

# Fundamentos de Sistemas de Operação

MIEI 2018/2019

## Laboratory session 8

### Objectives

Input/output (I/O) system [1] – the file system. Implementation of the *ls* command to list a directory's contents.

### Listing the contents of a directory

The goal of this work is to implement a *simplified version* of the *ls* command. This command lists orderly the contents of a directory received as argument or of the *current directory*, if none is given. The path to the directory may either be an *absolute path* starting at the root directory *'/'* or a *relative path to the current directory*. In the latter, the name may either be the current directory *'.'* or one of its sub-directories, (*'../'* or other). Some examples of the *ls* command with options *-l*, *-a* and *-i* may be:

```
$ ls -ali /home/user/mydir
422142  drwxrwx---  4 user user 4096 Nov 12 21:29 .
371048  drwxrwxr-x 10 user user 4096 Nov 12 21:03 ..
422152  -rw-rw-r--  1 user user  0 Nov 12 21:29 empty.txt
422146  drwxrwx---  2 user user 4096 Nov 13 00:11 shared
395362  drwxrwxr-x  3 user user 4096 Nov 12 21:55 subdirl
(...)
$ ls -al
drwxrwx---  4 user user 4096 Nov 12 21:29 .
drwxrwxr-x 10 user user 4096 Nov 12 21:03 ..
-rw-rw-r--  1 user user  0 Nov 12 21:29 empty.txt
drwxrwx---  2 user user 4096 Nov 13 00:11 shared
drwxrwxr-x  3 user user 4096 Nov 12 21:55 subdirl
(...)
$ ls -ali subdirl
395362  drwxrwxr-x  3 user user 4096 Nov 12 21:55 .
422142  drwxrwx---  4 user user 4096 Nov 12 21:29 ..
395362  drwxrwxr-x  2 user user 4096 Nov 12 21:56 subdirl2
422151  -rwxrwx---  1 user user 1247 Nov 12 21:29 tmp.c
```

Your program is supposed to show the follow information and meta-information for a directory:

- Lists the inode number, the owner id, and the time of the last modification of a file
- Lists the names and types of all the files (regular files and sub-directories)
  - In case of a directory, the program prints "*(dir)*"
  - In case of a regular file, the program prints its size in bytes "*(size)*"
  - All other cases, the program prints "*(other)*"

For instance, assuming that your program is named *myls*, the simplified outputs of the examples above are

```
$ ./myls /home/user/mydir
395362: 1000 21:55 subdirl (dir)
371048: 1000 21:3  .. (dir)
422159: 1000 23:29 myls (7979)
422142: 1000 23:29 . (dir)
422152: 1000 21:29 empty.txt (0)
422146: 1000 0:11 shared (dir)
...
$ ./myls
395362: 1000 21:55 subdirl (dir)
371048: 1000 21:3  .. (dir)
422159: 1000 23:29 myls (7979)
422142: 1000 23:29 . (dir)
422152: 1000 21:29 empty.txt (0)
422146: 1000 0:11 shared (dir)
...
```

```
$ ./mysls subdir1
422151: 1000 21:29 tmp.c (1247)
422142: 1000 21:29 .. (dir)
395362: 1000 21:55 . (dir)
422153: 1000 21:56 subdir2 (dir)
```

In order to display this information you have to use the *opendir*, *closedir*, *readdir*, and *localtime* operations and the *stat* system call from the C Standard library.

## Showing some extra information

Modify your program to print the file owner's name instead of its *id* number. For this you have to use the *getpwuid* function.

Based on the previous examples, your program is now supposed to print:

```
$ ./mysls /usr
266127: root 17:8 lib (dir)
2: root 12:57 .. (dir)
266128: root 22:57 local (dir)
(...)
$ ./mysls subdir1
422151: user 21:29 tmp.c (1247)
422142: user 21:29 .. (dir)
395362: user 21:55 . (dir)
422153: user 21:56 subdir2 (dir)
```

You can also include the full date, group name, and sort by file's name before printing.

## Following the sub-directories

Extend your program so that your command also shows the contents of any sub-directory within the directory received as argument. This is equivalent to the "*ls -aLR*" command. For instance,

```
$ ls -aLR ./subdir1
./subdir1/:
(...)
drwxrwxr-x 3 user user 4096 Nov 12 21:55 .
drwxrwx--- 4 user user 4096 Nov 12 21:29 ..
drwxrwxr-x 2 user user 4096 Nov 12 21:56 subdir2
-rwxrwx--- 1 user user 1247 Nov 12 21:29 tmp.c

./subdir1/subdir2:
(...)
drwxrwxr-x 2 user user 4096 Nov 12 21:56 .
drwxrwxr-x 3 user user 4096 Nov 12 21:55 ..
-rwxrwx--- 1 user user 1247 Nov 12 21:56 tmp2.c

$ ./mysls ./subdir1
./subdir1:
422151: user 21:29 tmp.c (1247)
422142: user 1:21 .. (dir)
395362: user 21:55 . (dir)
422153: user 21:56 subdir2 (dir)

./subdir1/subdir2:
395362: user 21:55 .. (dir)
422155: user 21:56 tmp2.c (1247)
422153: user 21:56 . (dir)
```

## Bibliography

[1] Sections about persistence (chapters 36 and 39) of the recommended book, "Operating Systems: Three Easy Pieces" Remzi H. Arpaci-Dusseau and Andrea C. Arpaci-Dusseau"

[2] <http://pages.cs.wisc.edu/~remzi/OSTEP/file-intro.pdf>