

## COMP26020 Programming Languages and Paradigms Part 1: C Programming

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# Variables, Types, Printing to the Console

# Variables

# Variables

```
#include <stdio.h>

int main() {
    int a;                // declare local variable a of type int (signed integer)

    a = 12;                // set the value of a to 12
    printf("a's value: %d\n", a); // print the value of a

    return 0;
}
```

[04-c-variables-types-printf/variables-1.c](#) 

- Variable: **name**, **type**, **value**
- Must be **declared** before being used
  - Declare with `<variable type> <variable name>;`

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[04-c-variables-types-printf/variables-1.c](#) 

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```
int _x;    // variable names should start with a letter or underscore
int sum;
int final_balance2; // it can contain a combination of letters/numbers/underscores
int a_long_variable_name_is_also_possible_but_not_very_practical;
```

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[04-c-variables-types-printf/variables-1.c](#) 

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```
int a; int b; int c;
int d = 12; // declare and set
int x, y = 10, z = 11; // declare x, y and z,
                        // set y and z

a = 12; // set a to 12
```

```
b = 20; // set b to 20
c = 10 + 10; // set c to 20
a = b; // a = 20
d++; // d = d + 1
y *= 2 // y = y * 2;
//
```

[04-c-variables-types-printf/variables-2.c](#) 

# Types

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Types are used by the compiler for 2 things:

- At build time, the compiler **checks the validity of operations** on the variable based on its type
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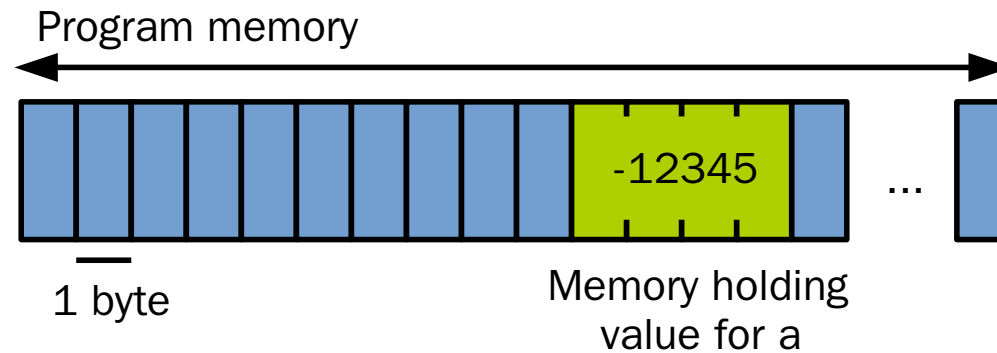
**3 basic types categories: integers, floating-point numbers, characters**



# Types

```
int a;           // signed integer takes 4 bytes in memory on the Intel x86-64 architecture  
a = -12345;
```

At runtime:



# Types

## Characters and floats:

```
char my_char_variable;  
float my_float_variable;  
  
my_char_variable = 'x'; // use single quotes for characters  
my_float_variable = 12.4;
```

# Types

Arithmetics mixing integers and floats:

```
int int1 = 2, int2 = 4;
float float1 = 2.8;

/* when mixed with floats in arithmetics, integers are promoted to floats */
float float_res = int1 + float1;           // float_res: 4.8
float float_res2 = int1 * (float1 + int2); // float_res2: 13.6

/* when stored in an integer variable, floats are _truncated_ */
int int_res = int1 + float1;               // int_res: 4

printf("float result:   %f\n", float_res);
printf("float result2:  %f\n", float_res2);
printf("integer result: %d\n", int_res);
```

[04-c-variables-types-printf/types.c](#) 

# More Types, Qualifiers

- Types: `char`, `int`, `float` (single precision), `double` (double precision)
- Integer qualifiers: `signed` (positive and negative integers), `unsigned` (only positive integers), `short` (smaller), `long` (larger)
- Determines the **storage size in memory**

```
short int a;           // signed, at least 16 bits: [-32,767,      +32,767]
int b;                 // signed, at least 16 bits: [-32,767,      +32,767]
unsigned int c;         // unsigned: [0,      +65,535]
long int d;             // at least 32 bits: [-2,147,483,647, +2,147,483,647]
unsigned long int e;     // unsigned: [0,      +4,294,967,295]
long long int f;        // at least 64 bits: [-9x10^18,      +9x10^18]
long long unsigned int g; // unsigned: [0,      +18x10^18]
float h;                // storage size unspecified, generally 32 bits
double i;               // storage size unspecified, generally 64 bits
```

- Exact implementation is **architecture dependent**
- Complete list here: [https://en.wikipedia.org/wiki/C\\_data\\_types](https://en.wikipedia.org/wiki/C_data_types)

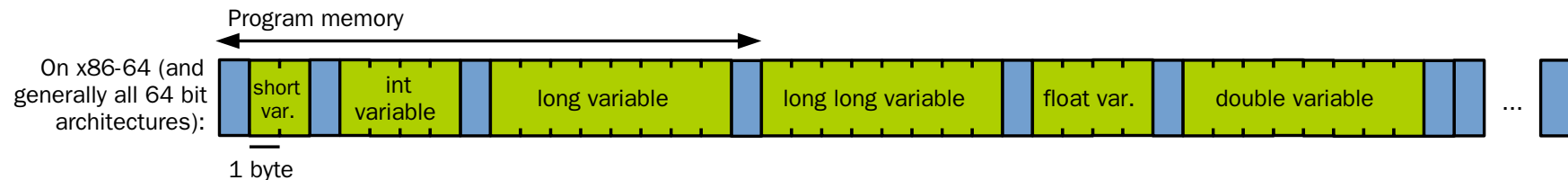
# Types: Storage Size in Memory

- Use `sizeof` to get the exact size of a type on a given machine:

```
int so_short = sizeof(short int);
int so_int = sizeof(int);
int so_uint = sizeof(unsigned int);
int so_long = sizeof(long int);
int so_longlong = sizeof(long long int);
int so_float = sizeof(float);
int so_double = sizeof(double);

printf("size of short:      %d bytes\n", so_short);
printf("size of int:        %d bytes\n", so_int);
printf("size of unsigned int:  %d bytes\n", so_uint);
printf("size of long int:      %d bytes\n", so_long);
printf("size of long long int: %d bytes\n", so_longlong);
printf("size of float:         %d bytes\n", so_float);
printf("size of double:        %d bytes\n", so_double);
```

[04-c-variables-types-printf/sizeof.c](#)



# Printing to the Console: printf

# Printing to the Console

- `printf` accepts **one or more arguments**:
  - Format string (mandatory)
  - Optionally a list of variables which values should be printed, replacing markers (e.g. `%d` in the format string)

```
int int_var = -1;
unsigned int uint_var = 12;
long int lint_var = 10;
float float_var = 2.5;
double double_var = 2.5;
char char_var = 'a';
char string_var[] = "hello";
```

```
//
```

```
printf("Integer: %d\n", int_var);
printf("Unsigned integer: %u\n", uint_var);
printf("Long integer: %ld\n", lint_var);
printf("Float: %f\n", float_var);
printf("Double: %lf\n", double_var);
printf("Characters: %c\n", char_var);
printf("String: %s\n", string_var);
```

```
printf("Several variables: %d, %lf, %s\n",
      int_var, double_var, string_var);
```

```
//
```

[04-c-variables-types-printf/printf.c](#) 

- Format string accepts escaped characters such as `\n` for line break
- See [here](#) for a list of all markers/modifiers

# Printing to the Console (2)

- Make sure to use the right marker!
  - In most situations the compiler won't tell you if you make a mistake and incorrect values will be displayed at runtime

```
int my_variable = -42;
printf("-42 printed with %%d: %d\n", my_variable);
printf("-42 printed with %%u: %u\n", my_variable); // -42 interpreted as an unsigned integer

unsigned long long int ull = 5467513055454315;
printf("5467513055454315 printed with %%llu: %llu\n", ull);
printf("5467513055454315 printed with %%u: %u\n", ull); // interprets only 4 bytes vs. 8 for llu
printf("5467513055454315 printed with %%d: %d\n", ull); // first 4 bytes, as unsigned
//
```

[@4-c-variables-types-printf/printf-bugs.c](#) 



# Summary

- Variables
  - Types
  - `printf`
- 

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