System Programming
1st Laboratory (week of 27th March 2018)

C programming revision

Pointers and pointers and arrays
I

Implement a program that concatenates all its arguments into a single string. Do not use any string manipulation function.
The program arguments are passed through the **`main`** parameters **`argc`** and **`argv`**:

- **`int main(int argc, char * argv)`**
- **`argv`** is a vector of strings. The first string in the name of the program
- **`argc`** in the number of elements of argv

Argv is an array of strings. The result of this program should be stored in a single array of characters (result_str). After the construction if this array, it should be printed in the screen with a single printf instruction.

Pointers and pointers and functions and DDD
II

Compile the program **`pointers.c`** and run it.
Execute the same program in the debugger to compare the printed values with the various relevant CPU registers:

- compile with the **`-g`** option
- run **`ddd`**
- place a breakpoint (for instance in the last line)
- run the program
- printf the Program Counter (**`print $pc`**)
- print the Stack Pointer (**`print $sp`**)

Compare the value of of the previous register to the values printed in the screen.
Why do the addresses of **`a`** and **`b`** are so different?

Read the following document to know how to work with gdb http://beej.us/guide/bggdb/

Observe the various printed values and fill the following table (also use the observations form DDD):

name	value	type	Segment/location
a			
&a			
b			
&b			
v			
&v			
p			
&p			

*p			
main			
&main			
exit			
&exit			

Main and function and compilation and linking
III

Look at the files **`test1.c`** **`test2.c`** **`test.h`** **`prog1.c`**
Try to compile the file **`lib1.c`** issuing the command **`gcc lib1.c`**
Try to compile the file **`prog1.c`** issuing the command **`gcc prog1.c`**
What happened?

How to just compile **`lib1.c`**?
How to create a program?
Compile the file prog1.c (and create a program) to use the **test2.c** functions.

Read https://www.cs.swarthmore.edu/~newhall/unixhelp/compilecycle.html to understand how compilation works.

Dynamic linking and pointers to functions
IV

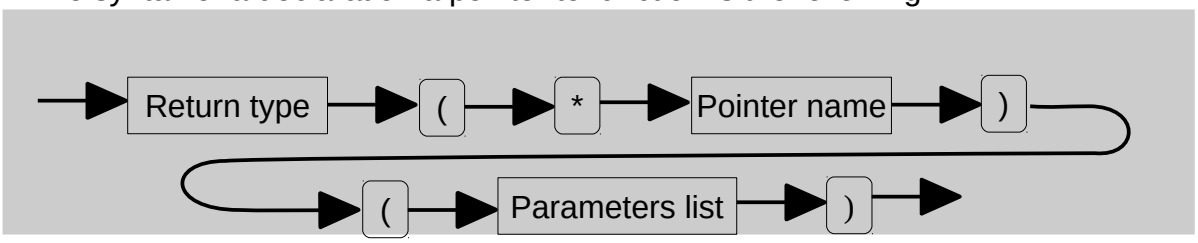
Sometime it is necessary to dynamical select the library to load depending on some input. In this class of applications several libraries offer functions with the same interface (name and arguments), and the application just calls one of those functions.
Observe the **`prog2.c`** program.
Create two dynamic libraries:

- **`gcc test1.c -o test1.so -ldl -shared -fPIC`**
  - creates test1.o
- **`gcc test2.c -o test1.so -ldl -shared -fPIC`**
  - creates tes2.o

How to load one of the libraries depending on the user input?
These new libraries (and the internal functions) can be loaded using another special library:

- **`man dlopen`**
- **`man dlsym`**

The use of this library is straightforward, but requires the knowledge of pointers to functions. A pointer to function is a variable that stores the address of a function (remember the exercise III).
The syntax of a declaration a pointer to function is the following:



Examples:

- **`int (*compare_cb)(int a, int b)`** is compatible with function **`int callme(int a, int b)`**
  - **`compare_cb = callme;`**
- and is called by **`compare_cb(10, 12)`**
- if preceded by by typedef pointer name is replaced by the new type name
  - **`typedef int (*type_pf)(int a, int b);`**
  - **`type ptr_f;`**
  - **`ptr_f = callme;`**
- the creation of arrays of pointer of function is easy:
  - **`int (*array_ptr[2])(int a, int b)`**
  - **`array_ptr[0] = array_ptr[1] = callme;`**
  - **`calling`**

More information:

- http://beej.us/guide/bgc/html/multi/morestuff.html#ptfunc
- http://www.yolinux.com/TUTORIALS/LibraryArchives-StaticAndDynamic.html