Lab 2. Input and Output

System Programming Assignment

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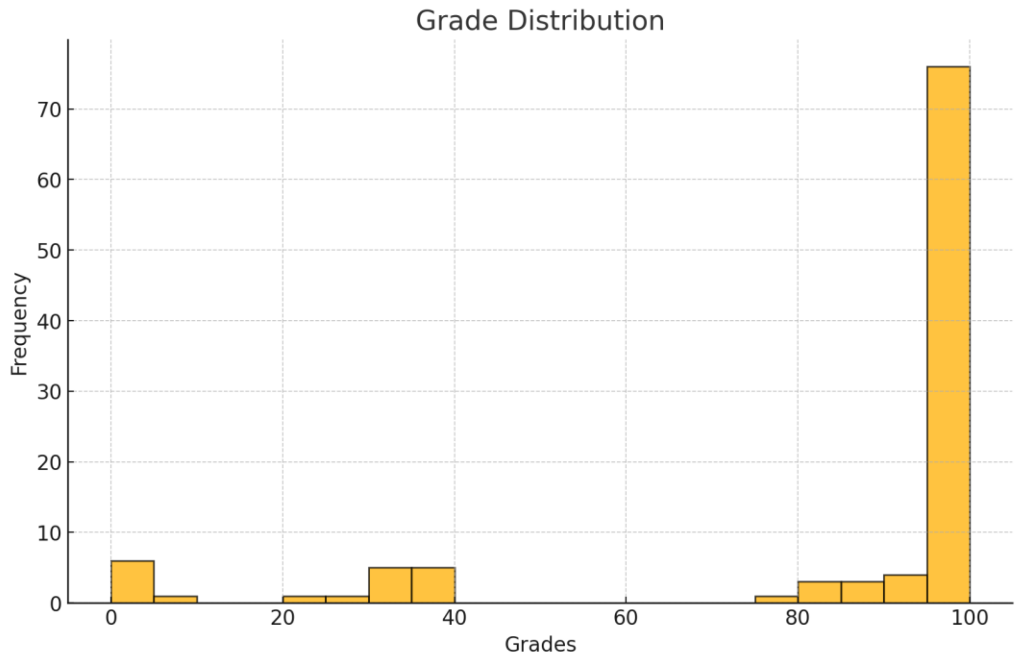
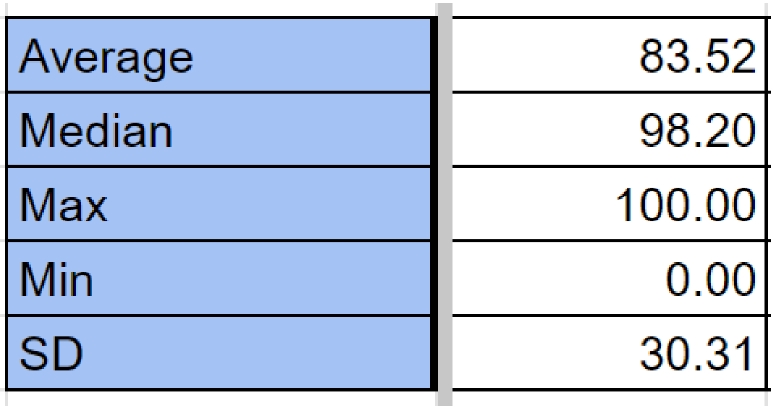
Lab 1 Grade Distribution

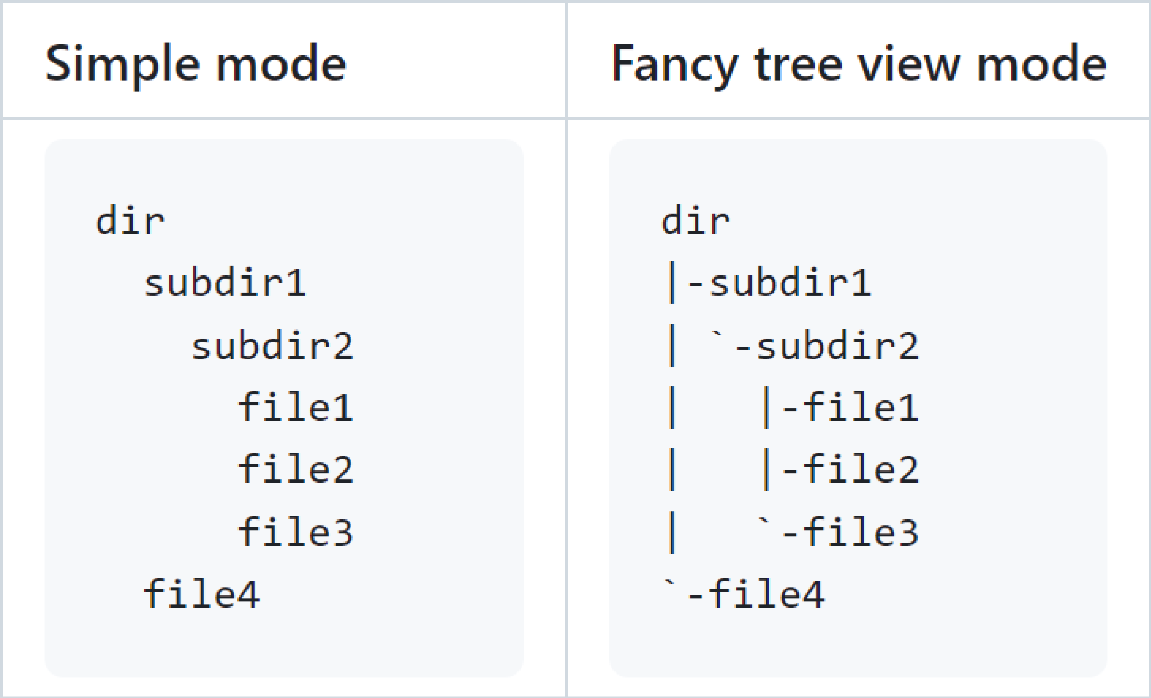




Average	83.52
Median	98.20
Max	100.00
Min	0.00
SD	30.31

- Note: Points may be deducted or given 0 points at lab 2
  - Compile issue (−6 points) : Source file must be compilable with Bacchus' gcc800
    - If it does not compilable with gcc, you will get no point.
  - Submission format (−5 points) : extension of 'readme', zipped file name as 202400000_assign2 (use the example folder name) or 'Users'
  - Late submission: given 0 points

Dirtree Overview



Simple mode

```
dir
  subdir1
    subdir2
      file1
      file2
      file3
  file4
```

Fancy tree view mode

```
dir
|-subdir1
| `-subdir2
|   |-file1
|   |-file2
|   `-file3
`-file4
```

Result of dirtree

- What is "dirtree"?
  - Dirtree recursively traverses a directory tree and prints out a sorted list of all files
  - Dirtree can also print a fancy directory tree and show details

Dirtree Specification - Operation

- Dirtree traverses each directory in the list directories recursively
- Prints all of directory entries in alphabetical order
  - Directories are listed before files
  - The special entries '.' and '..' are ignored
- About summary mode: A summary is printed after each dirtree's target directory
  - If several directories are traversed, an aggregate total is printed at the end.

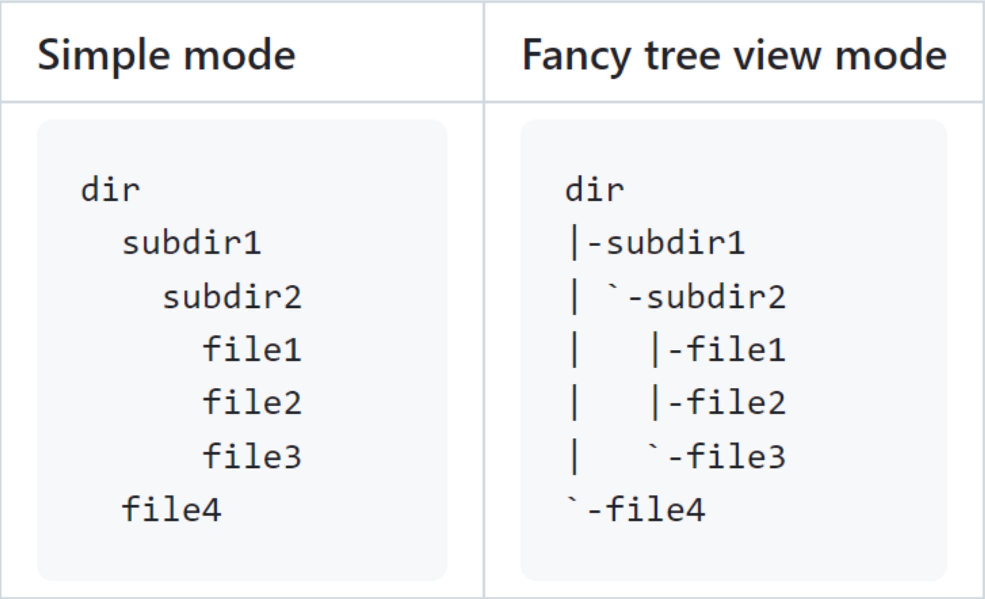
Dirtree Specification - Command Line Arguments

Option	Description
-h	Help screen
-t	Turn on fancy tree view
-v	Turn on detailed mode
-s	Turn on summary mode

Usage: `$ ./dirtree [Options] [Directories]`

- `-t`, `-v`, `-s` options may be used together or not used at all
  - 8 possible combinations

Dirtree Specification - Fancy Tree View Mode (1/5)



Simple mode

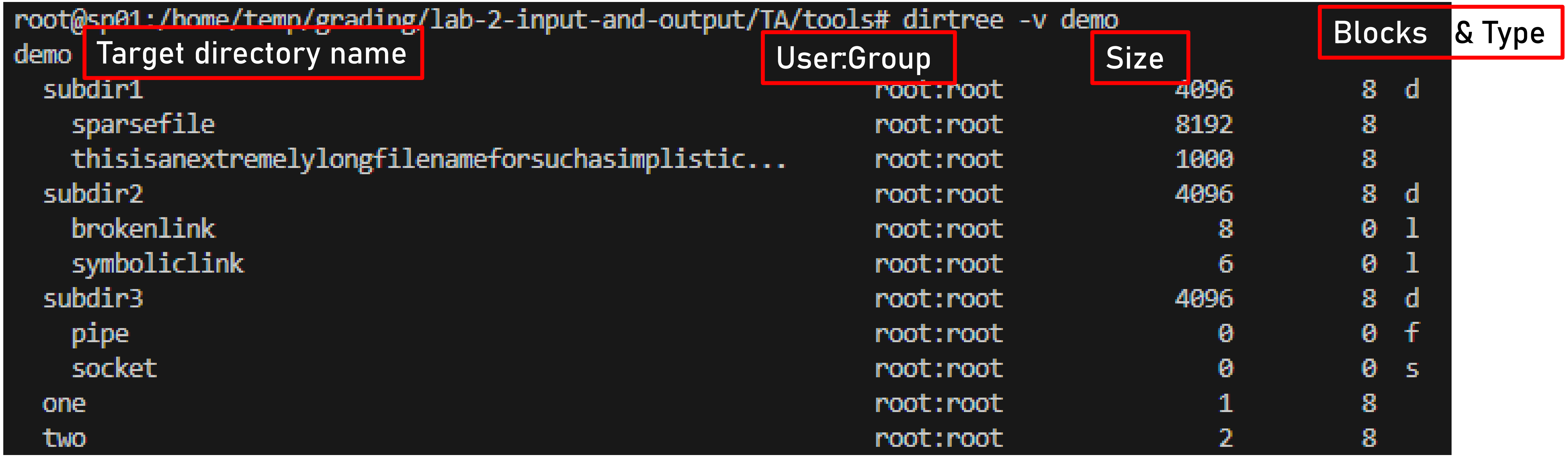
```
dir
  subdir1
    subdir2
      file1
      file2
      file3
  file4
```

Fancy tree view mode

```
dir
|-subdir1
| `-subdir2
|   |-file1
|   |-file2
|   `-file3
`-file4
```

- Simple mode command: ./dirtree
- Fancy tree view mode command: ./dirtree –t

Dirtree Specification - Detailed Mode (2/5)



```
root@sp01:/home/temp/grading/lab-2-input-and-output/TA/tools# dirtree -v demo
demo
  subdir1                                                  root:root        4096        8  d
    sparsefile                                             root:root        8192        8
    thisisanextremelylongfilenameforsuchasimplistic...     root:root        1000        8
  subdir2                                                  root:root        4096        8  d
    brokenlink                                             root:root           8        0  l
    symboliclink                                           root:root           6        0  l
  subdir3                                                  root:root        4096        8  d
    pipe                                                   root:root           0        0  f
    socket                                                 root:root           0        0  s
  one                                                      root:root           1        8
  two                                                      root:root           2        8
```

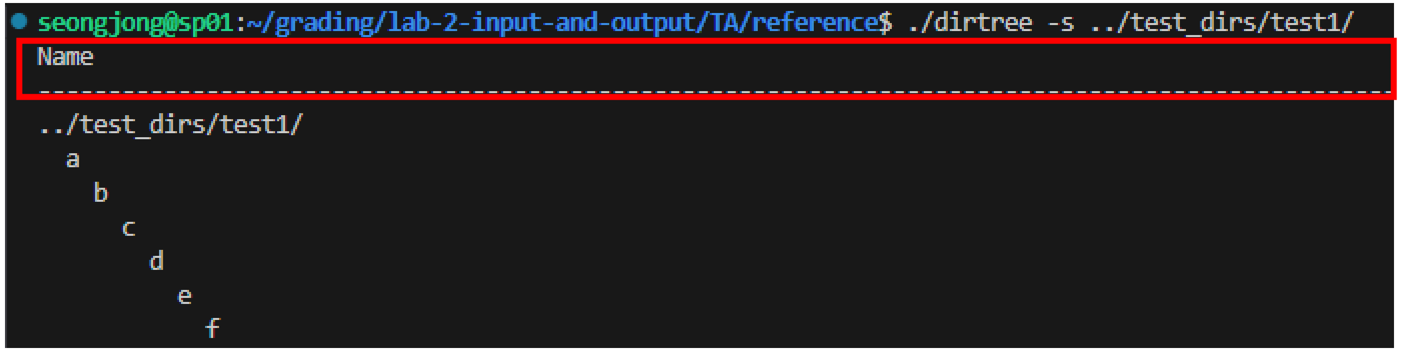
- It shows detail information of file and directories

Dirtree Specification – Detailed Mode (3/5)

Additional details for each entry	Description
User and group	Each file in Unix belongs to a user and a group. Detailed mode prints the names of the user and the group separated by a colon (:)
Size	The size of the file in bytes
Disk blocks	The number of blocks this file occupies on the disk
File type	Indicates the type of file by a single character

File Type	Character
File	*(empty)*
Directory	d
Link	l
Character device	c
Block device	b
Fifo	f
Socket	s

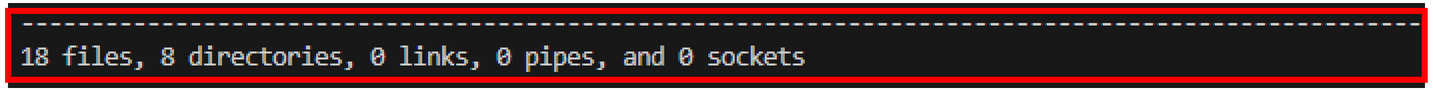
Dirtree Specification - Summary Mode (4/5)



```
seongjong@sp01:~/grading/lab-2-input-and-output/TA/reference$ ./dirtree -s ../test_dirs/test1/
Name
----------------------------------------------------------------------------------------------------
../test_dirs/test1/
  a
    b
      c
        d
          e
            f
```

header

⋮

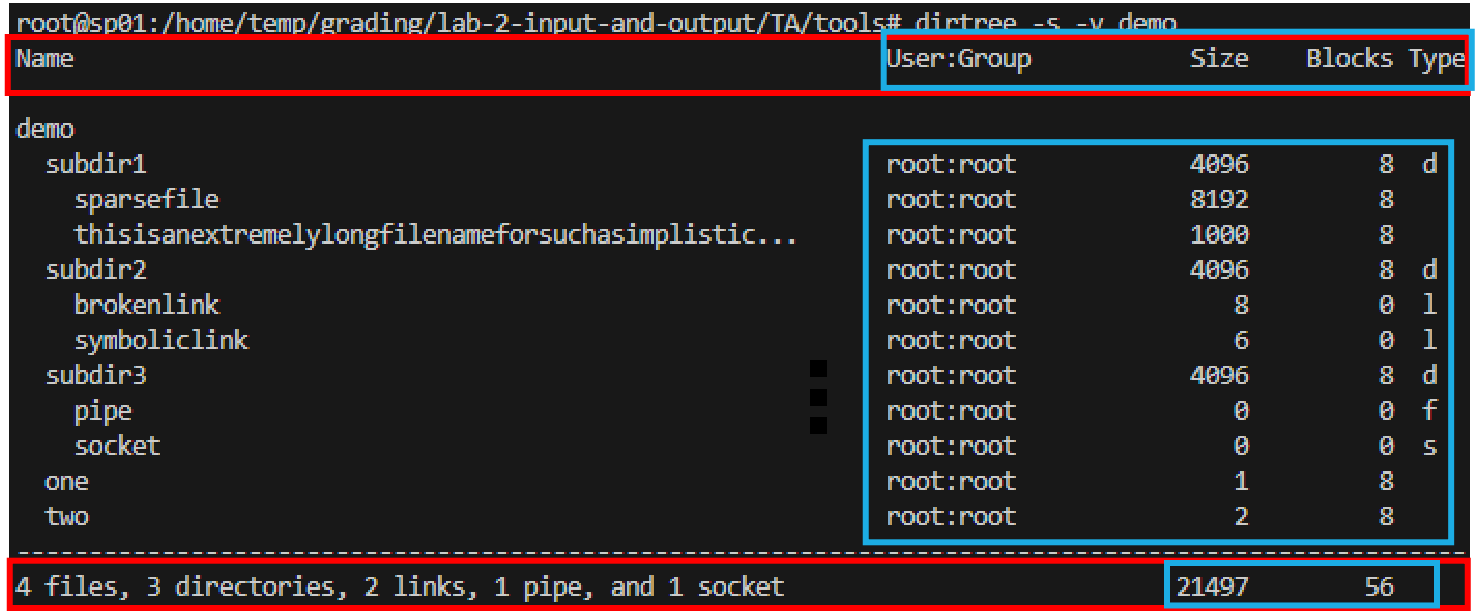


```
----------------------------------------------------------------------------------------------------
18 files, 8 directories, 0 links, 0 pipes, and 0 sockets
```

Footer (& one-liner containing statistics)

- Summary mode: dirtree prints a header and footer around each target directory and a one-liner containing statistics about the directory

Dirtree Specification - Detailed Mode + Summary Mode (5/5)



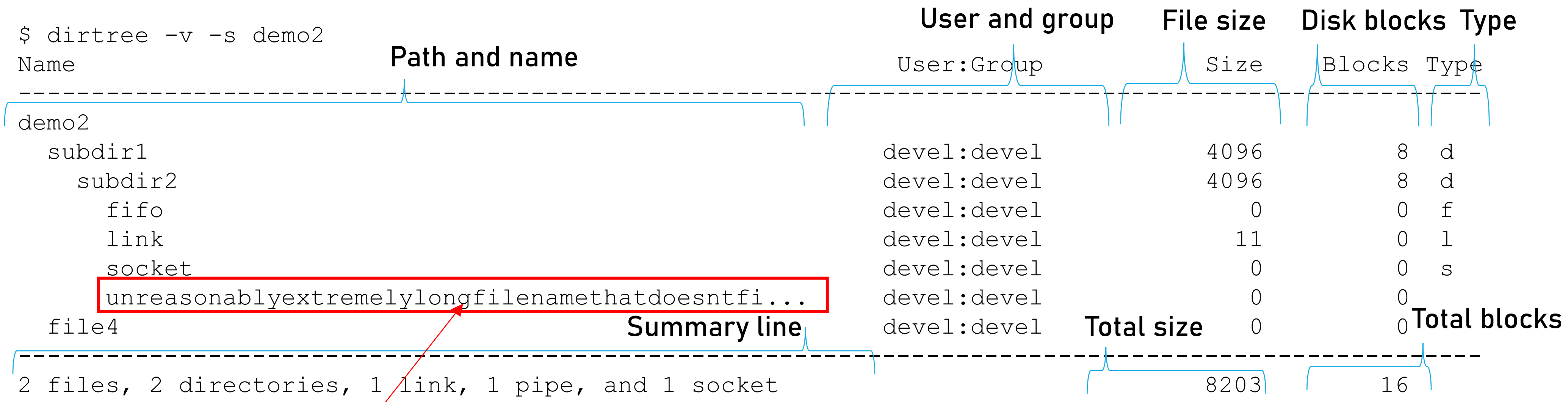
```
root@sp01:/home/temp/grading/lab-2-input-and-output/TA/tools# dirtree -s -v demo
Name                                                        User:Group           Size    Blocks Type

demo
  subdir1                                                   root:root            4096         8 d
    sparsefile                                              root:root            8192         8
    thisisanextremelylongfilenameforsuchasimplistic...     root:root            1000         8
  subdir2                                                   root:root            4096         8 d
    brokenlink                                              root:root               8         0 l
    symboliclink                                            root:root               6         0 l
  subdir3                                                   root:root            4096         8 d
    pipe                                                    root:root               0         0 f
    socket                                                  root:root               0         0 s
  one                                                       root:root               1         8
  two                                                       root:root               2         8
----------------------------------------------------------------------------------------------------
4 files, 3 directories, 2 links, 1 pipe, and 1 socket                           21497        56
```

Header w/ detailed information

Footer w/ detailed information

- Detailed mode: detailed information
- Summary mode: column title & total statistics
- Detailed mode + summary mode: detailed information, total statistics, column title, additional summary information by detailed mode
- Red boxes: effect of summary mode, blue boxes: effect of detailed mode

Dirtree Specification - Output Formatting (1/3)



```
$ dirtree -v -s demo2
Name                                                        User:Group            Size   Blocks Type
----------------------------------------------------------------------------------------------------
demo2
  subdir1                                                  devel:devel            4096        8  d
    subdir2                                                devel:devel            4096        8  d
      fifo                                                 devel:devel               0        0  f
      link                                                 devel:devel              11        0  l
      socket                                               devel:devel               0        0  s
      unreasonablyextremelylongfilenamethatdoesntfi...     devel:devel               0        0
  file4                                                    devel:devel               0        0
----------------------------------------------------------------------------------------------------
2 files, 2 directories, 1 link, 1 pipe, and 1 socket                              8203       16
```

Output element	Path and name	User name	Group name	File size	Disk blocks	Type	Summary line	Total size	Total blocks
Width	54	8	8	10	8	1	68	14	9
Alignment	left	right	left	right	right		left	right	right
Action on overflow	cut and end with three dots (Considerations when the '-v' option is present)	ignore	ignore	ignore	ignore		cut and end with three dots (Considerations when the '-v' && 's' options are present)	ignore	ignore

- Total line length: 100
- Handle the overflow at 'path and name' (with -v option) & 'summary line' (with -v - s options)

Dirtree Specification - Output Formatting (2/3)

```
         1         2         3         4         5         6         7         8         9        10
1........0.........0.........0.........0.........0.........0.........0.........0.........0.........0

Name                                                        User:Group           Size    Blocks Type 
----------------------------------------------------------------------------------------------------
<path and name                                       >  <  user>:<group >  <    size>  <blocks>  t
<path and name                                       >  <  user>:<group >  <    size>  <blocks>  t
...
----------------------------------------------------------------------------------------------------
<summary                                                           >   <  total size> <totblks>
```

There is a space here, please note.

- Please make sure this format is correct
  - Whitespace differences are acceptable
  - Newline character differences result in point deduction
  - Text mismatches result in point deduction
  - (using the diff command is recommended)
- 〈, 〉 symbols are also included in the character count
  - Your program should not print that symbol

Dirtree Specification - Output Formatting (3/3)

```
0 files, 2 directories, 1 link, 1 pipe, and 1 socket

1 file, 1 directory, 2 links, 0 pipes, and 5 sockets
```

- Zero or 〉=2 elements are output in plural form
- Exactly one element the singular form is used

Dirtree Specification - Error Handling (1/2)

```
$ dirtree -v /etc/cups
/etc/cups
  ...
  ppd                                                       root:lp              4096         8  d
    .keep_net-print_cups-0                                  root:root               0         0
  ssl                                                       root:lp              4096         8  d
     ERROR: Permission denied
  client.conf                                               root:root              31         8
  ...
```

- Permission errors should be handled by any option
  - The '`$ dirtree /home/seongjong`' command should also result in a permission error

Dirtree Specification - Error Handling (2/2)

```
$ dirtree -v /proc/self/fd
/proc/self/fd
  0                                                        devel:devel            64          0  l
  1                                                        devel:devel            64          0  l
  2                                                        devel:devel            64          0  l
  3                                                     No such file or directory
```

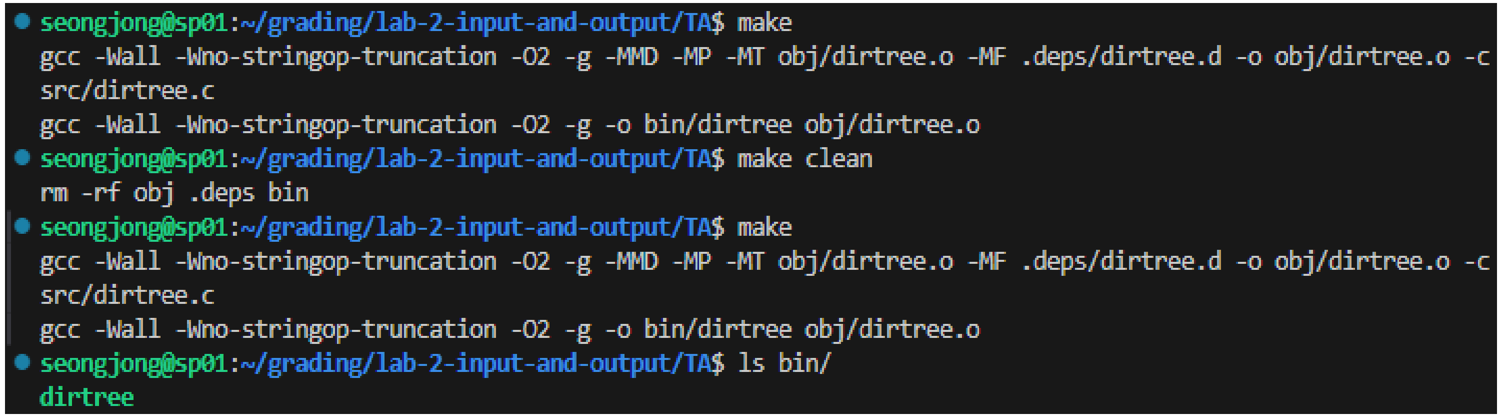
- ‘No such file or directory’ errors should be handled by detailed mode
  - File size, disk blocks, type are not printed
  - In this case, the output may be different from the result of the example executable file (such as different # of file descriptors). But that's okay
- Any errors other than these two (permission error, no such file or directory error) are not considered

Handout Overview

File or Directory	Description
README.md	For information
Makefile	Makefile driver program
src/dirtree.c	Skeleton for dirtree.c. Implement your solution by editing this file.
doc/	Doxygen instructions, configuration file, and auto-generated documentation
reference/	Reference implementation
tools/	Tools to generate directory trees for testing

- Makefile
  - `$ make`: automates the process of compiling and building programs
  - `$ make clean`: is used to remove compiled files and other generated files
- tools/: The tools directory contains tools to generate test directory trees to test your solution
- doc/: Doxygen is a documentation generation tool that automatically creates software documentation from annotated source code
  - Not included in the grading. Please look for students who are interested only

How to use ‘Makefile’



```
seongjong@sp01:~/grading/lab-2-input-and-output/TA$ make
gcc -Wall -Wno-stringop-truncation -O2 -g -MMD -MP -MT obj/dirtree.o -MF .deps/dirtree.d -o obj/dirtree.o -c
src/dirtree.c
gcc -Wall -Wno-stringop-truncation -O2 -g -o bin/dirtree obj/dirtree.o
seongjong@sp01:~/grading/lab-2-input-and-output/TA$ make clean
rm -rf obj .deps bin
seongjong@sp01:~/grading/lab-2-input-and-output/TA$ make
gcc -Wall -Wno-stringop-truncation -O2 -g -MMD -MP -MT obj/dirtree.o -MF .deps/dirtree.d -o obj/dirtree.o -c
src/dirtree.c
gcc -Wall -Wno-stringop-truncation -O2 -g -o bin/dirtree obj/dirtree.o
seongjong@sp01:~/grading/lab-2-input-and-output/TA$ ls bin/
dirtree
```

Example of use

File	Path
dirtree.c	~/assign2/src/
dirtree (executable file)	~/assign2/bin/

Basic directory structure (Assume that the ‘Makefile’ is located in ~/assignment2)

- You should keep the directory structure as specified in the Makefile
  - Basically, use the structure you downloaded the files for lab 2
- You don’t need to modify the content of Makefile
  - Just remember that:
  - `$ make`: compiles dirtree.c file
  - `$ make clean`: removes the results of the compilation (Necessary when performing a new compilation)

About ‘tools/’

File	Description
gentree.sh	Driver script to generate a test directory tree
mksock	Helper program to generate a Unix socket
*.tree	Script files describing the directory tree layout

Example of use: `$ ./gentree.sh demo.tree`

- You can create multiple test cases by modifying only the *.tree files
  - gentree.sh creates a test case directory based on input files (*.tree files)
  - mksock is used in gentree.sh and cannot be modified
  - Read the *.tree file contents. You can easily create test cases

Hints (Useful C Library Calls)

Topic	C library call	Description
String operations	strcmp()	compare two strings
	strncpy()	copy up to n characters of one string into another
	strdup()	create a copy of a string. Use free() to free it after use
	asprintf()	asprintf() is extremely helpful to print into a string and allocate memory for it at the same time. We will show some examples during the lab session.
Directory management	opendir()	open a directory to enumerate its entries
	closedir()	close an open directory
	readdir()	read next entry from directory
File meta data	stat()	retrieve meta data of a file, follow links
	lstat()	retrieve meta data of a file, do not follow links
User/group information	getpwuid()	retrieve user information (including their name) for a given user ID
	getgrgid()	retrieve group information (including its name) for a given group ID
Sorting	qsort()	quick-sort an array

Submit Format

Structure of directory:

```
YourID_assign2 (don't use dash)
 |-dirtree.c (source file)
 `-readme (don't use extension such as .txt, .md, …)
```

Example:

```
202400000_assign2
 |-dirtree.c (source file)
 `-readme
```

- Please set **files and directory's names** to match the examples above
  - Don't use any extension for readme file
  - Don't use dash for submit file
- Please place all source code in a **single file**
- Structure files and directories as shown above, then proceed with **compression**
- **Deadline: ~10.4 21:00**
  - **0 points if deadline is missed**

Grading

Test cases	Assigned points
dirtree ./target_directory	9
dirtree –s ./target_directory	4
dirtree –v ./target_directory	4
dirtree –t ./target_directory	4
dirtree -s -v ./target_directory	3
dirtree -s -t ./target_directory	3
dirtree -v -t ./target_directory	3
dirtree -s -v -t ./target_directory	4
dirtree <options> <multiple directories> (same as single directory case)	34
Error and overflow handling	16
README.md (information of your dirtree)	10
Whether compilation is possible with Makefile	6

- Functionality of each option: 68 points
  - 1 option not implemented: −28 points
  - 2 options not implemented: −40 points
  - 3 options not implemented: −66 points
- Tips for testing: use 'diff' command
- If the submission format is violated: −5 points
- If the source file cannot be compiled
  - w/ gcc800 in Makefile: −6 points
  - w/ gcc in Makefile: You will get no point