Lesson 2 - Introduction to C language

Logical Computational Thinking

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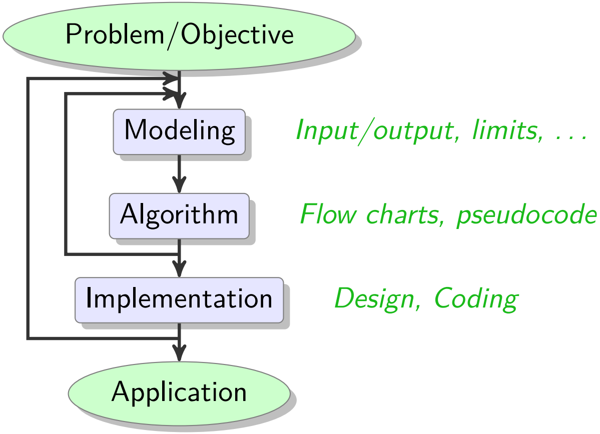
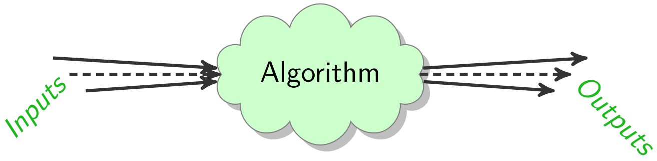
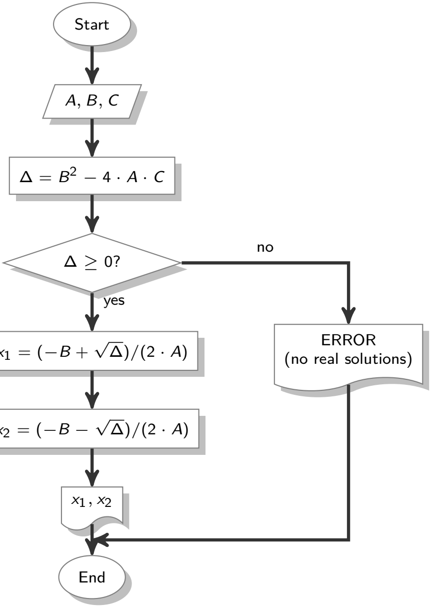
Review


Problem/Objective
Modeling
Input/output, limits, . . .
Algorithm
Flow charts, pseudocode
Implementation
Design, Coding
Application

Model



Algorithm


Start
A, B, C
$\Delta = B^2 - 4 \cdot A \cdot C$
$\Delta \geq 0?$
no
yes
$x_1 = (-B + \sqrt{\Delta})/(2 \cdot A)$
$x_2 = (-B - \sqrt{\Delta})/(2 \cdot A)$
x_1, x_2
ERROR
(no real solutions)
End

C language

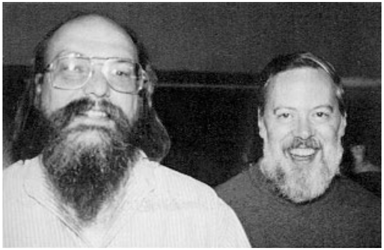


Figure: Ken Thompson and Dennis Ritchie

History

- ✓ The language C is developed in the 70's by Dennis Ritchie
- ✓ Along with the Unix system, created by Ken Thompson and Dennis Ritchie in the same years

Basics

Blocks

```
{
   ...
}
```

✓ Good practice to indent the code to the right every time a block is open, and to the left when is closed.

Comments

```
//Single line comment

/* Multiple
lines
comments */
```

Main and libraries

Libraries

```c
#include<stdio.h>
#include<math.h>
```

- ✓ For including code defined elsewhere.
- ✓ Can be custom libraries or standard libraries like:
  - `stdio.h` stands for *STandard Input Output* and provide basic interface with the terminal;
  - `math.h` provide some useful mathematical functions, like `pow` and `sqrt` .
- ✓ The `#include` directives must be write on top of the source file (before the main)

Main

✓ Is the entry point for the program.

```c
int main(void) {
  ...
  return 0;
}
```

or

```c
int main(int argc, char *argv[]) {
  ...
  return 0;
}
```

Example

hello_world.c

```c
//Compile it with gcc hello_world.c -o
    ↪ hello_world

#include<stdio.h>  //library for input/output

int main(void) {  //begin of main
  printf("Hello␣world!\n");  //output of
      ↪ string
  return 0;
}
```

Variables

Initialization

```
int var1;                //default initial value
float var2 = 3.1415; //custom initial value
int var3, var4, var5;//multiple initialization
```

- ✓ C is case sensitive, `int` ≠ `Int` ≠ `INT` .
- ✓ Allowed names can contains `[A-Z,a-z,0-9,_]` , cannot begin with a number.
- ✓ Good practices are: to use camel case or `_` for composed words, and to start with lower case. I.e. `camelCaseExample` .
- ✓ Also when possible define variables on method begin.

Variables

Assignation

```
var1 = 42;
```

- ✓ Is possible to use also expressions on the right of $=$
- ✓ Also with other variables or the same variable.

```
var3 = var4 + var5;
var3 = var3 - 1;
```

Variable types

Integer

type	size	min value	max value
`char`	1 byte	-128	127
`short`	2 bytes	-32,768	32,767
`int`	4 bytes	-2,147,483,648	2,147,483,647
`long`	8 bytes	-9,223,372,036,854,775,808	9,223,372,036,854,775,807
`unsigned char`	1 byte	0	255
`unsigned short`	2 bytes	0	65,535
`unsigned int`	4 bytes	0	4,294,967,295
`unsigned long`	8 bytes	0	18,446,744,073,709,551,615

✓ `char` is used also for the characters of the ascii table.

Variable types

Floating point

type	size	min value	max value	epsilon
`float`	4 bytes	$1.175494e^{-38}$	$3.402823e^{38}$	$1.192093e^{-07}$
`double`	8 bytes	$2.225074e^{-308}$	$1.797693e^{308}$	$2.220446e^{-16}$
`long double`	16 bytes	$3.362103e^{-4932}$	$1.189731e^{4932}$	$1.084202e^{-19}$

Boolean

✓ Is possible to use the type `bool` , and the values `true` and `false` .

✓ You need to add `#include<stdbool.h>` .

✓ Not really useful because you can use any integer type with the values:

- 0 for false;
- $\neq 0$ for true.

Operators (in priority order)

Arithmetic

1. `*` , `/` , `%` ;
2. `+` , `-` ;

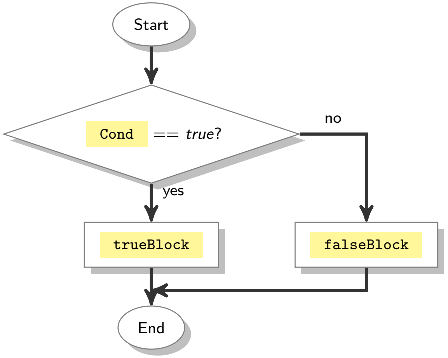
Logic

2. `!` ;
3. `<` , `>` , `<=` , `>=`
4. `==` , `!=` ;
5. `&&` ;
6. `||` ;

✓ Is possible to change order with `(` and `)` , i.e.:

```
(a+b)*c
```

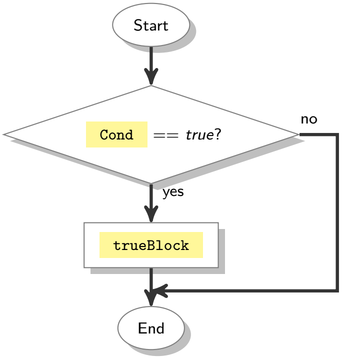
Selections



```
if(cond) {
  trueBlock;
} else {
  falseBlock;
}
```

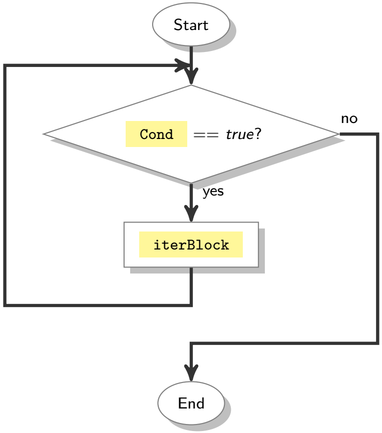
Selections

The `else` block is optional.



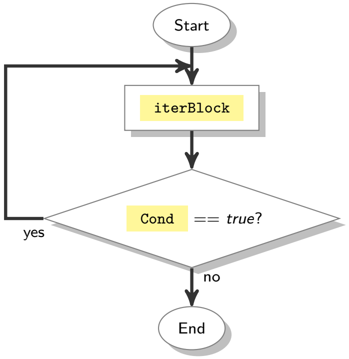
```
if(cond) {
  trueBlock;
}
```

While iteration



```
while(cond) {
  iterBlock;
}
```

Do-while iteration



```
do {
   iterBlock;
} while(cond);
```

For iteration

```
for(iniz; cond; oper) {
  iterBlock;
}
```

is equivalent to:

```
iniz;
while(cond) {
  iterBlock;
  oper;
}
```

For iteration example

forTest.c

```c
#include<stdio.h>

int main(void) {
  int i; //initialize var

  //iterate from i=1 while i<=42
  //incrementing i on each loop
  for(i = 1; i <= 42; i++) {
    printf("*"); //print an *
  }
  printf("\n");

  return 0;
}
```

User input/output

Output: `printf`

```
printf(format, var1, var2, ...);
```

- ✓ `format` is a string that contain the text to be send to output
- ✓ the format string can contains special chars using `\`
  - `\\` , `\"` , `\%` , `\n` (for new line)
- ✓ the format string can contains special format specifiers
  - for each specifier is necessary a corresponding variable `var`
  - the output string will be integrated with the value of the variables

Input: `scanf`

```
scanf(format, &var);
```

- ✓ `format` is a string with only one format specifier
- ✓ `var` is a variable name (remember to add the special char `&`)
- ✓ the input will be saved inside `var`

format specifiers

- ✓ for each data type corresponds a format specifier
- ✓ a format specifier is `%[length][specifier]`

Length	**Specifier**		
	`d`	`u`	`f` (`e` for $m\,10^n$)
(none)	`int`	`unsigned int`	`float`
`hh`	`char`	`unsigned char`	
`h`	`short`	`unsigned short`	
`l`	`long`	`unsigned long`	`double`
`L`			`long double`

For example:

- ✓ `%d` for `int`
- ✓ `%hu` for `unsigned short`
- ✓ `%Le` for `long double` (expressed in scientific notation)

printfScanfExample.c

```c
#include<stdio.h>

int main(void) {
  float floatVar;
  long longVar;
  printf("Input\\output\ndemonstration\n\n");
  printf("Insert a rational number: ");
  scanf("%f", &floatVar);
  printf("Insert a long integer: ");
  scanf("%ld", &longVar);
  printf("Rational is: %f; integer is: %ld\n", floatVar, longVar);
  printf("Rational in scientific notation: %e\n", floatVar);
  return 0;
}
```

```
$ gcc printfScanfExample.c -o example
$ ./example
Input\output
demonstration

Insert a rational number: 12.34
Insert a long integer: 123456
Rational is: 12.340000; integer is: 123456
Rational in scientific notation: 1.234000e+01
$
```