

Ch.5 Expression and operation

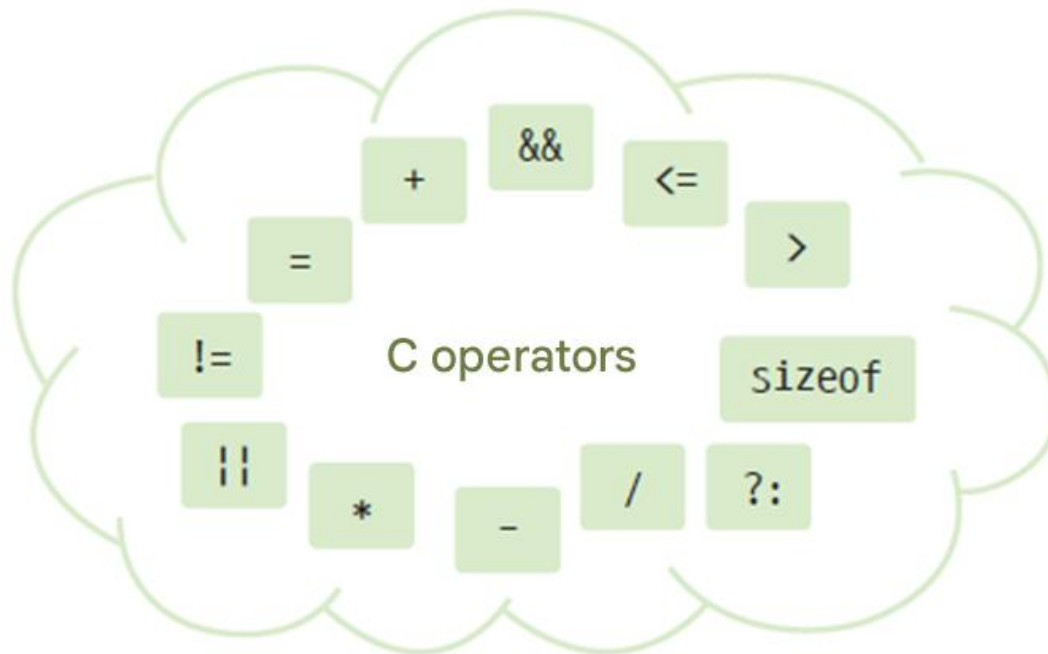
What you will learn in this chapter



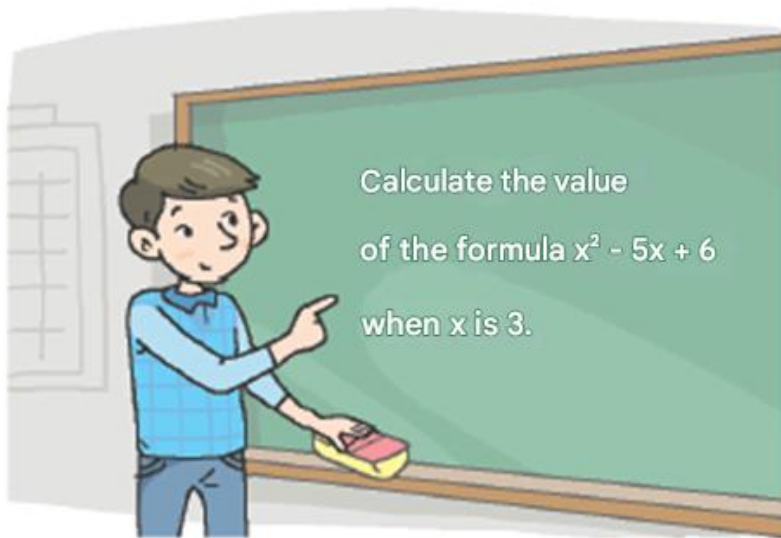
- * What are expression and operation?
- * Assignment operation
- * Arithmetic operations
- * Logical operations
- * Relational operations
- * Priority and associativity rules

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 expression



```
int x, y;
```

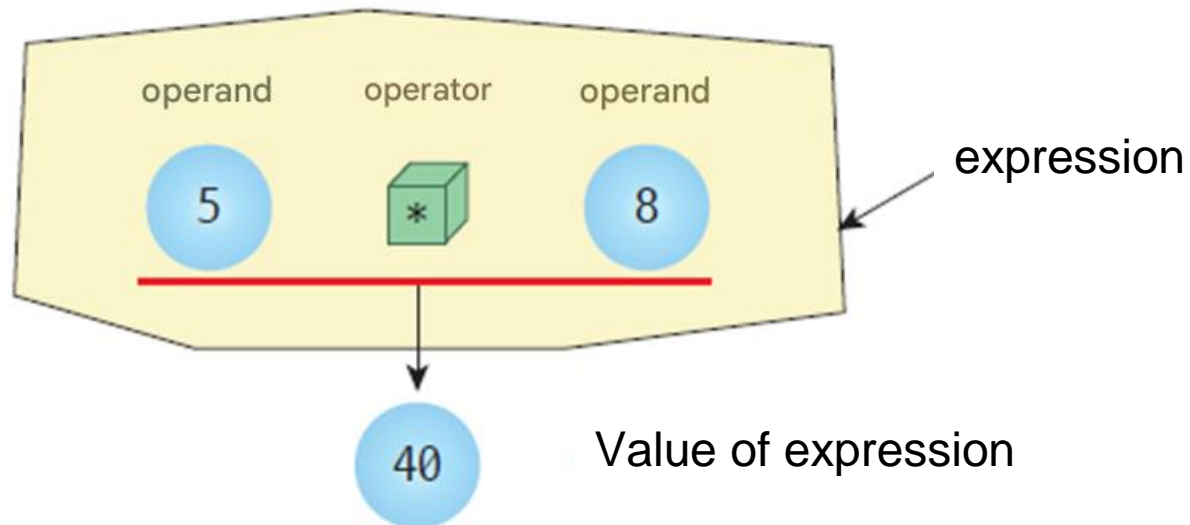
```
x = 3;
```

```
y = x*x - 5*x + 6;
```

```
printf("%d\n", y);
```

Expression

- 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

$$y = mx + b \quad \rightarrow y = m * x + b;$$

$$y = ax^2 + bx + c \quad \rightarrow y = a * x * x + b * x + c;$$

$$m = \frac{x + y + z}{3} \quad \rightarrow m = (x + y + z) / 3;$$



(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

Practice

```
#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
```

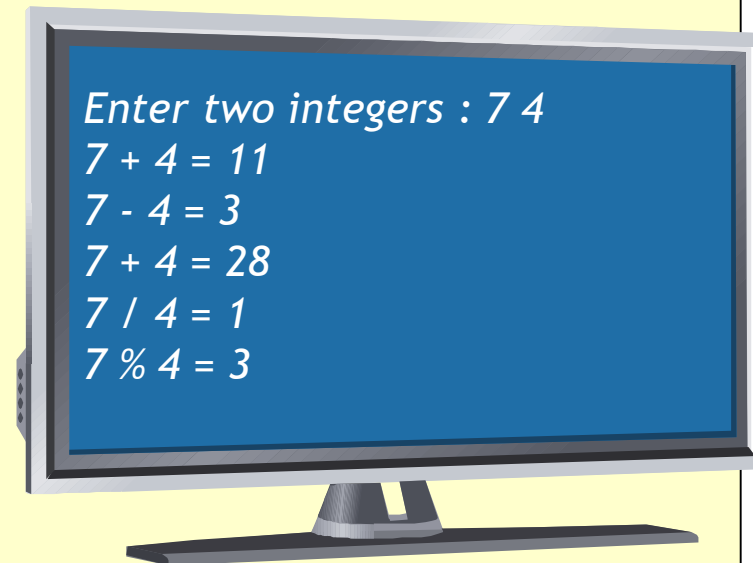
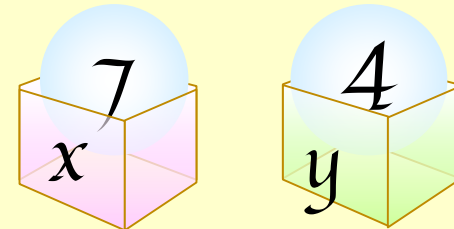
```
    printf( "%d / %d = %d" , x, y, result);
```

```
    result = x % y; // remainder
```

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

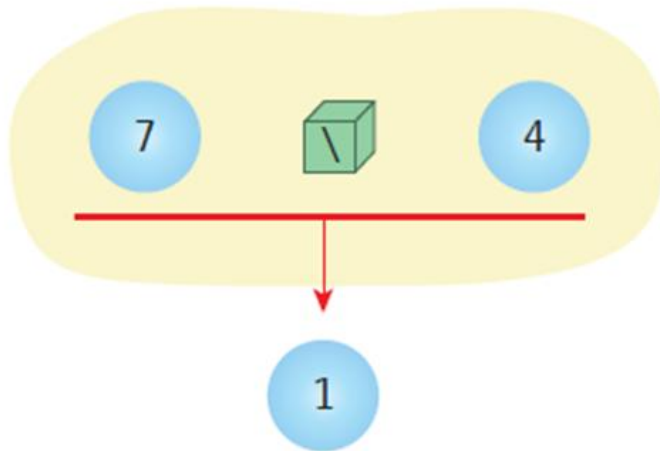
```
    return 0;
```

```
}
```

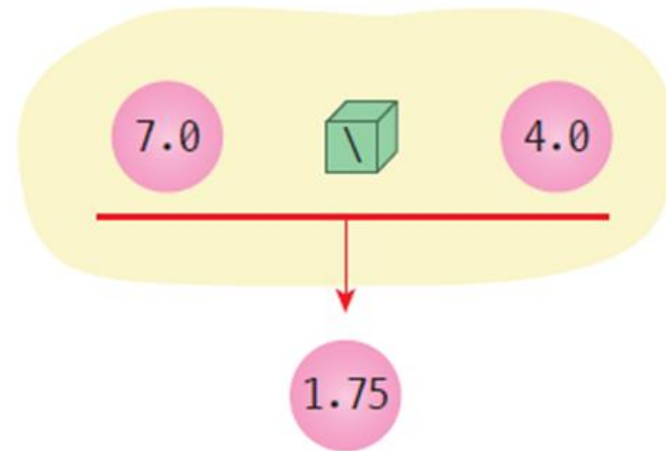


Division operator

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



Division of real integer



Division of real numbers

Real number Arithmetic operations

```
#include <stdio.h>

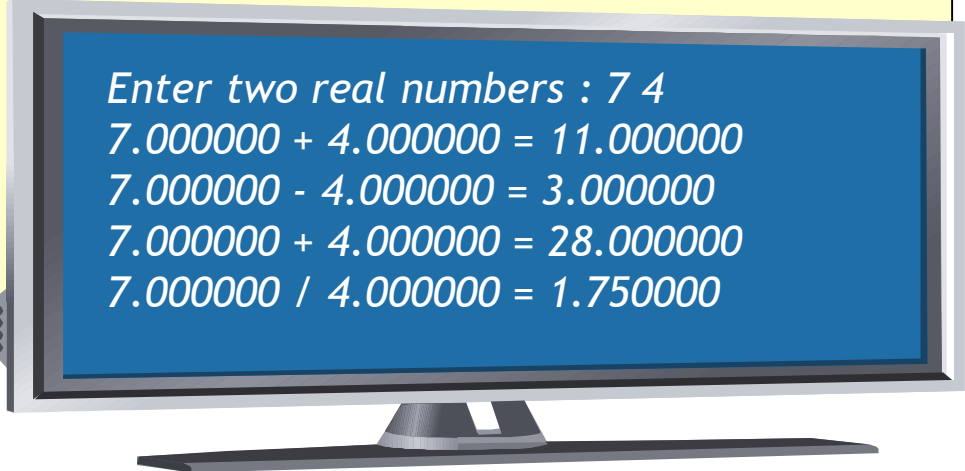
int main()
{
    double x, y, result;

    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 operator
 - $x \% 3$ is 0, then it is a multiple of 3

Remainder operator

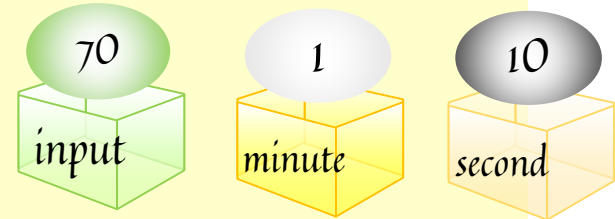
```
// Remainder operator program
#include <stdio.h>
#define SEC_PER_MINUTE 60 // 1 minute is 60 seconds

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;
}
```

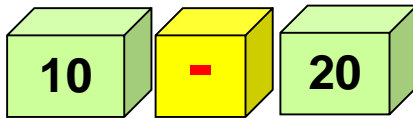


Enter seconds : 1000
1000 seconds is 16 minutes
and 40 seconds .

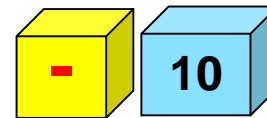
Sign operator

- Change the sign of a variable or constant

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



Binary
operator



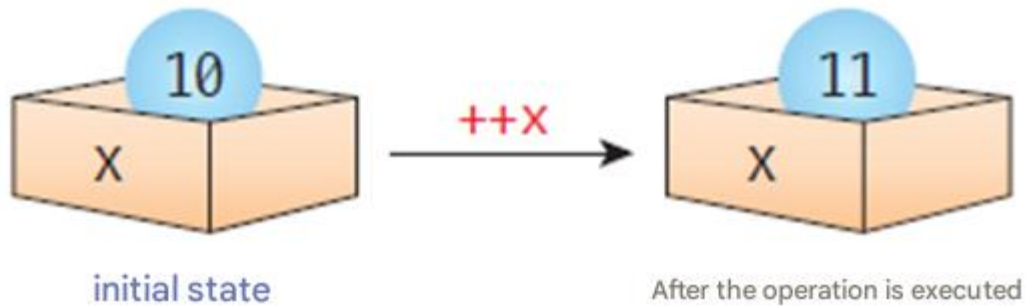
Unary
operator

- is both a
binary
operator and
a unary
operator.



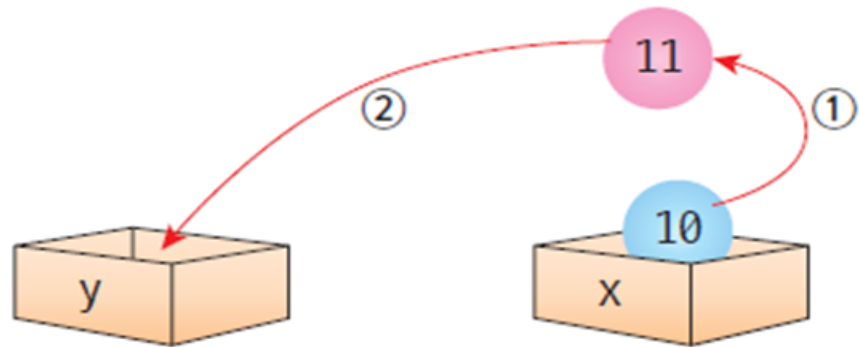
Increment/decrement operator

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



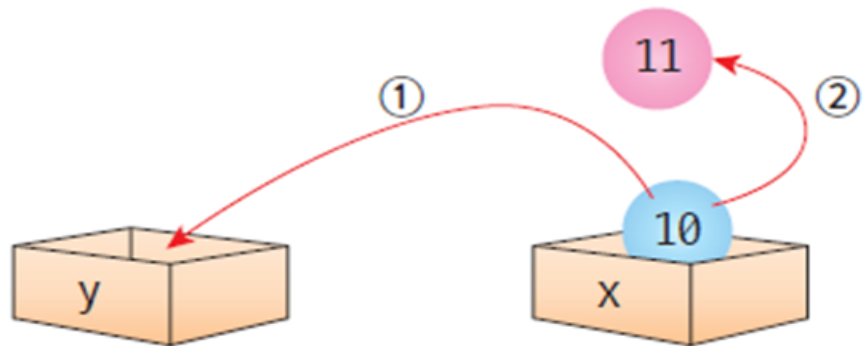
Difference between $++x$ and $x++$

$y = ++x;$



The increased value of x is assigned to y .

$y = x++;$



Substitute first, then increase later.

Increment/decrement operator summary

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

Example : Increment/decrement operator

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

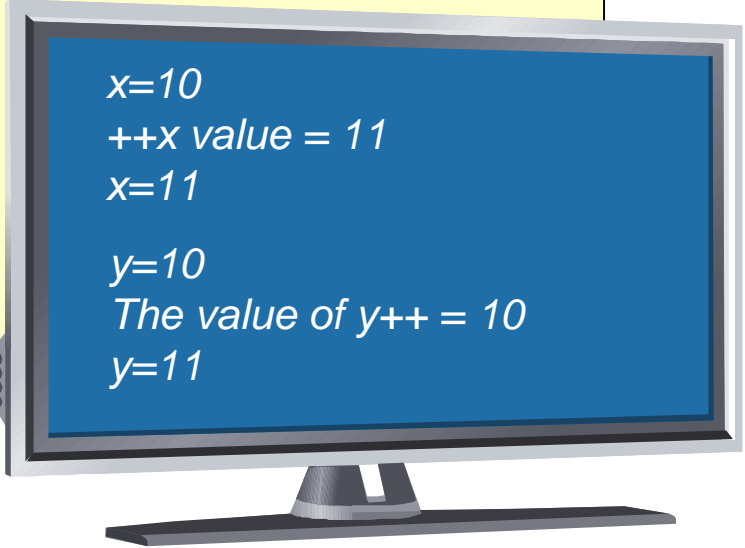
    printf("x=%d\n" , x);
    printf("++x value =%d\n", ++x);
    printf("x=%d\n\n" , x);

    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 expression .

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



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

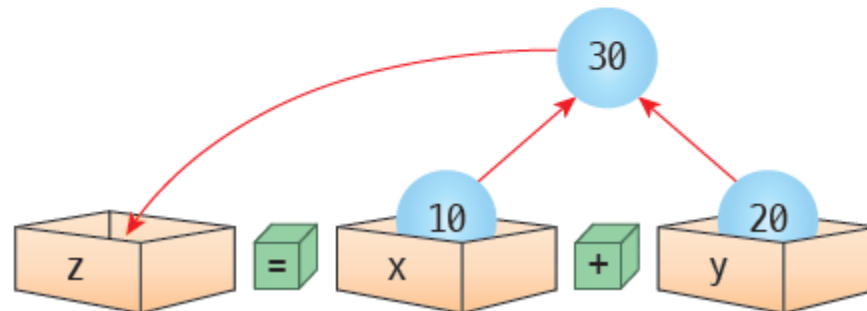
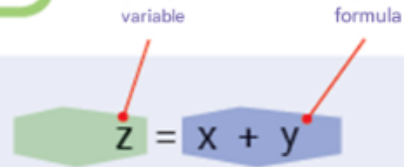
y=10
The value of y++ = 10
y=11
```

Assignment operator

Syntax

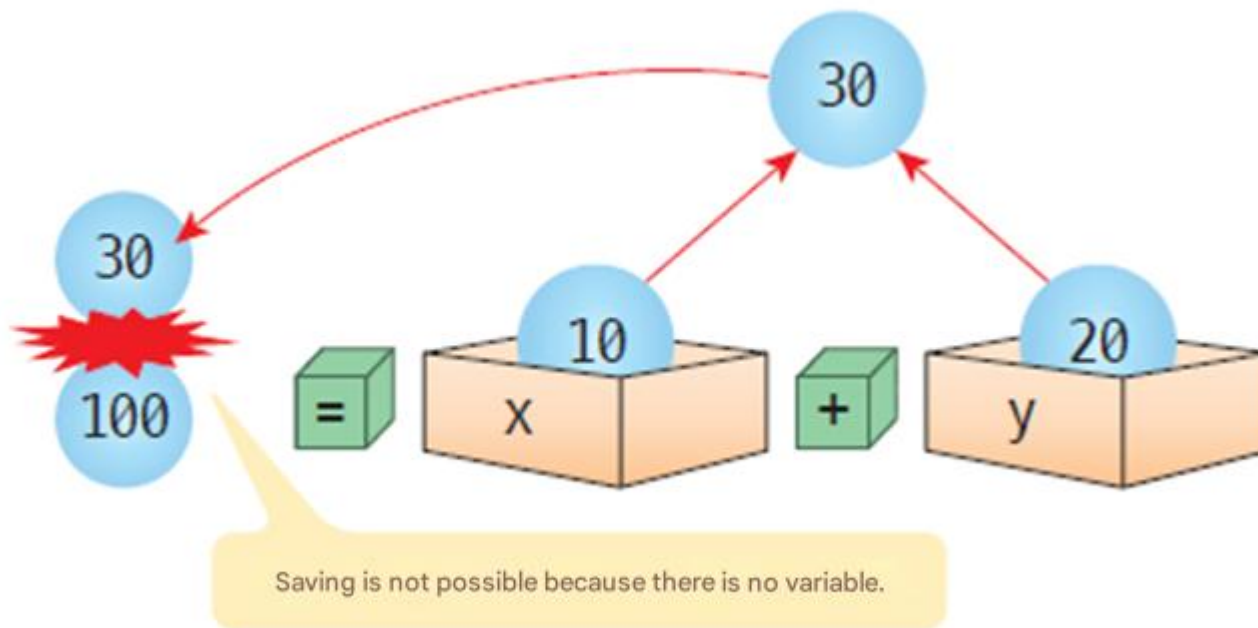
assignment operator

yes



Caution: assignment operators

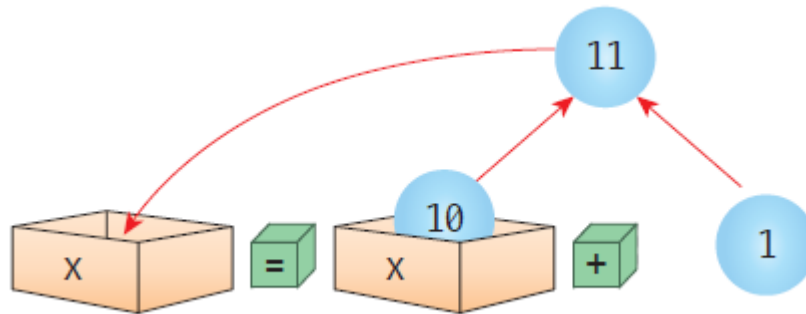
- `100 = x + y; // Compile error !`



Caution: assignment operators

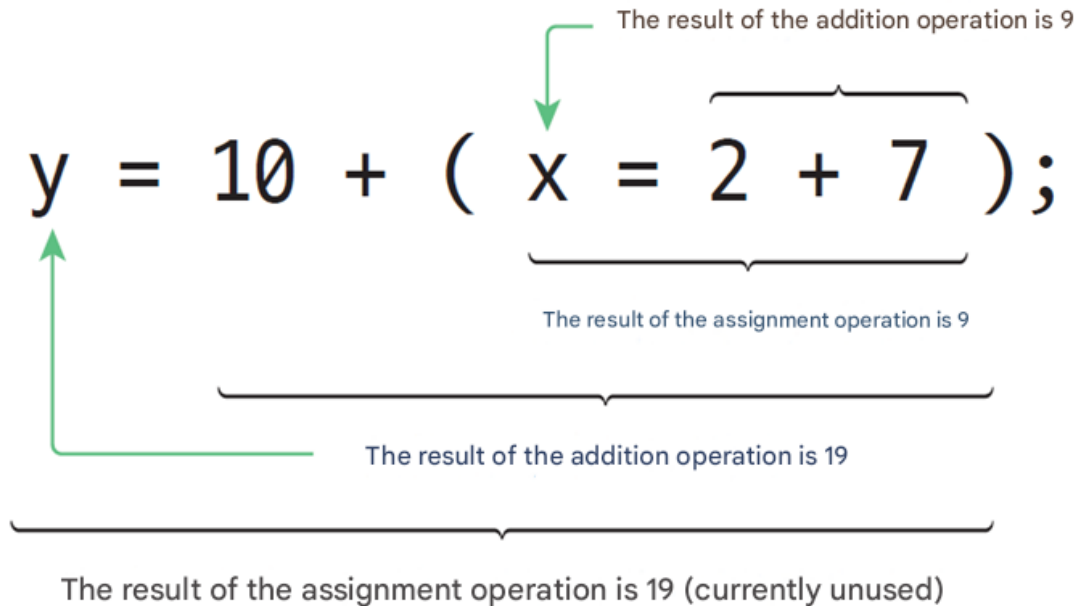
It is a correct statement in C , but mathematically incorrect.

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



The result of the assignment operation

Every operation has a result,
and assignment operations
also have a result.



Next sentence is also possible .

The diagram illustrates the execution of the statement `y = x = 3;`. A yellow box contains the code. Two red arcs are drawn above the code: one from the first equals sign to the number 3, and another from the second equals sign to the number 3. A blue line extends from the bottom of the yellow box towards the explanatory text box.

```
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 `y`



Example

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

```
int main( void )  
{
```

```
    int x, y;
```

```
    x = 1;
```

```
    printf ( " The value of expression x+1 is %d\n" , x+1);
```

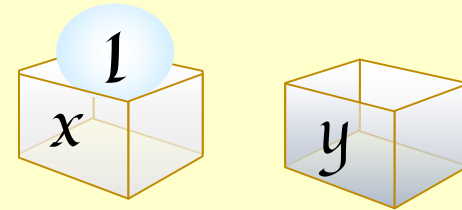
```
    printf ( " The value of the expression y=x+1 is %d\n" , y=x+1);
```

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

```
    printf ( " The value of the expression y=x=3 is %d\n" , y=x=3);
```

```
    return 0;
```

```
}
```



The value of the expression x+1 is 2

The value of the expression y=x+1 is 2

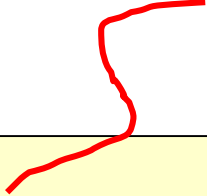
The value of the expression y=10+(x=2+7) is 19

The value of the expression y=x=3 is 3

Compound assignment operator

- A compound assignment operator is an operator that combines an assignment operator = and an arithmetic operator, such as +=.
- 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
<code>x += y</code>	<code>x = x + y</code>	<code>x &= y</code>	<code>x = x & y</code>
<code>x -= y</code>	<code>x = x - y</code>	<code>x = y</code>	<code>x = x y</code>
<code>x *= y</code>	<code>x = x * y</code>	<code>x ^= y</code>	<code>x = x ^ y</code>
<code>x /= y</code>	<code>x = x / y</code>	<code>x >>= y</code>	<code>x = x >> y</code>
<code>x %= y</code>	<code>x = x % y</code>	<code>x <<= y</code>	<code>x = x << y</code>

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;
```

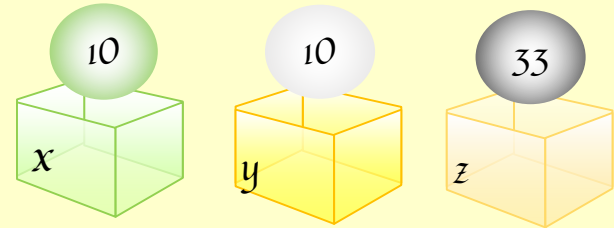
```
    y *= 2;
```

```
    z %= 10 + 20;
```

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

```
    return 0;
```

```
}
```



$x = 11 \ y = 20 \ z = 3$

Error

beware of errors

The following formula is incorrect. Why is that?

$\text{++}x = 10;$

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

$x = *y;$

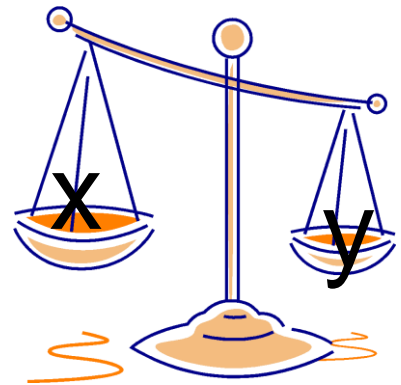
$x *= y$, NOT $=*$

Relational Operators

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

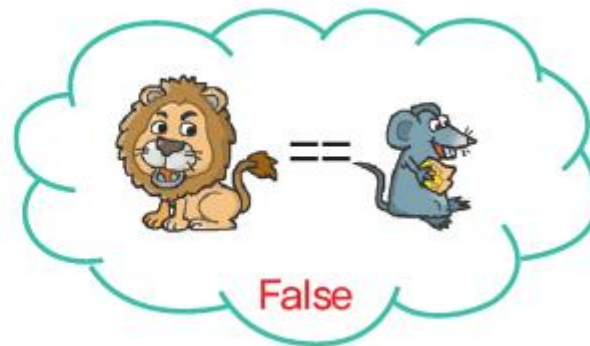
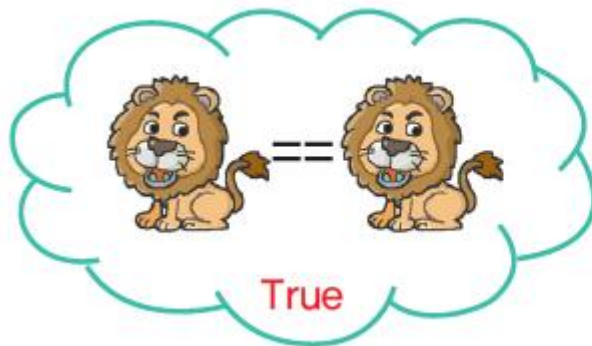
$x == y$

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

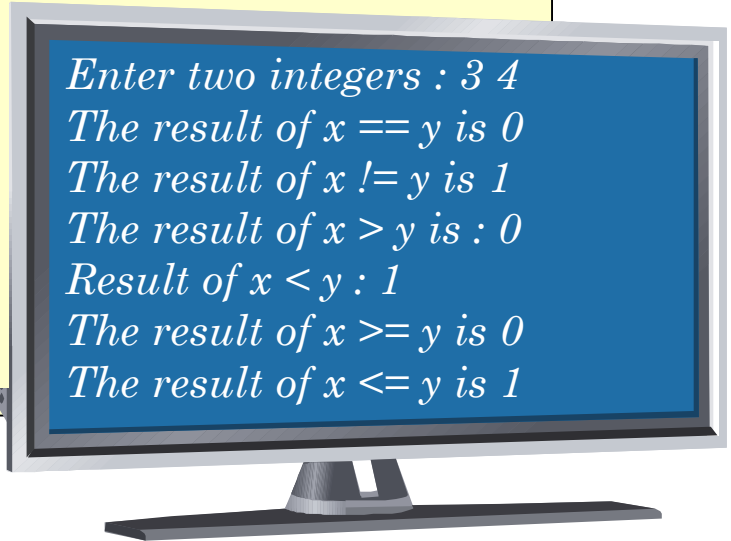
Practice

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

    return 0;
}
```



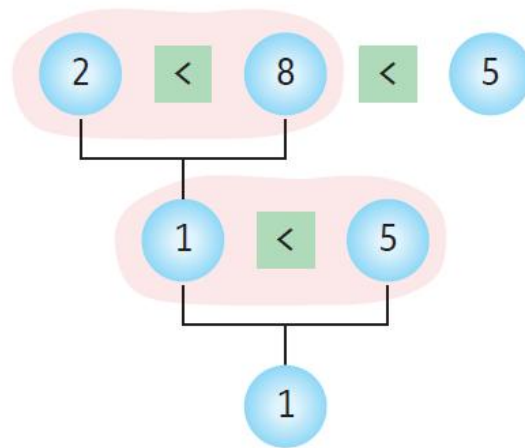
*Enter two integers : 3 4
The result of x == y is 0
The result of x != y is 1
The result of x > y is : 0
Result of x < y : 1
The result of x >= y is 0
The result of x <= y is 1*

Caution!

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

Caution: when using relational operators

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



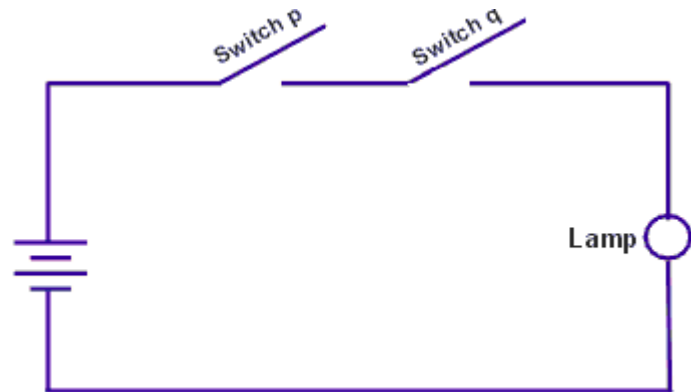
- The right way : $(2 < x) \ \&\& \ (x < 5)$

Logical Operators

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

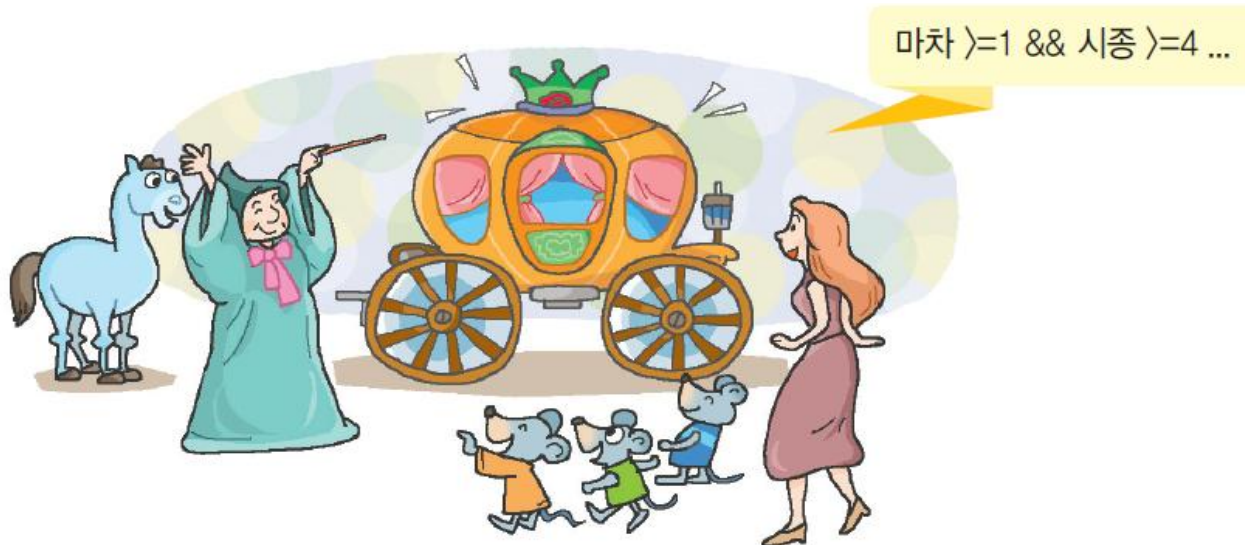
$x \ \&\& \ y$

Only when both x and y are true,
It is true.



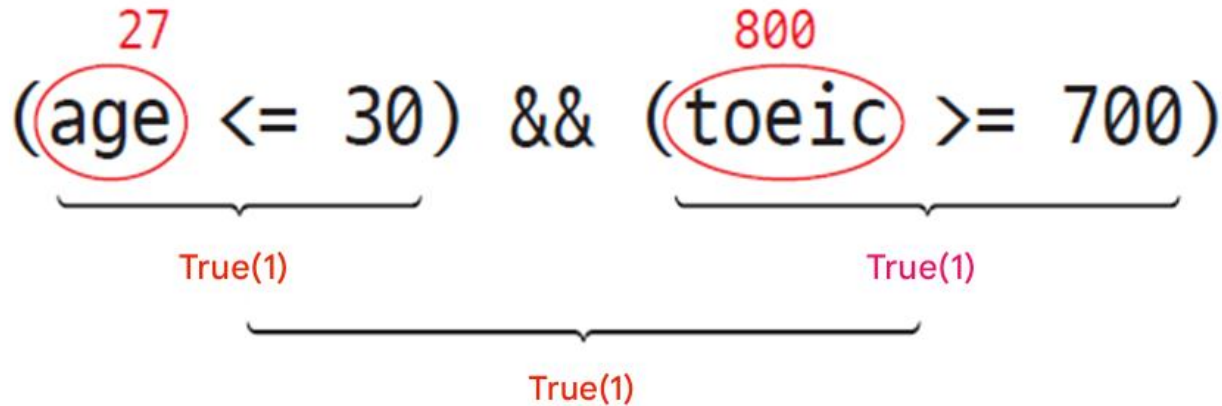
Logical Operators

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



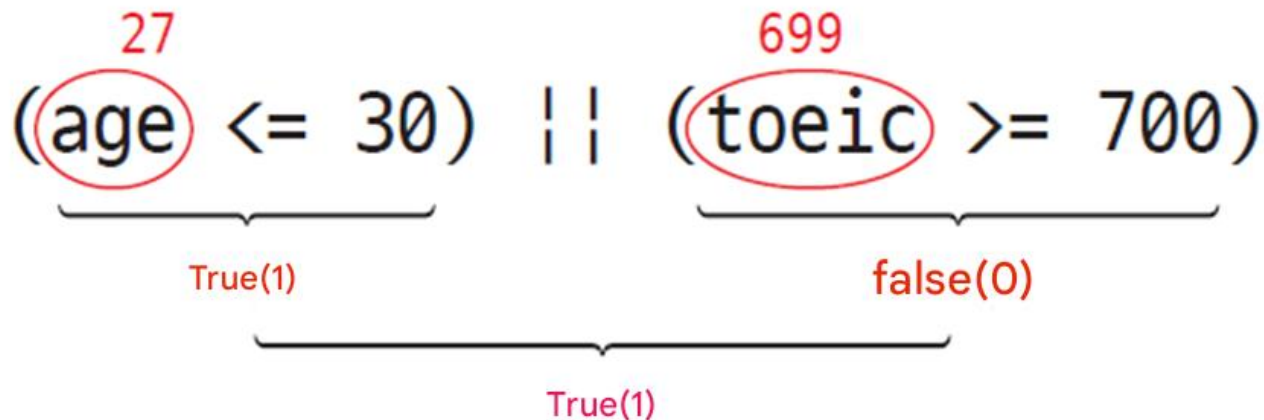
AND operator

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



OR operator

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

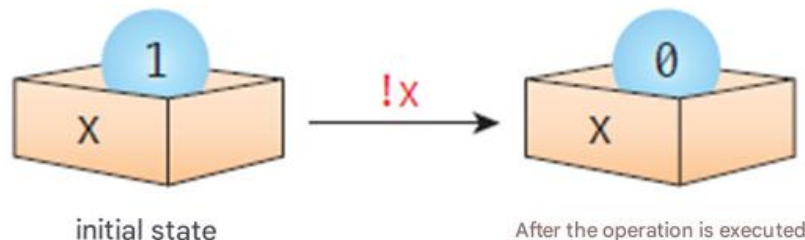


Examples of logical operators

- " 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) // x≠0 and 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.



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

How to express truth and false

- If a relational expression or logical expression is true, 1 is generated, and if it is false, 0 is generated.
- It is considered true if it is not 0, and false if it is 0.
- Negative numbers are considered false. (X)
(Example) When applying the NOT operator (True -> False)

```
!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

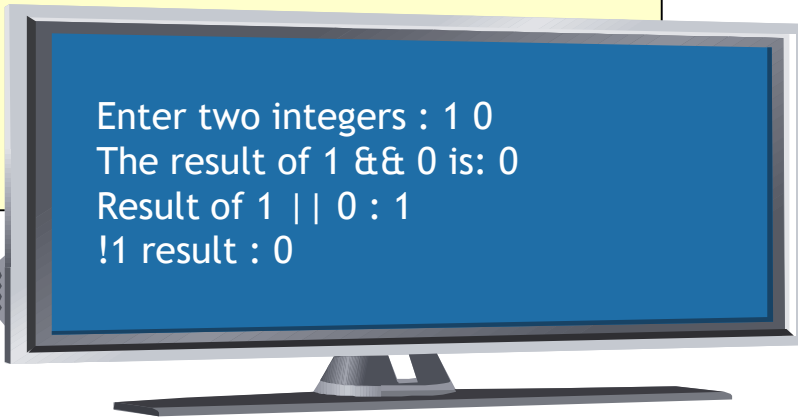
```
#include <stdio.h>

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

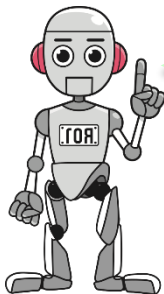
Shortcut calculation

- 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 operands are not evaluated.

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



The first operator is
If it's false, then
don't need
to check 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.



Lab: Leap year (2000, 2004, 2008, 2012, 2016, 2020, 2024)

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

Are parentheses
really necessary ?



Parentheses are
optional, but they
make reading easier .



Lab: Leap year

// A leap year is a year in which an extra 29 days are added to February every four years, making it a year of 366 days.

```
#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);
```

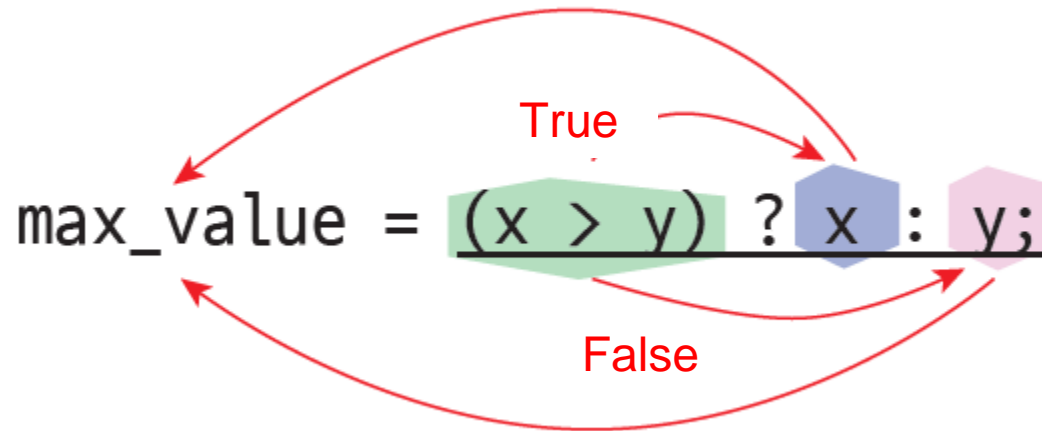
```
    return 0;
```

```
}
```



*Enter the year : 2012
result=1*

Conditional Operator



```
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 )  
{
```

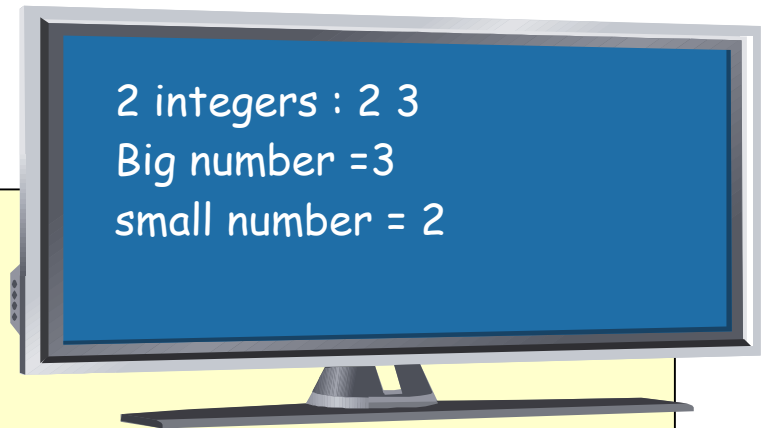
```
    int x,y ;
```

```
    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);
```

```
    return 0;
```

```
}
```



comma operator

- expressions connected by commas are calculated sequentially

It is calculated first.

$x++$,

It is calculated later.

$y++$;

Any
sentences are
executed
sequentially .



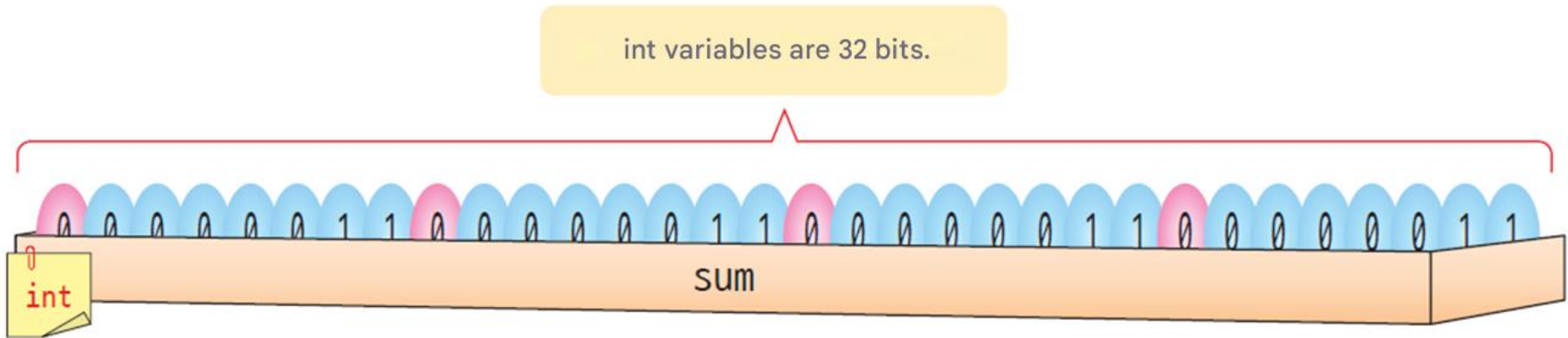
Examples of comma operators

```
x = 2+3, 5-3; // x=2+3 is executed first.
```

```
printf ( "Thank" ), printf ( "you!\n" );
```

```
x = 2, y = 3, z = 4;
```

All data is made up of bits .



Bitwise Operator

operator	meaning of operator	yes
&	bitwise AND	1 if both corresponding bits of the two operands are 1, otherwise 0
	bit OR	1 if only one of the corresponding bits of the two operands is 1, otherwise 0
^	bitwise XOR	1 if the corresponding bits of the two operands have different values, 0 otherwise
<<	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 00000000000001001 (9)

Variable2 00000000 00000000 00000000 00001010 (10)

(variable1 XOR variable2) 00000000 00000000 0000000000000011 (3)

Bitwise NOT operator

NOT 0 = 1
NOT 1 = 0

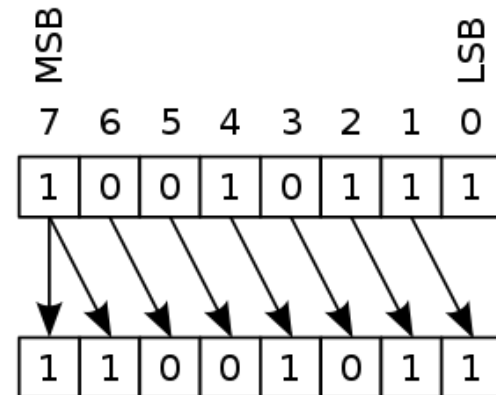
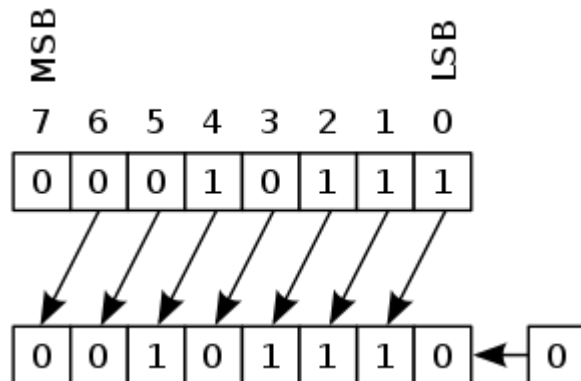
It becomes a negative number because the sign bit is inverted.

Variable1 00000000 00000000 00000000 00001001 (9)

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

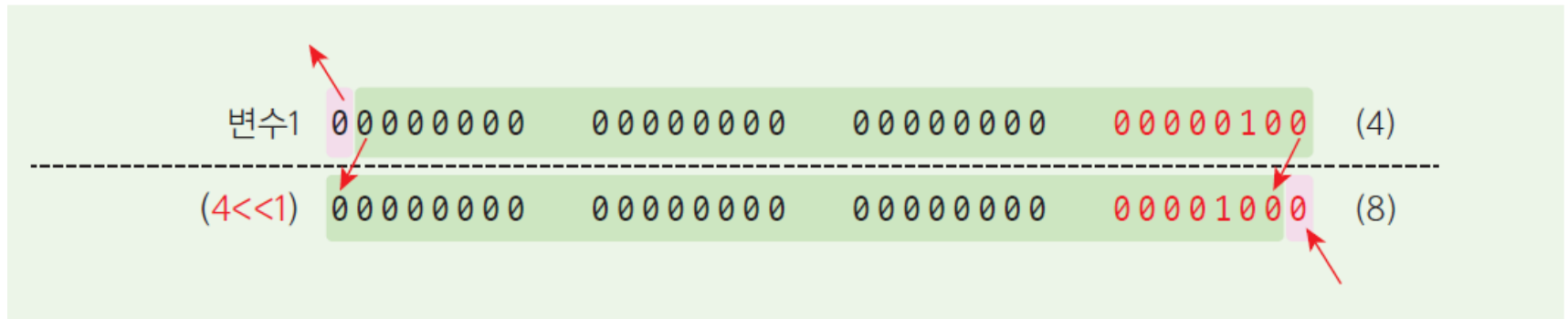
Bit shift operator

operator	sign	explanation
shift left bit	<<	$x \ll y$ shift the bits of x y spaces to the left
shift right bit	>>	$x \gg y$ Shift the bits of x y places to the right



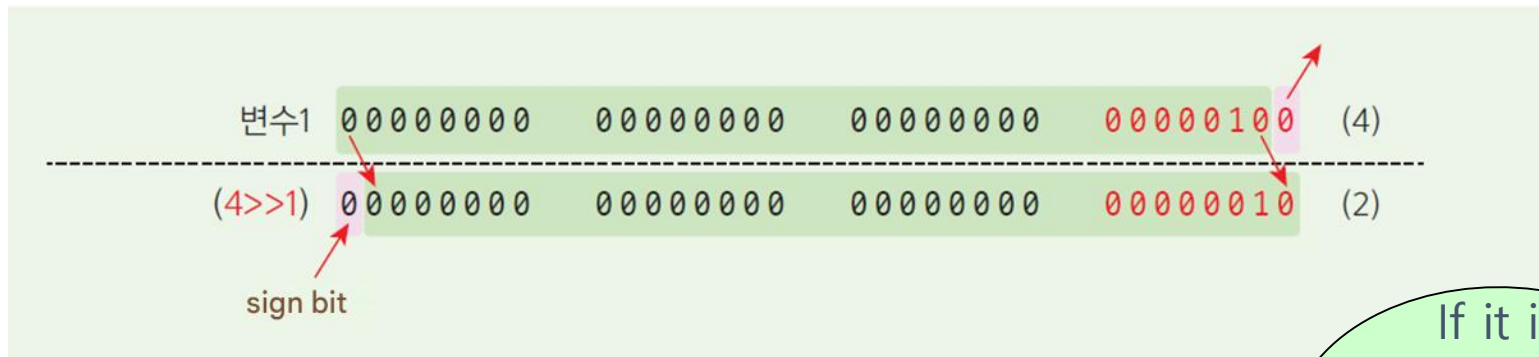
<< operator

- bit left
- The value is doubled



>> operator

- move
- The value is multiplied by 1/2



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

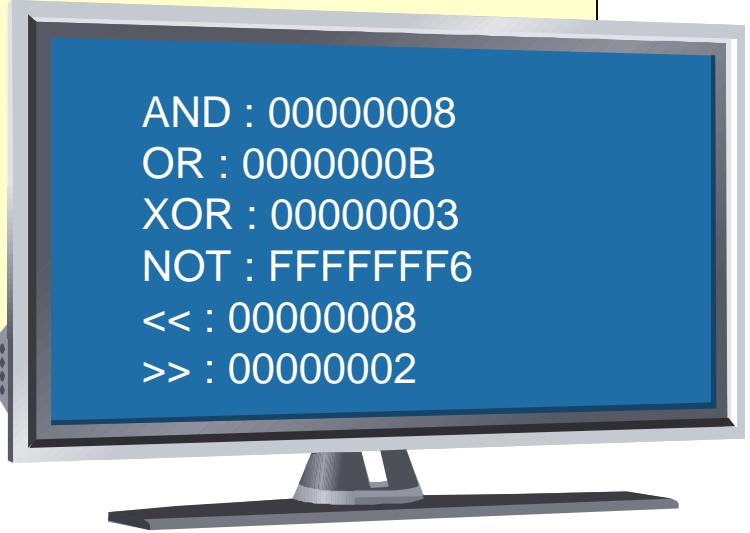


Example : Bitwise Operators

```
#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);

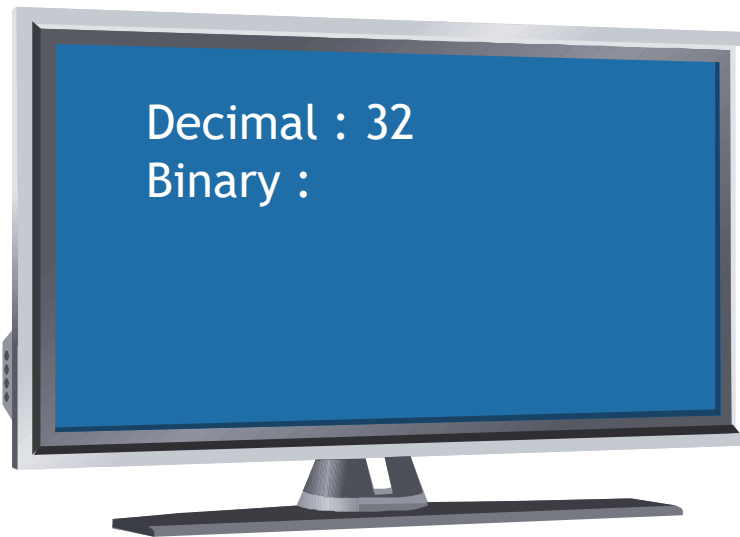
    return 0;
}
```



AND : 00000008
OR : 0000000B
XOR : 00000003
NOT : FFFFFFFF6
<< : 00000008
>> : 00000002

Lab: Outputting decimal to binary

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



Lab: Outputting decimal to binary

```
#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

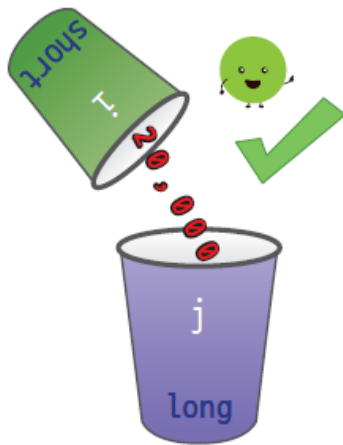
```
mask = mask >> 1; // Shift 1 bit to the right .  
((num & mask) == 0) ? printf( "0" ) : printf( "1" );  
mask = mask >> 1;  
((num & mask) == 0) ? printf( "0" ) : printf( "1" );  
mask = mask >> 1;  
((num & mask) == 0) ? printf( "0" ) : printf( "1" );  
mask = mask >> 1;  
((num & mask) == 0) ?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

```
return 0;
```

```
}
```


Type conversion

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

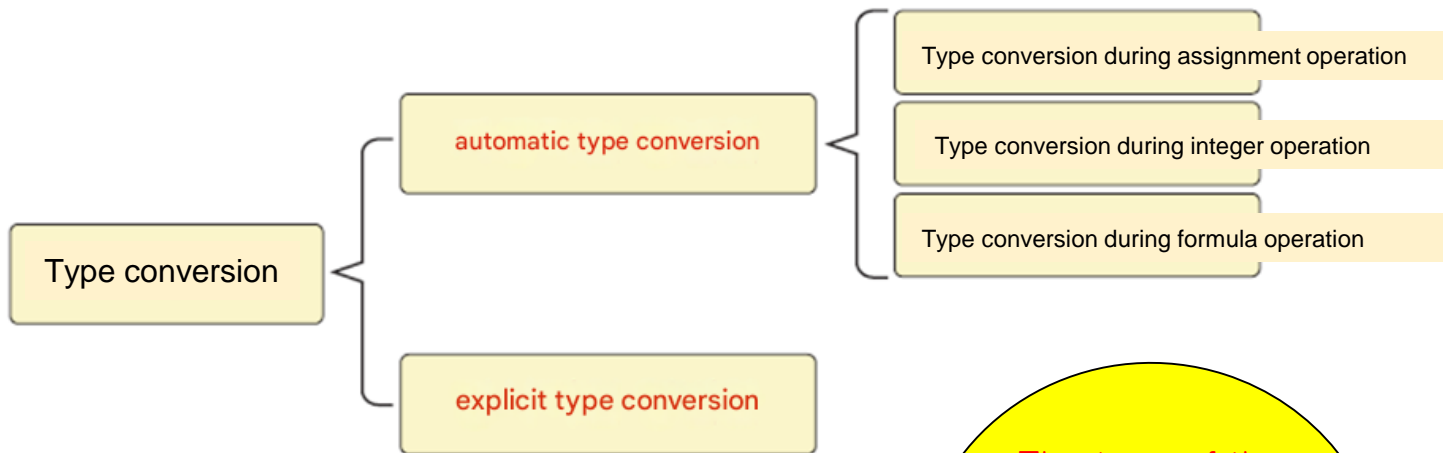


Be careful
because if you do
the conversion
incorrectly, some
of the data may be
lost.



Type conversion

- The type of data is converted during operation.



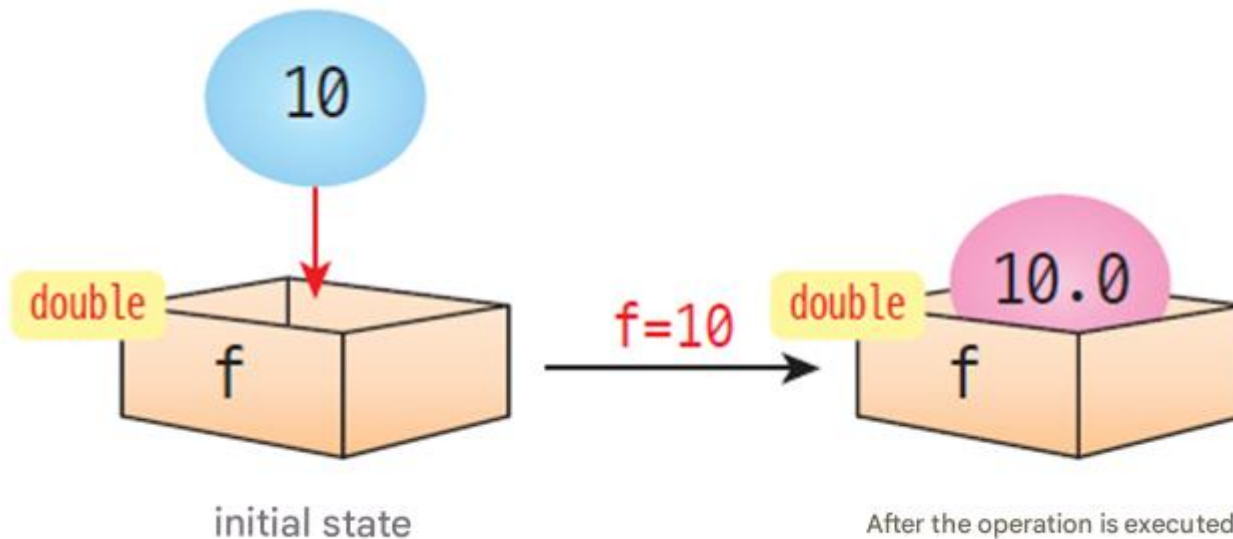
The type of the variable does not change, but the type of data stored in the variable changes .



Automatic type conversion during assignment operations

- Upward conversion

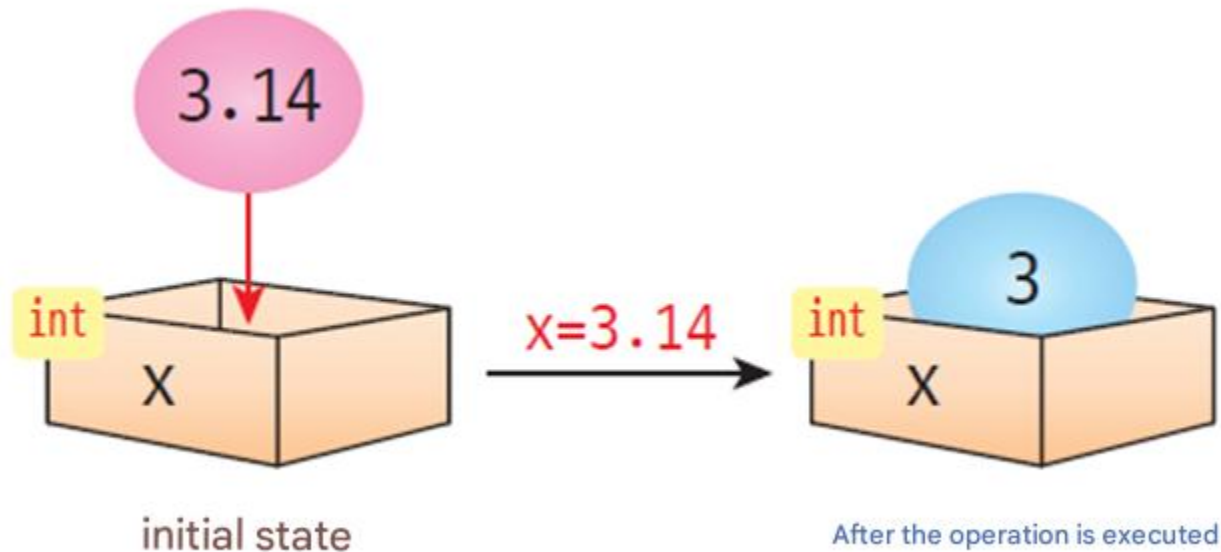
```
double f;  
f = 10 ; // 10.0 is stored in f .
```



Automatic type conversion during assignment operations

- Downward conversion

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

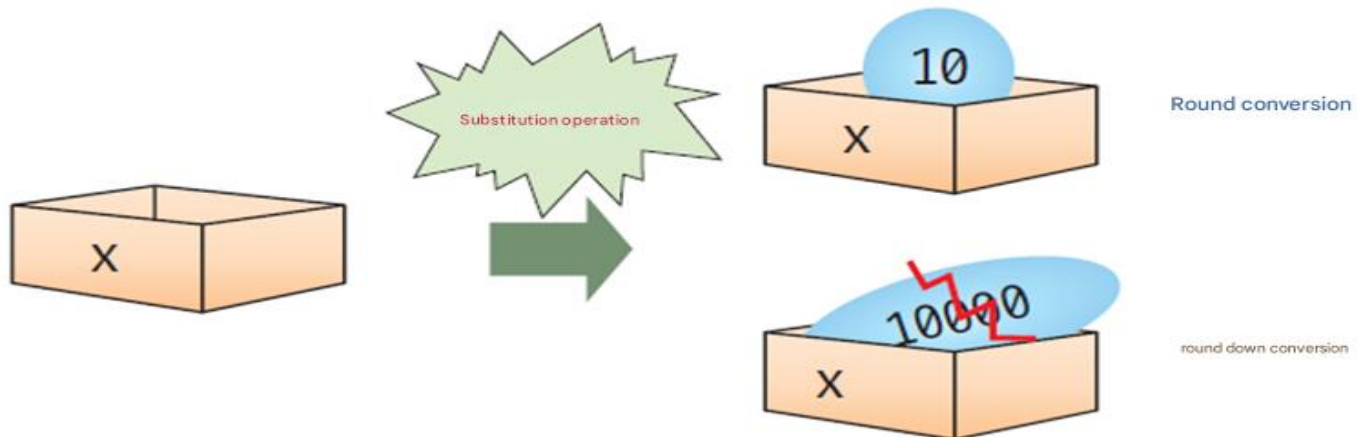


Integer type conversion

```
char x;
```

```
x = 10;           // OK
```

```
x = 10000;        // upper bytes are gone.
```



10000 = 0010 0111 0001 0000
Low 8 bits = 0001 0000 = 16

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;
}
```

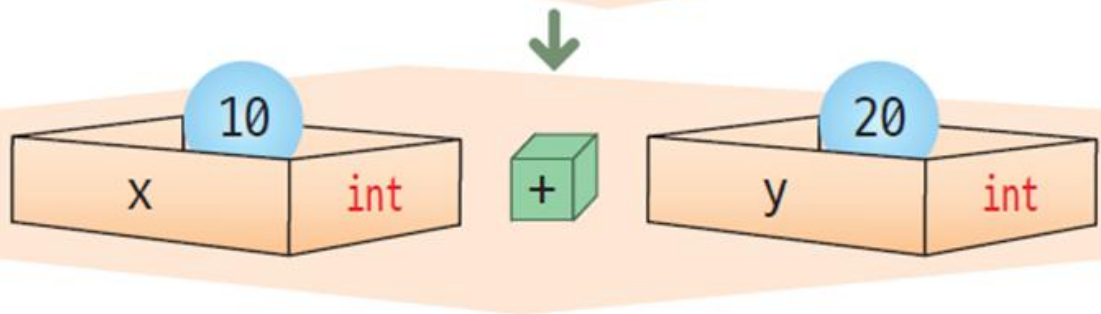
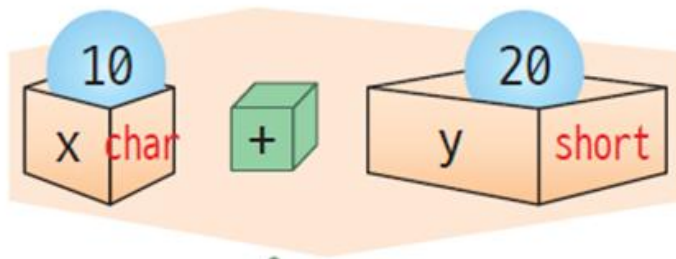
c:\...\convert1.c(10) : warning C4305: '=' : truncation from 'int' to 'char'

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 .

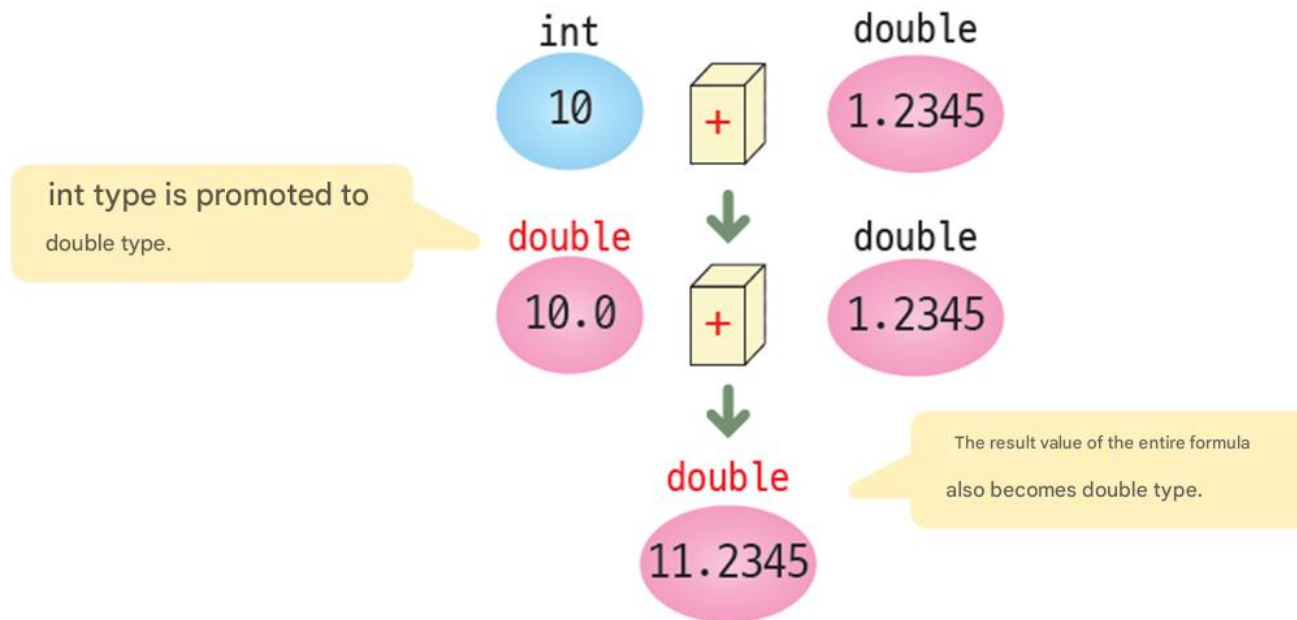


Char and short types are processed as int types.



Automatic type conversion in expressions

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



Explicit type conversion

Syntax

type conversion

yes

data type

formula

(int)1.23456

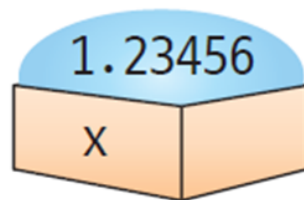
(double) x

(long) (x+y)

// Convert to int type

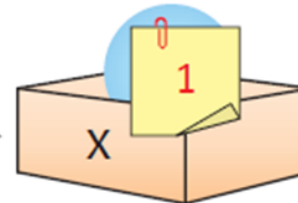
// Convert to double type

// Convert to long type



initial state

(int)



After the operation is executed

Example

```
#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

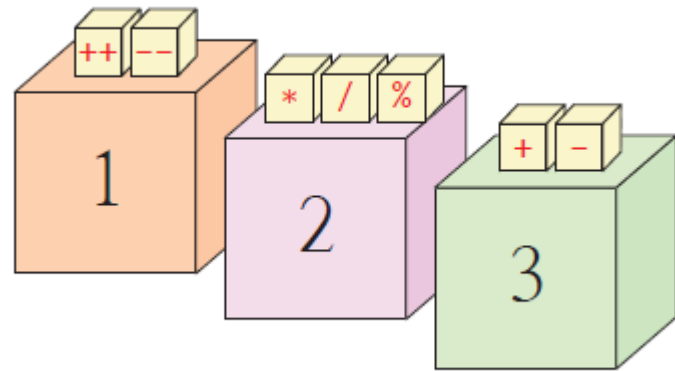
- Rules for which operator to evaluate first

$$x + y * z$$

Diagram illustrating operator precedence for the expression $x + y * z$. A bracket labeled ① groups $y * z$, indicating that multiplication is performed first. A second bracket labeled ② groups the entire expression $x + (y * z)$, indicating that addition is performed second.

$$(x + y) * z$$

Diagram illustrating operator precedence for the expression $(x + y) * z$. A bracket labeled ① groups $x + y$, indicating that addition is performed first. A second bracket labeled ② groups the entire expression $(x + y) * z$, indicating that multiplication is performed second.



Priority

Rank	Operator(s)	Description	Associativity
1	() [] -> .	Function call, array subscript, structure/union member access	Left to right
2	++ --	Postfix increment and decrement	Left to right
3	+ - ! ~ ++ -- (type) * & sizeof	Unary operators (sign, logical NOT, bitwise NOT, cast, dereference, address-of, size)	Right to left
4	* / %	Multiplication, division, remainder	Left to right
5	+ -	Addition, subtraction	Left to right
6	<< >>	Bitwise shift left, shift right	Left to right
7	< <= > >=	Relational (less/greater than)	Left to right
8	== !=	Equality and inequality	Left to right
9	&	Bitwise AND	Left to right
10	^	Bitwise XOR	Left to right
11		Bitwise OR	
12	&&	Logical AND	Left to right
13		Logical OR	
14	?:	Conditional (ternary) operator	Right to left
15	= += -= *= /= %= &= ^= `	= <<= >>= `	Assignment operators
16	,	Comma operator (sequential evaluation)	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 comma 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. Therefore, 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 .

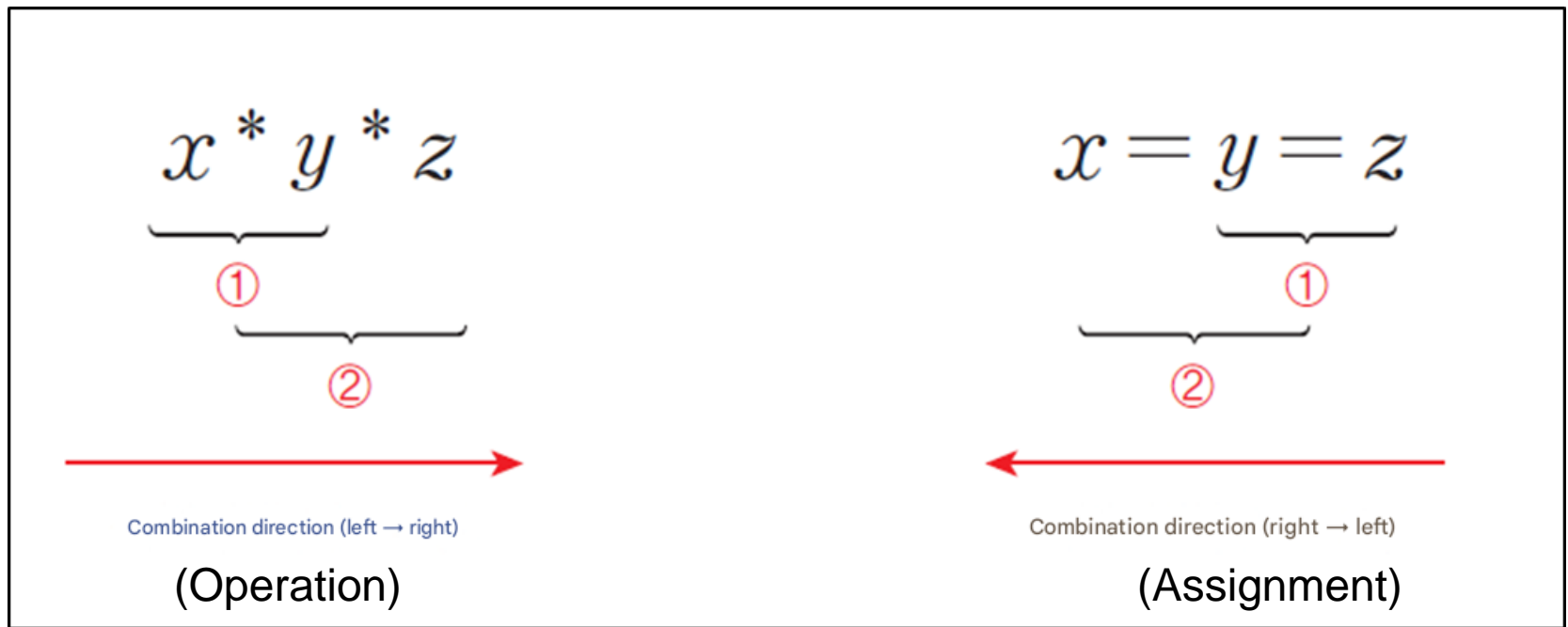
- $x < 5 \parallel x > 10 \&\& x > 0$

- $// x < 5 \parallel (x > 10 \&\& x > 0)$

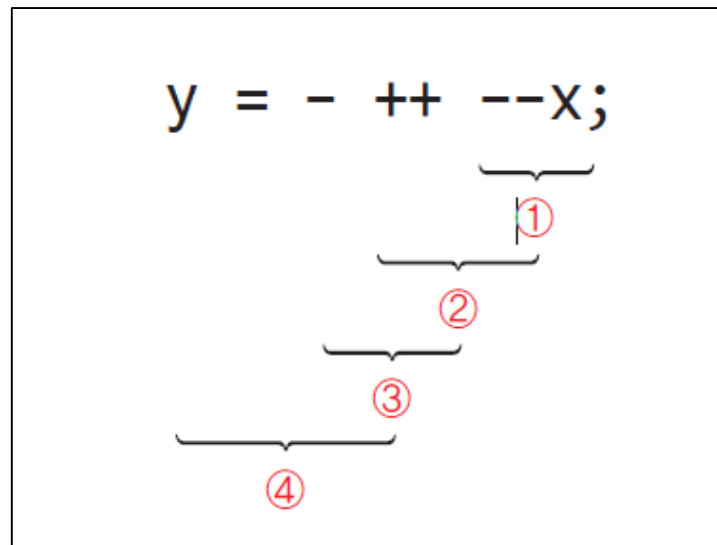
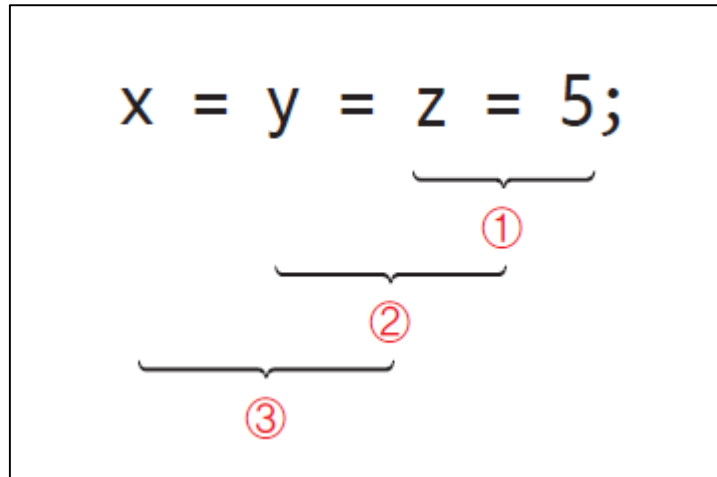
- Sometimes the order of evaluation of operators can be quite confusing.
In $x * y + w * y$ It is unclear which of $x * y$ and $w * y$ will be computed first.

Combination Rules

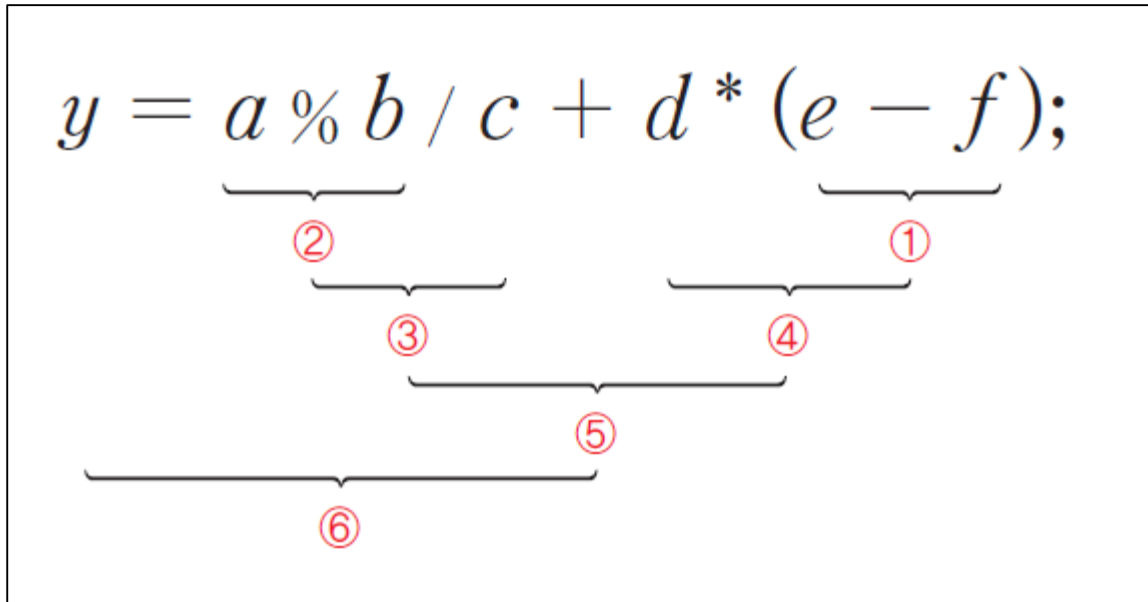
- If there are multiple operators with the same priority, the rule for which one should be performed first



Example of a combination rule



Example of a combination rule



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;
}
```



Q & A

