

General coding

stirlingcodingclub.github.io/coding_types/slides.pdf

Stirling Coding Club

02 November 2022

How does code actually work?

- ▶ Programmers work with **source code** (e.g., R, python)
- ▶ Computers execute **machine language** (binary)
- ▶ To get from source code to machine language, we can *compile* code or *interpret* it.

Compiled versus interpreted code

Compiled code

- ▶ Directly translates everything to machine language
- ▶ Translation must occur before running code
- ▶ C, C++, FORTRAN, Pascal (low-level languages)¹
- ▶ Two steps to execute code
- ▶ Faster performance (executes immediately after compiling)
- ▶ Slower and more laborious to code

¹Technically, any language *could* be compiled or interpreted.

Compiled versus interpreted code

Compiled code

- ▶ Directly translates everything to machine language
- ▶ Translation must occur before running code
- ▶ C, C++, FORTRAN, Pascal (low-level languages)¹
- ▶ Two steps to execute code
- ▶ Faster performance (executes immediately after compiling)
- ▶ Slower and more laborious to code

Interpreted code

- ▶ Code is run bit by bit through an interpreter
- ▶ Interpreter breaks down and executes code 'on the fly'
- ▶ R, Perl, MATLAB, Python (high-level languages)¹
- ▶ One step to execute code
- ▶ Slower performance (executes after interpreted)
- ▶ Faster and more intuitive to code

¹Technically, any language *could* be compiled or interpreted.

Compiled versus interpreted code

Compiled code

- ▶ Directly translates everything to machine language
- ▶ Translation must occur before running code
- ▶ C, C++, FORTRAN, Pascal (low-level languages)¹
- ▶ Two steps to execute code
- ▶ Faster performance (executes immediately after compiling)
- ▶ Slower and more laborious to code

Interpreted code

- ▶ Code is run bit by bit through an interpreter
- ▶ Interpreter breaks down and executes code 'on the fly'
- ▶ R, Perl, MATLAB, Python (high-level languages)¹
- ▶ One step to execute code
- ▶ Slower performance (executes after interpreted)
- ▶ Faster and more intuitive to code

¹Technically, any language *could* be compiled or interpreted.

R packages can include both compiled and intereted code

Name	Size	Type	Date Modified
R	4.1 kB	folder	28/01/21
notebook	4.1 kB	folder	28/01/21
src	4.1 kB	folder	24/01/21
docs	4.1 kB	folder	31/05/20
vignettes	4.1 kB	folder	27/05/20
tests	4.1 kB	folder	27/05/20
man	4.1 kB	folder	27/05/20
data	4.1 kB	folder	27/05/20
gmse.Rproj	303 bytes	R Project	24/01/21
DESCRIPTION	2.5 kB	plain text document	31/05/20
NEWS.md	2.4 kB	Markdown document	27/05/20
README.md	5.7 kB	Markdown document	27/05/20
_pkgdown.yml	477 bytes	YAML document	27/05/20
NAMESPACE	2.0 kB	plain text document	27/05/20
cran-comments.md	686 bytes	Markdown document	27/05/20

R packages can include both compiled and interpreted code

An R file named 'resource.R'

```
run_resource <- function(RESOURCE_c, LANDSCAPE_c, PARAMETERS_c){  
  .Call("resource", RESOURCE_c, LANDSCAPE_c, PARAMETERS_c);  
}
```

R packages can include both compiled and intereted code

An R file named 'resource.R'

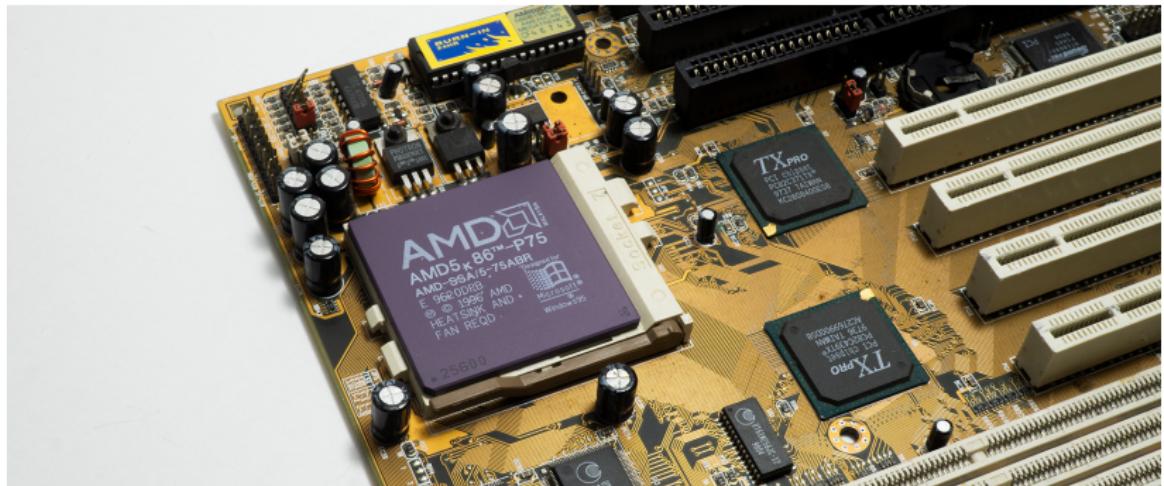
```
run_resource <- function(RESOURCE_c, LANDSCAPE_c, PARAMETERS_c){  
  .Call("resource", RESOURCE_c, LANDSCAPE_c, PARAMETERS_c);  
}
```

A C file named 'resource.c'

```
SEXP resource(SEXP RESOURCE, SEXP LANDSCAPE, SEXP PARAMETERS){  
  
  /* SOME STANDARD DECLARATIONS OF KEY VARIABLES, POINTERS */  
  /* ===== */  
  int xloc, yloc;      /* x and y locs in the RESOURCE array */  
  int land_x, land_y; /* x and y maximum loc given LANDSCAPE */  
  int zloc, land_z;   /* z locations */  
  int resource;        /* Index for resource (rows RESOURCE) */  
  int resource_new;    /* Index for resource in new array */  
  int trait;           /* Index for resource traits */  
  int res_number;      /* Resources included (default = 1) */
```

The role of the processor

- ▶ Machine code: list of instructions written in binary (1s & 0s)
- ▶ Binary instructions sent to the *Central Processing Unit (CPU)*
 - ▶ CPUs read & write to memory, and do maths (that's it)
 - ▶ Instructions tell CPU to read & write information to memory

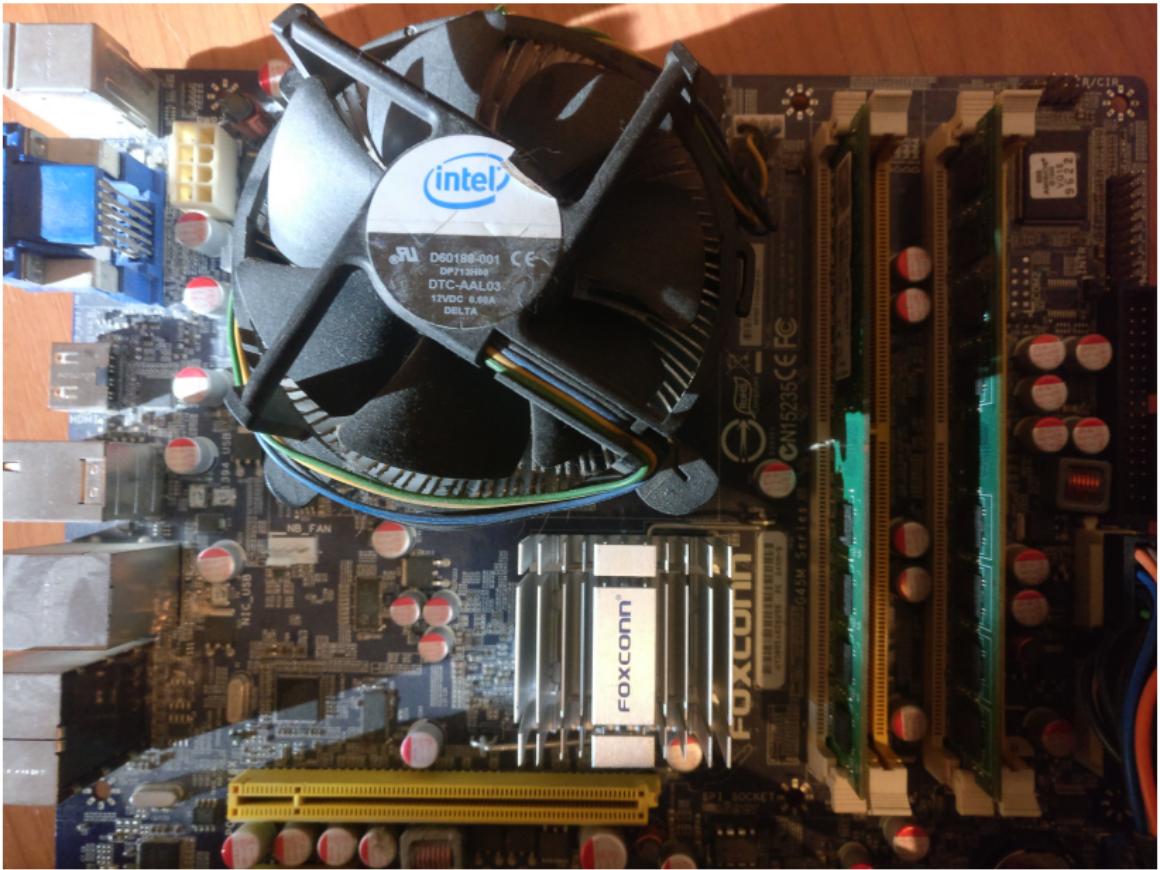


¹Image: Public domain

The role of memory

- ▶ Random-access memory (RAM, or just ‘memory’) is separate from the CPU, and holds data that can be read and changed
 - ▶ Memory exists as binary digits ('bits') of ones and zeros
 - ▶ Bits are grouped in chunks of eight to make one ‘byte’: *Unit of data storage large enough to hold any basic character.*





Thinking about computer memory

In R, memory is allocated automatically when we assign values.

```
array_1 <- 1:6; # Assign 'array_1' values 1 through 6
```

Thinking about computer memory

In R, memory is allocated automatically when we assign values.

```
array_1 <- 1:6; # Assign 'array_1' values 1 through 6
```

In C, memory needs to be allocated to a memory location.

Location 1	Location 2	Location 3	Location 4	Location 5	Location 6
0x7fc010	0x7fc011	0x7fc012	0x7fc013	0x7fc014	0x7fc015

Thinking about computer memory

In R, memory is allocated automatically when we assign values.

```
array_1 <- 1:6; # Assign 'array_1' values 1 through 6
```

In C, memory needs to be allocated to a memory location.

Location 1	Location 2	Location 3	Location 4	Location 5	Location 6
0x7fc010	0x7fc011	0x7fc012	0x7fc013	0x7fc014	0x7fc015

The 0x indicates hexadecimal, but we can translate to decimal.

Location 1	Location 2	Location 3	Location 4	Location 5	Location 6
8372240	8372241	8372242	8372243	8372244	8372245

Thinking about computer memory

In R, memory is allocated automatically when we assign values.

```
array_1 <- 1:6; # Assign 'array_1' values 1 through 6
```

In C, memory needs to be allocated to a memory location.

Location 1	Location 2	Location 3	Location 4	Location 5	Location 6
0x7fc010	0x7fc011	0x7fc012	0x7fc013	0x7fc014	0x7fc015

The 0x indicates hexadecimal, but we can translate to decimal.

Location 1	Location 2	Location 3	Location 4	Location 5	Location 6
8372240	8372241	8372242	8372243	8372244	8372245

```
array_1 = malloc(6 * sizeof(double));
```

Thinking about computer memory

	Column 2	Column 3	Column 4
Row 1	3	5	4
Row 2	1	7	6

Thinking about computer memory

	Column 2	Column 3	Column 4
Row 1	3	5	4
Row 2	1	7	6

```
##      [,1] [,2] [,3]
## [1,]    3    5    4
## [2,]    1    7    6
```

Thinking about computer memory

Pointer to pointer (**array2D)

