Introduction

Almost all file systems are hierarchical with tree structured files and directories. The normal way of dealing with that is to split the name or absolute pathname of a file into a number of directory names with the last component of the name representing the file name in its closest enclosing directory, e.g. `/Volumes/MacintoshHD2/Dropbox/current work/340 2014/A2` is the file called `A2` which is stored in the `340 2014` directory inside the `current work` directory of the `Dropbox` directory in the `MacintoshHD2` directory of the `Volumes` directory which is stored inside the the root file directory `/`.

Of course the different files and directories aren't really stored inside other directories, they are stored anywhere there was room on the disk device. The directory model makes it easier for us to deal with, organise and find files.

What you have to do

Provide a hierarchical filesystem inside one real file system directory. For the rest of this document when the "real directory" is referred to it means the actual Linux directory which contains all of the file system information for this assignment. There will be no real directories inside this real directory. When an "ffs directory" is referred to it means a flat file system directory which behaves as is described here.

Your program should be called "`A2com`". This should be executable as described in the **Note** section.

When you start your assignment it must create (if it doesn't already exist) the real directory called "`A2dir`" in the current working directory of the user.

Then your program prompts for and accepts a series of commands which allows the creation and manipulation of files inside this real directory. The prompt is "`ffs> `".

Only files can be created in this real directory but the names of the files can be broken into sections which produce behaviour which is very much like a hierarchical file system with directories.

Filenames look like this: "`-home-robert-OSCourse-2014-assgnmts-A 1`".

Each "`-`" is like the slash "`/`" in a normal hierarchical file system, it separates components of the pathname. These would normally be directories with the last component being either a directory or a file. In this assignment there are no directories but the system gives the appearance to a user of grouping files into directories.

The sections of the filename terminated by a "`-`" e.g. "`robert-`" can be regarded as an ffs directory name. So an ffs directory name always finishes with a "`-`". However you can use the name without the "`-`" as the ffs directory name, in this case "`robert`".

The root directory is called "`-`".

Any characters which are legal for the underlying Linux file system can be used in a filename. In particular filenames can have spaces in them.

Example

Here is the output of the real "`ls -l`" command on an `A2dir` real directory which has had some files created by the `A2com` program.

```
total 0
-rw-r--r-- 1 robert robert 83 Aug 28 20:44 -file1
-rw-r--r-- 1 robert robert 64 Aug 29 11:41 -fileA
-rw-r--r-- 1 robert robert 64 Aug 29 11:41 -fileB
-rw-r--r-- 1 robert robert  0 Aug 29 11:48 -home-robert
-rw-r--r-- 1 robert robert  0 Aug 28 11:12 -rrrr-dd-aaaa-file0
-rw-r--r-- 1 robert robert  0 Aug 28 11:12 -rrrr-dd-aaaa-file1
```

```
-rw-r--r-- 1 robert robert  0 Aug 28 11:12 -rrrr-dd-aaaa-file2
-rw-r--r-- 1 robert robert  0 Aug 28 11:12 -rrrr-dd-aaaa-file3
-rw-r--r-- 1 robert robert  0 Aug 28 11:12 -rrrr-dd-aaaa-file4
-rw-r--r-- 1 robert robert  0 Aug 28 11:12 -rrrr-dd-file0
-rw-r--r-- 1 robert robert  0 Aug 28 11:12 -rrrr-dd-file1
-rw-r--r-- 1 robert robert  0 Aug 28 11:12 -rrrr-file0
-rw-r--r-- 1 robert robert  0 Aug 28 11:12 -rrrr-file1
-rw-r--r-- 1 robert robert  0 Aug 28 11:12 -rrrr-file2
-rw-r--r-- 1 robert robert  0 Aug 28 11:12 -xx-file0
-rw-r--r-- 1 robert robert  0 Aug 28 11:12 -xx-file1
-rw-r--r-- 1 robert robert  0 Aug 28 11:12 -xx-file2
-rw-r--r-- 1 robert robert  0 Aug 29 11:39 -xx-o-aaa-file0
-rw-r--r-- 1 robert robert  0 Aug 29 11:39 -xx-o-aaa-file1
-rw-r--r-- 1 robert robert  0 Aug 29 11:39 -xx-o-aaa-file2
-rw-r--r-- 1 robert robert  0 Aug 29 11:39 -xx-o-aaa-file3
-rw-r--r-- 1 robert robert  0 Aug 29 11:39 -xx-o-aaa-file4
-rw-r--r-- 1 robert robert  0 Aug 29 11:39 -xx-o-aaa-xx-file0
-rw-r--r-- 1 robert robert  0 Aug 29 11:39 -xx-o-aaa-xx-file1
```

Here is the same information when displayed from inside the A2com program using the tree command (see later):

```
-
=
file1
fileA
fileB
    -home-
    ======
    robert
    -rrrr-
    ======
        -rrrr-dd-
        =========
            -rrrr-dd-aaaa-
            ==============
            file0
            file1
            file2
            file3
            file4
        file0
        file1
    file0
    file1
    file2
    -xx-
    ====
    file0
    file1
    file2
        -xx-o-
        ======
            -xx-o-aaa-
            ==========
            file0
            file1
            file2
            file3
            file4
                -xx-o-aaa-xx-
                =============
                file0
                file1
```

The real file system directory stores files only, and it stores them under their complete file names. For example there is nothing storing the "`home-`" directory in the real directory, it is implicit in the name of files such as "`-home-robert`"

The files must be stored in the real directory.

Commands

The `A2com` program prompts the user for input commands and then carries them out, repeating until the `quit` command is entered. Examples are shown in the appendix.

These are the commands which your `A2com` program must accept from the prompt.

`pwd`   this displays the current ffs working directory

`cd`   change the current ffs working directory. No parameter means go back to the ffs root directory "`-`". "`cd ..`" means to revert to the ffs parent directory of the current directory. "`cd name`" means to change the ffs working directory to `name`. If `name` starts with a "`-`" it is an absolute pathname. Otherwise it is relative to the working ffs directory. The closing "`-`" on the directory name may be missing.

`ls`   list the files and directories in the named ffs directory. If no name is given use the current working ffs directory. Uses the same rules for absolute and relative as `cd`. In the output files are indicated with "`f: `" preceding their names and directories are indicated with "`d: `".

`rls`   shows the output of the real "`ls -l`" command on the real `A2dir` directory

`tree`   shows all files below this directory as an indented tree structure. Uses the same parameter rules as `ls`.

`clear`   removes all files in the ffs root directory. This is like "`rm -rf /`" in Unix (not a good idea).

`create`   creates a file with the specified name. The name must not end with a "`-`" otherwise it would be a directory and we don't create directories directly. The name can be either absolute, starting with a "`-`", or relative to the working ffs directory.

`add`   appends text to the named file. The first parameter is the filename, the next parameter is the text and consists of the rest of the command line starting one space after the filename. The text is appended to the file. This is the only way to put data into a file. File names can be absolute or relative.

`cat`   displays the contents of the named file. File names can be absolute or relative.

`delete`   deletes the named file. File names can be absolute or relative.

`dd`   deletes a directory (including all files and directories under this point). It doesn't ask for confirmation. The directory name can be absolute or relative.

`quit`   quits the `A2com` program.

Testing

The markers will test your program by running it with a number of redirected input files. The files will be similar to the test input files on the assignment web page. If input is coming from a file your program should display the input before processing the command as in the appendix output.

Note

Your program can be written in any programming language available on Linux in the lab. In particular you can use C, Java, Python, Ruby or bash. Your assignment will be marked under Linux in the lab. You can probably write it on Windows, but you must test it on Linux before submitting it.

Along with your source code you must provide either an executable file or shell script called `A2com` which starts your program running. The markers will make this executable by setting the executable bit and then will run it by typing "`./A2com`". If you wrote your program in a language which needs compiling you need to provide a `make` file so that the markers can compile it easily. If you don't know what a `make` file is I will go over simple `make` rules in class.

The program must accept commands typed at the terminal window. It must also work correctly if the marker redirects input to the program from a file, e.g. `./A2com < test1`.

A large part of dealing with files is coping with errors. This assignment is not concerned with errors. All commands tested will be legal and sensible. It would still be nice if your program handled obvious errors nicely.

Questions

Answer the following questions. Put the answers in a simple text file called `A2Answers.txt`.

1. On the version of Linux in the lab, what is the maximum length of a file name? [1 mark]

2. What advantages does the flat file system have over traditional hierarchical file systems? Describe the implementation of one command which is easier with the flat system than with a traditional hierarchical system. [4 marks]

3. What disadvantages does the flat file system have over traditional hierarchical file systems? [3 marks]

4. Describe a way to minimise one of the disadvantages you mentioned in question 3. [1 mark]

Submitting the assignment

Submit all source files for your `A2com` program.

If you have written your program in a language which cannot be executed directly e.g. Java or C. You should also submit a make file. You may submit a simple shell script called `A2com` which starts your program.

Submit your `A2Answers.txt` file.

Make sure your name and upi is included in every file you submit.

Use the assignment drop box to submit - https://adb.auckland.ac.nz.

Any work you submit must be your work and your work alone – see the Departmental policy on cheating http://www.cs.auckland.ac.nz/compsci340s2c/assignments/.

Marking guide (worth 7% of your final grade)

[1 mark]   Name and upi in every submitted file.

[1 mark]   The `A2com` program can be set executable and run (possibly after running the `make` file).

[1 mark]   If input to `A2com` comes from a file the input is shown on the screen, just as if it had been typed.

None of the following implementation marks are allocated if the files don't get created in the real `A2dir` directory. Also no directories are created inside the real `A2dir` directory.

[2 marks]   `create` works correctly

[1 mark]   `clear` works correctly

[2 marks]   `add` works correctly

[1 mark]   `cat` works correctly

[1 mark]   `pwd` works correctly

[2 marks]   `cd` works correctly

[2 marks]   `ls` works correctly

[1 mark]   `rls` works correctly

[2 marks]   `tree` works correctly

[1 mark]   `delete` works correctly

[2 marks]   `dd` works correctly

[1 mark]   `quit` works correctly

Questions [9 marks] - Total 30 marks

Appendix

Output. Your programs should produce this output more or less exactly.

```
./A2com < test1
ffs> clear
ffs> ls
ffs> rls
total 0
ffs> quit

./A2com < test2
ffs> clear
ffs> create -fileA
ffs> create -fileB
ffs> add fileA This is the contents of fileA.
ffs> add fileB This is the contents of fileB.
ffs> cat fileA
This is the contents of fileA.
ffs> cat fileB
This is the contents of fileB.
ffs> ls
f: fileA
f: fileB
ffs> rls
total 0
-rw-rw-r-- 1 robert robert 30 Aug 29  2014 -fileA
-rw-rw-r-- 1 robert robert 30 Aug 29  2014 -fileB
ffs> quit

./A2com < test3
ffs> clear
ffs> create -fileA
ffs> create -fileB
ffs> create -rrrr-file0
ffs> create -rrrr-file1
ffs> create -rrrr-file2
ffs> create -rrrr-dd-file0
ffs> create -rrrr-dd-file1
ffs> create -rrrr-dd-aaaa-file0
ffs> create -rrrr-dd-aaaa-file1
ffs> create -rrrr-dd-aaaa-file2
ffs> create -rrrr-dd-aaaa-file3
ffs> create -rrrr-dd-aaaa-file4
ffs> create -xx-file0
ffs> create -xx-file1
ffs> create -xx-file2
ffs> create -xx-o-file0
ffs> create -xx-o-file1
ffs> create -xx-o-file2
ffs> create -xx-o-file3
ffs> create -xx-o-file4
ffs> create -xx-o-aaa-file0
ffs> create -xx-o-aaa-file1
ffs> create -xx-o-aaa-file2
ffs> create -xx-o-aaa-file3
ffs> create -xx-o-aaa-file4
ffs> create -xx-o-aaa-xx-file0
ffs> create -xx-o-aaa-xx-file1
ffs> create -xx-o-aaa-xx-file2
ffs> create -xx-o-aaa-xx-file3
ffs> create -xx-o-aaa-xx-file4
ffs> create -xx-o-aaa-xx-file5
ffs> ls
f: fileA
f: fileB
d: rrrr
d: xx
ffs> rls
total 0
-rw-rw-r-- 1 robert robert 0 Aug 29  2014 -fileA
-rw-rw-r-- 1 robert robert 0 Aug 29  2014 -fileB
-rw-rw-r-- 1 robert robert 0 Aug 29  2014 -rrrr-dd-aaaa-file0
-rw-rw-r-- 1 robert robert 0 Aug 29  2014 -rrrr-dd-aaaa-file1
-rw-rw-r-- 1 robert robert 0 Aug 29  2014 -rrrr-dd-aaaa-file2
-rw-rw-r-- 1 robert robert 0 Aug 29  2014 -rrrr-dd-aaaa-file3
-rw-rw-r-- 1 robert robert 0 Aug 29  2014 -rrrr-dd-aaaa-file4
-rw-rw-r-- 1 robert robert 0 Aug 29  2014 -rrrr-dd-file0
-rw-rw-r-- 1 robert robert 0 Aug 29  2014 -rrrr-dd-file1
```

```
-rw-rw-r-- 1 robert robert 0 Aug 29  2014 -rrrr-file0
-rw-rw-r-- 1 robert robert 0 Aug 29  2014 -rrrr-file1
-rw-rw-r-- 1 robert robert 0 Aug 29  2014 -rrrr-file2
-rw-rw-r-- 1 robert robert 0 Aug 29  2014 -xx-file0
-rw-rw-r-- 1 robert robert 0 Aug 29  2014 -xx-file1
-rw-rw-r-- 1 robert robert 0 Aug 29  2014 -xx-file2
-rw-rw-r-- 1 robert robert 0 Aug 29  2014 -xx-o-aaa-file0
-rw-rw-r-- 1 robert robert 0 Aug 29  2014 -xx-o-aaa-file1
-rw-rw-r-- 1 robert robert 0 Aug 29  2014 -xx-o-aaa-file2
-rw-rw-r-- 1 robert robert 0 Aug 29  2014 -xx-o-aaa-file3
-rw-rw-r-- 1 robert robert 0 Aug 29  2014 -xx-o-aaa-file4
-rw-rw-r-- 1 robert robert 0 Aug 29  2014 -xx-o-aaa-xx-file0
-rw-rw-r-- 1 robert robert 0 Aug 29  2014 -xx-o-aaa-xx-file1
-rw-rw-r-- 1 robert robert 0 Aug 29  2014 -xx-o-aaa-xx-file2
-rw-rw-r-- 1 robert robert 0 Aug 29  2014 -xx-o-aaa-xx-file3
-rw-rw-r-- 1 robert robert 0 Aug 29  2014 -xx-o-aaa-xx-file4
-rw-rw-r-- 1 robert robert 0 Aug 29  2014 -xx-o-aaa-xx-file5
-rw-rw-r-- 1 robert robert 0 Aug 29  2014 -xx-o-file0
-rw-rw-r-- 1 robert robert 0 Aug 29  2014 -xx-o-file1
-rw-rw-r-- 1 robert robert 0 Aug 29  2014 -xx-o-file2
-rw-rw-r-- 1 robert robert 0 Aug 29  2014 -xx-o-file3
-rw-rw-r-- 1 robert robert 0 Aug 29  2014 -xx-o-file4
ffs> cd rrrr-dd-
ffs> pwd
-rrrr-dd-
ffs> ls
d: aaaa
f: file0
f: file1
ffs> cd ..
ffs> pwd
-rrrr-
ffs> ls
d: dd
f: file0
f: file1
f: file2
ffs> cd
ffs> pwd
-
ffs> ls
f: fileA
f: fileB
d: rrrr
d: xx
ffs> quit

./A2com < test4
ffs> clear
ffs> create -fileA
ffs> create -fileB
ffs> create -rrrr-file0
ffs> create -rrrr-file1
ffs> create -rrrr-file2
ffs> create -rrrr-dd-file0
ffs> create -rrrr-dd-file1
ffs> create -rrrr-dd-aaaa-file0
ffs> create -rrrr-dd-aaaa-file1
ffs> create -rrrr-dd-aaaa-file2
ffs> create -rrrr-dd-aaaa-file3
ffs> create -rrrr-dd-aaaa-file4
ffs> create -xx-file0
ffs> create -xx-file1
ffs> create -xx-file2
ffs> create -xx-o-file0
ffs> create -xx-o-file1
ffs> create -xx-o-file2
ffs> create -xx-o-file3
ffs> create -xx-o-file4
ffs> create -xx-o-aaa-file0
ffs> create -xx-o-aaa-file1
ffs> create -xx-o-aaa-file2
ffs> create -xx-o-aaa-file3
ffs> create -xx-o-aaa-file4
ffs> create -xx-o-aaa-xx-file0
ffs> create -xx-o-aaa-xx-file1
ffs> create -xx-o-aaa-xx-file2
ffs> create -xx-o-aaa-xx-file3
ffs> create -xx-o-aaa-xx-file4
```

```
ffs> create -xx-o-aaa-xx-file5
ffs> tree
-
=
fileA
fileB
    -rrrr-
    ======
        -rrrr-dd-
        =========
            -rrrr-dd-aaaa-
            ==============
            file0
            file1
            file2
            file3
            file4
        file0
        file1
    file0
    file1
    file2
    -xx-
    ====
    file0
    file1
    file2
        -xx-o-
        ======
            -xx-o-aaa-
            ==========
            file0
            file1
            file2
            file3
            file4
                -xx-o-aaa-xx-
                =============
                file0
                file1
                file2
                file3
                file4
                file5
        file0
        file1
        file2
        file3
        file4
ffs> tree -xx-o-aaa
-xx-o-aaa-
==========
file0
file1
file2
file3
file4
    -xx-o-aaa-xx-
    =============
    file0
    file1
    file2
    file3
    file4
    file5
ffs> quit

./A2com < test5
ffs> clear
ffs> create -xx-file0
ffs> create -xx-file1
ffs> create -xx-file2
ffs> create -xx-o-file0
ffs> create -xx-o-file1
ffs> create -xx-o-file2
ffs> create -xx-o-file3
ffs> create -xx-o-file4
ffs> create -xx-o-aaa-file0
ffs> create -xx-o-aaa-xx-file1
```

```
ffs> ls xx
f: file0
f: file1
f: file2
d: o
ffs> tree xx
-xx-
====
file0
file1
file2
    -xx-o-
    ======
        -xx-o-aaa-
        ==========
        file0
            -xx-o-aaa-xx-
            =============
            file1
    file0
    file1
    file2
    file3
    file4
ffs> delete xx-file1
ffs> cd xx
ffs> ls
f: file0
f: file2
d: o
ffs> tree
-xx-
====
file0
file2
    -xx-o-
    ======
        -xx-o-aaa-
        ==========
        file0
            -xx-o-aaa-xx-
            =============
            file1
    file0
    file1
    file2
    file3
    file4
ffs> quit

./A2com < test6
ffs> clear
ffs> create -fileA
ffs> create -fileB
ffs> create -rrrr-file0
ffs> create -rrrr-file1
ffs> create -rrrr-file2
ffs> create -rrrr-dd-file0
ffs> create -rrrr-dd-file1
ffs> create -rrrr-dd-aaaa-file0
ffs> create -rrrr-dd-aaaa-file1
ffs> create -rrrr-dd-aaaa-file2
ffs> create -rrrr-dd-aaaa-file3
ffs> create -rrrr-dd-aaaa-file4
ffs> create -xx-file0
ffs> create -xx-file1
ffs> create -xx-file2
ffs> create -xx-o-file0
ffs> create -xx-o-file1
ffs> create -xx-o-file2
ffs> create -xx-o-file3
ffs> create -xx-o-file4
ffs> create -xx-o-aaa-file0
ffs> create -xx-o-aaa-file1
ffs> create -xx-o-aaa-file2
ffs> create -xx-o-aaa-file3
ffs> create -xx-o-aaa-file4
ffs> create -xx-o-aaa-xx-file0
ffs> create -xx-o-aaa-xx-file1
```

```
ffs> create -xx-o-aaa-xx-file2
ffs> create -xx-o-aaa-xx-file3
ffs> create -xx-o-aaa-xx-file4
ffs> create -xx-o-aaa-xx-file5
ffs> rls
total 0
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -fileA
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -fileB
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -rrrr-dd-aaaa-file0
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -rrrr-dd-aaaa-file1
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -rrrr-dd-aaaa-file2
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -rrrr-dd-aaaa-file3
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -rrrr-dd-aaaa-file4
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -rrrr-dd-file0
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -rrrr-dd-file1
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -rrrr-file0
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -rrrr-file1
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -rrrr-file2
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-file0
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-file1
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-file2
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-o-aaa-file0
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-o-aaa-file1
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-o-aaa-file2
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-o-aaa-file3
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-o-aaa-file4
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-o-aaa-xx-file0
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-o-aaa-xx-file1
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-o-aaa-xx-file2
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-o-aaa-xx-file3
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-o-aaa-xx-file4
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-o-aaa-xx-file5
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-o-file0
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-o-file1
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-o-file2
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-o-file3
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-o-file4
ffs> tree
-
=
fileA
fileB
    -rrrr-
    ======
        -rrrr-dd-
        =========
            -rrrr-dd-aaaa-
            ==============
            file0
            file1
            file2
            file3
            file4
        file0
        file1
    file0
    file1
    file2
    -xx-
    ====
    file0
    file1
    file2
        -xx-o-
        ======
            -xx-o-aaa-
            ==========
            file0
            file1
            file2
            file3
            file4
                -xx-o-aaa-xx-
                =============
                file0
                file1
                file2
                file3
                file4
```

```
                        file5
                file0
                file1
                file2
                file3
                file4
ffs> dd rrrr
ffs> rls
total 0
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -fileA
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -fileB
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-file0
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-file1
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-file2
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-o-aaa-file0
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-o-aaa-file1
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-o-aaa-file2
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-o-aaa-file3
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-o-aaa-file4
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-o-aaa-xx-file0
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-o-aaa-xx-file1
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-o-aaa-xx-file2
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-o-aaa-xx-file3
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-o-aaa-xx-file4
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-o-aaa-xx-file5
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-o-file0
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-o-file1
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-o-file2
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-o-file3
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-o-file4
ffs> tree
-
=
fileA
fileB
    -xx-
    ====
    file0
    file1
    file2
        -xx-o-
        ======
            -xx-o-aaa-
            ==========
            file0
            file1
            file2
            file3
            file4
                -xx-o-aaa-xx-
                =============
                file0
                file1
                file2
                file3
                file4
                file5
        file0
        file1
        file2
        file3
        file4
ffs> cd xx
ffs> dd o
ffs> rls
total 0
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -fileA
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -fileB
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-file0
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-file1
-rw-r--r--  1 robert  staff  0 29 Aug 15:19 -xx-file2
ffs> tree
-xx-
====
file0
file1
file2
ffs> cd
ffs> tree
```

```
-
=
fileA
fileB
    -xx-
    ====
    file0
    file1
    file2
ffs> quit
```