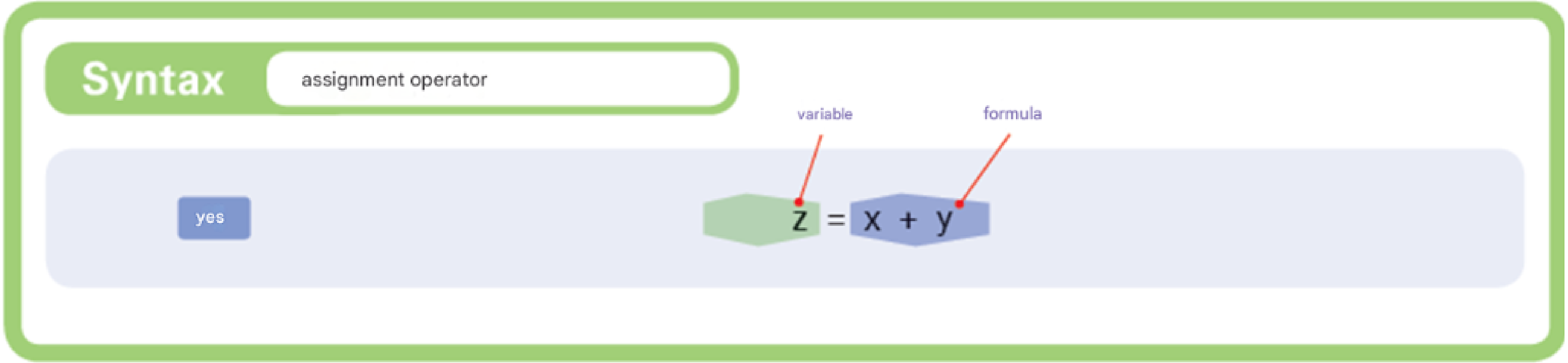
First, the value is increased and the increased value is used in the formula .

Use the current value in the formula first and increases later .



```
x=10
++x value = 11
x=11

y=10
The value of y++ = 10
y=11
```

Assignment operator

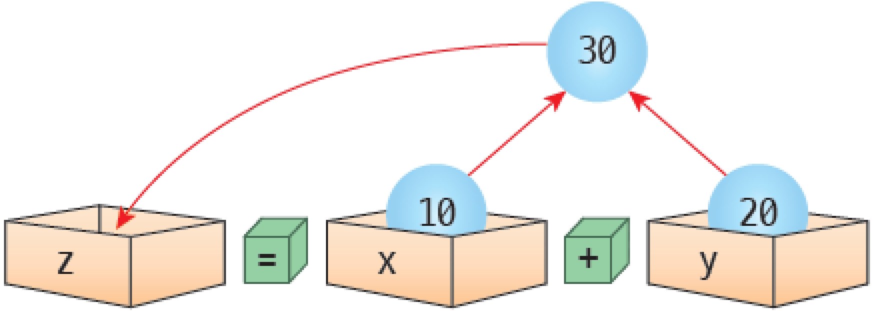


Syntax assignment operator

variable formula

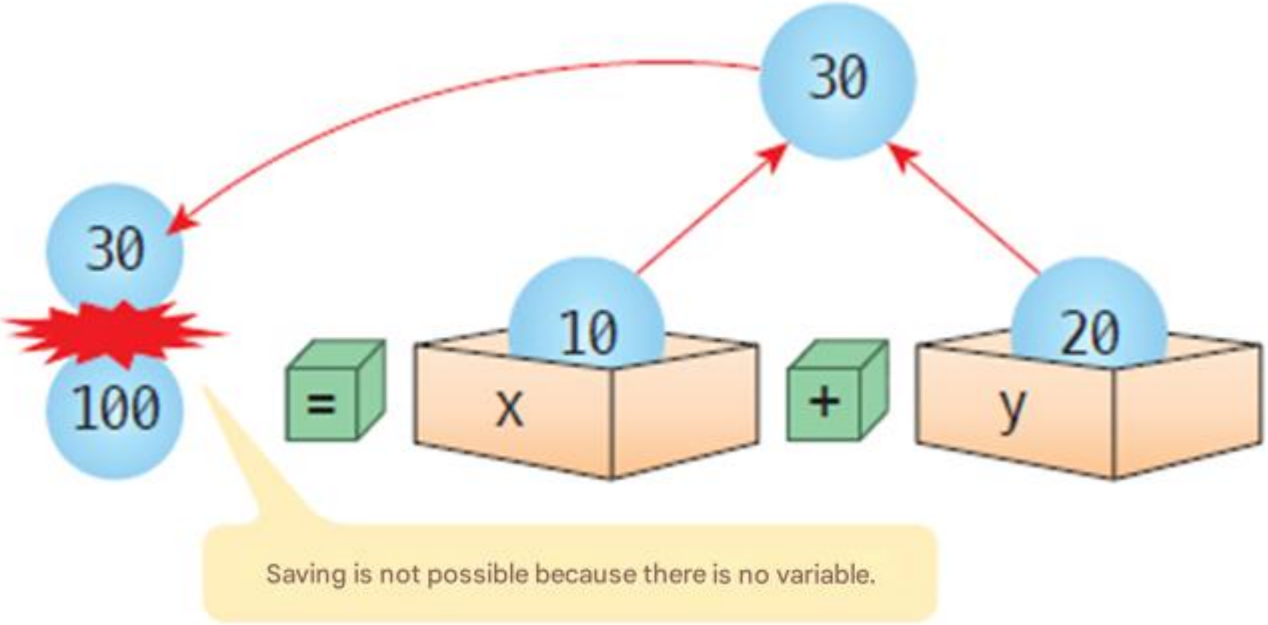
yes

z = x + y



Caution: assignment operators

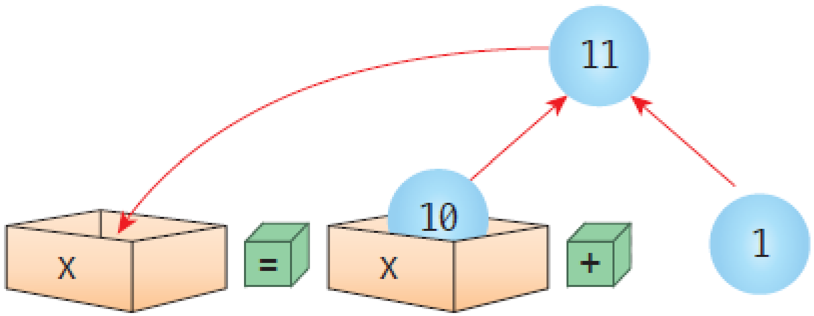
- 100 = x + y; // Compile error !



Caution: assignment operators

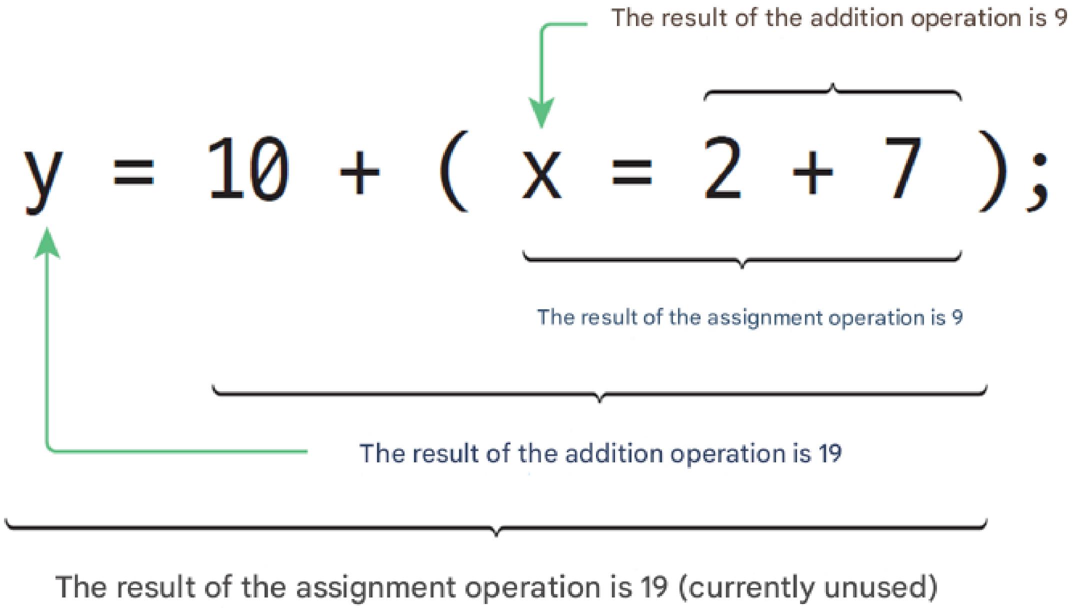
It is a correct statement in C , but mathematically incorrect.

```
x = x + 1;
```



The result of the assignment operation

All operations involve
There is a result value
Substitution operation
There is a result value .



The result of the addition operation is 9

```
y = 10 + ( x = 2 + 7 );
```

The result of the assignment operation is 9

The result of the addition operation is 19

The result of the assignment operation is 19 (currently unused)

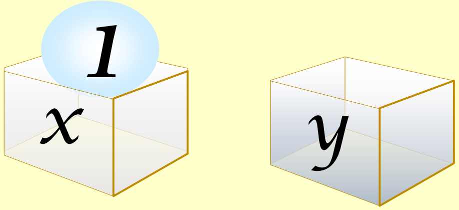
Next sentence is also possible .

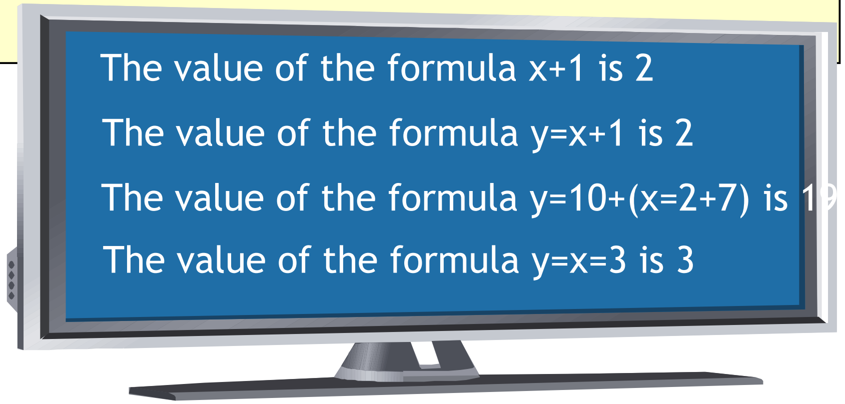
```
y = x = 3;
```

A statement that assigns the same value to multiple variables can be written as follows . Here, x = 3 is first performed, and then the resulting value, 3 , is assigned to

Example

```
/* Assignment operator program * /
#include < stdio.h >

int main( void )
{
        int x, y;

        x = 1;
        printf ( " The value of formula x+1 is %d\n" , x+1);
        printf ( " The value of the formula y=x+1 is %d\n" , y=x+1);
        printf ( " The value of the formula y=10+(x=2+7) is %d\n" , y=10+(x=2+7));
        printf ( " The value of the formula y=x=3 is %d\n" , y=x=3);

        return 0;
}
```

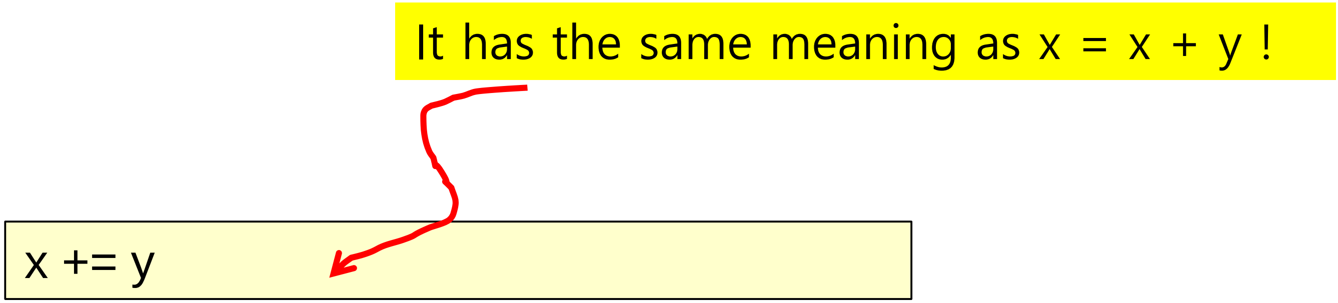




```
The value of the formula x+1 is 2
The value of the formula y=x+1 is 2
The value of the formula y=10+(x=2+7) is 19
The value of the formula y=x=3 is 3
```

Compound assignment operator

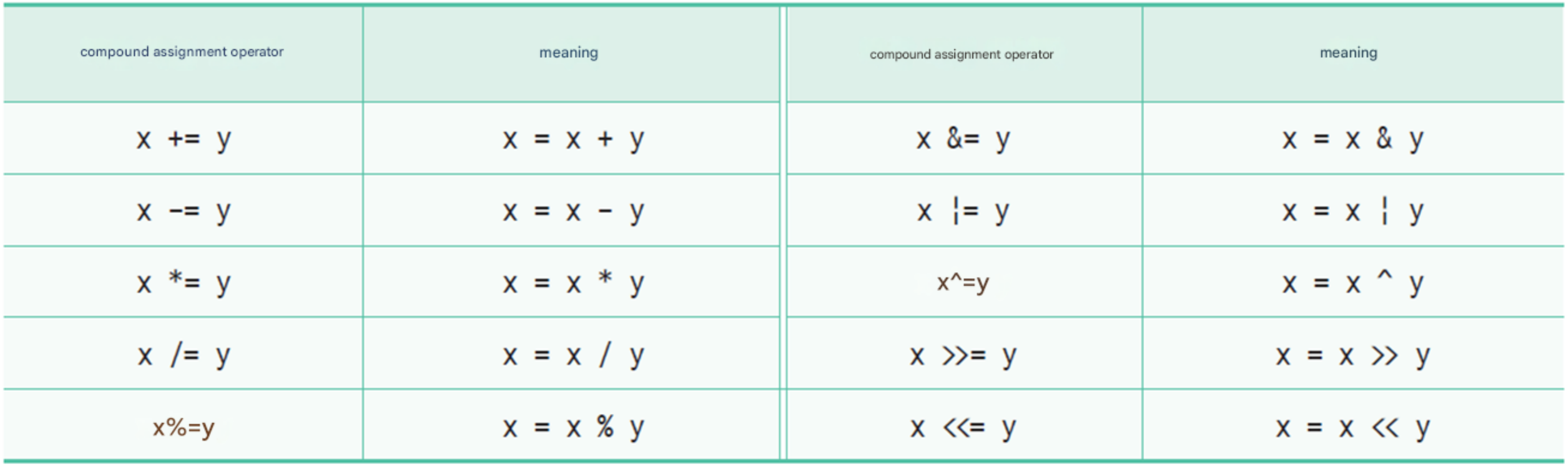
- A compound assignment operator is an operator that combines
- You can make the source simpler



It has the same meaning as x = x + y !

```
x += y
```

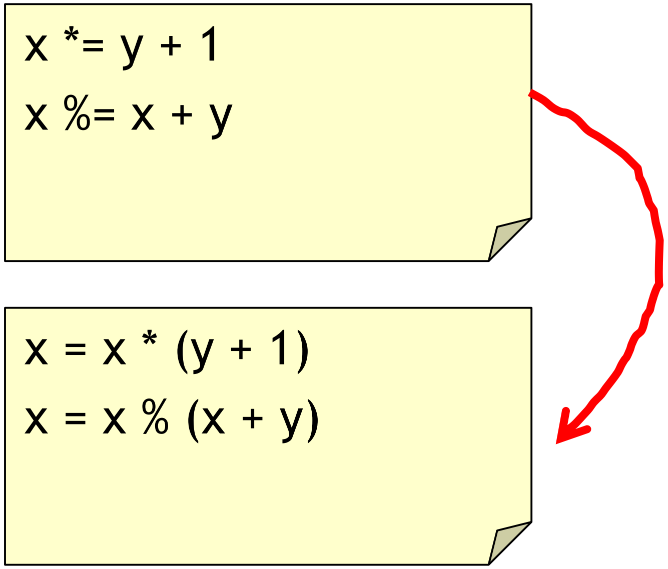
Compound assignment operator



compound assignment operator	meaning	compound assignment operator	meaning
x += y	x = x + y	x &= y	x = x & y
x -= y	x = x - y	x ¦= y	x = x ¦ y
x *= y	x = x * y	x^=y	x = x ^ y
x /= y	x = x / y	x >>= y	x = x >> y
x%=y	x = x % y	x <<= y	x = x << y

Quiz

- If we solve the following equation and rewrite it, what would it be?

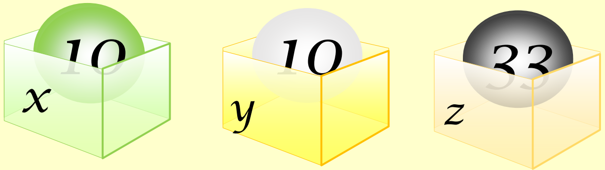


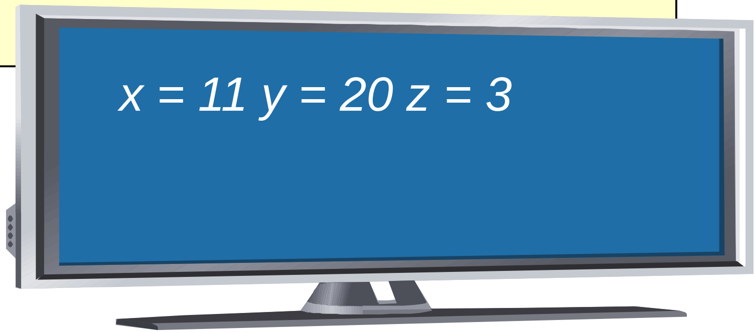
```
x *= y + 1
x %= x + y
```

```
x = x * (y + 1)
x = x % (x + y)
```

Compound assignment operator

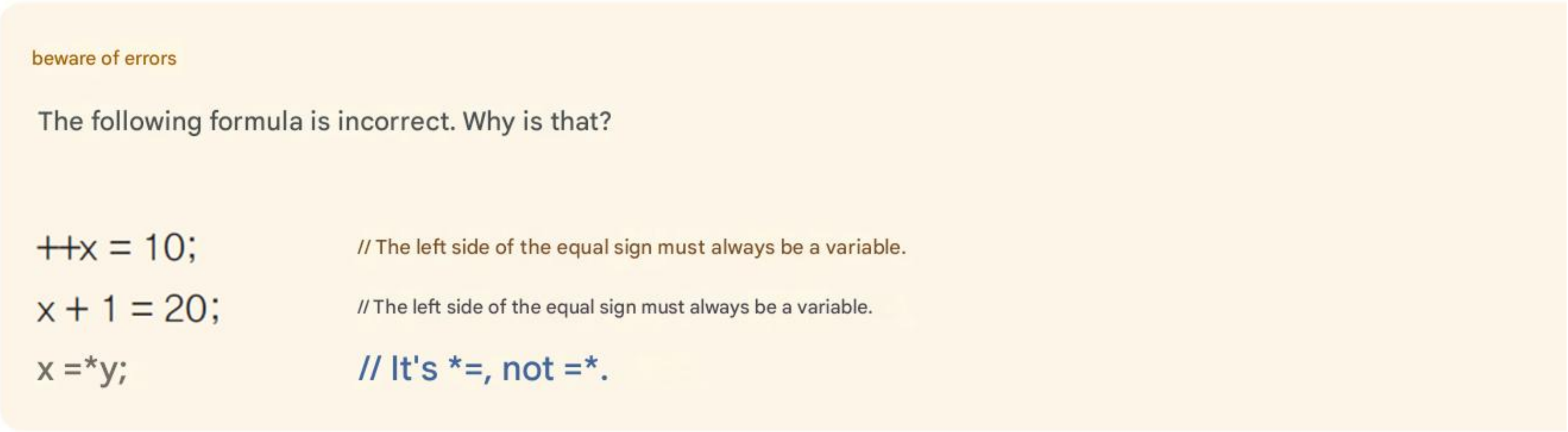
```
// Compound assignment operator program
#include < stdio.h >

int main( void )
{
       int x = 10, y = 10, z = 33;

      x += 1;
      y *= 2;
      z %= 10 + 20;

       printf ( "x = %d y = %d z = %d \n" , x, y, z);
       return 0;
}
```





```
x = 11 y = 20 z = 3
```

Error Alert



beware of errors

The following formula is incorrect. Why is that?

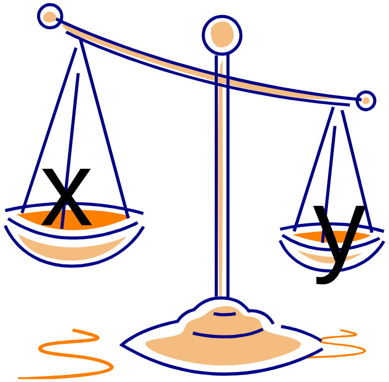
```
++x = 10;         // The left side of the equal sign must always be a variable.
x + 1 = 20;       // The left side of the equal sign must always be a variable.
x =*y;            // It's *=, not =*.
```

Relational Operators

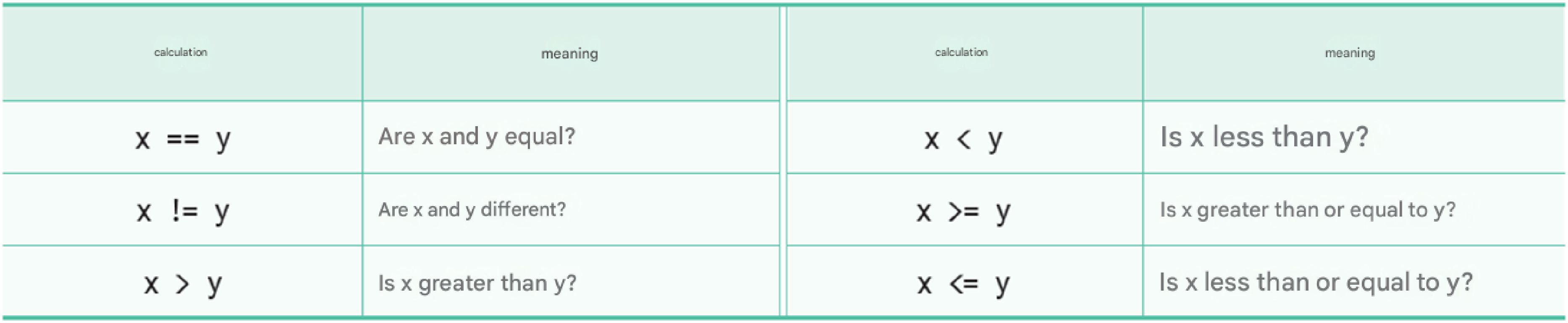
- Operator that compares two operands
- The result is true (1) or false (0).

x == y

Compares whether the values of x and y are equal .



Relational Operators



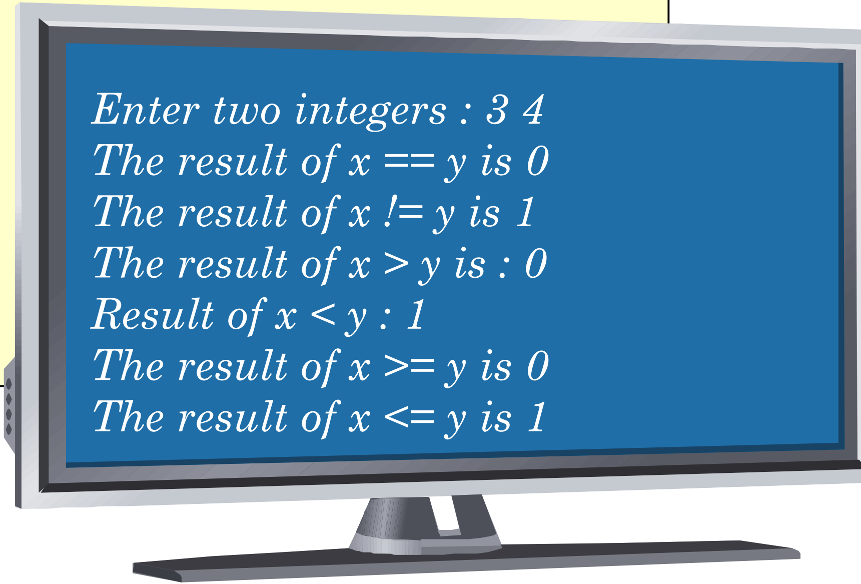
calculation	meaning	calculation	meaning
x == y	Are x and y equal?	x < y	Is x less than y?
x != y	Are x and y different?	x >= y	Is x greater than or equal to y?
x > y	Is x greater than y?	x <= y	Is x less than or equal to y?

Examples of relational operators

```
1 == 1 // true (1)
1 != 2 // true (1)
2 > 1 // true (1)
x >= y // true if x is greater than or equal to y (1) , otherwise false (0)
```

Example

```c
#include < stdio.h >
int main( void )
{
        int x, y;

      printf ( " Enter two integers : ");
      scanf ( "% d%d " , &x, &y);

      printf ( " The result of x == y : %d", x == y);
      printf ( " The result of x != y : %d", x != y);
      printf ( " Result of x > y : %d", x > y);
      printf ( " The result of x < y : %d", x < y);
      printf ( " The result of x >= y : %d", x >= y);
      printf ( " The result of x <= y : %d", x <= y);

      return 0;
}
```



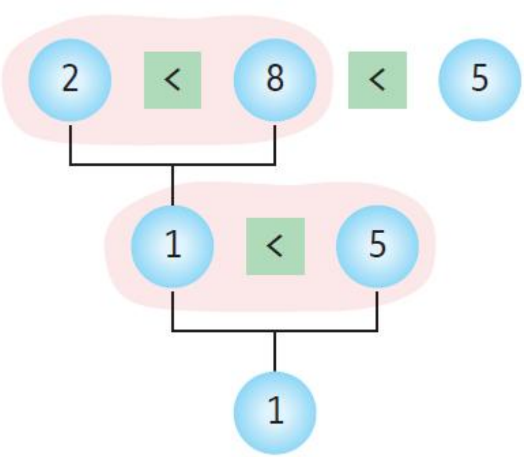
```
Enter two integers : 3 4
The result of x == y is 0
The result of x != y is 1
The result of x > y is : 0
Result of x < y : 1
The result of x >= y is 0
The result of x <= y is 1
```

Caution!

- (x = y)
  - Substitute the value of y into x . The value of this formula is the value of x .
- (x == y)
  - x and y are equal, the value of the formula is 1, otherwise it is 0 .
  - (x == y) to (x = y) Be careful not to use it incorrectly !

Caution: when using relational operators

- As in mathematics, 2 < x < 5 and If you write them together, you will get wrong results .



- The right way : (2 < x) && (x < 5)

When comparing real numbers

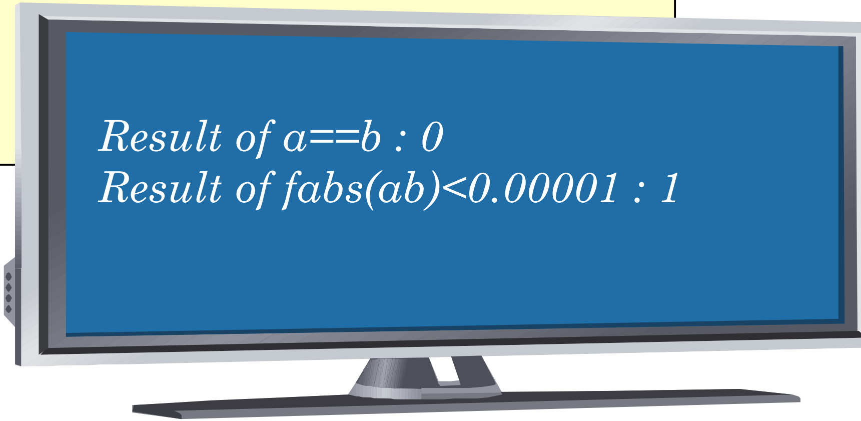
- (1e32 + 0.01) > 1e32
  - -> False because the values on both sides are considered equal

- (fabs(xy)) < 0.0001
  - Correct formula

Mistakes may have some errors !

Example

```
#include < stdio.h >
#include < math.h >

int main( void )
{
 double a, b;
a = (0.3 * 3) + 0.1;
b = 1;
 printf ( " Result of a==b : %d \n" , a == b);


 printf ( " Result of fabs(ab)<0.00001 : %d \n" , fabs(a - b) < 0.0001);
 return 0;
}
```



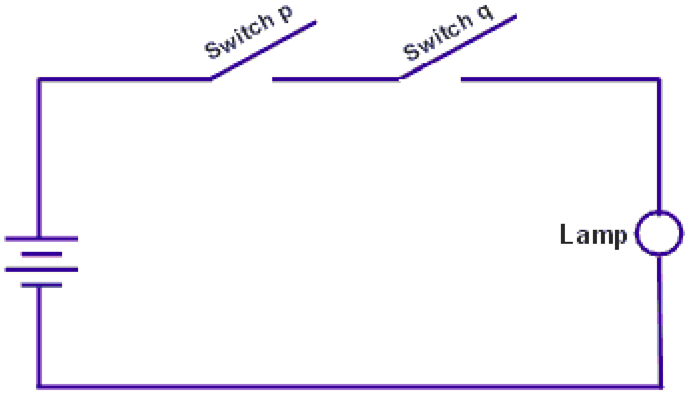
```
Result of a==b : 0
Result of fabs(ab)<0.00001 : 1
```

Logical Operators

- An operator that combines multiple conditions to determine true or false.
- The result is true (1) or false (0).

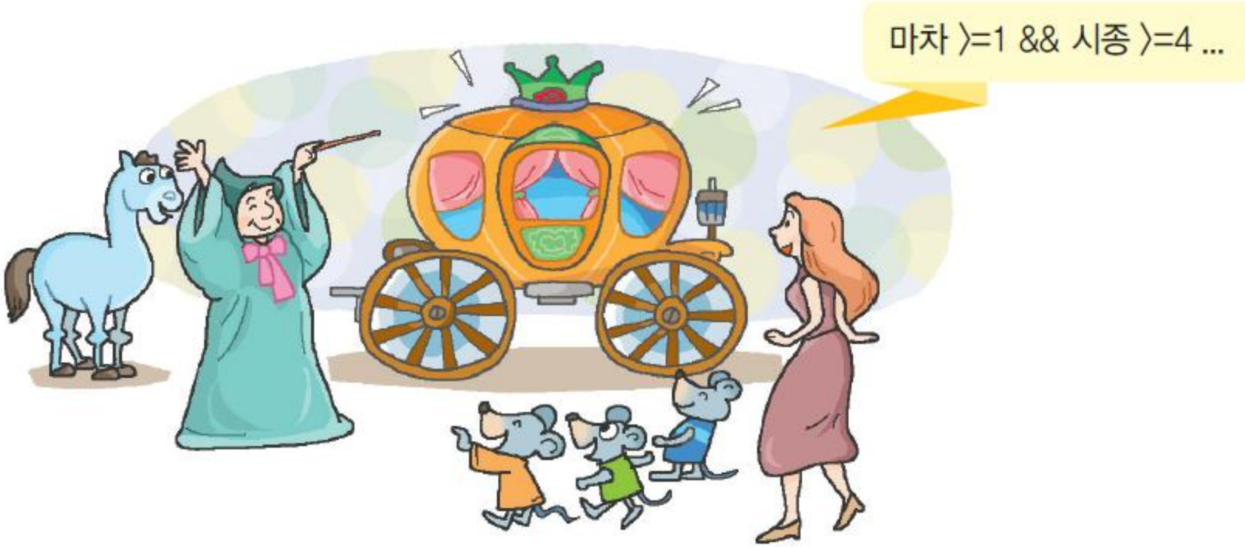
Both x and y are true
It is true only if .

x && y



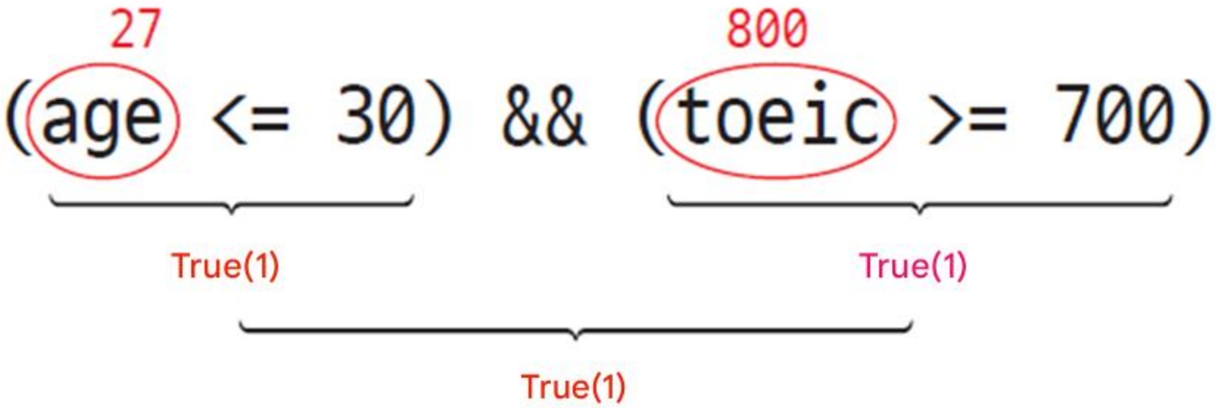
Logical Operators

calculation	meaning
x && y	AND operation, true if both x and y are true, otherwise false
x ¦¦ y	OR operation, true if only one of x or y is true, false if both are false
!x	NOT operation, false if x is true, true if x is false



AND operator

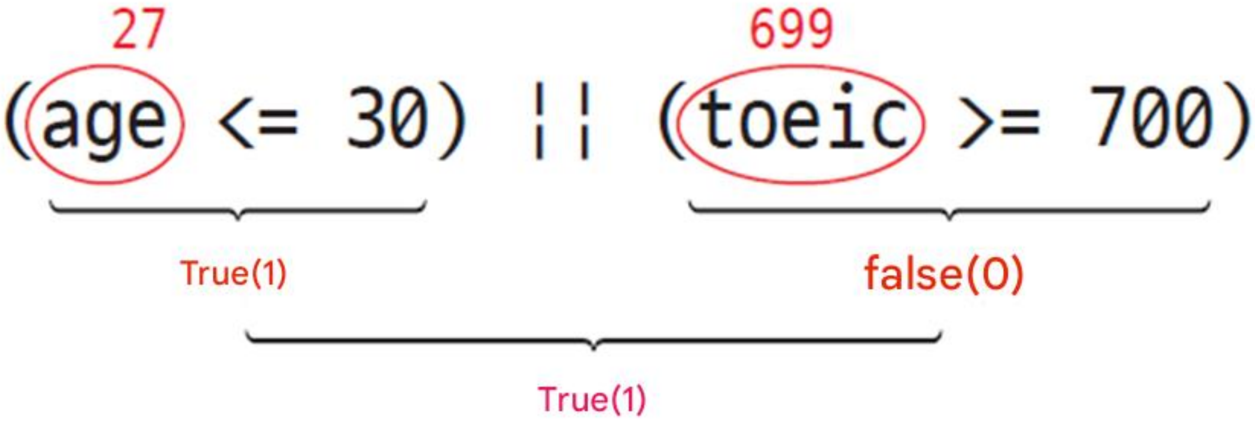
- a company is hiring new employees and they set a requirement that the applicants be under 30 years old and have a TOEIC scor e of 700 or higher .



```
(age <= 30) && (toeic >= 700)
```

OR operator

- the conditions for hiring new employees have changed so that they must be under 30 years old or have a TOEIC score of 700 or higher .



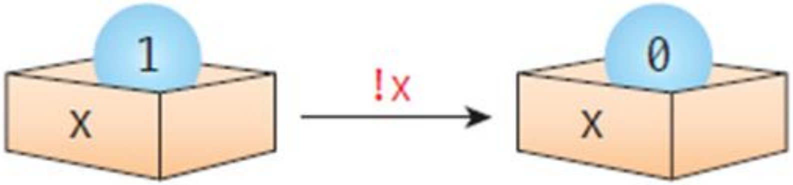
```
(age <= 30) || (toeic >= 700)
```

Examples of logical operators

- “ Is x one of 1, 2, or 3 ?”
    - (x == 1) || (x == 2) || (x == 3)
- “ x is greater than or equal to 60 and less than 100 .”
    - (x >= 60) && (x < 100)
- “ x is neither 0 nor 1 .”
    - (x != 0) && (x != 1) //

NOT operator

- If the value of the operand is true, the result of the operation is made false , and if the value of the operand is false, the result of the operation is made true .



initial state

After the operation is executed

```
result = !1; // 0 is assigned to result .
result = !(2==3); // 1 is assigned to result .
```

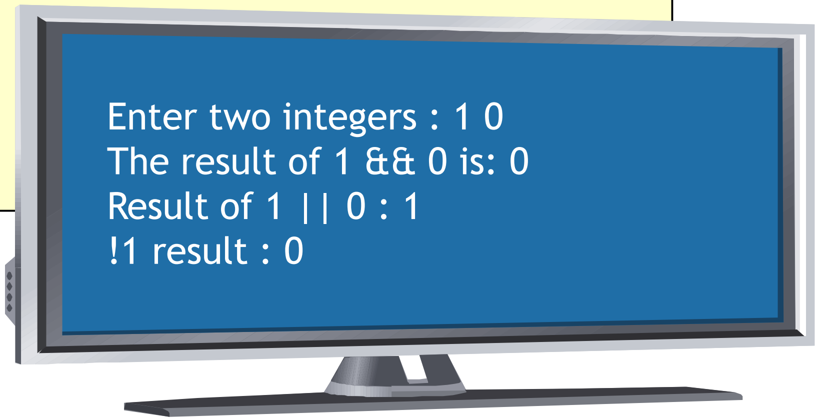
How to express truth and false

- If a relational formula or logical formula is true, 1 is generate, and if it is false, 0 is generated .
- the truth or falsity of an operand, it is considered true if it is not 0 , and false if it is 0 .
- Negative numbers are considered false .
- (Example) When applying the NOT operator

```
!0 // The value of the expression is 1
!3 // The value of the expression is 0
!-3             // The value of the expression is 0
```

Example

```c
#include < stdio.h >

int main( void )
{
     int x, y;

     printf ( " Enter two integers : ");
     scanf ( "%d %d" , &x, &y) ;

     printf ( "%d && %d result : %d", x, y, x && y) ;
     printf ( "%d || %d result : %d", x, y, x || y) ;
     printf ( "!%d result : %d", x, !x );

     return 0;
}
```



```
Enter two integers : 1 0
The result of 1 && 0 is: 0
Result of 1 || 0 : 1
!1 result : 0
```

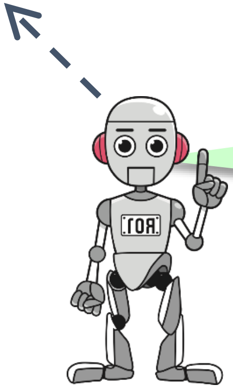
Shortcut calculation

- For the && operator , if the first operand is false, the other operands are not evaluated .

```
( 2 > 3 ) && ( ++x < 5 )
```

- For the || operator , if the first operand is true, the other operand s are not evaluated .

```
( 3 > 2 ) || ( --x < 5 )
```

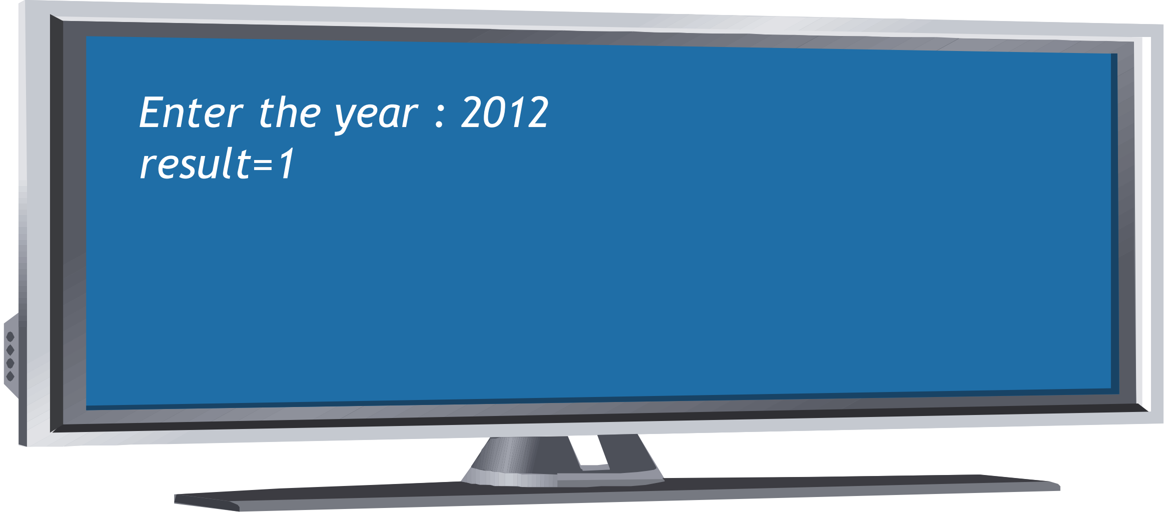


The first operator is
If it's false, then don't need
To calculate the rest

Please be
careful that
++ and --
may not run.

Lab: Leap year

- Conditions for a leap year
  - The year is divisible by 4 .
  - Years divisible by 100 are excluded .
  - A year that is divisible by 400 is a leap year .



```
Enter the year : 2012
result=1
```

Lab: Leap year

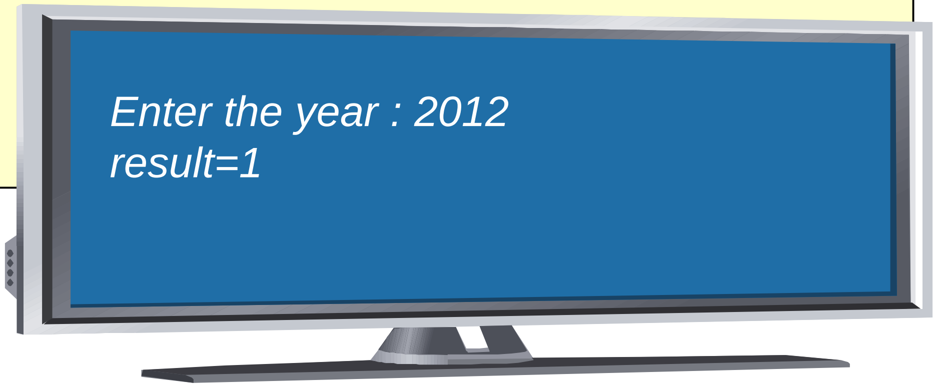
- Expressing the conditions for a leap year in a formula
  - ((year % 4 == 0) && (year % 100 != 0)) || (year % 400 == 0)

Are parentheses really necessary ?

Parentheses are optional, but they make reading easier .

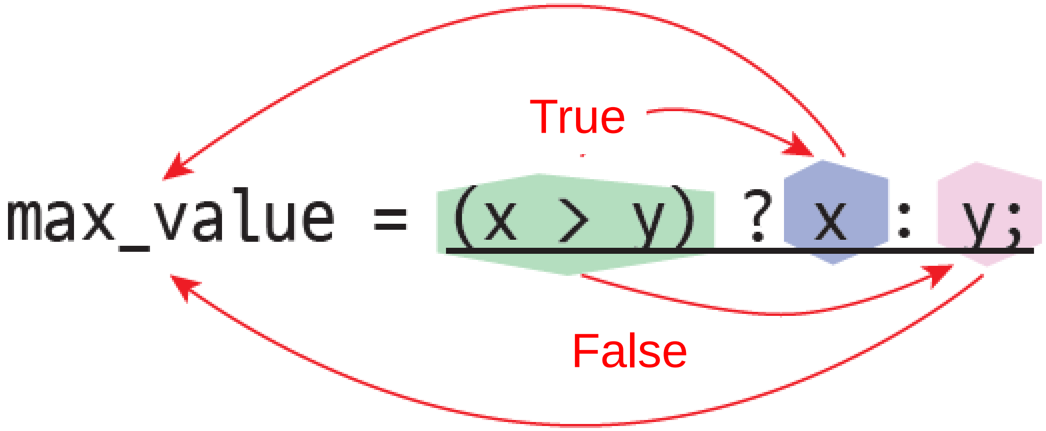
Lab: Leap year

```
#include < stdio.h >
int main( void )
{
    int year, result;

    printf ( " Enter the year : " );
    scanf ( "%d" , &year);

    result = ( (year % 4 == 0) && (year % 100 != 0)) || (year % 400 == 0);
    printf ( "result=%d \n" , result);

    return 0;
}
```



```
Enter the year : 2012
result=1
```

Conditional Operator

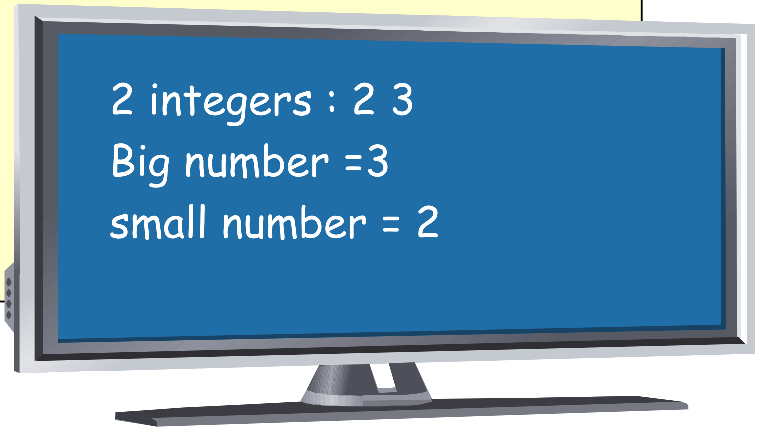


```
max_value = (x > y) ? x : y;
```

```
 absolute_value = (x > 0) ? x : -x; // Calculate absolute value
 max_value = (x > y) ? x : y; // Calculate maximum value
 min_value = (x < y) ? x : y; // Calculate minimum value
(age > 20) ? printf ( " Adult \n" ): printf ( " Teenager \n" );
```

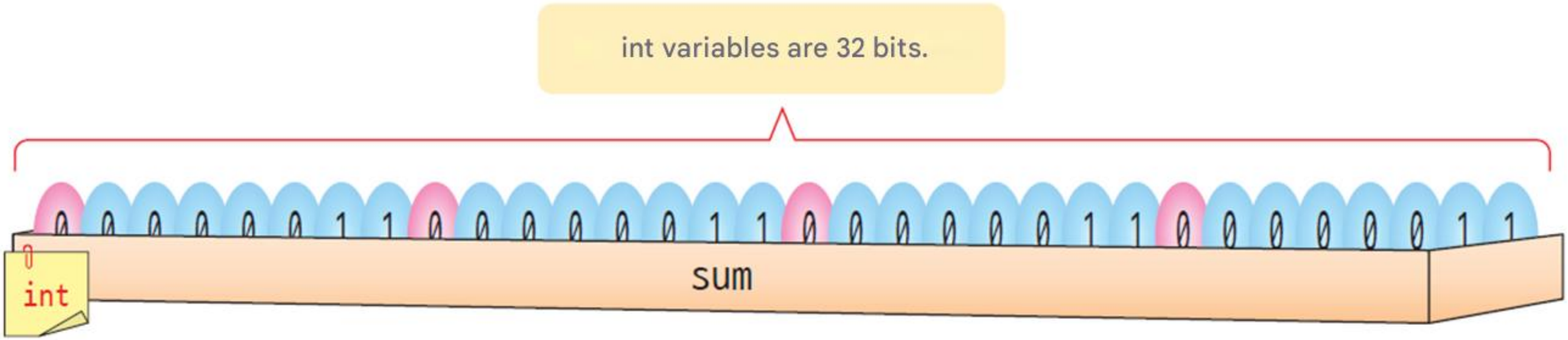
Example

```
// Conditional operator program
#include < stdio.h >

int main( void )
{
  int x,y ;

  printf ( " Two integers : " );
  scanf( "%d %d" , &x, &y);

  printf ( " large number =%d \n" , (x > y) ? x : y );
  printf ( " small number =%d \n" , (x < y) ? x : y );
}
```



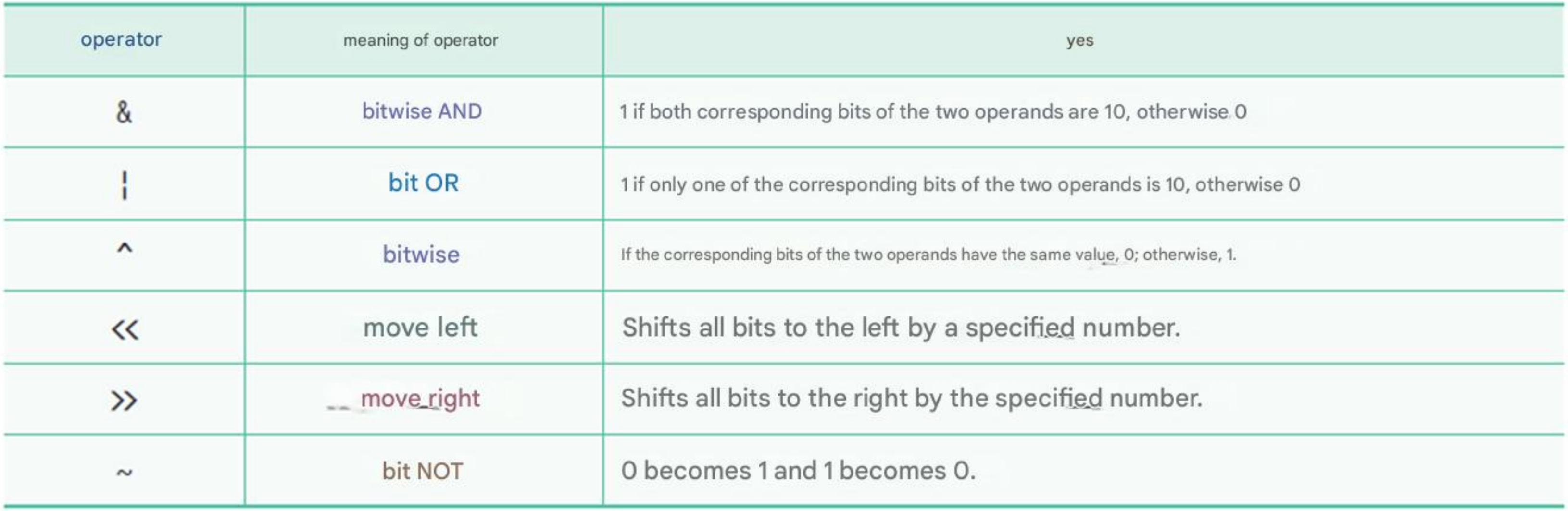
```
2 integers : 2 3
Big number =3
small number = 2
```

All data is made up of bits .



int variables are 32 bits.

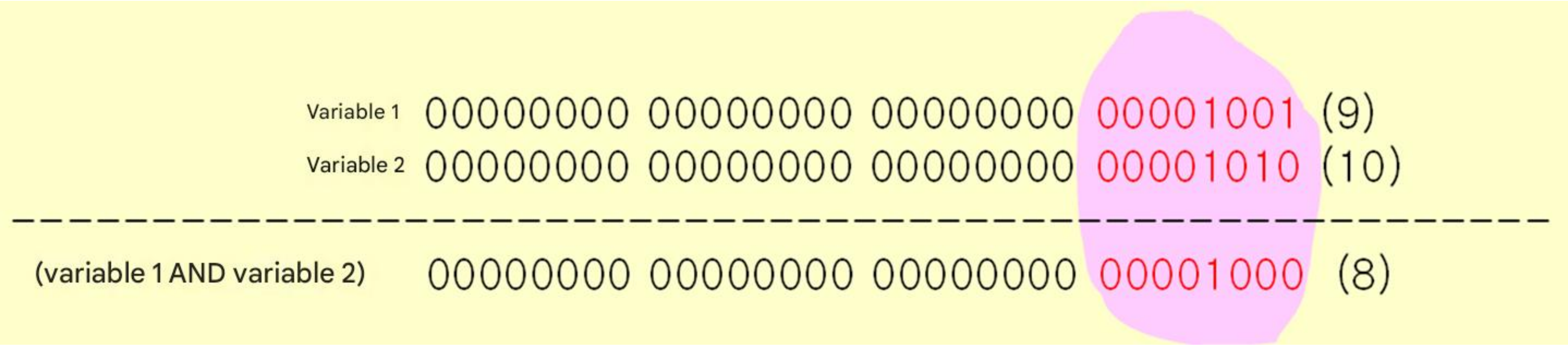
Bitwise Operator



operator	meaning of operator	yes
&	bitwise AND	1 if both corresponding bits of the two operands are 10, otherwise 0
¦	bit OR	1 if only one of the corresponding bits of the two operands is 10, otherwise 0
^	bitwise	If the corresponding bits of the two operands have the same value, 0; otherwise, 1.
<<	move left	Shifts all bits to the left by a specified number.
>>	move right	Shifts all bits to the right by the specified number.
~	bit NOT	0 becomes 1 and 1 becomes 0.

Bitwise AND operator

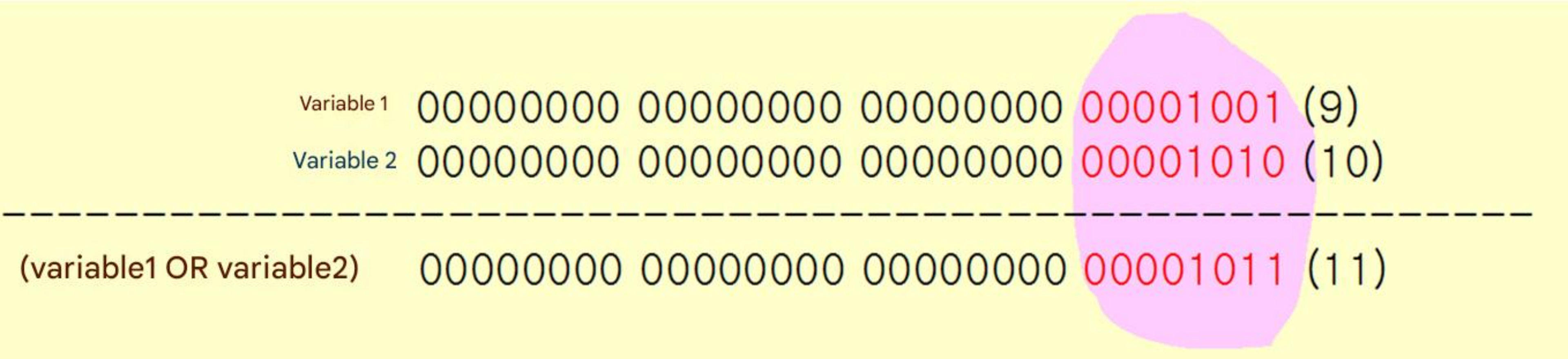
0 AND 0 = 0
1 AND 0 = 0
0 AND 1 = 0
1 AND 1 = 1



```
Variable 1  00000000 00000000 00000000 00001001 (9)
Variable 2  00000000 00000000 00000000 00001010 (10)
-----------------------------------------------------------------
(variable 1 AND variable 2)  00000000 00000000 00000000 00001000 (8)
```

Bit OR operator

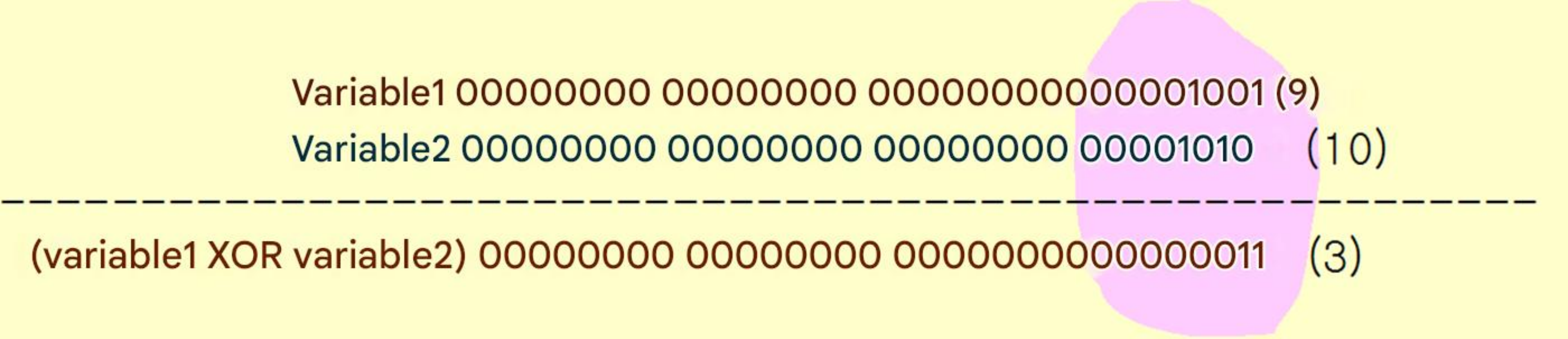
0 OR 0 = 0
1 OR 0 = 1
0 OR 1 = 1
1 OR 1 = 1



```
Variable 1             00000000 00000000 00000000 00001001 (9)
Variable 2             00000000 00000000 00000000 00001010 (10)
-----------------------------------------------------------------
(variable1 OR variable2) 00000000 00000000 00000000 00001011 (11)
```

Bitwise XOR operator

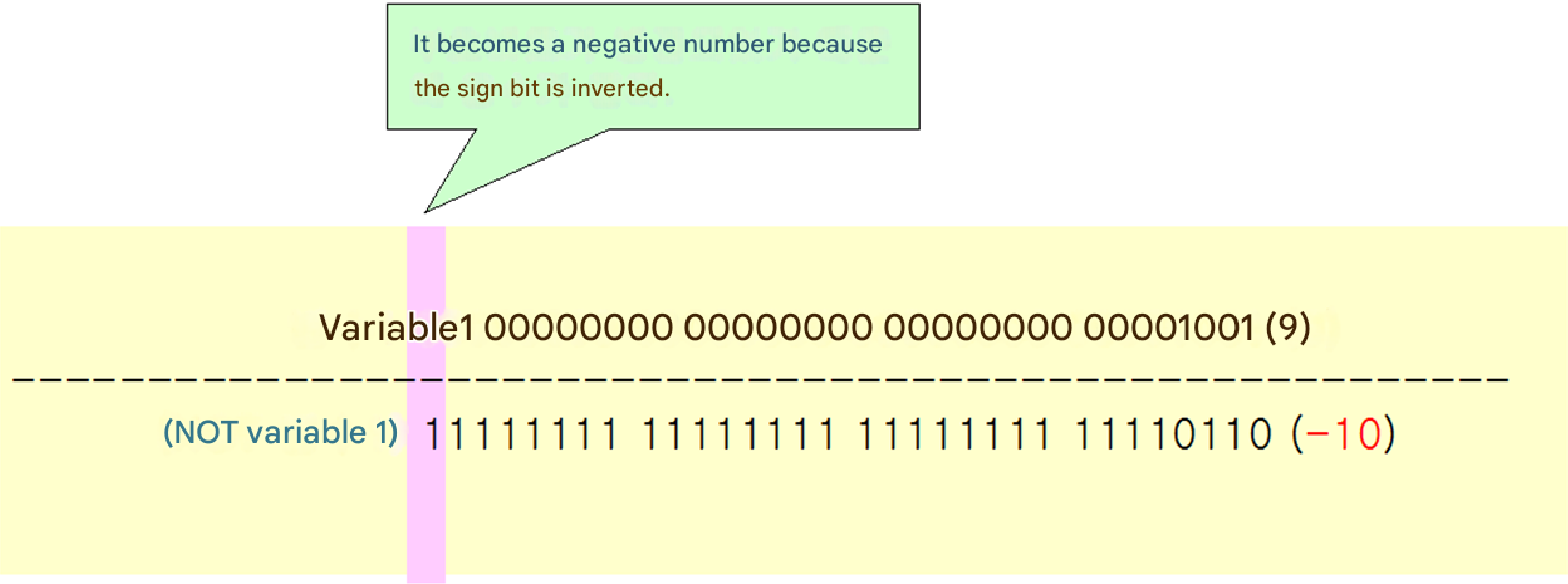
0 XOR 0 = 0
1 XOR 0 = 1
0 XOR 1 = 1
1 XOR 1 = 0



```
Variable1 00000000 00000000 0000000000001001 (9)
Variable2 00000000 00000000 00000000 00001010    (10)
----------------------------------------------------------
(variable1 XOR variable2) 00000000 00000000 0000000000000011    (3)
```

Bitwise NOT operator

NOT 0 = 1
NOT 1 = 0

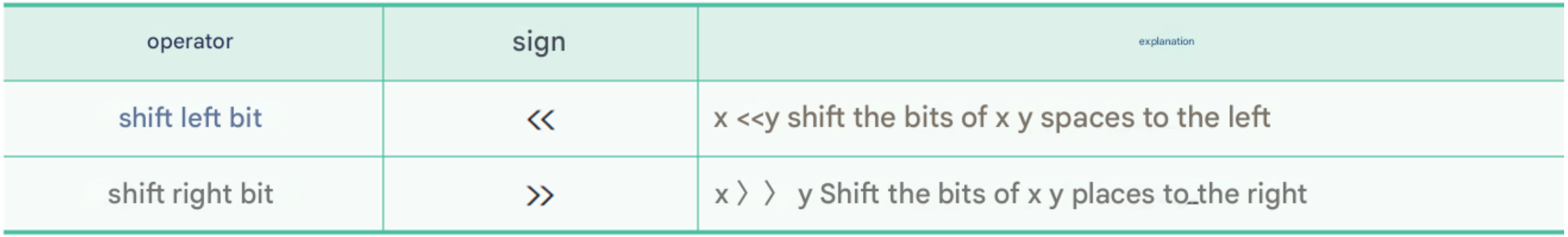


It becomes a negative number because the sign bit is inverted.

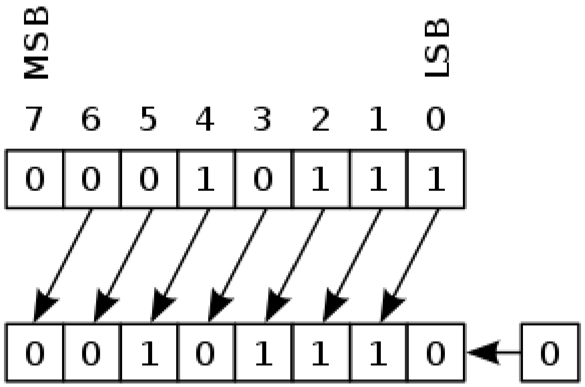
Variable1 00000000 00000000 00000000 00001001 (9)

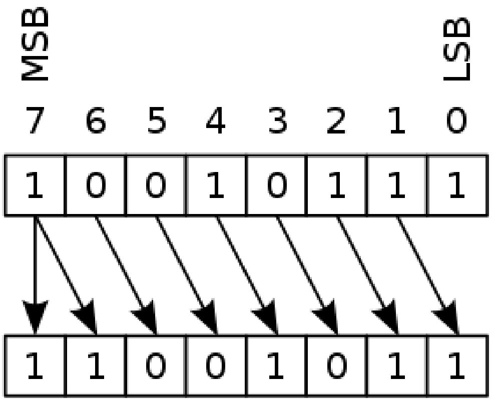
(NOT variable 1) 11111111 11111111 11111111 11110110 (−10)

Bit shift operator



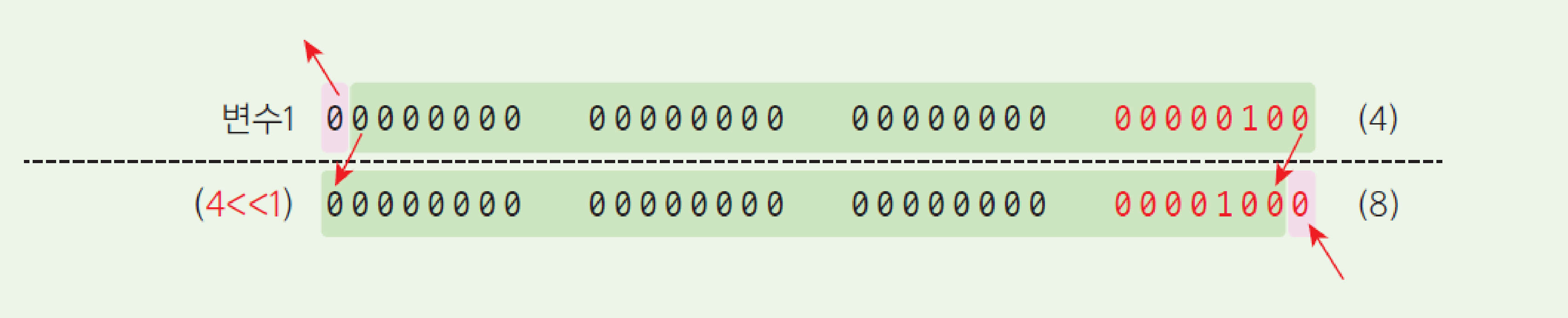
operator	sign	explanation
shift left bit	≪	x <<y shift the bits of x y spaces to the left
shift right bit	≫	x 〉〉 y Shift the bits of x y places to_the right





<< operator

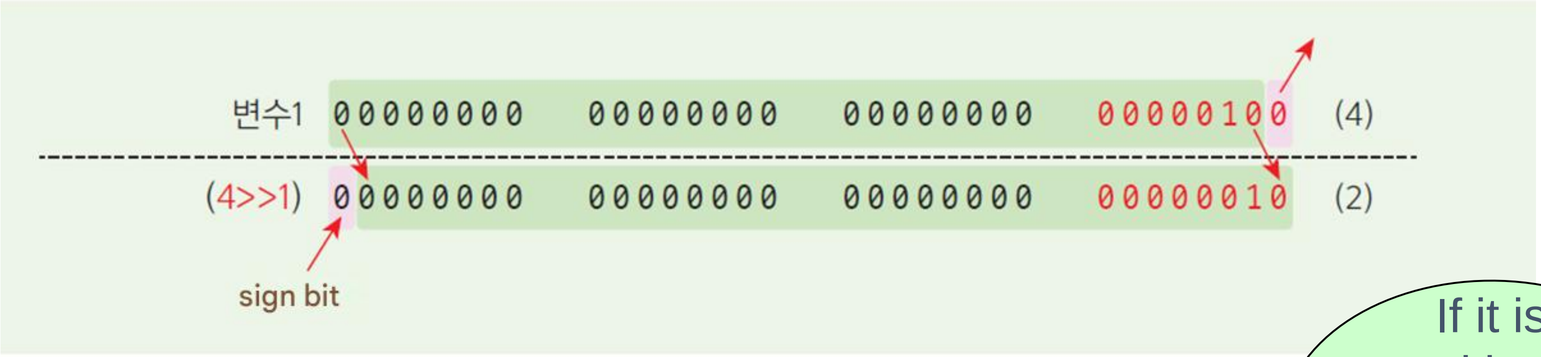
- bit left
- The value is doubled .



```
변수1   00000000  00000000  00000000  00000100  (4)
------------------------------------------------------
(4<<1)  00000000  00000000  00000000  00001000  (8)
```

>> operator

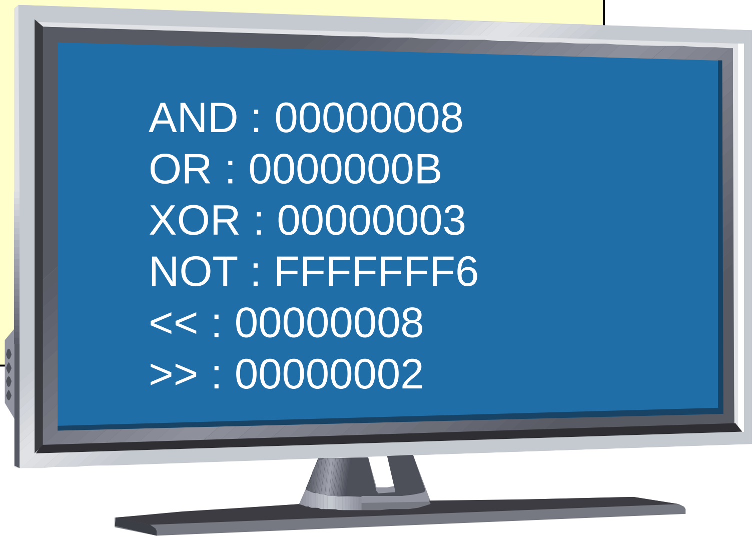
- move
- The value is multiplied by 1/2 .



If it is positive, 0 comes in from the left .

Example : Bitwise Operators

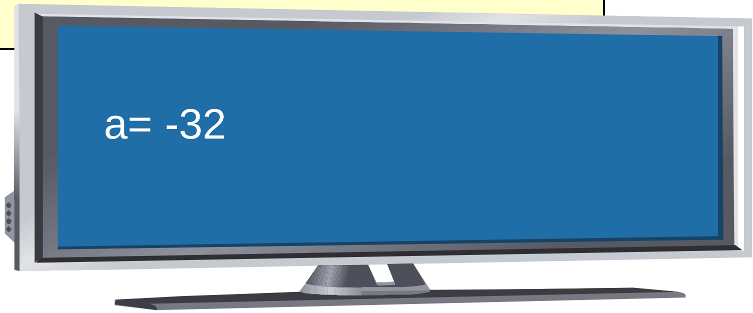
```
#include < stdio.h >

int main( void )
{
        printf ( "AND : %08X\n" , 0x9 & 0xA);
        printf( "OR : %08X\n" , 0x9 | 0xA);
        printf( "XOR : %08X\n" , 0x9 ^ 0xA);
        printf ( "NOT : %08X\n" , ~0x9);
        printf( "<< : %08X\n" , 0x4 << 1);
        printf( ">> : %08X\n" , 0x4 >> 1);

        return 0;
}
```



```
AND : 00000008
OR : 0000000B
XOR : 00000003
NOT : FFFFFFF6
<< : 00000008
>> : 00000002
```

Example : Creating 2 's Complement with Bitwise Operators

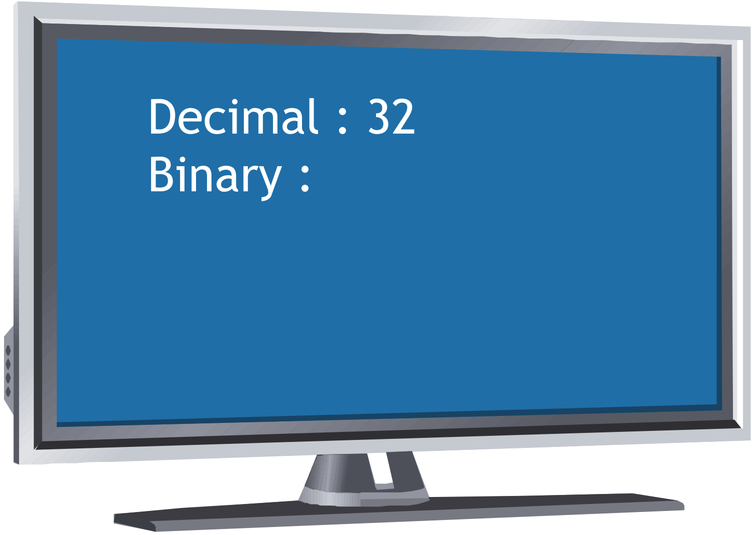
```
#include < stdio.h >

int main( void )
{
    int a = 32;
    a = ~a; // Make it 1 's complement using NOT operator .
    a = a + 0x01; // add 1 .
    printf( "a= %d \n" , a);

    return 0;
}
```



```
a= -32
```

Lab: Outputting decimal to binary

- use bitwise operators to display decimal numbers less than 128 in binary format on the screen .



```
Decimal : 32
Binary :
```

Lab: Outputting decimal to binary

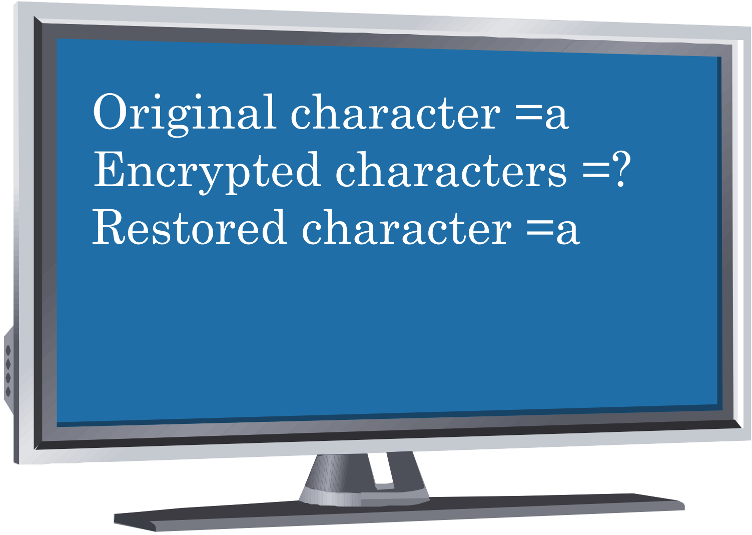
```
#define _CRT_SECURE_NO_WARNINGS
#include <stdio.h>

int main( void )
{
        unsigned int num;
        printf ( " Decimal : " );
        scanf ( "%u" , &num);

        unsigned int mask = 1 << 7; // mask = 10000000
        printf ( " Binary : " );

        ((num & mask) == 0) ? printf( "0" ) : printf( "1" );
        mask = mask >> 1; // Shift 1 bit to the right .
        ((num & mask) == 0) ? printf( "0" ) : printf( "1" );
        mask = mask >> 1; // Shift 1 bit to the right .
        ((num & mask) == 0) ? printf( "0" ) : printf( "1" );
```

Lab: Outputting decimal to binary

```
    mask = mask >> 1; // Shift 1 bit to the right .
    ((num & mask) == 0) ? printf( "0" ) : printf( "1" );
     mask = mask >> 1;
     ((num & mask) == 0) ? printf( "0" ) : printf( "1" );
     mask = mask >> 1;
     ((num & mask) == 0) ? printf( "0" ) : printf( "1" );
     mask = mask >> 1;
     ((num & mask) == 0) ? printf( "0" ) : printf( "1" );
     mask = mask >> 1;
     ((num & mask) == 0) ? printf( "0" ) : printf( "1" );
     printf ( "\n" );

     return 0;
}
```

Lab: Encryption using XOR

- To encrypt a single character, just do x= x^key ; . Decryption is also possible . x= x^key ; That's it .



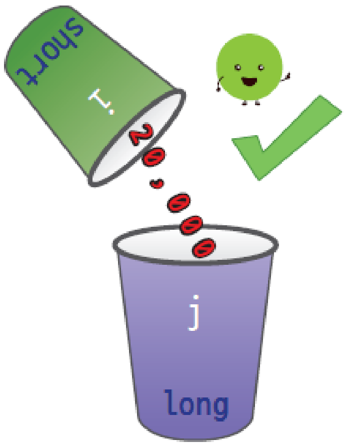
```
Original character =a
Encrypted characters =?
Restored character =a
```

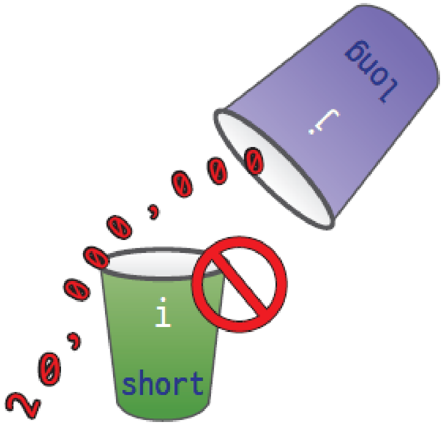
Lab: Encryption using XOR

```
#include < stdio.h >
int main(void)
{
 char data = 'a' ;
 char key = 0xff;
 char encrpted_data , orig_data ;

 printf ( " Original character =%c\n" , data );

 encrpted_data = data ^ key;
 printf ( " Encrypted character =%c \n" , encrpted_data );

 orig_data = encrpted_data ^ key;
 printf ( " Restored character =%c\n" , orig_data );

 return 0;
}
```

Type conversion

- Type conversion is changing the type of data during execution.

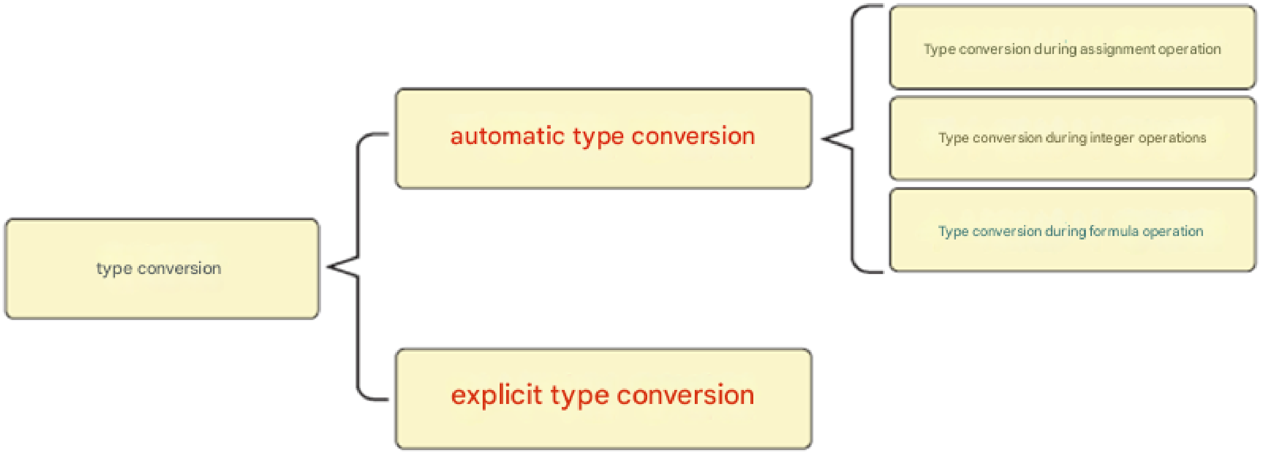




Be careful
because if you
do the
conversion
incorrectly,
some of the
data may be
lost.
Do it .

Type conversion

- The type of data is converted during operation.



type conversion

automatic type conversion

Type conversion during assignment operation

Type conversion during integer operations

Type conversion during formula operation

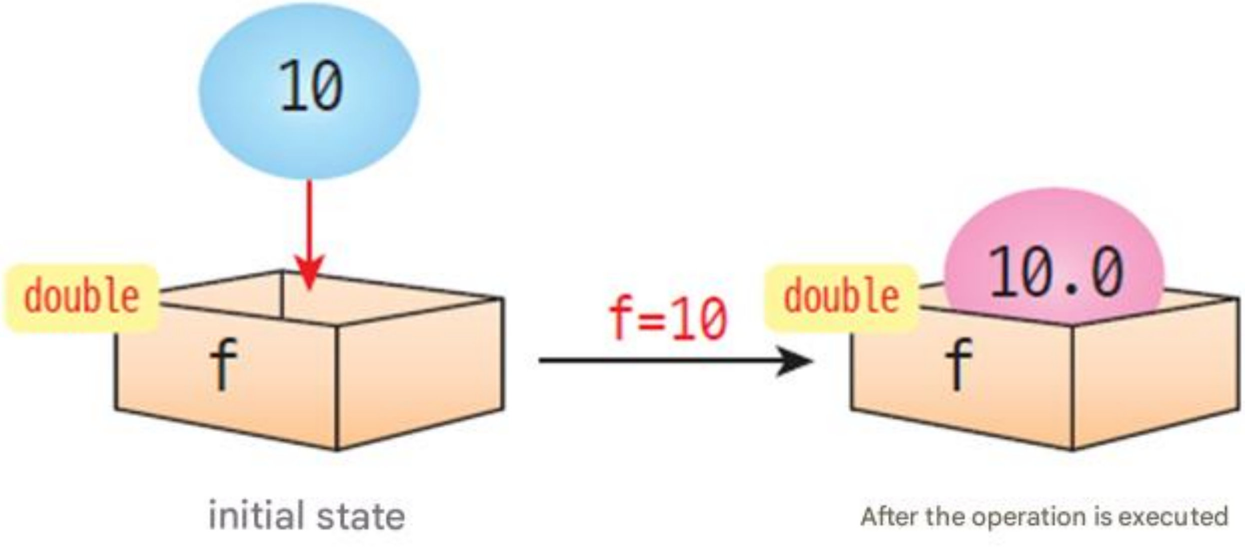
explicit type conversion

The type of the variable does not change, but the type of data stored in the variable changes .

Automatic type conversion during assignment operations

- Upward conversion

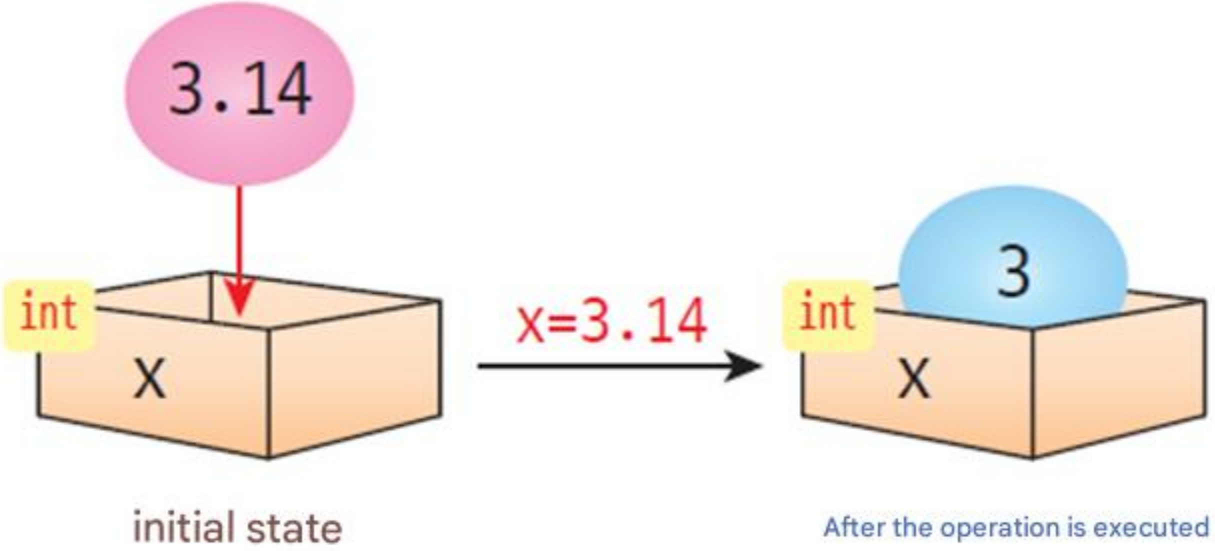
```
double f;
f = 10 ; // 10.0 is stored in f .
```



Automatic type conversion during as signment operations

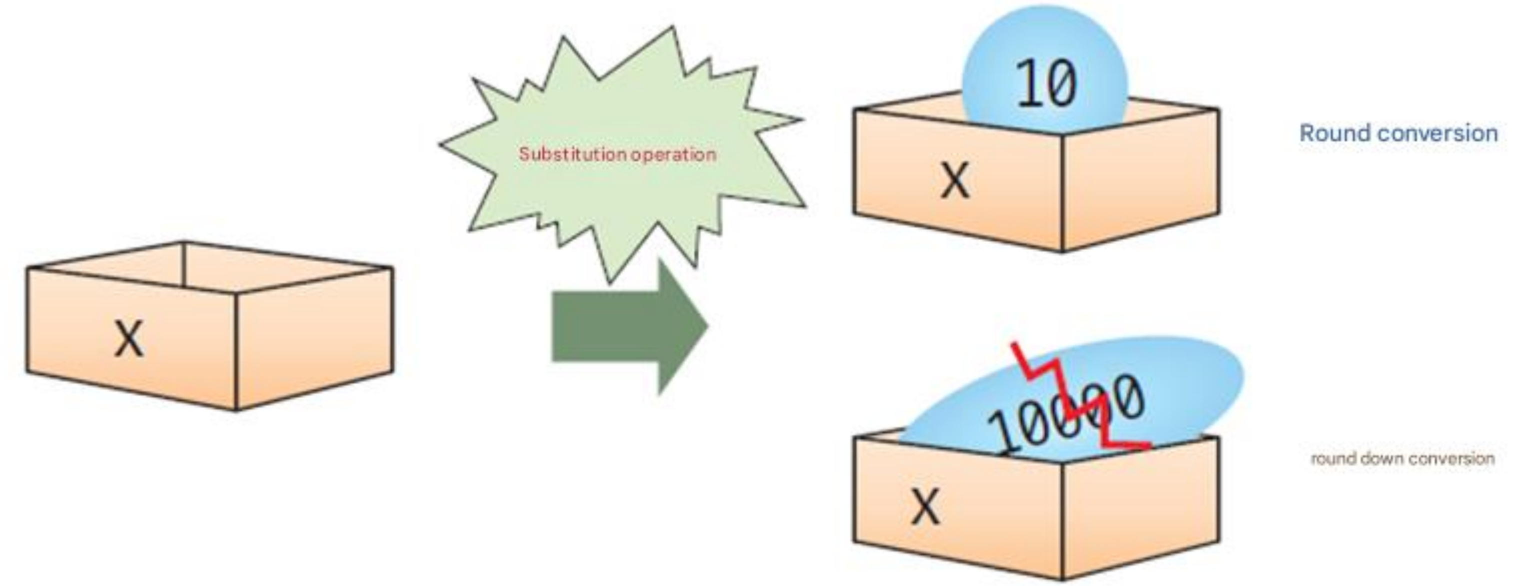
- Downward conversion

```
int i;
i = 3.141592; // 3 is stored in i .
```



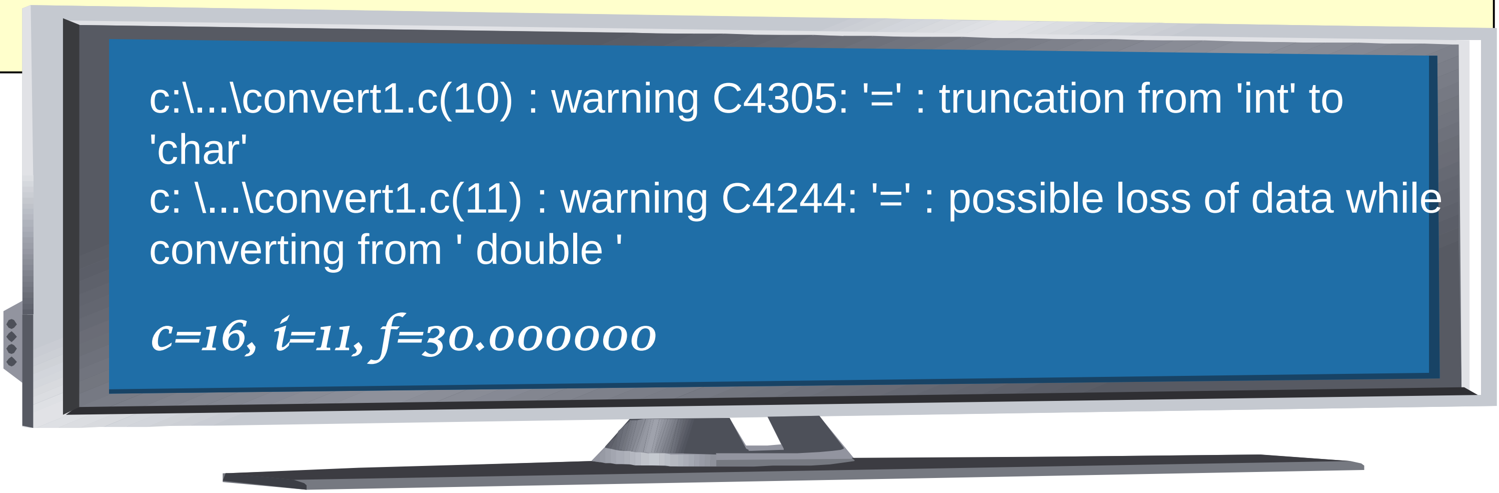
Integer type conversion

```
char x;

x = 10; // OK
x = 10000; // upper The bytes are gone .
```



Up and down conversions

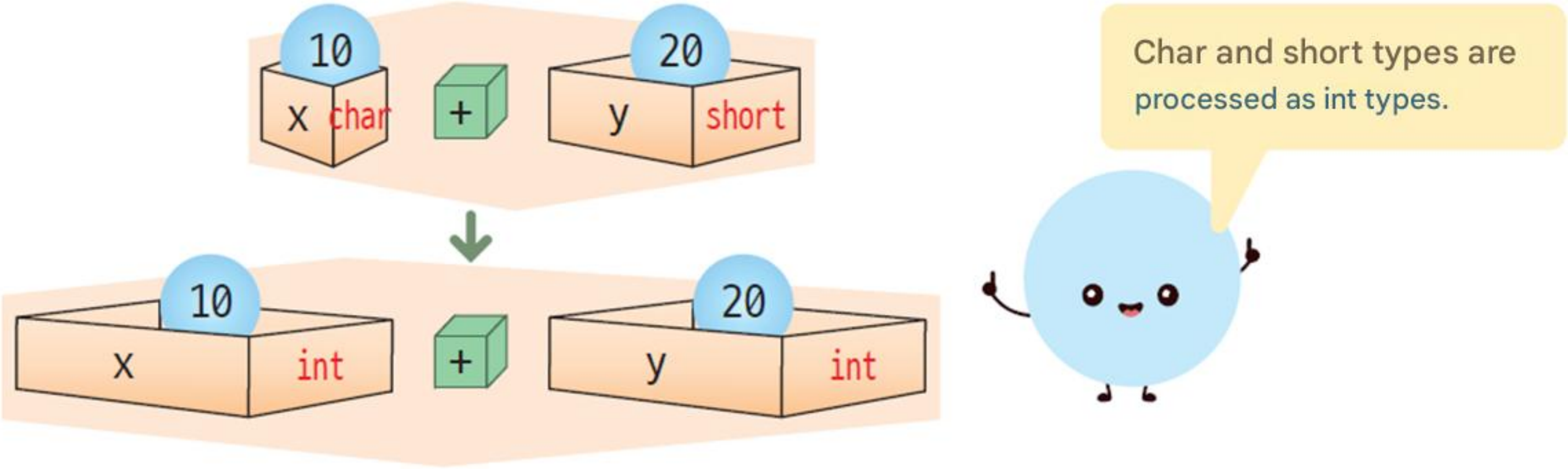
```
#include <stdio.h>
int main( void )
{
        char c;
        int i;
        float f;

        c = 10000; // Round down
        i = 1.23456 + 10; // Round down
        f = 10 + 20; // round up
        printf( "c = %d, i = %d, f = %f \n" , c, i, f);
       return 0;
}
```



```
c:\...\convert1.c(10) : warning C4305: '=' : truncation from 'int' to
'char'
c: \...\convert1.c(11) : warning C4244: '=' : possible loss of data while
converting from ' double '

c=16, i=11, f=30.000000
```

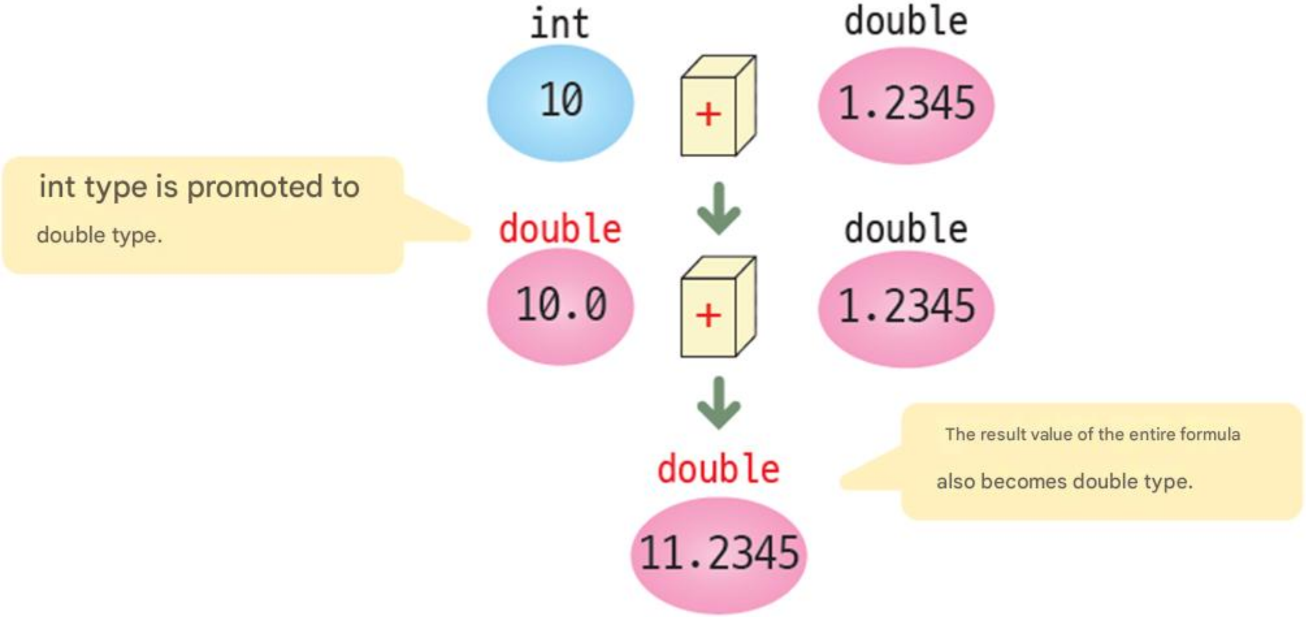
Automatic type conversion when performing integer operations

- When performing integer operations , if the type is char or short , it is automatically converted to int type and then calculated.



Automatic type conversion in formulas

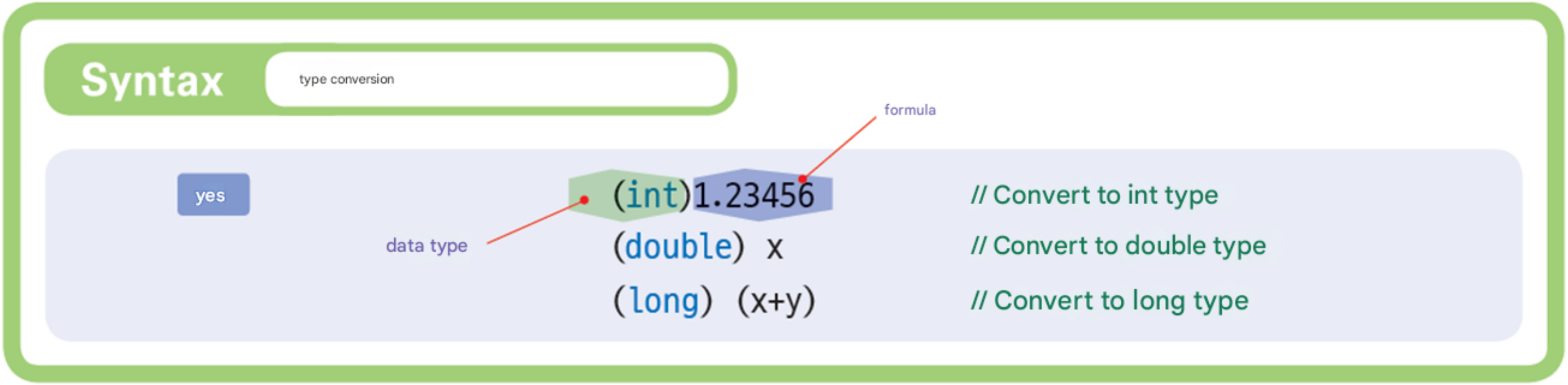
- When different data types are used together, they are unified into a larger data type .



int type is promoted to double type.

The result value of the entire formula also becomes double type.

Explicit type conversion



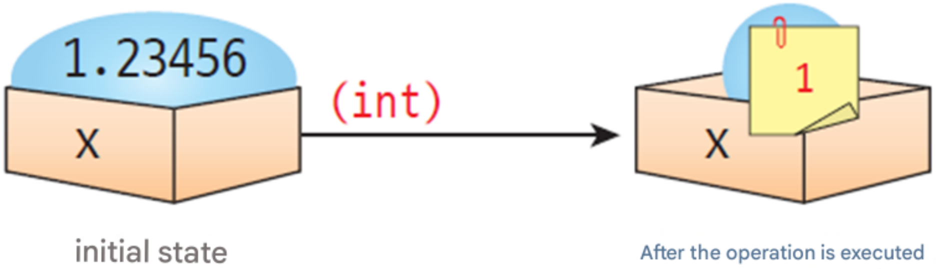
Syntax type conversion

yes

data type

formula

```
(int)1.23456      // Convert to int type
(double) x        // Convert to double type
(long) (x+y)      // Convert to long type
```



Example

```
#define _CRT_SECURE_NO_WARNINGS
#include < stdio.h >

int main( void )
{
        int i ;
        double f;

        f = 5 / 4;

        printf ( "%f\n" , f);

        f = ( double )5 / 4;
        printf ( "%f\n" , f);

        f = 5.0 / 4;
        printf ( "%f\n" , f);
```

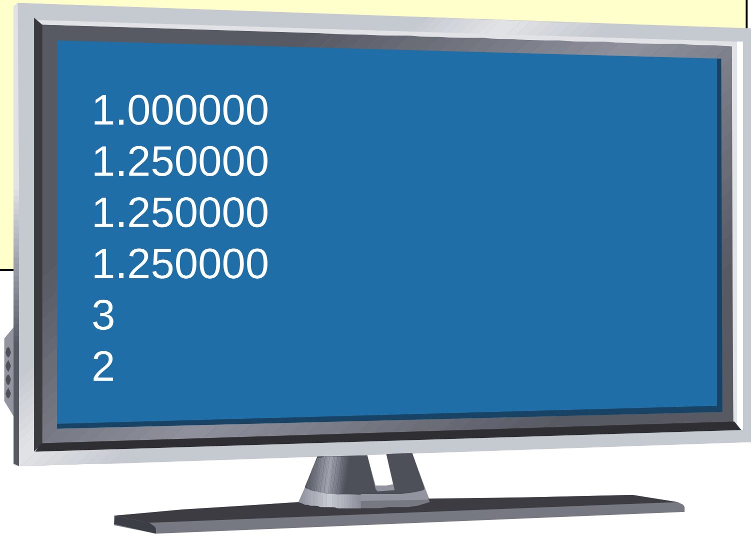
5/4 becomes 1 ,
which becomes 1.0

5 becomes 5.0 , so the
overall result is 1.25

Example

```
        f = ( double )5 / ( double )4;
        printf ( "%f\n" , f);

        i = 1.3 + 1.8;
        printf ( "%d\n" , i );

        i = ( int )1.3 + ( int )1.8;

        printf ( "%d\n" , i );
        return 0;
}
```

1.3 becomes 1 and
1.8 also becomes 1 ,
so the final result is 2

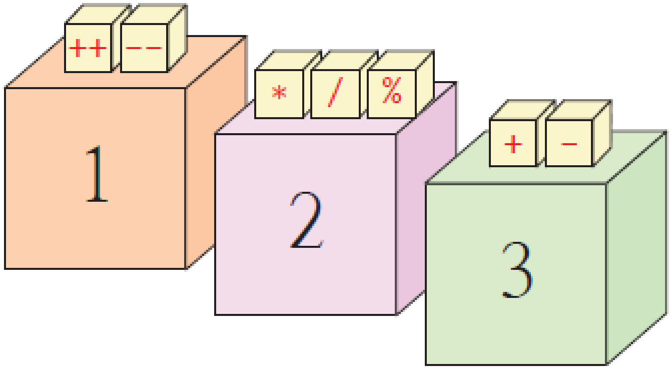


```
1.000000
1.250000
1.250000
1.250000
3
2
```

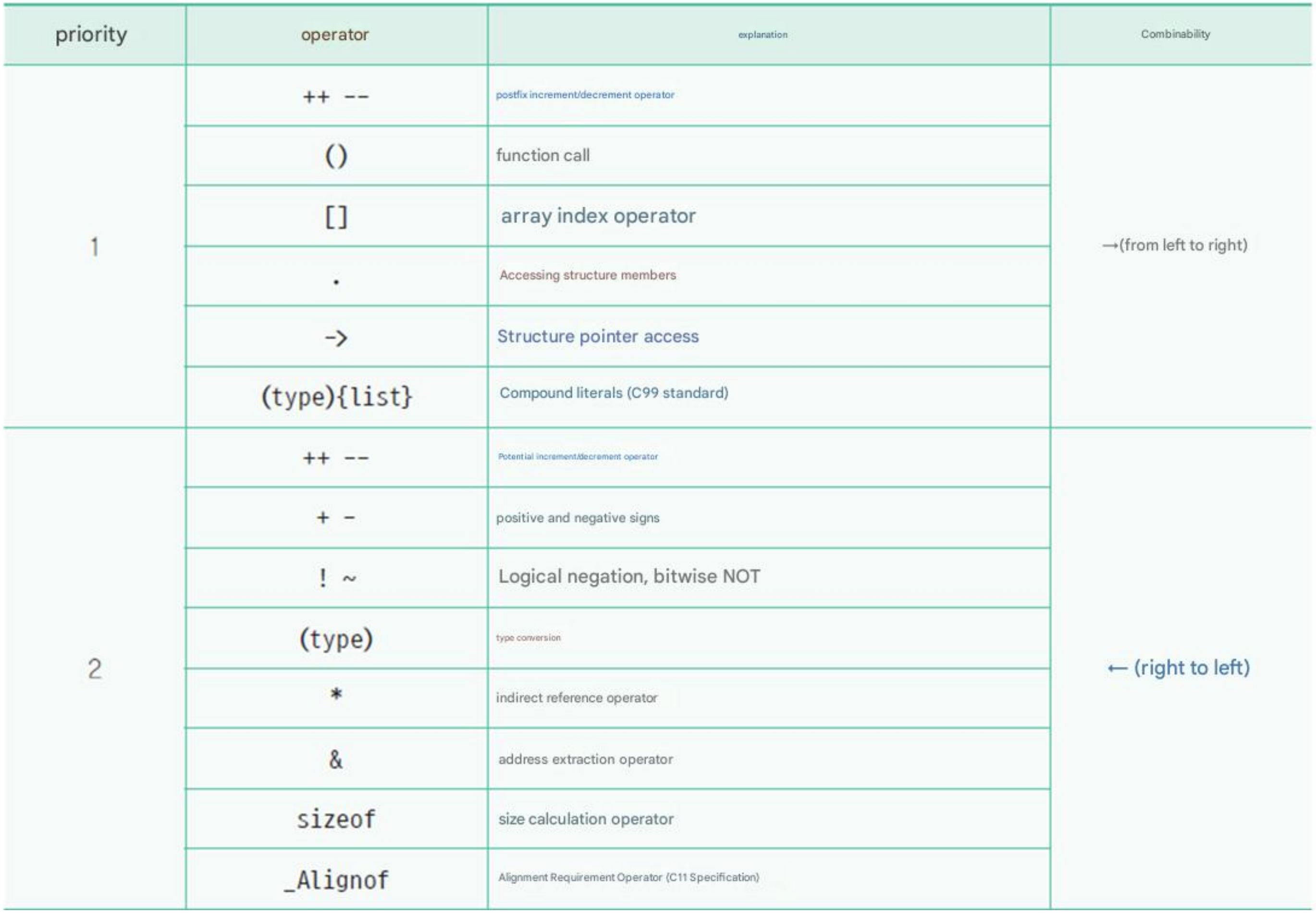
Priority

- Rules for which operator to evaluate first

$$\underbrace{x + \underbrace{y * z}_{①}}_{②} \qquad \underbrace{\underbrace{(x + y)}_{①} * z}_{②}$$



Priority



priority	operator	explanation	Combinability
1	`++ --`	postfix increment/decrement operator	→(from left to right)
	`()`	function call	
	`[]`	array index operator	
	`.`	Accessing structure members	
	`->`	Structure pointer access	
	`(type){list}`	Compound literals (C99 standard)	
2	`++ --`	Potential increment/decrement operator	← (right to left)
	`+ -`	positive and negative signs	
	`! ~`	Logical negation, bitwise NOT	
	`(type)`	type conversion	
	`*`	indirect reference operator	
	`&`	address extraction operator	
	`sizeof`	size calculation operator	
	`_Alignof`	Alignment Requirement Operator (C11 Specification)	

3	* / %	Multiplication, Division, Remainder	→(from left to right)
4	+ -	Addition, subtraction	
5	<< >>	bit shift operator	
6	< <=	relational operators	
	> >=	relational operators	
7	== !=	relational operators	
8	&	bitwise AND	
9	^	bitwise	
10	¦	bit OR	
11	&&	Logical AND operator	
12	¦¦	Logical OR operator	
13	?:	Ternary Conditional Operator	← (right to left)
14	=	assignment operator	
	+= -=	compound assignment operator	
	*= /= %=	compound assignment operator	
	<<= >>=	compound assignment operator	
	&= ^= ¦=	compound assignment operator	
15	,	comma operator	→(from left to right)

General guidelines for priorities

- Comma < Assignment < Logic < Relation < Arithmetic < Unary
- Parentheses operators have the highest precedence.
- All unary operators have higher precedence than binary operators .
- Assignment operators have the lowest precedence, except for the comm a operator .
- If you can't remember the precedence of operators, use parentheses.
    - (x <= 10) && (y >= 20)
- Relational and logical operators have lower precedence than arithmetic operators .
    - x + 2 == y + 3
- Relational operators have higher precedence than logical operators . The refore, you can use sentences like the following with confidence .
    - x > y && z > y // Same as (x > y) && (z > y) .

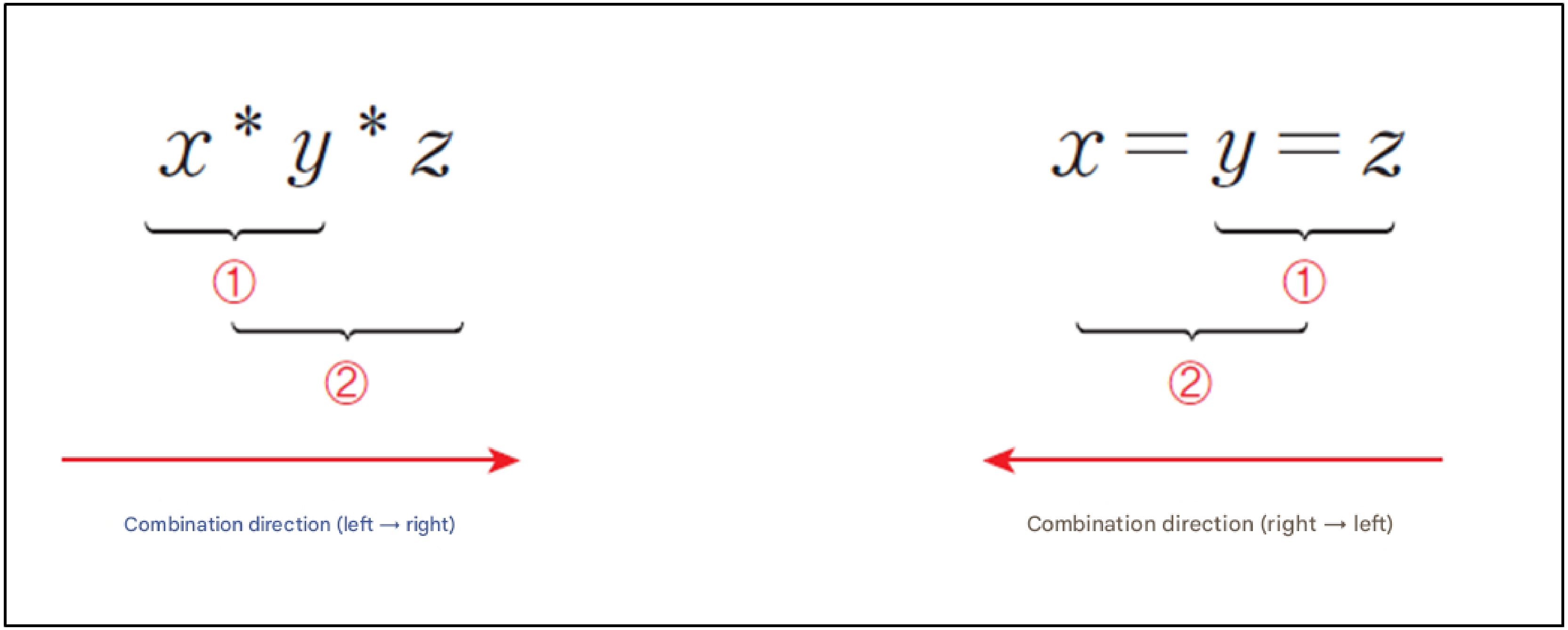
General guidelines for priorities

- among logical operators, the && operator has higher precedence than the || operator .
  - x < 5 || x > 10 && x > 0 // Same as x < 5 || (x > 10 && x > 0)

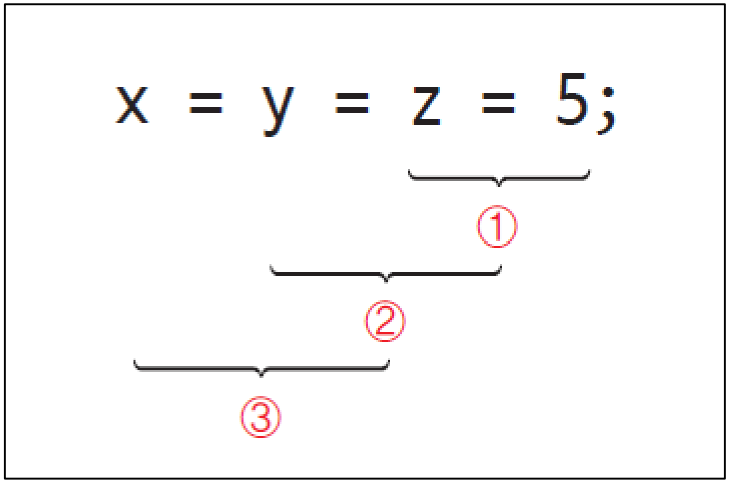
- Sometimes the order of evaluation of operators can be quite confusing . In x * y + w * y It is unclear which of x * y and w * y will be computed first .

Combination Rules

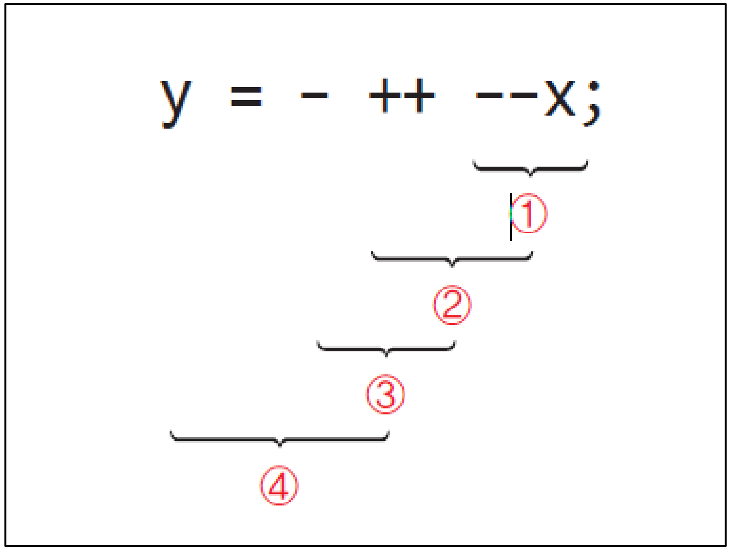
- If there are multiple operators with the same priority, the rule for which one should be performed first


x * y * z
①
②
Combination direction (left → right)
x = y = z
①
②
Combination direction (right → left)

Example of a combination rule



```
x = y = z = 5;
```



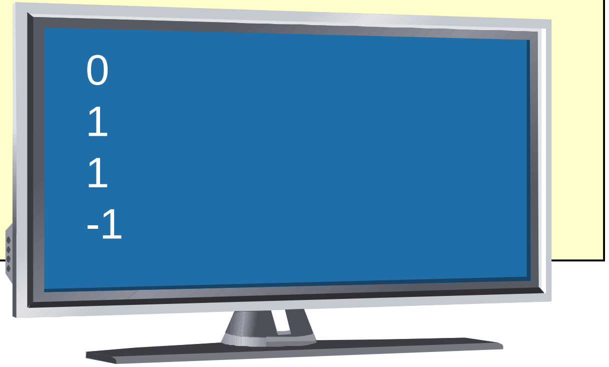
```
y = - ++ --x;
```

Example of a combination rule

$$\underbrace{y = \underbrace{\underbrace{\underbrace{a \,\%\, b}_{\text{②}} \,/\, c}_{\text{③}} + \underbrace{d * \underbrace{(e - f)}_{\text{①}}}_{\text{④}}}_{\text{⑤}}}_{\text{⑥}};$$

Example

```
#include < stdio.h >
int main( void )
{
	int x=0, y=0;
	int result;

	result = 2 > 3 || 6 > 7 ;
	printf ( "%d" , result);

	result = 2 || 3 && 3 > 2 ;
	printf ( "%d" , result);

	result = x = y = 1;
	printf ( "%d" , result);

	result = - ++x + y--;
	printf ( "%d" , result);

	return 0;
}
```



```
0
1
1
-1
```

Q & A