

Variables and types

Bachelor of Science - École polytechnique

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Key concepts

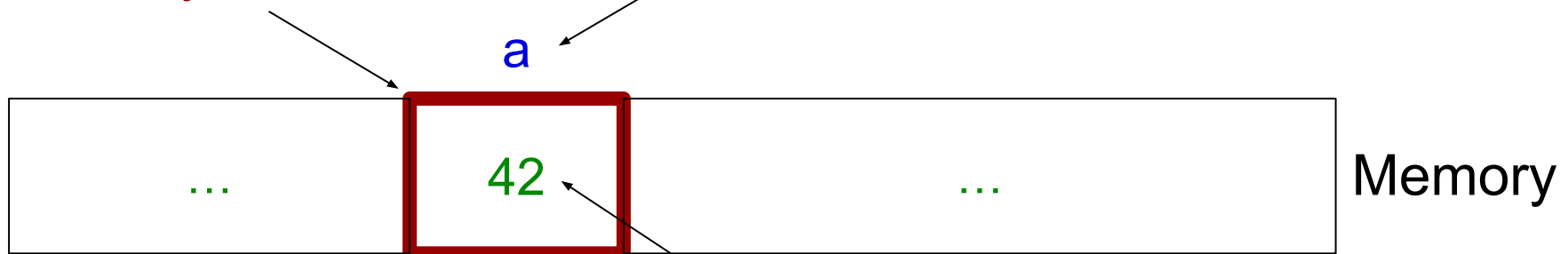
- Variable declaration: `type var;`
- Common types:
 - Integer: `char`, `short`, `int`, `long`, `long long`,
 - Real numbers: `float`, `double`
 - String: `char*` (not really, but enough for the moment)
 - Array: `type[]`
- Type conversion
 - Implicit cast when no information is lost
 - Explicit with a cast operator otherwise: `(type)`

Variables in C

- A variable **is a memory location** that has
 - A **name**: the symbol that identifies the memory location
 - A **type**: the nature of the memory location
 - A **value**: the content of the memory location

The variable **is** the memory location

The variable is named **a**



It has the type **int**
(integer)

and it contains the
value **42**

Common types in C

- Integer numbers:
 - `char` (1 byte)
 - `short` (2 bytes)
 - `int` (implementation specific, most of the time 4 bytes)
 - `long` (4 bytes)
 - `long long` (8 bytes)
 - prefix with `unsigned` for an unsigned integer, otherwise `signed`
- Real numbers:
 - `float` (4 bytes)
 - `double` (8 bytes)
- String
 - `char*` (implementation specific)
(Note: `char*` is not a string at all, but as a first approximation, imagine that it's the case)
- Array (a sequence of elements with the same type)
 - `type[]` (for example `int[]` for an array of `int`)

The pseudo-type void

- `void` is a pseudo-type used to indicate that a function returns nothing

```
void say_hello() {  
    printf("hello\n");  
    return; // optional  
}
```

The literals in C

- **Integer**: an integer value such as `0`
 - Encoded as an `int` (4 bytes)
 - If suffixed with `l`, encoded as a long long (8 bytes), e.g., `0l`
- **Character**: a letter surrounded by a single quote such as `'a'`
 - A character is converted into an integer named its ascii code
 - And encoded as a `char` (1 byte)
 - That's why the type `char` in C is considered as an integer type
- **Real number**: a number with a dot such as `3.14`
(you can also write it as `2.13e-2`, which means $2.13 \cdot 10^{-2}$)
 - Encoded as a float (4 bytes)
 - If suffixed with `l`, encoded as a `double` (8 bytes), e.g., `3.14l`
- **String**: a sequence of characters surrounded by a double quote, such as `"Hello, world!\n"`

Declaring a variable

- Each variable in C has to be explicitly declared
 - With `type` name;
 - The type of a variable is fixed and cannot change

```
int main(int argc, char* argv[]) {  
    int x;          /* declare an int */  
    float f;       /* declare a float */  
    char* name;    /* declare a string */  
    int tab[4];    /* declare an array of 4 int */  
  
    x = 42;  
    f = 3.14;  
    name = "Tyrion Lannister";  
    tab[0] = 42; /* set the first elements of the array */  
  
    return 0;  
}
```

Declaring a variable

- You can also declare a variable and gives it an initial value in a single statement

```
int main(int argc, char* argv[]) {  
    int x = 42;  
    int y = x + 1;  
    float f = 3.14;  
    char* name = "Tyrion Lannister";  
  
    return 0;  
}
```


Declaring a variable

- Or declare multiple variables in a single statement

```
int main(int argc, char* argv[]) {  
    int x, y = 3, z;  
  
    return 0;  
}
```

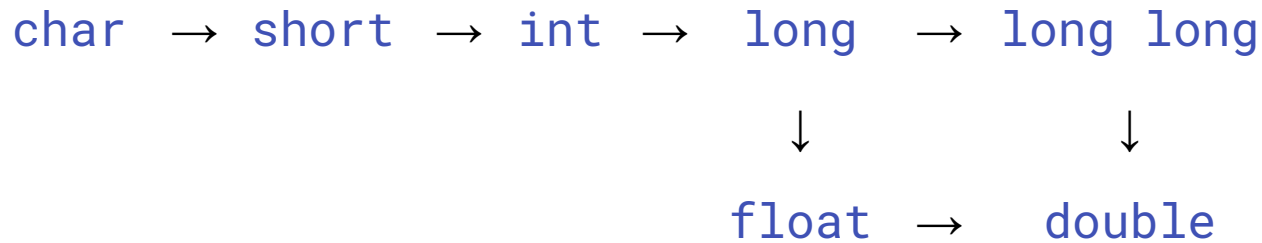
Constant

- A variable can be declared constant with the `const` keyword
 - Assign a value when it is declared
 - Cannot change later
- Avoid bugs (read-only variable) and enables optimizations

```
int main(int argc, char* argv[]) {  
    const int x = 42;  
    printf("%d\n", x);  
    //x = 33; => forbidden  
    return 0;  
}
```

Type conversion and cast operator

- You can convert a value from a type `s` to a type `d` with a **cast**
 - Implicit cast when no information is lost



- Explicit cast with a cast operator otherwise: (`type`)

```
char    a = 'a';           // 'a' => 97
int     b = a;             // 97
float   c = b;             // 97.0
double  d = c;             // 97.0

short   e = (short)d;     // 97
char    f = (char)97.3;   // 97 => 'a'
```

Printing a variable

- The `printf` function prints its arguments on the terminal
 - Take as argument a **format** followed by arguments
 - Note: an integer smaller than 4 bytes is promoted to 4 bytes

	4 bytes	8 bytes	Other
signed decimal	<code>%d</code>	<code>%ld</code>	
unsigned decimal	<code>%u</code>	<code>%lu</code>	
hexadecimal	<code>%x</code>	<code>%lx</code>	
character	<code>%c</code>		
string			<code>%s</code>

```
printf("Bip: %i %f %c %s\n", 42, 3.14, 'a', "bap");  
=> "Bip: 42 3.14 a bap"
```

Comparison with python

- C is an **explicitly typed** language
 - You have to explicitly declare a variable
 - And gives it a type at declaration
 - And the type cannot change later

```
int x;  
x = 42;  
// x = "hello" => error
```

- Python is a **dynamically typed** language
 - A variable is automatically created when it is used
 - Its type is dynamically deduced from the assigned value
 - The type can change dynamically

```
x = 42  
# the type of x can change dynamically  
x = "hello"
```

Pro and cons

■ Explicit typing

- + Detect typing bugs at compilation
- + Simplify memory management since the size of a variable is known at compilation time
- - More work for the developer

■ Dynamic typing

- - Detect typing bugs too late, at runtime!
- - Complexify memory management since the size of a variable can change during execution (\Rightarrow performance overheads)
- + Less work for the developer

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