Basic Course in C Programming

Pasi Sarolahti
11.1.2019

Agenda

What is C, how it differs from Python?

Course arrangements

Programming tools and submission system

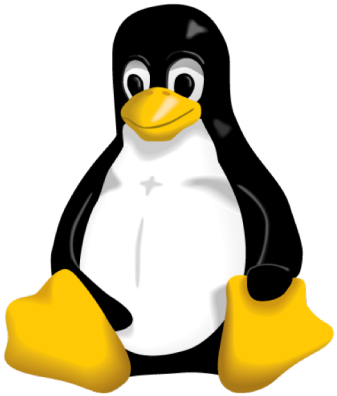
Example of solving a task

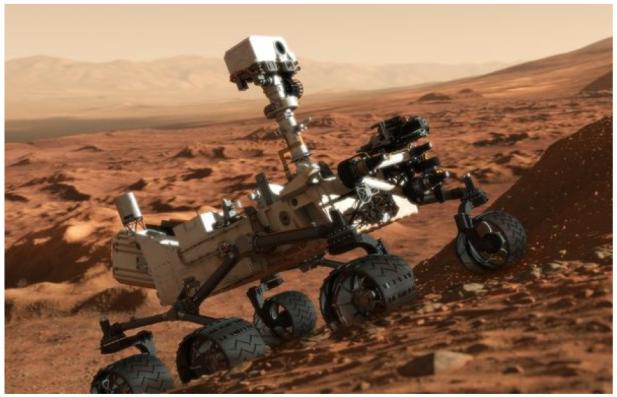
(Subjective) Objectives for the course

- ”Tutustua C-kieleen ja oppia käyttämään sitä työkaluna muiden kielien rinnalla”
- ”Olen kuullut, että kurssi on erittäin työläs ja haastava. Toivon, että onnistun tekemään tehtävät itse, ilman ulkopuolista apua”
- ”Know enough about C to be able to learn C++ without too much trouble.”
- ”Tavoitteeni on oppia c-ohjelmoinnin perusteet erinomaisesti, koska uskon että c-ohjelmoinnista on hyötyä tulevaisuuden kannalta.”
- ”Haluan oppia miten, miksi ja missä tilanteissa C-kieltä voidaan hyödyntää.”
- ”Toivoisin, että tentti on järkevä, eikä hirveästi tarvitsisi "koodata paperille”””
- ”Toivottavasti on hauskaa. :D”
- ”Odotan kurssilta runsaasti uutta ymmärrystä ohjelminnista yleisesti, etenkin syvällisempää ymmärtämistä tietokoneen toiminnasta ohjelmakoodin takana.

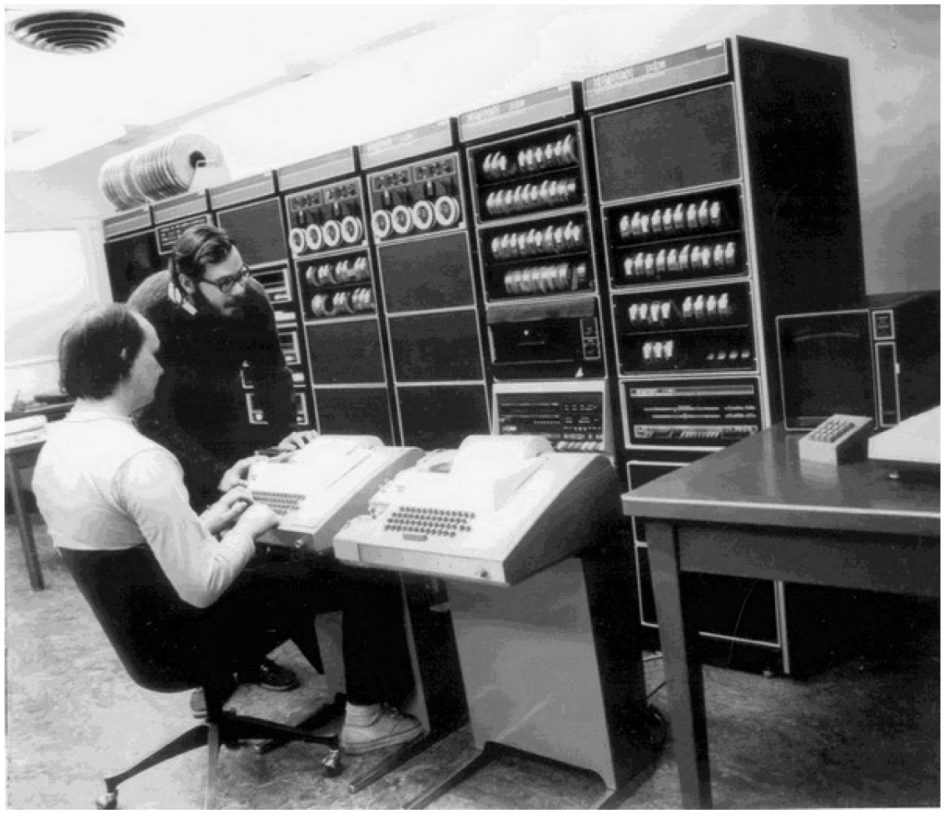
Course feedback from last year

What C?





Ken Thompson & Dennis Ritchie



http://www.computerhistory.org/fellowawards/hall/bios/Ken,Thompson/

C vs Python

Python

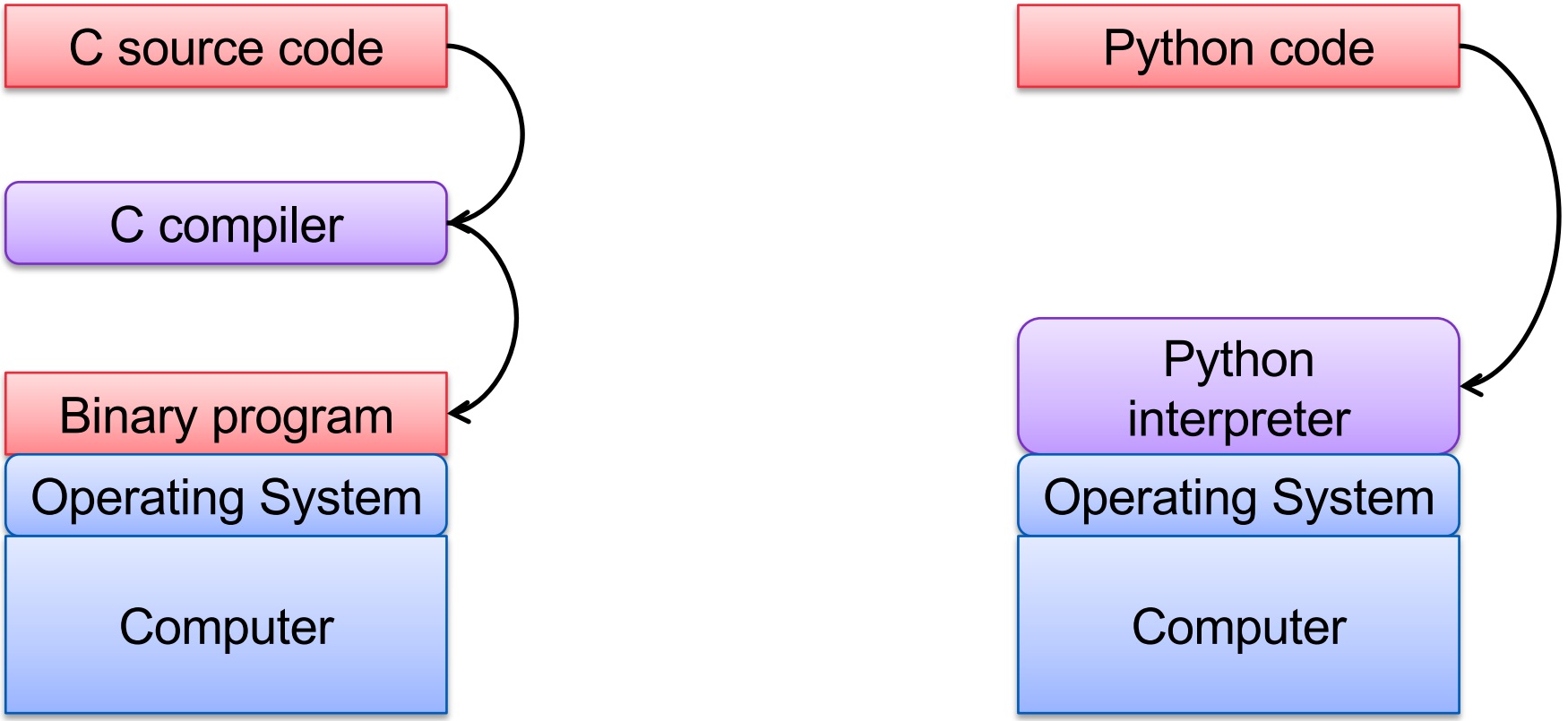
```
friends = ['john', 'pat', 'gary', 'michael']
for i, name in enumerate(friends):
    print "iteration {iteration} is {name}".format(iteration=i, name=name)
```

C

```
#include <stdio.h>

int main(void) {
    const char *friends[] = { "john", "pat", "gary", "michael" };
    for (int i = 0; i < 4; i++) {
        printf("iteration %d is %s\n", i, friends[i]);
    }
}
```

C vs. Python


C source code
C compiler
Binary program
Operating System
Computer
Python code
Python interpreter
Operating System
Computer

C vs. Python differences

Formatting

- Technically, indentation and line endings don't matter in C

Variables

- Variables must always be declared before use, type cannot be changed afterwards

Syntax

- Semicolon terminates statement
- Braces used to indicate program blocks

Memory Management

C Properties

Small, simple low level language

Functionality in functions, data accessible through variables

- No classes, no objects

Static typing: type of variable determined at compile time

I/O, strings, etc. implemented as libraries

Learning objectives

Basics of C language, including:

- Basic structures, data types, syntax
- Pointers, memory management
- Binary operations

Ability to produce short C programs

Ability debug (i.e., find errors) from own and others' code

Note: Mastering programming (in C or otherwise) requires experience – one course only gives a starting point

- Hopefully spikes continued interest

Ways of working

One learns programming by programming

Many automatically assessed programming tasks

- Allows independent work

Material and exercises in network

No lectures

- Fri 29.3.: Another common information session on project and exam arrangements

Schedule (see details in MyCourses)

Assessment

40% Exercises

- Min. 500 points
- Min. 7 rounds must be completed with at least 50 points

30% Programming task

30% Exam

- At least 8 points required from max. 16
- Done using computer

Total grade will be calculated as weighed average from above

Exam

- **Exam will be done using your own laptop, on a system booted from USB**
  - Test before actual exam
- **If USB does not work for you**
  - Some number of laptops for borrowing
  - Option to use computer class

Exercises and Assistants

Protocol

- Short intro/demo in the beginning of exercise session
- Working on exercises, assistants help

We do not have ticket/queue system

- Assistants aim at distributing evenly in the class room, check through students in orderly way

Course Material

Discussion and questions

Preferred: Slack

- Join by: https://aalto-c.slack.com/signup
- No Aalto email? Contact course personnel using email (below)

You can share your solutions using a link from TIM

- Visibility: course personnel always, those students who have already solved the task. After deadline everyone.

Email: c-ohjelmointi@netlab.hut.fi

- Only for administrative issues

Producing a C Program

Aalto-yliopisto
Sähkötekniikan korkeakoulu

C programming steps

1. **Write source code with text editor**
   - Source code files have .c suffix
   - Larger software consists of several modules (several .c files)
2. **Produce binary code**
   - **Precompiler**: remove comments, process headers, etc.
   - **Compiler**: From source code to object files
   - **Linker**: Combine object files into running program
   - If there are warnings or errors, go back to 1 and fix
3. **Test program**
   - If does not work correctly, go back to 1 and fix

Typical files in C programming

.c suffix indicates source code files

- There may be several in single program

.h suffix indicates header files

- Definitions of data types, data structures, etc.
- .c files refer to this using #include directive
- Commonly needed with libraries

Building the program

There are different compilers, such as “gcc” or “clang”

On terminal window (e.g. in Linux):
`gcc <lähdetiedosto.c>`

- Produces binary a.out file that can be executed

If there are several .c files, all are listed on the command line

- Typically on larger project “make” is used to make this easier
- Or one would use IDE, that does this automatically

Result of building

Everything fine: no output

Compile errors

- Compiler cannot produce executable file

Warnings

- Compiler is able to produce binary executable file
- However, code is very likely erroneous, therefore should be fixed

Look for line numbers in notifications to locate the error

Simple example

```c
#include <stdio.h>
int main(void)
{
    /* The following line will print out some text */
    printf("hello, world\n");
}
```

- **#include**: include standard I/O functions in program (such as printf)
- **int main**: starts the main function that always begins program
- **/* .. */**: comment, can contain anything, ignored by compiler
- **printf**: function that outputs the string given in parameters

What happens to C program?

ASM

```
    global  _main
    extern  _printf
    section .text
main:
    push    message
    call    _printf
    add     esp, 4
    ret
message:
    db  'hello, world', 10, 0
```

https://excelwithbusiness.com/blog/say-hello-world-in-28-different-programming-languages/

What happens to C program?

Konekieli

```
b8    21 0a 00 00   #moving "!\n" into eax
a3    0c 10 00 06   #moving eax into first memory location
b8    6f 72 6c 64   #moving "orld" into eax
a3    08 10 00 06   #moving eax into next memory location
b8    6f 2c 20 57   #moving "o, W" into eax
a3    04 10 00 06   #moving eax into next memory location
b8    48 65 6c 6c   #moving "Hell" into eax
a3    00 10 00 06   #moving eax into next memory location
b9    00 10 00 06   #moving pointer to start of memory location into ecx
ba    10 00 00 00   #moving string size into edx
bb    01 00 00 00   #moving "stdout" number to ebx
b8    04 00 00 00   #moving "print out" syscall number to eax
cd    80            #calling the linux kernel to execute our print to stdout
b8    01 00 00 00   #moving "sys_exit" call number to eax
cd    80            #executing it via linux sys_call
```

https://excelwithbusiness.com/blog/say-hello-world-in-28-different-programming-languages/

About tools

Good old: command line + editor

- Editor: e.g. Atom, Kate, Emacs, Vi, Notepad++
- Compile program in terminal

Modern: Integrated Development Environment (IDE)

- Everything in single package
- Netbeans, Eclipse, Visual Studio, Xcode

Some instructions provided with course material

Have a nice course!