Computer Science

C operators and expressions

Operators and expressions in C

- Numerical expressions and operators
- Arithmetical operators
- Relational and logical operators
- Bitwise operators
- Assignment operators and expressions
- Other operators
  - Conditional operator
  - Comma operator
  - Address and indirection operators
  - `sizeof` operator
- Precedence and order of evaluation
- Type conversions

Numerical expressions and operators

- A **numerical expression** is formed by
  - Operators
  - Operands
- An **operator** is a symbol that indicates how the operands must be processed in the expressions
- An **operand** is the object that is processed: variables, constants, etc.

Arithmetical operators

- If the operands are of different types, the lower precision ones are transformed to the greater type

OPERATOR	OPERATION	OPERANDS
+	Addition	Integers or reals
-	Subtraction	Integers or reals
*	Multiplication	Integers or reals
/	Division	Integers or reals
%	Modulus: Remainder of integer division	Integers
-	Unary minus (sign change)	Just one operand (integer or real)

Relational and logical operators (I)

- Operands can be of any type but the result is always an integer with just two possible values: 1 (*true*) or 0 (*false*)

	LOGICAL OPERATORS
OPERATOR	**OPERATION AND RESULT**
&&	Logical **AND**. Result is 1 if both operands are non-zero (ie. if one or both are 0, result is 0).
||	Logical **OR**. Result is 1 if any of the operands is non-zero (ie. result is 0 just when both operands are 0).
!	Logical **NOT**. Result is 1 if the operand is 0, and 0 otherwise.

Relational and logical operators (II)

RELATIONAL OPERATORS	
OPERATOR	**OPERATION AND RESULT**
<	Result is 1 if the left operand is **lower than** the right one; 0 otherwise.
>	Result is 1 if the left operand is **greater than** the right one; 0 otherwise
<=	Result is 1 if the left operand is **lower than or equal to** the right one; 0 otherwise.
>=	Result is 1 if the left operand is **greater than or equal to** the right one; 0 otherwise.
!=	Result is 1 if the operands are **different**; 0 otherwise.
==	Result is 1 if the operands are **equal**; 0 otherwise.

Bitwise operators

- They operate with the individual bits of the operands, which must be integer type (`int` or `char`)

OP.	OPERATION AND RESULT
&	**AND** between bits of the operands
|	**OR** between bits of the operands
^	**XOR** (Exclusive OR) between bits of the operands
~	**1'Complement** of the operand (at the right of the operator)
<<	**Left shift** of the left operand by the number of positions given by the positive right operand (filling vacants with zeros).
>>	**Right shift** of the left operand by the number of position given by the positive right operand. If the operand is `unsigned` fills vacants with zeros, if signed, fill vacants with sign bit (arithmetic shift).

Assignment operators (I)

- They assign values to one variable
  - Simple assignment operator =
    - a = 2
  - Increment ++ and decrement -- operators
    - Increment/decrement by 1 the value of a variable in a expression

`++variable`. First increment, later use.

```
x = 1;
y = ++x;    // x is now 2, y is also 2
y = x++;    // x is now 3, y is 2
```

`variable++`. First use, later increment

```
x = 3;
y = x--;    // x is now 2, y is 3
y = --x;    // x is now 1, y is also 1.
```

Assignment operators (II)

- Operation *and* assignment

```
variable (op)= expresion;
```

Is equivalent to

```
variable = variable (op) expresion;
```

  - `(op)` is the assignment operator
  - `expresion` is the expression that will be evaluated along with variable to obtain its new value

```
i += 2
i = i + 2
```

are equivalent expressions

Assignment operators (III)

OP.	OPERACIÓN Y RESULTADO
`*=`	**Multiplication and assignment**. `C *= A` equiv. to `C = C*A`
`/=`	**Division and assignment**. `C /= A` equiv. to `C = C/A`
`%=`	**Modulus and assignment**. `C %= A` equiv. to `C = C%A`
`+=`	**Addition and assignment**. `C += A` equiv. to `C = C+A`
`-=`	**Subtraction and assignment**. `C -= A` equiv. to `C = C-A`

Assignment operators (IV)

OP.	OPERATION (bit level) AND RESULT	
<<=	**Left shift AND assignment**	`C <<= 2` equiv. to `C = C<<2`
>>=	**Right shift AND assignment**	`C >>= 2` equiv. to `C = C>>2`
&=	**Bitwise AND and assignment**	`C &= 2` equiv. to `C = C&2`
|=	**Bitwise OR and assignment**	`C |= 2` equiv. to `C = C|2`
^=	**Bitwise XOR and assignment**.	`C ^= 2` equiv. to `C = C^2`

Other operators (I)

- **Condicional Operator «?:»**

  `expr1 ? expr2 : expr3`
  - If `expr1` is true, then `expr2`, is evaluated
  - If `expr1` is false, then `expr3` is evaluated
  - Ex. `(a >= b) ? puts("a>=b") : puts("b>a");`

- **Comma Operator «,»**
  - Mostly used in the `for` statement.
  - When used to concatenates expressions and variables or to separates elements in argument lists is NOT an operator (do not guarantee left to right evaluation)

Other operators (II)

- **Address operator «&»**
  - `&variable` obtains the memory address of `variable`
- **Indirection operator «`*`»**
  - `*identifier` refers to the content of memory address `identifier`
- **Operator «`sizeof`»**
  - Returns the number of bytes that the operand occupies in memory

Precedence and order of evaluation (I)

Order		OPERATORS										ASOCIATIVITY
1º	`()`	`[]`	`.`	`->`	`sizeof`							Left to Right
2º	`-`	`~`	`!`	`*`	`++`	`--`	`(tipo)`					Right to Left
3º	`*`	`/`	`%`									Left to Right
4º	`+`	`-`										Left to Right
5º	`<<`	`>>`										Left to Right
6º	`<`	`<=`	`>`	`>=`								Left to Right
7º	`==`	`!=`										Left to Right
8º	`&`											Left to Right
9º	`^`											Left to Right
10º	`|`											Left to Right
11º	`&&`											Left to Right
12º	`||`											Left to Right
13º	`?:`											Right to Left
14º	`=`	`*=`	`/=`	`%=`	`+=`	`-=`	`<<=`	`>>=`	`&=`	`|=`	`^=`	Right to Left
15º	`,`											Left to Right

Precedence and order of evaluation (II)

- Precedence and order of evaluation (table)
  - Operators in the same line have the same priority
  - Priority decreases from top to bottom
  - Parenthesis are evaluated from inside to outside (as usual)
  - Some ambiguities may exists dependin on the compiler

USE PARENTHESIS!! when doubting

Type conversions (I)

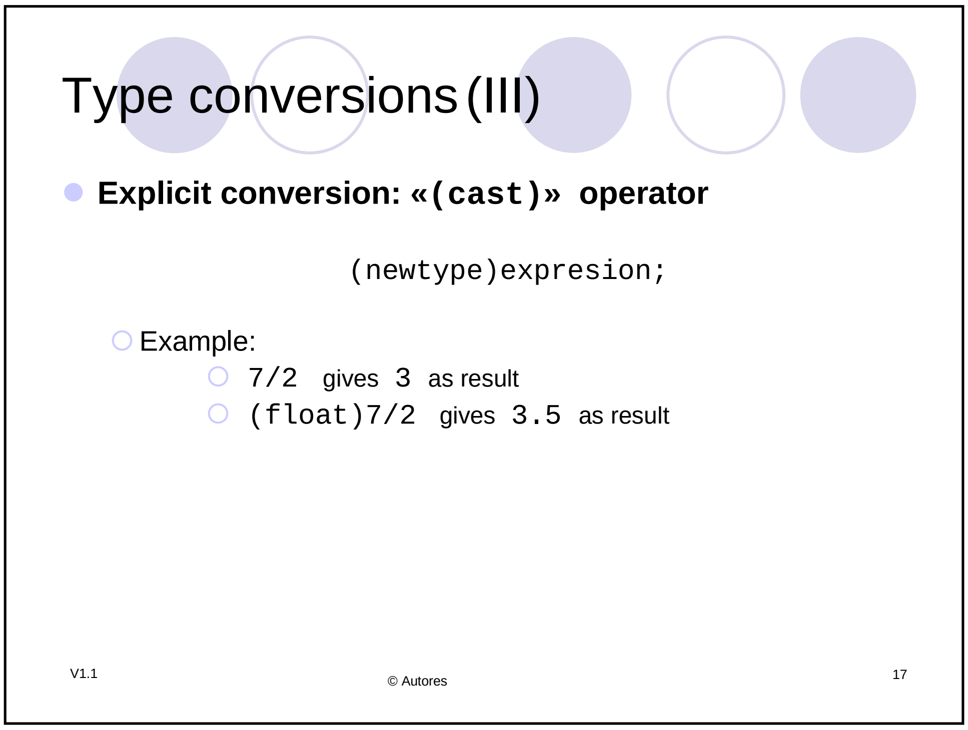
- In expressions operands are type-converted automatically
  - With reals involved, all are converted to the high precision one
  - Real constants are `double` by default
  - `char` and `short` are converted to `int` or to `unsigned int`
  - With integers involved, all are converted to the longest one

EXAMPLE

```
long a
char b;
int c, f;
float d;
f = a + b*c/d ;
```

- b is converted c type (`int`) and `b*c` is `int`
- `b*c` is converted to `float` and divided by d
- a is converted to `float` and added to `b*c/d`.
- `float` a+`b*c/d` is converted to `int` (eliminating fractional part) and saved in integer `f`

Better try not to mix types…



Type conversions (III)

- **Explicit conversion: «`(cast)`» operator**

```
(newtype)expresion;
```

  - Example:
    - `7/2` gives `3` as result
    - `(float)7/2` gives `3.5` as result

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