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the full report with files can be found here

Lab1: ELF

Description

This `bldd` app is a command-line tool designed to find executables in a specified directory (or a single file) that use a given shared library (or a directory of shared libraries). It supports cross-architecture analysis and provides output in multiple formats (terminal, text file, or PDF).

Implementaiton

let's divide the logic of the app into several files, each is going to handle different logic:

1. **bldd.py**: entry point of the app, it parses the arguments and it's responsible for the whole process orchestration
2. **file_utils.py**: executes necessary checks on files and detects shared library objects
3. **architecture_utils.py**:it detects the architecture of the file
4. **ldd_utils.py**: it extracts the shared library dependencies using `objdump`
5. **shared_library_finder.py**: it handles the logic of finding shared libraries and executables
6. **output_utils.py**: it handles the output saving and formatting

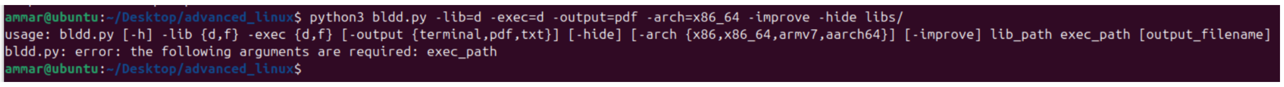
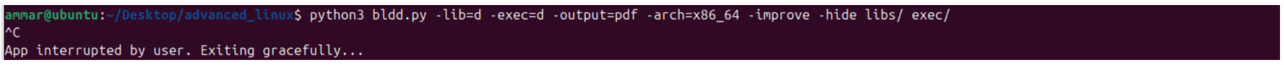
Specification

the app supports flags which makes it flexable for different use cases

- `-lib`: required flag, it specifies whether user wants to pass single shared library file `(-lib=f)`, or a directory of shared library files `(-lib=d)`
- `-exec`: required flag, it specifies whether user wants to pass single executable file `(-lib=f)`, or a directory of executable files `(-lib=d)`
- `-output`: optional flag, it directs the output to one of three possible destinations:
  - `terminal`: the default value
  - `pdf`: it generates the report in a pdf file (the default name is `output.pdf` unless if it was specified)
  - `txt`: it generates the report in a text file (the default name is `output.txt` unless if it was specified)
- `-arch`: optional flag, it specifies which architecture to handle out of the following:
  - `x86_64`
  - `x64`
  - `armv7`
  - `aarch64` **Note**: by default all the previous architectures are accepted unless if it was specified
- `-improve`: optional flag, if mentioned, the app will utilize threads to parallelize the execution and make it faster (by default it's disabled)
- `-hide`: optional flag, if mentioned, the app will hide shared libraries which have no corresponding executables from the report (by default it's disabled)

- `-help` or `-h`: to display the help page

Interruption and Handling Errors

- the app handles erorrs related to missing/passing invalid flags and arguments with informative output which indicate where the error is
  
```
ammar@ubuntu:~/Desktop/advanced_linux$ python3 bldd.py -lib=d -exec=d -output=pdf -arch=x86_64 -improve -hide libs/
usage: bldd.py [-h] -lib {d,f} -exec {d,f} [-output {terminal,pdf,txt}] [-hide] [-arch {x86,x86_64,armv7,aarch64}] [-improve] lib_path exec_path [output_filename]
bldd.py: error: the following arguments are required: exec_path
ammar@ubuntu:~/Desktop/advanced_linux$
```
- the app performs graceful exit when receiving `ctrl + c` signal from the user
  
```
ammar@ubuntu:~/Desktop/advanced_linux$ python3 bldd.py -lib=d -exec=d -output=pdf -arch=x86_64 -improve -hide libs/ exec/
^C
App interrupted by user. Exiting gracefully...
```

Output

- the app displays the **Shared Libraries** sorted by the number of corresponding executables (from highest to lowest), and each **Executable Files** list is sorted lexicographically (alphabetically) for each shared library
- when `terminal` option is specified for output, **ANSI codes** are applied to the output to apply a colorful and readable output

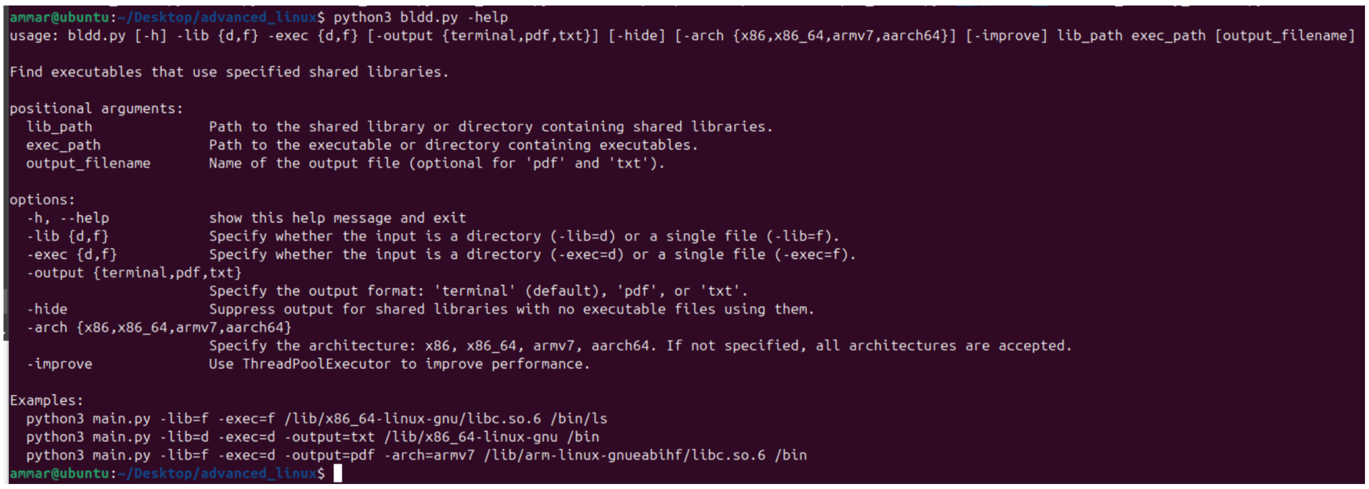
Help Page

help page can be accessed by executing `python3 bldd.py -help`:

output:

```
usage: bldd.py [-h] -lib {d,f} -exec {d,f} [-output {terminal,pdf,txt}] [-
hide] [-arch {x86,x86_64,armv7,aarch64}] [-improve] lib_path exec_path
[output_filename]

Find executables that use specified shared libraries.

positional arguments:
  lib_path              Path to the shared library or directory containing
shared libraries.
  exec_path             Path to the executable or directory containing
executables.
  output_filename       Name of the output file (optional for 'pdf' and
'txt').

options:
  -h, --help            show this help message and exit
  -lib {d,f}            Specify whether the input is a directory (-lib=d)
or a single file (-lib=f).
  -exec {d,f}           Specify whether the input is a directory (-exec=d)
or a single file (-exec=f).
  -output {terminal,pdf,txt}
                        Specify the output format: 'terminal' (default),
'pdf', or 'txt'.
  -hide                 Suppress output for shared libraries with no
executable files using them.
```

```
  -arch {x86,x86_64,armv7,aarch64}
                        Specify the architecture: x86, x86_64, armv7,
aarch64. If not specified, all architectures are accepted.
  -improve              Use ThreadPoolExecutor to improve performance.

Examples:
  python3 main.py -lib=f -exec=f /lib/x86_64-linux-gnu/libc.so.6 /bin/ls
  python3 main.py -lib=d -exec=d -output=txt /lib/x86_64-linux-gnu /bin
  python3 main.py -lib=f -exec=d -output=pdf -arch=armv7 /lib/arm-linux-
gnueabihf/libc.so.6 /bin
```



```
ammar@ubuntu:~/Desktop/advanced_linux$ python3 bldd.py -help
usage: bldd.py [-h] -lib {d,f} -exec {d,f} [-output {terminal,pdf,txt}] [-hide] [-arch {x86,x86_64,armv7,aarch64}] [-improve] lib_path exec_path [output_filename]

Find executables that use specified shared libraries.

positional arguments:
  lib_path              Path to the shared library or directory containing shared libraries.
  exec_path             Path to the executable or directory containing executables.
  output_filename       Name of the output file (optional for 'pdf' and 'txt').

options:
  -h, --help            show this help message and exit
  -lib {d,f}            Specify whether the input is a directory (-lib=d) or a single file (-lib=f).
  -exec {d,f}           Specify whether the input is a directory (-exec=d) or a single file (-exec=f).
  -output {terminal,pdf,txt}
                        Specify the output format: 'terminal' (default), 'pdf', or 'txt'.
  -hide                 Suppress output for shared libraries with no executable files using them.
  -arch {x86,x86_64,armv7,aarch64}
                        Specify the architecture: x86, x86_64, armv7, aarch64. If not specified, all architectures are accepted.
  -improve              Use ThreadPoolExecutor to improve performance.

Examples:
  python3 main.py -lib=f -exec=f /lib/x86_64-linux-gnu/libc.so.6 /bin/ls
  python3 main.py -lib=d -exec=d -output=txt /lib/x86_64-linux-gnu /bin
  python3 main.py -lib=f -exec=d -output=pdf -arch=armv7 /lib/arm-linux-gnueabihf/libc.so.6 /bin
ammar@ubuntu:~/Desktop/advanced_linux$
```

Requirements

- the following python libraries:
  - os
  - sys
  - argparse
  - signal
  - re
  - subprocess
  - threading
  - concurrent.futures
  - fpdf
- the sysetm dependencies:
  - objdump

Examples and Proofs

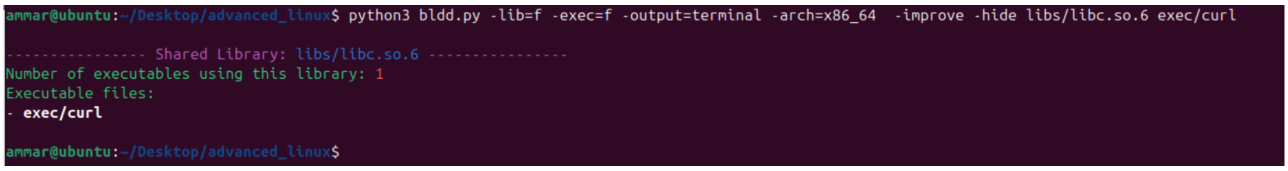
to make quick and simple examples to visualize and test the functionality of the app, let's pick some libraries and copy them from `/lib/x86_64-linux-gnu/` to a local directory `/libs`, and let's copy some executable libraries from `/bin` to a local directory `/exec`

Example 1

- let's run the app for a single library and a single executable file, and direct the output to the terminal:

```
python3 bldd.py -lib=f -exec=f -output=terminal -arch=x86_64  -improve
-hide libs/libc.so.6 exec/curl
```

- output:



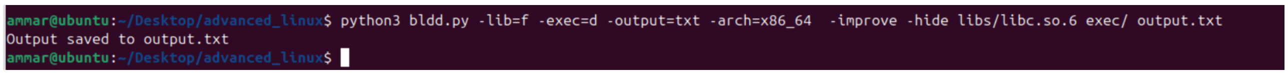
```
ammar@ubuntu:~/Desktop/advanced_linux$ python3 bldd.py -lib=f -exec=f -output=terminal -arch=x86_64  -improve -hide libs/libc.so.6 exec/curl

--------------- Shared Library: libs/libc.so.6 ---------------
Number of executables using this library: 1
Executable files:
- exec/curl

ammar@ubuntu:~/Desktop/advanced_linux$
```

Example 2

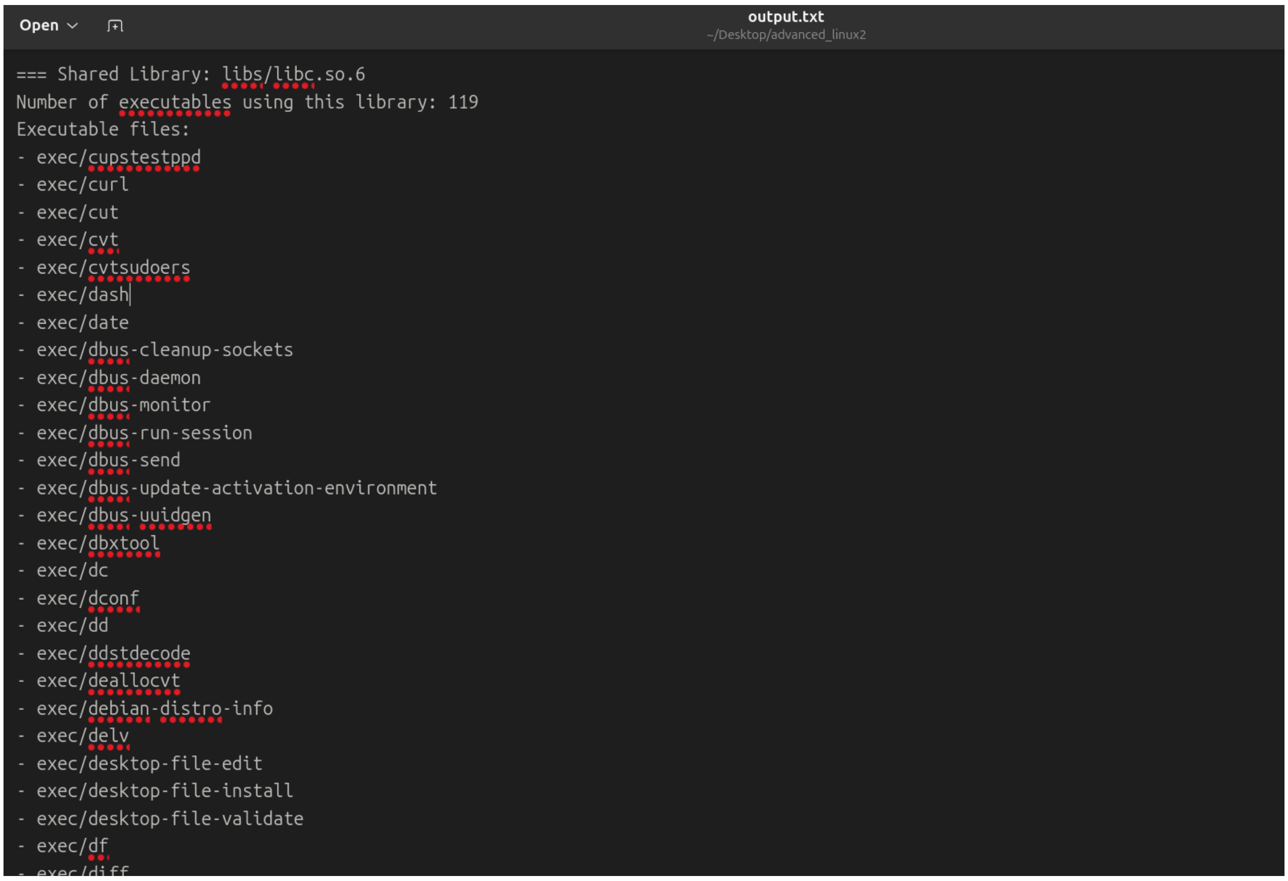
- let's run the app for a single library and a directory of executable files, and direct the output to a text file `output.txt`:

```
python3 bldd.py -lib=f -exec=d -output=txt -arch=x86_64  -improve -
hide libs/libc.so.6 exec/ output.txt
```

- output:



```
ammar@ubuntu:~/Desktop/advanced_linux$ python3 bldd.py -lib=f -exec=d -output=txt -arch=x86_64  -improve -hide libs/libc.so.6 exec/ output.txt
Output saved to output.txt
ammar@ubuntu:~/Desktop/advanced_linux$
```



```
=== Shared Library: libs/libc.so.6
Number of executables using this library: 119
Executable files:
- exec/cupstestppd
- exec/curl
- exec/cut
- exec/cvt
- exec/cvtsudoers
- exec/dash
- exec/date
- exec/dbus-cleanup-sockets
- exec/dbus-daemon
- exec/dbus-monitor
- exec/dbus-run-session
- exec/dbus-send
- exec/dbus-update-activation-environment
- exec/dbus-uuidgen
- exec/dbxtool
- exec/dc
- exec/dconf
- exec/dd
- exec/ddstdecode
- exec/deallocvt
- exec/debian-distro-info
- exec/delv
- exec/desktop-file-edit
- exec/desktop-file-install
- exec/desktop-file-validate
- exec/df
- exec/diff
```

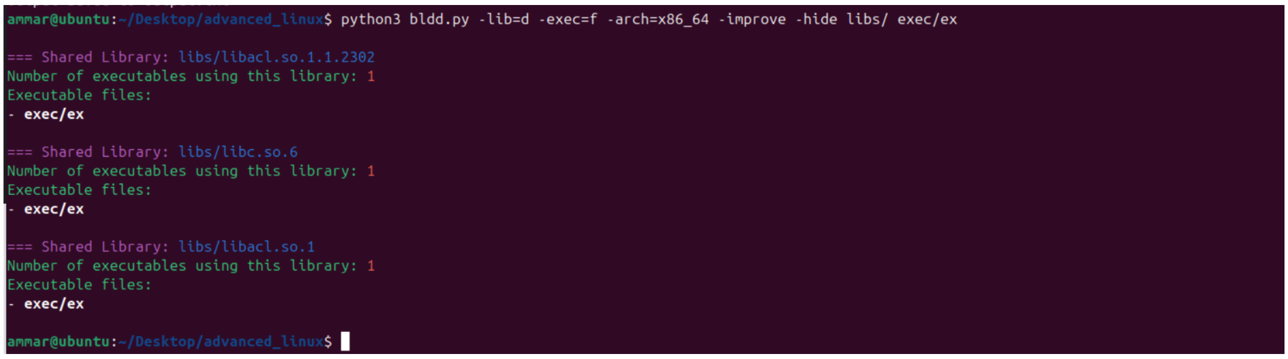
Example 3

- let's run the app for a directory of libraries and a single executable file, and direct the output to the terminal:

```
python3 bldd.py -lib=d -exec=f -arch=x86_64 -improve -hide libs/
exec/ex
```

- output:

```
=== Shared Library: libs/libacl.so.1.1.2302
Number of executables using this library: 1
Executable files:
- exec/ex

=== Shared Library: libs/libc.so.6
Number of executables using this library: 1
Executable files:
- exec/ex

=== Shared Library: libs/libacl.so.1
Number of executables using this library: 1
Executable files:
- exec/ex
```



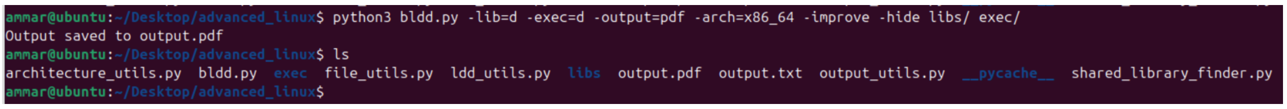
```
ammar@ubuntu:~/Desktop/advanced_linux$ python3 bldd.py -lib=d -exec=f -arch=x86_64 -improve -hide libs/ exec/ex

=== Shared Library: libs/libacl.so.1.1.2302
Number of executables using this library: 1
Executable files:
- exec/ex

=== Shared Library: libs/libc.so.6
Number of executables using this library: 1
Executable files:
- exec/ex

=== Shared Library: libs/libacl.so.1
Number of executables using this library: 1
Executable files:
- exec/ex

ammar@ubuntu:~/Desktop/advanced_linux$
```

Example 4

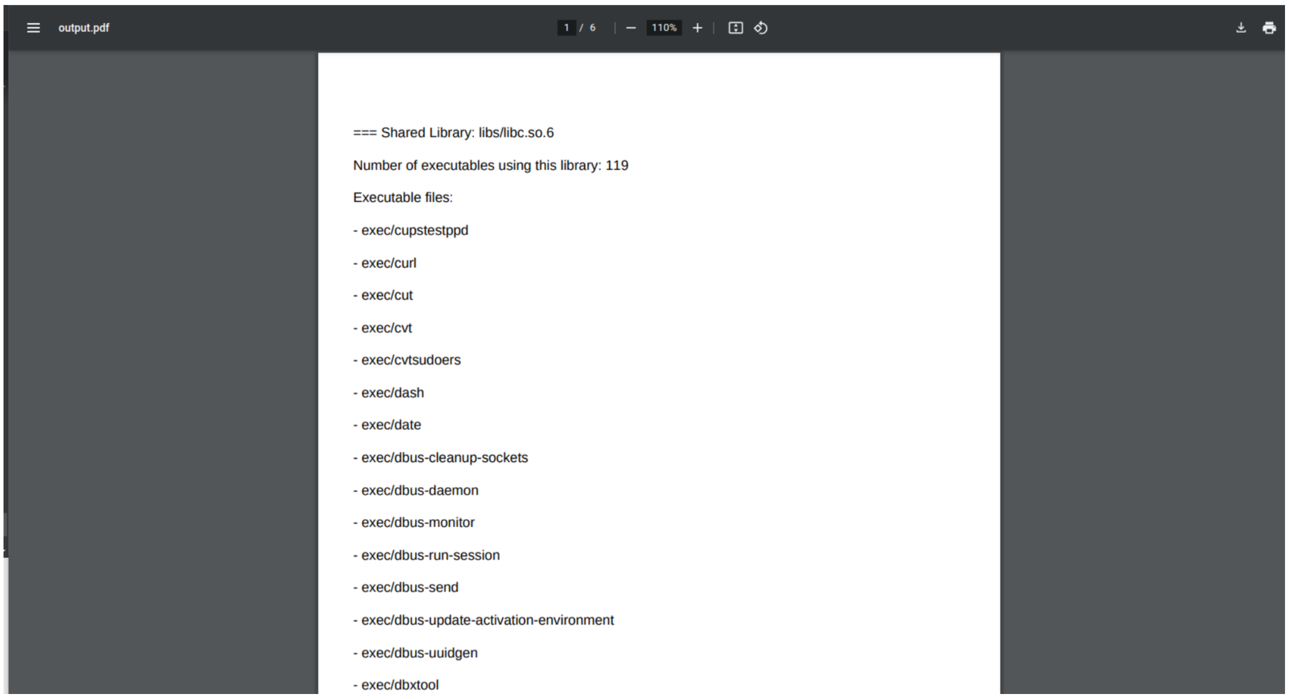
- let's run the app for a directory of libraries and a directory of executable files, and direct the output to a pdf file:

```
python3 bldd.py -lib=d -exec=d -output=pdf -arch=x86_64 -improve -hide
libs/ exec/
```

- output:



```
ammar@ubuntu:~/Desktop/advanced_linux$ python3 bldd.py -lib=d -exec=d -output=pdf -arch=x86_64 -improve -hide libs/ exec/
Output saved to output.pdf
ammar@ubuntu:~/Desktop/advanced_linux$ ls
architecture_utils.py  bldd.py  exec  file_utils.py  ldd_utils.py  libs  output.pdf  output.txt  output_utils.py  __pycache__  shared_library_finder.py
ammar@ubuntu:~/Desktop/advanced_linux$
```



```
=== Shared Library: libs/libc.so.6
Number of executables using this library: 119
Executable files:
- exec/cupstestppd
- exec/curl
- exec/cut
- exec/cvt
- exec/cvtsudoers
- exec/dash
- exec/date
- exec/dbus-cleanup-sockets
- exec/dbus-daemon
- exec/dbus-monitor
- exec/dbus-run-session
- exec/dbus-send
- exec/dbus-update-activation-environment
- exec/dbus-uuidgen
- exec/dbxtool
```

Attachments

- `bldd.py`
- `file_utils.py`
- `architecture_utils.py`
- `ldd_utils.py`
- `shared_library_finder.py`
- `output_utils.py`
- `output.txt` file from `Example 2`
- `output.pdf` file from `Example 4`
- `lib/` directory which was used in the examples
- `exec/` directory which was used in the examples