

# Strings

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*(based and/or partially inspired by Pedro Vasconcelos's slides for Imperative Programming)*

# Strings

- We can use **character arrays** to represent text *strings*
- C strings are terminated with a zero code character (represented as `'\0'`)
  - ▶ the string `"Abba"` is 

A	b	b	a	\0
---	---	---	---	----
  - ▶ the empty string `""` is 

\0
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- The `'\0'` character is a terminator that marks the end of the string
  - ▶ is not part of the text
- The length of the string is determined by the position of `'\0'`
- Like other arrays, we must declare strings with a size. As explained before, using a macro can help making modifications easier:

```
#define MAX_SIZE 100
...
char text[MAX_SIZE]; // space for 99 characters + '\0'
```

# Initializing strings

- Initialize using character constants:

```
char text[6] = { 'H', 'e', 'l', 'l', 'o', '\0' };
```

- We can also initialize with the characters in quotes:

```
char text[6] = "Hello";
```

- In this second form, the terminator `'\0'` is automatically inserted at the end.
- We can declare a longer length than necessary:

```
char text[100] = "Hello"; // remaining characters are \0
```

- If we omit the size, the compiler reserves only what is necessary:

```
char text[] = "Hello"; // size 6
```

# Printing and reading strings

- To print a string we can use:
  - ▶ `printf` with the format `%s`
  - ▶ or the `puts` function (prints string followed by a newline `'\n'`)

```
#include <stdio.h>

char text[] = "Hello, world";
printf("%s\n", text); // equivalent to puts
puts(text);
```

- To read a string we can use:
  - ▶ `scanf` with the format `%s` (read a string separated by whitespaces)
  - ▶ the `fgets` function (reads a string of at most  $k$  chars from a stream)

(more on the differences between `scanf` and `fgets` on the next slides)

# Reading strings - scanf

- Imagine you have a file `input.txt` with the following content:

```
hello world
programming
```

- The following program would read three separated strings ( `scanf` uses *whitespace*, such as spaces or newlines, to separate *tokens*):

```
#include <stdio.h>

#define MAX 100

int main(void) {
    char s1[MAX], s2[MAX], s3[MAX];

    scanf("%s %s %s", s1, s2, s3);
    printf("[%s] [%s] [%s]\n", s1, s2, s3);

    return 0;
}
```

```
$ g++ -Wall -o code code.c && ./code < input.txt
[hello] [world] [programming]
```

# Reading strings - scanf and fgets

- `scanf` with `%s` can be *dangerous* if the input has more characters the size of the string - it will write to memory spaces it shouldn't
  - ▶ This is known as a [buffer overflow](#)
- To solve this we can use the `fgets` function:

```
#include <stdio.h>
#define MAX_SIZE 100
...
char text[MAX_SIZE];
fgets(text, MAX_SIZE, stdin);
```

- ▶ The second argument specifies the maximum size (it stops reading if the inputs has more characters)
- ▶ The third argument specifies the input channel ( `stdin` is standard input)
- ▶ `fgets` will read everything (including spaces) until `MAX_SIZE` , newline or EOF is reached
- ▶ If there is no more input, it return `NULL`

# Reading strings - scanf and fgets

- With the same `input.txt` file as before:

```
hello world
programming
```

- Using `fgets` we get:

```
#include <stdio.h>

#define MAX 100

int main(void) {
    char s[MAX];

    while (fgets(s, MAX, stdin) != NULL) {
        printf("%s", s); // s contains the newline
    }

    return 0;
}
```

```
$ g++ -Wall -o code code.c && ./code < input.txt
hello world
programming
```

# String Library

- C has a `string.h` library with many string functions
  - ▶ You can check the [documentation page](#)
- Here are two of the most common functions:
  - ▶ `strlen(s)` - return the length of string `s`
  - ▶ `strcmp(s1, s2)` - returns:
    - ★ Negative value if `s1` appears before `s2` in lexicographical order
    - ★ Zero if `s1` and `s2` compare equal
    - ★ Positive value if `s1` appears after `s2` in lexicographical order

```
char s1[MAX] = "Pedro", s2[MAX] = "Ribeiro";
int len1 = strlen(s1), len2 = strlen(s2);

printf("%s has length %d\n", s1, len1);
printf("%s has length %d\n", s2, len2);
printf("strcmp(%s,%s) = %d\n", s1, s2, strcmp(s1, s2));
printf("strcmp(%s,%s) = %d\n", s2, s1, strcmp(s2, s1));
```

```
Pedro has length 5
Ribeiro has length 7
strcmp(Pedro,Ribeiro) = -2
strcmp(Ribeiro,Pedro) = 2
```