

Fundamentals of Programming I



Data Types: Technical Details

Grado en Ingeniería Informática

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int

Integer Numbers

Value range:

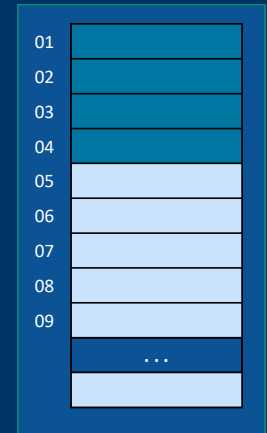
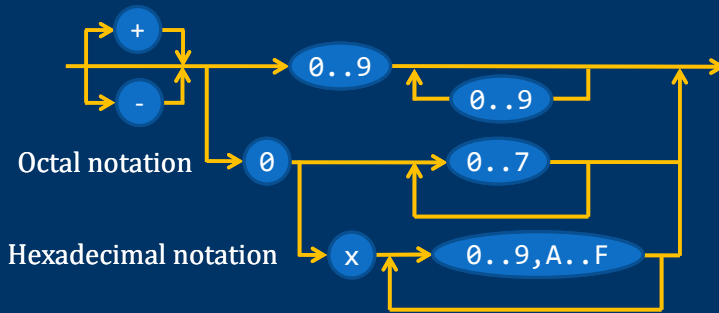
-2147483648 .. 2147483647

Memory Bytes: **4***

Literals:

1363, -12, 010, 0x1A

(*) Machine dependent
4 bytes is the most common
To know how many bytes
are used, use the function:
`sizeof(int)`



int

Integer Numbers

Octal Notation (base 8: digits between 0 and 7):

-010 = -8 in decimal notation

$$10 = 1 \times 8^1 + 0 \times 8^0 = 1 \times 8 + 0$$

0423 = 275 in decimal notation

$$423 = 4 \times 8^2 + 2 \times 8^1 + 3 \times 8^0 = 4 \times 64 + 2 \times 8 + 3 = 256 + 16 + 3$$

Hexadecimal Notation (base 16):

Valid digits: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F

0x1F = 31 in decimal notation

$$1F = 1 \times 16^1 + F \times 16^0 = 1 \times 16 + 15$$

0xAD = 173 in decimal notation

$$AD = A \times 16^1 + D \times 16^0 = 10 \times 16 + 13 = 160 + 13$$



float

Real Numbers (with decimals)

Value Range:

$\pm 1.18e-38 \dots 3.40e+38$

Memory Bytes: 4*

(*) `sizeof(float)`

Floating point. Precision: 7 digits

Literals:

✓ Standard notation: 134.45, -1.1764



✓ Scientific notation: 1.4E2, -5.23e-02



01	
02	
03	
04	
05	
06	
07	
08	
09	
	...



Scientific Notation



An optional sign followed by
a number with only one digit as integer part followed by
the letter e or E and the exponent (power of 10) with or without sign:

$-5.23e-2 \rightarrow -5.23 \times 10^{-2} \rightarrow -0.0523$

$1.11e2 \rightarrow 1.11 \times 10^2 \rightarrow 111.0$

$7.4523e-04 \rightarrow 7.4523 \times 10^{-4} \rightarrow 0.00074523$

$-3.3333e+06 \rightarrow -3.3333 \times 10^6 \rightarrow -3.333.300$



double

Real Numbers (with decimals)

Value Range:

$\pm 2.23e-308 \dots 1.79e+308$

Memory Bytes: 8*

(*) `sizeof(double)`

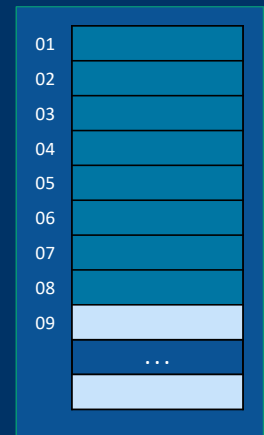
Floating point. Precision: 15 digits

Literals:

✓ Standard notation: 134.45, -1.1764



✓ Scientific notation: 1.4E2, -5.23e-02



char

Characters

Value Range:

Character Set (ASCII)

Memory Bytes: 1 (FC)

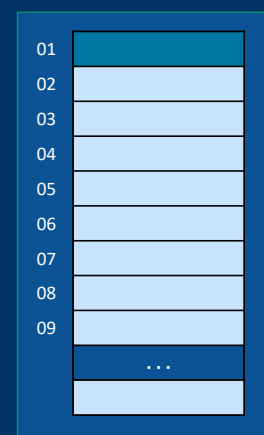
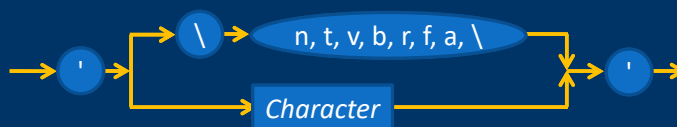
Literals:

'a', '%', '\t'

Backslash Characters (*escape sequences*)

Control characters

'\t' = tab, '\n' = newline, ...



char

ASCII Character Set:

American Standard Code for Information Interchange (1963)

Characters with codes from 0 to 127 (7 bits)

- Control characters:
Codes from 0 to 31 and 127
Tab, newline,...
- Printable characters:
Codes from 32 to 126

```
!"#$%&'()*+,-./
0123456789:;<=>?
@ABCDEFGHIJKLMNO
PQRSTUVWXYZ[\]^_
`abcdefghijklmnopqrstuvwxyz
{|}~
```

Extended ASCII Character Set (8 bits):

ISO-8859-1

+ Codes from 128 to 255

Multiple character encodings: EBCDIC, UNICODE, UTF-8, ...



bool

Logical Values

Only two possible values:

- *True*
- *False*

Memory Bytes: 1 (FC)

Literals:

true, false

Actually, any number other than 0 is equivalent to **true** and 0 is equivalent to **false**

01	
02	
03	
04	
05	
06	
07	
08	
09	
	...

string

Character sequences

"Hello", "Enter the numerator: ", "X142FG5TX?%A"



Character sequences

Enough memory is assigned for the sequence

The `string` library must be included with the `std` namespace:

```
#include <string>
using namespace std;
```



Beware!

Typographic quotes (opening/close) “...” are not allowed
Be sure to use straight quotes: “...”



Literals with Type Specification

By default an integer literal is considered `int` data

- `long int`: 35L, 1546l
- `unsigned int`: 35U, 1546u
- `unsigned long int`: 35UL, 1546ul

By default a real literal is considered `double` data

- `float`: 1.35F, 15.46f
- `long double`: 1.35L, 15.46l

Shortcuts for Type Modifiers

`short` \equiv `short int`

`long` \equiv `long int`

Better to avoid them

Minimize the information to remember about the language



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