

Back to Basics : Command Line for Developers

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<https://tinyurl.com/nfjsvv-cli>

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Speaker Qualifications

- Specialize in next-generation technologies
- Author of O'Reilly book "WebAssembly : The Definitive Guide"
- Author of O'Reilly Videos on Hypermedia, Linking Data, Security and Encryption
- Author of "Resource-Oriented Architecture Patterns for Webs of Data"
- Teaches and speaks internationally about REST, Semantic Web, WebAssembly, Data Science, Machine Learning, GPU Computing, Security, Visualization, Architecture
- Worked in Defense, Finance, Retail, Hospitality, Video Game, Health Care, Telecommunications and Publishing Industries
- International Pop Recording Artist

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Agenda

- Introduction
- Text-Processing Tools
- Programming Tools
- System Tools
- Networking Tools
- Future Fun

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Introduction

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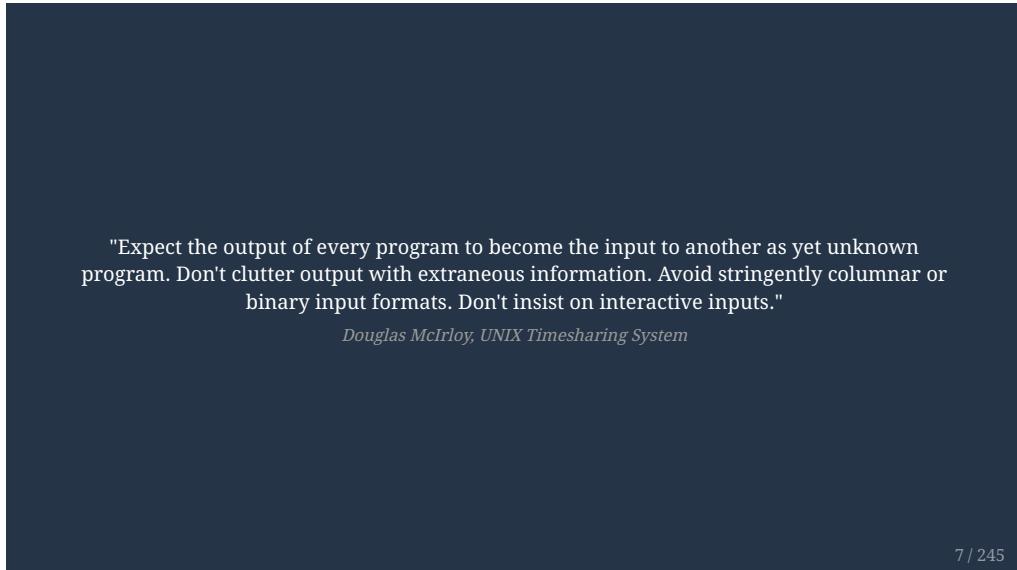


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"Make each program do one thing well. To do a new job, build afresh rather than complicate old programs by adding new features."

Douglas McIrroy, UNIX Timesharing System

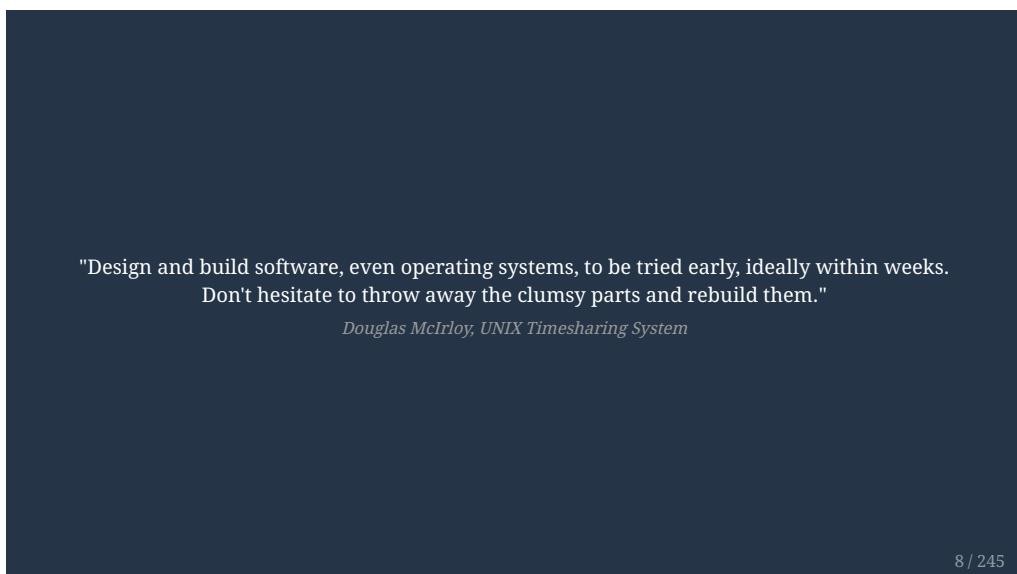
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"Expect the output of every program to become the input to another as yet unknown program. Don't clutter output with extraneous information. Avoid stringently columnar or binary input formats. Don't insist on interactive inputs."

Douglas McIrroy, UNIX Timesharing System

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"Design and build software, even operating systems, to be tried early, ideally within weeks. Don't hesitate to throw away the clumsy parts and rebuild them."

Douglas McIrroy, UNIX Timesharing System

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"Use tools in preference to unskilled help to lighten a programming task, even if you have to detour to build the tools and expect to throw some of them out after you've finished using them."

Douglas McIlroy, UNIX Timesharing System

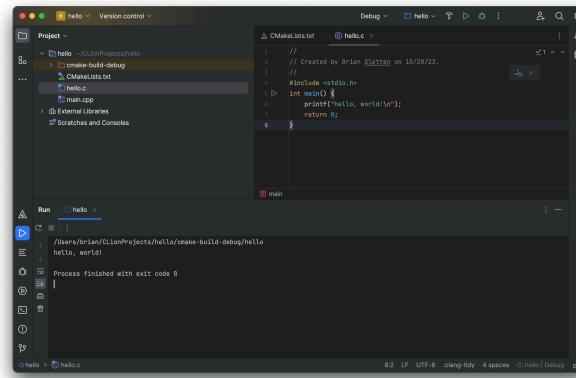
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Hello, World!

```
#include <stdio.h>

int main() {
    printf("hello, world!\n");
    return 0;
}
```

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Compiling By Hand with gcc

```
~/src/classes/cli/hello $ gcc hello.c
~/src/classes/cli/hello $ ls -alF
total 80
drwxr-xr-x@ 4 brian  staff   128 Oct 28 12:16 .
drwxr-xr-x@ 3 brian  staff    96 Oct 28 12:16 ..
-rwxr-xr-x@ 1 brian  staff  33432 Oct 28 12:16 a.out*
-rw-r--r--@ 1 brian  staff     75 Oct 28 12:16 hello.c
```

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Compiling By Hand with gcc

```
~/src/classes/cli/hello $ gcc hello.c
~/src/classes/cli/hello $ ls -alF
total 80
drwxr-xr-x@ 4 brian  staff   128 Oct 28 12:16 .
drwxr-xr-x@ 3 brian  staff    96 Oct 28 12:16 ../
-rwxr-xr-x@ 1 brian  staff  33432 Oct 28 12:16 a.out*
-rw-r--r--@ 1 brian  staff     75 Oct 28 12:16 hello.c
```

```
~/src/classes/cli/hello $ a.out
a.out: command not found
```

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Compiling By Hand with gcc

```
~/src/classes/cli/hello $ gcc hello.c
~/src/classes/cli/hello $ ls -alF
total 80
drwxr-xr-x@ 4 brian  staff   128 Oct 28 12:16 .
drwxr-xr-x@ 3 brian  staff    96 Oct 28 12:16 ../
-rwxr-xr-x@ 1 brian  staff  33432 Oct 28 12:16 a.out*
-rw-r--r--@ 1 brian  staff     75 Oct 28 12:16 hello.c
```

```
~/src/classes/cli/hello $ a.out
a.out: command not found
```

```
~/src/classes/cli/hello $ ./a.out
hello, world!
```

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Adding Directories to Your Path

```
# bash
# $HOME/.bashrc
export PATH="/home/brian/anaconda3/bin:$PATH"

# fish
# $HOME/.config/fish/config.fish

set -x JENVPATH /Users/brian/.jenv
set -x PATH $JENVPATH/bin $PATH $HOME/.cargo/bin $HOME/bin
```

- <https://www.cyberciti.biz/faq/unix-linux-adding-path/>
- <https://fishshell.com/docs/current/tutorial.html>

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Using clang instead of gcc

```
~/src/classes/cli/hello $ clang hello.c
~/src/classes/cli/hello $ ls -laF
total 80
drwxr-xr-x@ 4 brian  staff   128 Oct 28 12:17 ./
drwxr-xr-x@ 3 brian  staff    96 Oct 28 12:16 ../
-rw-r-xr-x@ 1 brian  staff  33432 Oct 28 12:17 a.out*
-rw-r--r--@ 1 brian  staff    75 Oct 28 12:16 hello.c
```

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Using clang instead of gcc

```
~/src/classes/cli/hello $ clang hello.c
~/src/classes/cli/hello $ ls -laF
total 80
drwxr-xr-x@ 4 brian  staff   128 Oct 28 12:17 .
drwxr-xr-x@ 3 brian  staff    96 Oct 28 12:16 ../
-rwxr-xr-x@ 1 brian  staff  33432 Oct 28 12:17 a.out*
-rw-r--r--@ 1 brian  staff    75 Oct 28 12:16 hello.c
```

```
brian@bug ~/s/c/c/hello> set -x PATH $PATH .
```

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Using clang instead of gcc

```
~/src/classes/cli/hello $ clang hello.c
~/src/classes/cli/hello $ ls -laF
total 80
drwxr-xr-x@ 4 brian  staff   128 Oct 28 12:17 .
drwxr-xr-x@ 3 brian  staff    96 Oct 28 12:16 ../
-rwxr-xr-x@ 1 brian  staff  33432 Oct 28 12:17 a.out*
-rw-r--r--@ 1 brian  staff    75 Oct 28 12:16 hello.c
```

```
brian@bug ~/s/c/c/hello> set -x PATH $PATH .
```

```
brian@bug ~/s/c/c/hello> which ls
/bin/ls
```

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Using clang instead of gcc

```
~/src/classes/cli/hello $ clang hello.c
~/src/classes/cli/hello $ ls -laF
total 80
drwxr-xr-x@ 4 brian  staff   128 Oct 28 12:17 .
drwxr-xr-x@ 3 brian  staff    96 Oct 28 12:16 ../
-rw xr-xr-x@ 1 brian  staff  33432 Oct 28 12:17 a.out*
-rw-r--r--@ 1 brian  staff    75 Oct 28 12:16 hello.c

brian@bug ~/s/c/c/hello> set -x PATH $PATH .

brian@bug ~/s/c/c/hello> which ls
/bin/ls

~/src/classes/cli/hello $ which a.out
./a.out
```

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Using clang instead of gcc

```
~/src/classes/cli/hello $ clang hello.c
~/src/classes/cli/hello $ ls -laF
total 80
drwxr-xr-x@ 4 brian  staff   128 Oct 28 12:17 .
drwxr-xr-x@ 3 brian  staff    96 Oct 28 12:16 ../
-rw xr-xr-x@ 1 brian  staff  33432 Oct 28 12:17 a.out*
-rw-r--r--@ 1 brian  staff    75 Oct 28 12:16 hello.c

brian@bug ~/s/c/c/hello> set -x PATH $PATH .

brian@bug ~/s/c/c/hello> which ls
/bin/ls

~/src/classes/cli/hello $ which a.out
./a.out

~/src/classes/cli/hello $ a.out
hello, world!
```

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Redirecting stdout

```
~/src/classes/cli/hello $ ./a.out
hello, world!
~/src/classes/cli/hello $ ./a.out > hello.out
~/src/classes/cli/hello $ ls -laF
total 88
drwxr-xr-x@ 5 brian  staff   160 Oct 28 13:10 .
drwxr-xr-x@ 3 brian  staff    96 Oct 28 12:16 ..
-rw-r--r--@ 1 brian  staff  33432 Oct 28 12:17 a.out*
-rw-r--r--@ 1 brian  staff    75 Oct 28 12:16 hello.c
~/src/classes/cli/hello $ cat hello.out
hello, world!
```

Redirecting stdout

```
~/src/classes/cli/hello $ ./a.out 1> hello-1.out
~/src/classes/cli/hello $ ls -alF
total 96
drwxr-xr-x@ 6 brian  staff  192 Oct 28 13:11 .
drwxr-xr-x@ 3 brian  staff   96 Oct 28 12:16 ..
-rwxr-xr-x@ 1 brian  staff  33432 Oct 28 12:17 a.out*
-rw-r--r--@ 1 brian  staff    14 Oct 28 13:11 hello-1.out
-rw-r--r--@ 1 brian  staff    75 Oct 28 12:16 hello.c
-rw-r--r--@ 1 brian  staff    14 Oct 28 13:10 hello.out
~/src/classes/cli/hello $ diff hello-1.out hello.out
```

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Upcasing with tr

```
~/src/classes/cli/hello $ ./a.out | tr a-z A-Z
HELLO, WORLD!
```

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man tr

TR(1)	General Commands Manual	TR(1)
NAME	tr - translate characters	
SYNOPSIS	<code>tr [-Ccsu] string1 string2</code> <code>tr [-Ccu] -d string1</code> <code>tr [-Ccu] -s string1</code> <code>tr [-Ccu] -ds string1 string2</code>	
DESCRIPTION	The <code>tr</code> utility copies the standard input to the standard output with substitution or deletion of selected characters.	
The following options are available:		
-C	Complement the set of characters in <code>string1</code> , that is “-C ab” includes every character except for ‘a’ and ‘b’.	
-c	Same as -C but complement the set of values in <code>string1</code> .	
-d	Delete characters in <code>string1</code> from the input.	
:		

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<https://tldr.sh>

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tldr tr

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More Fun with tr

```
~/src/classes/cli/hello $ ./a.out | tr [:lower:] [:upper:]
HELLO, WORLD!
```

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More Fun with tr

```
~/src/classes/cli/hello $ ./a.out | tr [:lower:] [:upper:]
HELLO, WORLD!
~/src/classes/cli/hello $ ./a.out | tr -d h
ello, world!
```

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More Fun with tr

```
~/src/classes/cli/hello $ ./a.out | tr [:lower:] [:upper:]
HELLO, WORLD!
~/src/classes/cli/hello $ ./a.out | tr -d h
ello, world!
~/src/classes/cli/hello $ ./a.out | tr h H
Hello, world!
```

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More Fun with tr

```
~/src/classes/cli/hello $ ./a.out | tr [:lower:] [:upper:]
HELLO, WORLD!
~/src/classes/cli/hello $ ./a.out | tr -d h
ello, world!
~/src/classes/cli/hello $ ./a.out | tr h H
Hello, world!
~/src/classes/cli/hello $ clang hello.c
~/src/classes/cli/hello $ ./a.out
À bientôt, Chloé!
~/src/classes/cli/hello $ ./a.out | tr "[=e=]" "e"
À bientôt, Chloë!
```

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More Fun with tr

```
~/src/classes/cli/hello $ ./a.out | tr [:lower:] [:upper:]
HELLO, WORLD!
~/src/classes/cli/hello $ ./a.out | tr -d h
ello, world!
~/src/classes/cli/hello $ ./a.out | tr h H
Hello, world!
~/src/classes/cli/hello $ clang hello.c
~/src/classes/cli/hello $ ./a.out
À bientôt, Chloë!
~/src/classes/cli/hello $ ./a.out | tr "[=e]" "e"
À bientôt, Chloe!
~/src/classes/cli/hello $ ./a.out | tr 'àáàééèííò' 'aaaaeeeeiiio'
À bientot, Chloe!
```

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Copying From stdin to stdout

```
#include <stdio.h>

int main(){
    char c;
    while ( (c=getchar()) != EOF ){
        putchar(c);
    }
    return 0;
}
```

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Copying From stdin to stdout

```
#include <stdio.h>

int main(){
    char c;
    while ( (c=getchar()) != EOF ){
        putchar(c);
    }
    return 0;
}

~/src/classes/cli/hello $ clang copy.c -o copy
~/src/classes/cli/hello $ ./copy
Hello           <----- Reads from keyboard
Hello           <----- Copies to console
```

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Redirecting stdin and stdout

```
brian@bug ~/s/c/c/hello> hello
hello, world!
```

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Redirecting stdin and stdout

```
brian@bug ~/s/c/c/hello> hello  
hello, world!  
brian@bug ~/s/c/c/hello> hello | copy  
hello, world!
```

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Redirecting stdin and stdout

```
brian@bug ~/s/c/c/hello> hello  
hello, world!  
brian@bug ~/s/c/c/hello> hello | copy  
hello, world!  
brian@bug ~/s/c/c/hello> hello > hello.out  
brian@bug ~/s/c/c/hello> cat hello.out  
hello, world!
```

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Redirecting stdin and stdout

```
brian@bug ~/s/c/c/hello> hello  
hello, world!  
  
brian@bug ~/s/c/c/hello> hello | copy  
hello, world!  
  
brian@bug ~/s/c/c/hello> hello > hello.out  
brian@bug ~/s/c/c/hello> cat hello.out  
hello, world!  
  
brian@bug ~/s/c/c/hello> hello | copy > hello.out  
brian@bug ~/s/c/c/hello> cat hello.out  
hello, world!
```

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Redirecting stdin and stdout

```
brian@bug ~/s/c/c/hello> hello  
hello, world!  
  
brian@bug ~/s/c/c/hello> hello | copy  
hello, world!  
  
brian@bug ~/s/c/c/hello> hello > hello.out  
brian@bug ~/s/c/c/hello> cat hello.out  
hello, world!  
  
brian@bug ~/s/c/c/hello> hello | copy > hello.out  
brian@bug ~/s/c/c/hello> cat hello.out  
hello, world!  
  
brian@bug ~/s/c/c/hello> copy < hello.out > hello2.out  
brian@bug ~/s/c/c/hello> cat hello2.out  
hello, world!
```

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Working with stdio and Python

```
import sys
# https://www.askpython.com/python/python-stdin-stdout-stderr
stdin_fileno = sys.stdin

# Keeps reading from stdin and quits only if the word 'exit' is there
# This loop, by default does not terminate, since stdin is open
for line in stdin_fileno:
    # Remove trailing newline characters using strip()
    if 'exit' == line.strip():
        print('Found exit. Terminating the program')
        exit(0)
    else:
        print('Message from sys.stdin: ---> {} <---'.format(line))
```

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Running the Script with Python

```
brian@bug ~/s/c/c/hello> python3 copy.py
Hello.
Message from sys.stdin: ---> Hello.
<---
How are you?
Message from sys.stdin: ---> How are you?
<---
exit
Found exit. Terminating the program
```

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Making the Python Self-Executing

```
#!/usr/bin/env python
import sys
# https://www.askpython.com/python/python-stdin-stdout-stderr
stdin_fileno = sys.stdin

# Keeps reading from stdin and quits only if the word 'exit' is there
# This loop, by default does not terminate, since stdin is open
for line in stdin_fileno:
    # Remove trailing newline characters using strip()
    if 'exit' == line.strip():
        print('Found exit. Terminating the program')
        exit(0)
    else:
        print('Message from sys.stdin: ---> {} <---'.format(line))
```

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Making the Python Self-Executing

```
#!/usr/bin/env python
import sys
# https://www.askpython.com/python/python-stdin-stdout-stderr
stdin_fileno = sys.stdin

# Keeps reading from stdin and quits only if the word 'exit' is there
# This loop, by default does not terminate, since stdin is open
for line in stdin_fileno:
    # Remove trailing newline characters using strip()
    if 'exit' == line.strip():
        print('Found exit. Terminating the program')
        exit(0)
    else:
        print('Message from sys.stdin: ---> {} <---'.format(line))
```

```
brian@bug ~/s/c/c/hello> chmod ogu+rx copy.py
brian@bug ~/s/c/c/hello> ls -laF copy.py
-rwxr-xr-x@ 1 brian  staff  456 Oct 29 15:42 copy.py*
```

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Using the Python Script

```
brian@bug ~/s/c/c/hello [1]> copy.py < input.txt
Message from sys.stdin: ---> Hello, I am text in a file.
<---
Message from sys.stdin: ---> I will be copied and printed to stdout.
<---
Message from sys.stdin: ---> Until you hit the next line.
<---
Found exit. Terminating the program
```

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Using the Python Script

```
brian@bug ~/s/c/c/hello [1]> copy.py < input.txt
Message from sys.stdin: ---> Hello, I am text in a file.
<---
Message from sys.stdin: ---> I will be copied and printed to stdout.
<---
Message from sys.stdin: ---> Until you hit the next line.
<---
Found exit. Terminating the program
```

```
brian@bug ~/s/c/c/hello> copy.py < input.txt > copy.out
brian@bug ~/s/c/c/hello> cat copy.out
Message from sys.stdin: ---> Hello, I am text in a file.
<---
Message from sys.stdin: ---> I will be copied and printed to stdout.
<---
Message from sys.stdin: ---> Until you hit the next line.
<---
Found exit. Terminating the program
```

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Adding stderr

```
import sys
# https://www.askpython.com/python/python-stdin-stdout-stderr

stdout_fileno = sys.stdout
stderr_fileno = sys.stderr

sample_input = [ 3, 12, 30, 50, 'banana' ]

for ip in sample_input:
    # Prints to stdout
    stdout_fileno.write(str(ip) + '\n')
    # Tries to add an Integer with string. Raises an exception
    try:
        ip = ip + 100
    # Catch all exceptions
    except:
        stderr_fileno.write('Exception Occurred!\n')
```

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Using stdout and stderr

```
brian@bug ~/s/c/c/hello> python3 convert.py
3
12
30
50
banana
Exception Occurred!
```

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Using stdout and stderr

```
brian@bug ~/s/c/c/hello> python3 convert.py
3
12
30
50
banana
Exception Occurred!
```

```
brian@bug ~/s/c/c/hello> python3 convert.py > convert.out
Exception Occurred!
```

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Using stdout and stderr

```
brian@bug ~/s/c/c/hello> python3 convert.py
3
12
30
50
banana
Exception Occurred!
```

```
brian@bug ~/s/c/c/hello> python3 convert.py > convert.out
Exception Occurred!
```

```
brian@bug ~/s/c/c/hello> python3 convert.py > convert.out 2> /dev/null
brian@bug ~/s/c/c/hello> cat convert.out
3
12
30
50
banana
```

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Text-Processing Tools

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Start with a Song

```
brian@bug ~/s/c/c/hello> cat song.txt
I like to eat, eat, eat
Apples and bananas
I like to eat, eat, eat
Apples and bananas
Oh I like to ate, ate, ate
Aaples and bananays
I like to ate, ate, ate
Aaples and bananays
I like to eat, eat, eat
Eaples and beneneys
I like to eat, eat, eat
Eaples and beneneys
Oh, I like to ite, ite, ite
Iples and bbininis
...
```

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Counting Elements

```
brian@bug ~/s/c/c/hello> wc song.txt
      24      110     525 song.txt
      |       |       |
    lines   words   bytes
```

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head

```
brian@bug ~/s/c/c/hello> head song.txt
I like to eat, eat, eat
Apples and bananas
I like to eat, eat, eat
Apples and bananas
Oh I like to ate, ate, ate
Aaples and bananays
I like to ate, ate, ate
Aaples and bananays
I like to eat, eat, eat
Eaples and beneneyns
```

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tail

```
brian@bug ~/s/c/c/hello> tail song.txt
I like to ite, ite, ite
I ples and bininis
I like to ote, ote, ote
Oaples and bononos
I like to ote, ote, ote
Oaples and bononos
I like to ute, ute, ute
Uuples and bununus
I like to ute, ute, ute
Uuples and bununus
```

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Following Files with tail

```
brian@bug ~/s/c/c/hello> tail -f foo.txt
```

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less

```
brian@bug ~/s/c/c/text> less raw_sentences.txt
```

```
No , he says now .
And what did he say ?
The money 's there .
That was a week ago .
But he made only the first .
Then he will tell me for them to do it .
But he shouldnt do it .
They have to come down to the people .
I do n't know what that is .
No , I wouldnt .
Well , I wouldnt .
And no , it was not the one .
You could do a better one now ?
There was a place like that I knew of .
Be here now , and so on .
It 's not going to get us both of you .
So it 's not going to get in my way .
We all have it , we all have it .
No one 's going to do any of it for us .
Well , I want more .
With more , we can do more .
Who to take into school or not take into school ?
Both of us , we can get one just the same .
We all have it .
So easy .
You can put that out there .
But only a part .
That 's the only way I know , he said .
But that was a week ago .
It 'll be the last time .
raw_sentences.txt
```

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less (+F or Shift-F)

```
brian@bug ~/s/c/c/text> less +F raw_sentences.txt
```

```
What about that ?
He said , Well , so is this .
Only a part , and where we are .
It could have been over .
I think the old man should be .
Now I think they should be .
It does nt do me any good and it does nt do the team any good .
Can I have a beer ?
She would , and they did .
The other wouldnt , he said .
I do nt think he did it .
If you do not want to see you ?
Going after your company was a political game .
We have to get back after it .
It 's not about us , which is what 's all about .
That 's just the world .
We have to get back after it .
Where are we ?
People are not .
The other is cold ;
Would we want it ;
So do you want it ?
It 's a family business .
When do we get back some time ?
Now it is over .
I do not care .
He said we are going to work , you and I .
Where people get their money and how they get it .
It 's easy to say no .
Only one in five said no .
Waiting for data... (interrupt to abort)
```

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less (slash pattern)

```

text -- less raw_sentences.i -/a/c/text -- less raw_sentences.txt - 100x31
He was nt even from New York .
But some people will .
All right , what we do it ?
It 's best for us .
And I think it 's because that 's not how I want them to be .
Women who can do .
I just does n't very long .
we are , and he is .
I said : You are right .
But you are not the one of the world .
Will it go to the state , which could use it to house people ?
But this was big for us .
Now , we do .
Fishes are in the right place at the right time .
It 's to the left of that .
This is the right place .
After a while , you do n't .
I said : No , it 's not .
For some people , it 's not .
It 's a good life out here .
I think it 's because he did nt do it all .
After me , it 's the United States .
Honesty is the best policy .
what 's about the money ?
I said : There is no money .
There may be a market for this .
I would like to be President , he said .
What would you like to go to if you were a city ?
If you were a city , which would you be ?

```

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<https://ryanstutorials.net/regular-expressions-tutorial/>

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Global Regular Expression Pattern (grep)

```
brian@bug ~/s/c/c/hello> grep bananas song.txt
Apples and bananas
Apples and bananas
```

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Global Regular Expression Pattern (grep)

```
brian@bug ~/s/c/c/hello> grep bananas song.txt
Apples and bananas
Apples and bananas
```

```
brian@bug ~/s/c/c/hello> cat song.txt | grep bananas
Apples and bananas
Apples and bananas
```

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Global Regular Expression Pattern (grep)

```
brian@bug ~/s/c/c/hello> grep bananas song.txt  
Apples and bananas  
Apples and bananas
```

```
brian@bug ~/s/c/c/hello> cat song.txt | grep bananas  
Apples and bananas  
Apples and bananas
```

```
brian@bug ~/s/c/c/hello> grep apples song.txt
```

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Global Regular Expression Pattern (grep)

```
brian@bug ~/s/c/c/hello> grep bananas song.txt  
Apples and bananas  
Apples and bananas
```

```
brian@bug ~/s/c/c/hello> cat song.txt | grep bananas  
Apples and bananas  
Apples and bananas
```

```
brian@bug ~/s/c/c/hello> grep apples song.txt
```

```
brian@bug ~/s/c/c/hello [1]> grep -i apples song.txt  
Apples and bananas  
Apples and bananas
```

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Overmatching

```
brian@bug ~/s/c/c/hello> grep I song.txt
I like to eat, eat, eat
I like to eat, eat, eat
Oh I like to ate, ate, ate
I like to ate, ate, ate
I like to eat, eat, eat
I like to eat, eat, eat
Oh, I like to ite, ite, ite
Iples and bininis
I like to ite, ite, ite
Iples and bininis
I like to ote, ote, ote
I like to ote, ote, ote
I like to ute, ute, ute
I like to ute, ute, ute
```

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Positional Qualifer: SOL

```
brian@bug ~/s/c/c/hello> grep "^I" song.txt
I like to eat, eat, eat
I like to eat, eat, eat
I like to ate, ate, ate
I like to eat, eat, eat
I like to eat, eat, eat
Iples and bininis
I like to ite, ite, ite
Iples and bininis
I like to ote, ote, ote
I like to ote, ote, ote
I like to ute, ute, ute
I like to ute, ute, ute
```

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Positional Qualifier: EOL

```
brian@bug ~/s/c/c/hello> grep "e\$" song.txt
Oh I like to ate, ate, ate
I like to ate, ate, ate
Oh, I like to ite, ite, ite
I like to ite, ite, ite
I like to ote, ote, ote
I like to ote, ote, ote
I like to ute, ute, ute
I like to ute, ute, ute
```

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Regexs and grep

```
brian@bug ~/s/c/c/hello> grep b[au]n[au]n[au]s song.txt
Apples and bananas
Apples and bananas
Uuples and bununus
Uuples and bununus
```

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Regexs and grep

```
brian@bug ~/s/c/c/hello> grep b[au]n[au]n[au]s song.txt
Apples and bananas
Apples and bananas
Uuples and bununus
Uuples and bununus
```

```
brian@bug ~/s/c/c/hello> grep b[au]n[au]n[ua]s song.txt
Apples and bananas
Apples and bananas
Uuples and bununus
Uuples and bununus
```

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More Sophisticated Regexes

```
brian@bug ~/s/c/c/hello [1]> grep -E 'b([au]n?)\{3}s' song.txt
Apples and bananas
Apples and bananas
Uuples and bununus
Uuples and bununus
```

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More Sophisticated Regexes

```
brian@bug ~/s/c/c/hello [1]> grep -E 'b([au]n?)\{3}s' song.txt
Apples and bananas
Apples and bananas
Uuples and bununus
Uuples and bununus
```

```
brian@bug ~/s/c/c/hello> grep -E 'b([aiou]n?)\{3}s' song.txt
Apples and bananas
Apples and bananas
Ibles and bininis
Ibles and bininis
Oaples and bononos
Oaples and bononos
Uuples and bununus
Uuples and bununus
```

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Extending the Regex

```
brian@bug ~/s/c/c/hello> grep -E 'b([aiou]n?)\{3}y?s' song.txt
Apples and bananas
Apples and bananas
Aaples and bananays
Aaples and bananays
Ibles and bininis
Ibles and bininis
Oaples and bononos
Oaples and bononos
Uuples and bununus
Uuples and bununus
```

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egrep

```
brian@bug ~/s/c/c/hello> egrep "b([aiou]n?)\{3}y?s" song.txt
Apples and bananas
Apples and bananas
Aaples and bananays
Aaples and bananays
Ibles and bininis
Ibles and bininis
Oaples and bononos
Oaples and bononos
Uuples and bununus
Uuples and bununus
```

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Multiple Options

```
brian@bug ~/s/c/c/hello> egrep "[Aa]pples|bononos" song.txt
Apples and bananas
Apples and bananas
Oaples and bononos
Oaples and bononos
```

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grep variants

- fgrep
- zgrep, zegrep, zfgrep
- bzgrep, bzegrep, bzfgrep

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<https://github.com/BurntSushi/ripgrep>

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<https://github.com/junegunn/fzf>

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Stream Editor (sed)

```
brian@bug ~/s/c/c/hello> sed s/bananas/pizza/ < song.txt
I like to eat, eat, eat
Apples and pizza
I like to eat, eat, eat
Apples and pizza
Oh I like to ate, ate, ate
Aaples and bananays
I like to ate, ate, ate
Aaples and bananays
I like to eat, eat, eat
...
```

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Stream Editor (sed)

```
brian@bug ~/s/c/c/hello> sed s/bananas/pizza/ < song.txt
I like to eat, eat, eat
Apples and pizza
I like to eat, eat, eat
Apples and pizza
Oh I like to ate, ate, ate
Aaples and bananays
I like to ate, ate, ate
Aaples and bananays
I like to eat, eat, eat
...
```

```
brian@bug ~/s/c/c/hello> cat song.txt | sed s/bananas/pizza/
I like to eat, eat, eat
Apples and pizza
I like to eat, eat, eat
Apples and pizza
Oh I like to ate, ate, ate
Aaples and bananays
I like to ate, ate, ate
Aaples and bananays
I like to eat, eat, eat
...
```

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Piping It All Together

```
brian@bug ~/s/c/c/hello> cat song.txt | sed s/Aaples/Apples/ | sed s/bananays/bananas/
I like to eat, eat, eat
Apples and bananas
I like to eat, eat, eat
Apples and bananas
Oh I like to ate, ate, ate
Apples and bananas
I like to ate, ate, ate
Apples and bananas
I like to eat, eat, eat
Eaples and beneneys
I like to eat, eat, eat
Eaples and beneneys
```

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Regular Expressions with sed

```
brian@bug ~/s/c/c/hello> cat song.txt | sed s/[aiou]te/eat/
I like to eat, eat, eat
Apples and bananas
I like to eat, eat, eat
Apples and bananas
Oh I like to eat, ate, ate
Aaples and bananays
I like to eat, ate, ate
Aaples and bananays
I like to eat, eat, eat
Eaples and beneneys
I like to eat, eat, eat
Eaples and beneneys
Oh, I like to eat, ite, ite
Iples and bininis
I like to eat, ite, ite
Iples and bininis
I like to eat, ote, ote
Oaples and bononos
I like to eat, ote, ote
Oaples and bononos
I like to eat, ute, ute
Uuples and bununus
I like to eat, ute, ute
Uuples and bununus
```

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More Regular Expressions with sed

```
brian@bug ~/s/c/c/hello> cat song.txt | sed s/[aiou]te/eat/g      <----- Global substitution
I like to eat, eat, eat
Apples and bananas
I like to eat, eat, eat
Apples and bananas
Oh I like to eat, eat, eat
Aaples and bananays
I like to eat, eat, eat
Aaples and bananays
I like to eat, eat, eat
Eaples and beneneys
I like to eat, eat, eat
Eaples and beneneys
Oh, I like to eat, eat, eat
Iples and bininis
I like to eat, eat, eat
Iples and bininis
I like to eat, eat, eat
Oaples and bononos
I like to eat, eat, eat
Oaples and bononos
I like to eat, eat, eat
Uuples and bununus
I like to eat, eat, eat
Uuples and bununus
```

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<https://github.com/chmln/sd>

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<https://linuxhandbook.com/awk-command-tutorial/>

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Programming Tools

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Compiling By Hand

```
~/src/classes/cli/hello $ gcc hello.c
~/src/classes/cli/hello $ ls -alF
total 80
drwxr-xr-x@ 4 brian  staff   128 Oct 28 12:16 .
drwxr-xr-x@ 3 brian  staff    96 Oct 28 12:16 ..
-rw-r-xr-x@ 1 brian  staff  33432 Oct 28 12:16 a.out*
-rw-r--r--@ 1 brian  staff     75 Oct 28 12:16 hello.c
~/src/classes/cli/hello $ ./a.out
hello, world!
```

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Compiling By Hand

```
~/src/classes/cli/hello $ gcc hello.c
~/src/classes/cli/hello $ ls -alF
total 80
drwxr-xr-x@ 4 brian  staff   128 Oct 28 12:16 .
drwxr-xr-x@ 3 brian  staff    96 Oct 28 12:16 ..
-rwxr-xr-x@ 1 brian  staff  33432 Oct 28 12:16 a.out*
-rw-r--r--@ 1 brian  staff    75 Oct 28 12:16 hello.c
~/src/classes/cli/hello $ ./a.out
hello, world!
```

```
~/src/classes/cli/hello $ clang hello.c
~/src/classes/cli/hello $ ls -laF
total 80
drwxr-xr-x@ 4 brian  staff   128 Oct 28 12:17 .
drwxr-xr-x@ 3 brian  staff    96 Oct 28 12:16 ..
-rwxr-xr-x@ 1 brian  staff  33432 Oct 28 12:17 a.out*
-rw-r--r--@ 1 brian  staff    75 Oct 28 12:16 hello.c
~/src/classes/cli/hello $ ./a.out
hello, world!
```

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Using Makefiles

```
hello:
    echo "Building hello..."
```

|
tab

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Using Makefiles

```
hello:  
    echo "Building hello..."  
    |  
    tab
```

```
brian@bug ~$ c/c/hello> make  
echo "Building hello..."  
Building hello...
```

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Building with make

```
hello:  
    echo "Building hello..."  
    clang -o hello hello.c
```

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Building with make

```
hello:  
    echo "Building hello..."  
    clang -o hello hello.c
```

```
brian@bug ~/s/c/c/hello> make  
echo "Building hello..."  
Building hello...  
clang -o hello hello.c
```

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Building with make

```
hello:  
    echo "Building hello..."  
    clang -o hello hello.c
```

```
brian@bug ~/s/c/c/hello> make  
echo "Building hello..."  
Building hello...  
clang -o hello hello.c
```

```
brian@bug ~/s/c/c/hello> ls -laF hello  
-rwxr-xr-x 1 brian staff 33432 Oct 30 14:12 hello*
```

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Building with make

```
hello:  
    echo "Building hello..."  
    clang -o hello hello.c  
  
brian@bug ~/s/c/c/hello> make  
echo "Building hello..."  
Building hello...  
clang -o hello hello.c  
  
brian@bug ~/s/c/c/hello> ls -laF hello  
-rwxr-xr-x  1 brian  staff  33432 Oct 30 14:12 hello*  
  
brian@bug ~/s/c/c/hello> make  
make: `hello' is up to date.
```

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Adding targets

```
hello:  
    echo "Building hello..."  
    clang -o hello hello.c  
  
clean:  
    rm hello
```

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Adding targets

```
hello:
    echo "Building hello..."
    clang -o hello hello.c

clean:
    rm hello
```



```
brian@bug ~/s/c/c/hello> make clean
rm hello
brian@bug ~/s/c/c/hello> make
echo "Building hello..."
Building hello...
clang -o hello hello.c
```

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https://www.gnu.org/software/automake/manual/html_node/

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<https://cmake.org/>

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<https://ninja-build.org/>

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<https://bazel.build/>

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What is a.out?

```
~/src/classes/cli/hello $ file a.out
a.out: Mach-O 64-bit executable arm64
```

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What is a.out?

```
~/src/classes/cli/hello $ file a.out  
a.out: Mach-O 64-bit executable arm64
```

```
~/src/classes/cli/hello $ nm a.out  
000000001000000000 T __mh_execute_header  
00000000100003f58 T _main  
                                U _printf
```

Looking at the Contents

Magic Numbers

```
~/src/classes/cli/hello $ od -h a.out
000000 facf feed 000c 0100 0000 0000 0002 0000
0000020 0011 0000 0420 0000 0085 0020 0000 0000
0000040 0019 0000 0048 0000 5f5f 4150 4547 455a
0000060 4f52 0000 0000 0000 0000 0000 0000 0000
...

```

<https://en.wikipedia.org/wiki/Mach-O>

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Magic Numbers

```
~/src/classes/cli/hello $ od -h a.out
000000 facf feed 000c 0100 0000 0000 0002 0000
0000020 0011 0000 0420 0000 0085 0020 0000 0000
0000040 0019 0000 0048 0000 5f5f 4150 4547 455a
0000060 4f52 0000 0000 0000 0000 0000 0000 0000
...

```

<https://en.wikipedia.org/wiki/Mach-O>

```
~/g/2/u/c/i/cli> od -h clion.png
0000000 5089 474e 0a0d 0a1a 0000 0d00 4849 5244
0000020 0000 3c0a 0000 d406 0608 0000 4100 2d94
0000040 0023 0a00 69b2 4343 4950 4343 5020 6f72
0000060 6966 656c 0000 8948 9795 5407 e913 8016
0000100 99ff 90f4 02d0 9011 7a12 de93 4802 a109
0000120 5005 0e90 4236 2012 1094 a853 5976 c15c
0000140 a0b5 8222 4565 2297 360a 0daa 60b1 1161

```

https://en.wikipedia.org/wiki/List_of_file_signatures

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strings

```
~/src/classes/cli/hello $ strings a.out  
hello, world!
```

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<https://sdkman.io>

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<https://github.com/reitzig/sdkman-for-fish>

(For fish shell fans)

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Listing JDKs

```
brian@bug ~> sdk list java
```

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Listing JDKs

```
brian@bug ~> sdk list java
```

Available Java versions for max90 ARM Adonis						
Vendor	Label	Type	Version	Distro	Status	Identifier
Corretto	21	java	21	amazoncorretto	21-amazon	
	20.8.2	java	20.8.2	amazoncorretto	20-8.2-amazon	
	20.8.1	java	20.8.1	amazoncorretto	20-8.1-amazon	
	17.8.9	java	17.8.9	amazoncorretto	17-8.9-amazon	
	17.8.8	java	17.8.8	amazoncorretto	17-8.8-amazon	
	17.8.7	java	17.8.7	amazoncorretto	17-8.7-amazon	
	17.8.6	java	17.8.6	amazoncorretto	17-8.6-amazon	
	11.20.28	java	11.20.28	amazoncorretto	11.20.28-amazon	
	8.4.202	java	8.4.202	amazoncorretto	8.4.202-amazon	
	8.4.192	java	8.4.192	amazoncorretto	8.4.192-amazon	
	8.4.172	java	8.4.172	amazoncorretto	8.4.172-amazon	
Gluon	22.1.0-rtls	gluon	22.1.0-rtls	gluon	22.1.0-rtls-gluon	
GraalVM CE	21.8.1	graalvm	21.8.1	graalvm	21-8.1-gradle	
	20.8.1	graalvm	20.8.1	graalvm	20-8.1-gradle	
	17.8.9	graalvm	17.8.9	graalvm	17-8.9-gradle	
	17.8.8	graalvm	17.8.8	graalvm	17-8.8-gradle	
GraalVM Oracle	21.8.1	graal	21.8.1	graal	21.8.1-gradal	
	20.8.1	graal	20.8.1	graal	20.8.1-gradal	
	17.8.9	graal	17.8.9	graal	17.8.9-gradal	
	17.8.8	graal	17.8.8	graal	17.8.8-gradal	
	17.8.7	graal	17.8.7	graal	17.8.7-gradal	
	22.0.21	openj9	22.0.21	openj9	22.0.21-openj9	
	22.0.19	openj9	22.0.19	openj9	22.0.19-openj9	
	22.0.17	openj9	22.0.17	openj9	22.0.17-openj9	
	22.0.16	openj9	22.0.16	openj9	22.0.16-openj9	

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<http://tweezer.local:8080/bosatsu/slides/nfjsvw/cli#1>

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nfjsvw/cli

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Managing JDK Installations

```
brian@bug ~> java -version
openjdk version "11.0.20" 2023-07-18 LTS
OpenJDK Runtime Environment Corretto-11.0.20.8.1 (build 11.0.20+8-LTS)
OpenJDK 64-Bit Server VM Corretto-11.0.20.8.1 (build 11.0.20+8-LTS, mixed mode)
```

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<http://twoezer.local:8080/beesetsu/slides/pficyw/eli#1>

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Managing JDK Installations

```
brian@bug ~> java -version
openjdk version "11.0.20" 2023-07-18 LTS
OpenJDK Runtime Environment Corretto-11.0.20.8.1 (build 11.0.20+8-LTS)
OpenJDK 64-Bit Server VM Corretto-11.0.20.8.1 (build 11.0.20+8-LTS, mixed mode)
```

```
brian@bug ~> sdk install java 21-amzn
Downloading: java 21-amzn
In progress...
#####
#                                             100.0%
Repackaging Java 21-amzn...
Done repackaging...
Cleaning up residual files...
Installing: java 21-amzn
Done installing!
Do you want java 21-amzn to be set as default? (Y/n):
```

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Temporarily Using Another JDK

```
brian@bug ~> sdk use java 21-amzn
Using java version 21-amzn in this shell.
brian@bug ~> java -version
openjdk version "21.0.1" 2023-10-17 LTS
OpenJDK Runtime Environment Corretto-21.0.1.12.1 (build 21.0.1+12-LTS)
OpenJDK 64-Bit Server VM Corretto-21.0.1.12.1 (build 21.0.1+12-LTS, mixed mode, sharing)
```

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Setting a Default JDK

```
brian@bug ~> sdk default java 11.0.20-amzn  
setting java 11.0.20-amzn as the default version for all shells.
```

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<https://www.jenv.be>

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<https://github.com/nvm-sh/nvm>

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<https://github.com/so-fancy/diff-so-fancy>

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diff

```
brian@bug ~/s/c/c/hello> cat song.txt | sed s/[aio]te/eat/g > song.out
```

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diff

```
brian@bug ~/s/c/c/hello> cat song.txt | sed s/[aio]te/eat/g > song.out
```

```
brian@bug ~/s/c/c/hello> diff song.txt song.out
5c5
< Oh I like to ate, ate, ate
---
> Oh I like to eat, eat, eat
7c7
< I like to ate, ate, ate
---
> I like to eat, eat, eat
13c13
< Oh, I like to ite, ite, ite
---
> Oh, I like to eat, eat, eat
.
.
```

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diff Unified View

```
brian@bug ~/s/c/c/hello> diff -u song.txt song.out
--- song.txt      2023-10-29 19:03:21
+++ song.out     2023-10-30 19:03:50
@@ -2,23 +2,23 @@
 Apples and bananas
 I like to eat, eat, eat
 Apples and bananas
-Oh I like to ate, ate, ate
+Oh I like to eat, eat, eat
 Apples and bananays
-I like to ate, ate, ate
+I like to eat, eat, eat
 Apples and bananays
 I like to eat, eat, eat
 Eaples and beneneys
 I like to eat, eat, eat
 Eaples and beneneys
 .
.
```

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Installing SpringBoot CLI

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Installing SpringBoot CLI

SDKMan

```
$ sdk install springboot
$ spring --version
Spring CLI v3.1.5
```

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Installing SpringBoot CLI

SDKMan

```
$ sdk install springboot
$ spring --version
Spring CLI v3.1.5
```

MacOS Homebrew

```
$ brew tap spring-io/tap
$ brew uninstall springboot
$ brew install spring-boot
```

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Installing SpringBoot CLI

SDKMan

```
$ sdk install springboot
$ spring --version
Spring CLI v3.1.5
```

MacOS Homebrew

```
$ brew tap spring-io/tap
$ brew uninstall springboot
$ brew install spring-boot
```

Windows

<https://tinyurl.com/yasgrkff>

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Initializing Projects

```
$ spring init -d[list of dependencies]
```

Initializing Projects

```
$ spring init -d[list of dependencies]
```

```
$ spring init --list
```



Supported dependencies	
Id	Description
activemq	Spring JMS support with Apache ActiveMQ 'Classic'.
actuator	Supports built-in (or custom) endpoints that let you monitor and manage your application - such as application health, metrics, sessions, etc.

Initializing Projects

```
$ spring init -dweb,jpa,security
```

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Initializing Projects

```
$ spring init -dweb,jpa,security
```

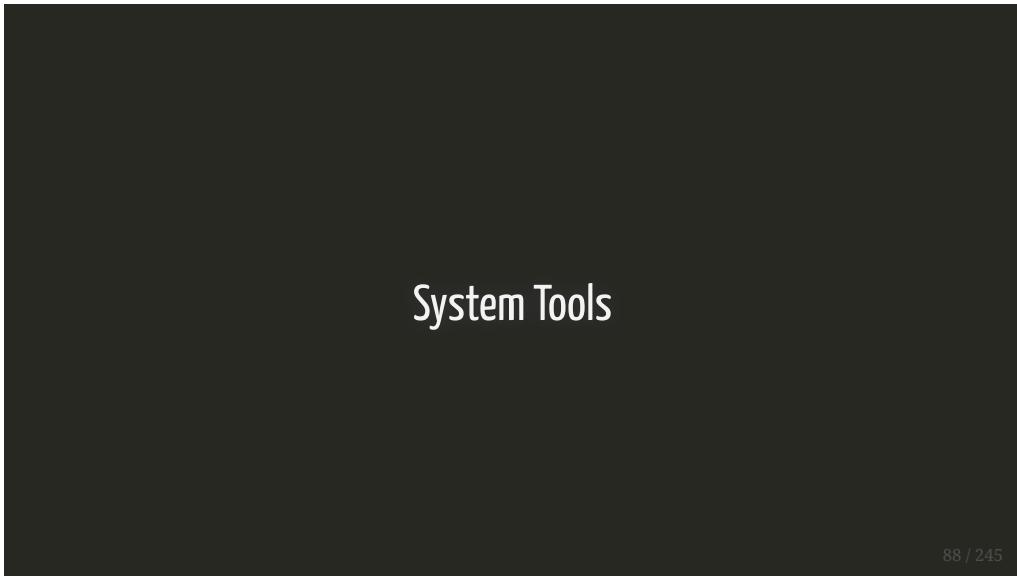
```
$ spring init -dweb,jpa,security --type gradle-project
```

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Initializing Projects

```
$ spring init -dweb,jpa,security  
$ spring init -dweb,jpa,security --type gradle-project  
$ spring init -dweb,jpa,security --type gradle-project -p war
```

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System Tools

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<https://the.ex.a.website>

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exa

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exa --long

<http://tweezer.local:8080/bosatsu/slides/nfjsvvw/cli#1>

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Pictures — ~/D/Pictures — -fish — 80x24

nfjsvvw/cli

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```
exercise-4 — ~/s/t/exercise-4 — -fish — 104x7
brian@bug ~/s/t/exercise-4> exa --header --long --list-dirs model.h5 jsmodel /dev/{stdout,urandom}
Permissions Size User Date Modified Name
drwxr-xr-x  - brian 15 Aug 2019 jsmodel
.rw-r--r--  17M brian 15 Aug 2019 model.h5
lrwxr-xr-x   0 root 25 Oct 12:27 /dev/stdout -> fd/1
crw-rw-rw-  0,1 root 25 Oct 12:27 /dev/urandom
brian@bug ~/s/t/exercise-4>
```

<http://tweezer.local:8080/bosatsu/slides/nfjsvvw/cli#1>

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Files in MB/KB

```
brian@bug ~/D/Pictures> exa --header --long *.png
Permissions Size User Date Modified Name
.rw-r--r--@ 238k brian 31 Mar 2019 brian-bio.png
.rw-r--r--@ 923k brian 13 Feb 2018 brian-kauai.png
.rw-r--r--@ 794k brian 31 Mar 2019 brian_sletten.png
.rw-r--r--@ 775k brian 21 Feb 2019 bungee.png
.rw-r--r--@ 638k brian 14 Sep 2020 logo.png
.rw-r--r--@ 131k brian 1 Nov 2017 me.png
```

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<https://www.logicmonitor.com/blog/what-the-hell-is-a-kibibyte>

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Files in Mi/Ki

```
brian@bug ~/D/Pictures> exa --binary --header --long *.png
Permissions  Size User Date Modified Name
.rw-r--r--@ 232Ki brian 31 Mar 2019 brian-bio.png
.rw-r--r--@ 902Ki brian 13 Feb 2018 brian-kauai.png
.rw-r--r--@ 775Ki brian 31 Mar 2019 brian_sletten.png
.rw-r--r--@ 757Ki brian 21 Feb 2019 bungee.png
.rw-r--r--@ 623Ki brian 14 Sep 2020 logo.png
.rw-r--r--@ 128Ki brian 1 Nov 2017 me.png
```

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Files in Bytes

```
brian@bug ~/D/Pictures> exa --bytes --header --long *.png
Permissions  Size User Date Modified Name
.rw-r--r--@ 237,989 brian 31 Mar 2019 brian-bio.png
.rw-r--r--@ 923,340 brian 13 Feb 2018 brian-kauai.png
.rw-r--r--@ 793,890 brian 31 Mar 2019 brian_sletten.png
.rw-r--r--@ 774,949 brian 21 Feb 2019 bungee.png
.rw-r--r--@ 638,069 brian 14 Sep 2020 logo.png
.rw-r--r--@ 131,453 brian 1 Nov 2017 me.png
```

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Group Info

```
brian@bug ~/D/Pictures> exa --header --group --long *.png
Permissions Size User Group Date Modified Name
.rw-r--r--@ 238k brian staff 31 Mar 2019 brian-bio.png
.rw-r--r--@ 923k brian staff 13 Feb 2018 brian-kauai.png
.rw-r--r--@ 794k brian staff 31 Mar 2019 brian_sletten.png
.rw-r--r--@ 775k brian staff 21 Feb 2019 bungee.png
.rw-r--r--@ 638k brian staff 14 Sep 2020 logo.png
.rw-r--r--@ 131k brian staff 1 Nov 2017 me.png
```

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Timestamp Info

```
brian@bug ~/D/Pictures> exa -lh --accessed --modified
Permissions Size User Date Modified Date Accessed Name
.rw-r--r--@ 93k brian 29 Apr 2015 27 Sep 23:24 61731069.jpg
.rw-r--r--@ 126k brian 23 Mar 2016 27 Sep 23:24 61818104.jpg
.rw-r--r--@ 269k brian 24 Feb 2012 27 Sep 23:24 Ambfv9DCAAA1GcE.jpg
.rw-r--r--@ 35k brian 17 May 2014 27 Sep 23:24 Bn343cQIgAAf2TP.jpg
.rw-r--r--@ 48k brian 22 Mar 2018 27 Sep 23:24 BoringEnormous_2017-Sep-25.jpg
.rw-r--r--@ 20k brian 23 May 2014 27 Sep 23:24 BoWUwSCIAAvuL9.jpg
.rw-r--r--@ 238k brian 31 Mar 2019 27 Sep 23:24 brian-bio.png
.rw-r--r--@ 923k brian 13 Feb 2018 27 Sep 23:24 brian-kauai.png
.rw-r--r--@ 794k brian 31 Mar 2019 27 Sep 23:24 brian_sletten.png
.rw-r--r--@ 438k brian 20 Apr 2017 27 Sep 23:24 briansletten.jpg
.rw-r--r--@ 122k brian 18 Apr 2017 27 Sep 23:24 bsletten_2017-Apr-18-1.jpg
.rw-r--r--@ 171k brian 18 Apr 2017 27 Sep 23:24 bsletten_2017-Apr-18.jpg
.rw-r--r--@ 197k brian 19 Apr 2017 27 Sep 23:24 bsletten_2017-Apr-19-1.jpg
.rw-r--r--@ 278k brian 19 Apr 2017 27 Sep 23:24 bsletten_2017-Apr-19.jpg
.
.
.
```

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Formatting Timestamps

```
brian@bug ~/D/Pictures> exa -lh --accessed --modified --time-style=long-iso
Permissions Size User Date Modified Date Accessed Name
.rw-r--r--@ 93k brian 2015-04-29 09:40 2023-09-27 23:24 61731069.jpg
.rw-r--r--@ 126k brian 2016-03-23 13:04 2023-09-27 23:24 61818104.jpg
.rw-r--r--@ 269k brian 2012-02-24 10:35 2023-09-27 23:24 AmbFv9DCAAAlGcE.jpg
.rw-r--r--@ 35k brian 2014-05-17 16:14 2023-09-27 23:24 Bn343cQ1gAaf2TP.jpg
.rw-r--r--@ 48k brian 2018-03-22 15:18 2023-09-27 23:24 BoringEnormous_2017-Sep-25.jpg
.rw-r--r--@ 20k brian 2014-05-23 19:41 2023-09-27 23:24 BoWUnwSCIAuuvLg.jpg
.rw-r--r--@ 238k brian 2019-03-31 11:04 2023-09-27 23:24 brian.bio.png
.rw-r--r--@ 923k brian 2018-02-13 16:35 2023-09-27 23:24 brian-kauai.png
.rw-r--r--@ 794k brian 2019-03-31 11:06 2023-09-27 23:24 brian_sletten.png
.rw-r--r--@ 438k brian 2017-04-20 14:07 2023-09-27 23:24 briansletten.jpg
.rw-r--r--@ 122k brian 2017-04-18 21:11 2023-09-27 23:24 bsletten_2017-Apr-18-1.jpg
.rw-r--r--@ 171k brian 2017-04-18 21:11 2023-09-27 23:24 bsletten_2017-Apr-18.jpg
.rw-r--r--@ 197k brian 2017-04-19 15:58 2023-09-27 23:24 bsletten_2017-Apr-19-1.jpg
.rw-r--r--@ 278k brian 2017-04-19 15:58 2023-09-27 23:24 bsletten_2017-Apr-19.jpg
.
.
.
```

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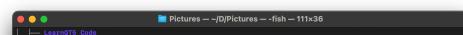
Grid View

```
brian@bug ~/D/Pictures [3]> exa --long --grid /bin
.rwxr-xr-x 134k root 20 Oct 00:35 [
.r-xr-xr-x 1.3M root 20 Oct 00:35 bash
.rwxr-xr-x 135k root 20 Oct 00:35 cat
.rwxr-xr-x 137k root 20 Oct 00:35 chmod
.rwxr-xr-x 153k root 20 Oct 00:35 cp
.rwxr-xr-x 1.2M root 20 Oct 00:35 csh
.rwxr-xr-x 307k root 20 Oct 00:35 dash
.rwxr-xr-x 168k root 20 Oct 00:35 date
.rwxr-xr-x 185k root 20 Oct 00:35 dd
.rwxr-xr-x 135k root 20 Oct 00:35 df
.rwxr-xr-x 134k root 20 Oct 00:35 echo
.rwxr-xr-x 235k root 20 Oct 00:35 ed
.rwxr-xr-x 135k root 20 Oct 00:35 expr
.rwxr-xr-x 134k root 20 Oct 00:35 hostname
.rwxr-xr-x 134k root 20 Oct 00:35 kill
.r-xr-xr-x 2.6M root 20 Oct 00:35 ksh
.rwxr-xr-x 394k root 20 Oct 00:35 launchctl
.rwxr-xr-x 135k root 20 Oct 00:35 link
.rwxr-xr-x 135k root 20 Oct 00:35 ln
.rwxr-xr-x 187k root 20 Oct 00:35 ls
.rwxr-xr-x 134k root 20 Oct 00:35 mkdir
.rwxr-xr-x 136k root 20 Oct 00:35 mv
.rwxr-xr-x 321k root 20 Oct 00:35 pax
.rwsf-xr-x 204k root 20 Oct 00:35 ps
.rwxr-xr-x 134k root 20 Oct 00:35 pwd
.rwxr-xr-x 134k root 20 Oct 00:35 realpath
.rwxr-xr-x 135k root 20 Oct 00:35 rm
.rwxr-xr-x 134k root 20 Oct 00:35 rmdir
.rwxr-xr-x 134k root 20 Oct 00:35 sh
.rwxr-xr-x 134k root 20 Oct 00:35 sleep
.rwxr-xr-x 168k root 20 Oct 00:35 stty
.rwxr-xr-x 134k root 20 Oct 00:35 sync
.rwxr-xr-x 1.2M root 20 Oct 00:35 tcsh
.rwxr-xr-x 134k root 20 Oct 00:35 test
.rwxr-xr-x 135k root 20 Oct 00:35 unlink
.rwxr-xr-x 134k root 20 Oct 00:35 wait4path
.rwxr-xr-x 1.4M root 20 Oct 00:35 zsh
```

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Tree View

```
brian@bug ~/D/Pictures> exa --tree --level=2 $HOME/Dropbox/Documents/Books/
```



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<https://github.com/sharkdp/bat>

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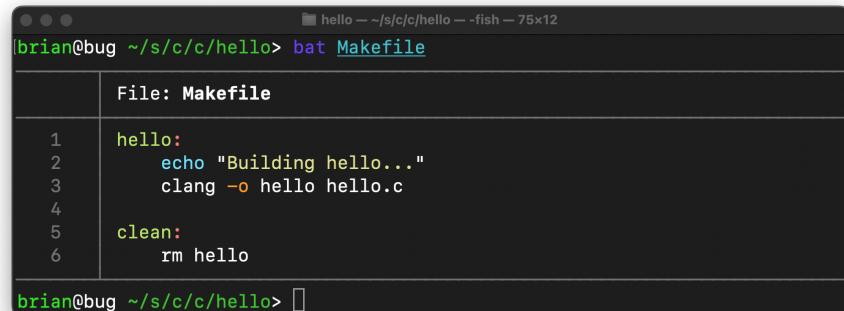


brian@bug ~\$ cat hello.c

	File: hello.c
1	#include <stdio.h>
2	int main() {
3	printf("hello, world!\n");
4	return 0;
5	}

brian@bug ~\$

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brian@bug ~\$ cat Makefile

	File: Makefile
1	hello:
2	echo "Building hello..."
3	clang -o hello hello.c
4	
5	clean:
6	rm hello

brian@bug ~\$

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<https://github.com/dalance/procs>

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<https://danielmiessler.com/p/find/>

106 / 245

<https://htop.dev/>

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<https://www.howtoforge.com/linux-lsof-command/>

108 / 245

<https://linuxize.com/post/how-to-use-linux-screen/>

109 / 245

<https://www.hamvoeke.com/blog/a-quick-and-easy-guide-to-tmux/>

110 / 245

<https://www.ssh.com/academy/ssh/command>

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<https://github.com/muesli/duf>

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<https://www.siliconbunny.com/fsn-the-irix-3d-file-system-tool-from-jurassic-park/>

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<https://github.com/dylanaraps/neofetch>

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<http://www.figlet.org>

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Render Text in Ascii Art

```
brian@bug ~/Desktop> figlet "CLI is for heroes"
```



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Figlet Options

```
brian@bug ~/src/classes/cli > tldr figlet
figlet
Generate ASCII banners from user input.
See also: showfigfonts.
More information: <http://www.figlet.org/figlet-man.html>.

- Generate by directly inputting text:
  figlet input_text

- Use a custom font file:
  figlet input_text -f path/to/font_file.flf

- Use a font from the default font directory (the extension can be omitted):
  figlet input_text -f font_filename

- Pipe command output through FIGlet:
  command | figlet

- Show available FIGlet fonts:
  showfigfonts optional_string_to_display
```

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```
[brian@bug ~/Desktop> echo -e "\033[32mhello\033[0m"
hello
brian@bug ~/Desktop> ]
```

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Using Ansi Escape Sequences Programmatically

```
from termcolor import colored
.

if status == DirResult.PUBLISHED:
    print(colored(f"{d} : +", "green"))
    print(f"    {get_author(os.path.join(db_dir, d, result[1]))}")
    if len(meaps) > 0:
        print(f"        MEAPS: {len(meaps)}")
elif status == DirResult.MEAP:
    age = calculate_age(os.path.join(db_dir, d, result[2][0]))
    print(colored(f"{d} : Latest MEAP: {result[2][0]} {age}", "yellow"))
    print(f"    {get_author(os.path.join(db_dir, d, result[2][0]))}")
elif status == DirResult.DUPLICATE_MEAPS:
    meap_to_keep, meaps_to_delete = evaluate_meaps(result[2])
    meaps = meaps_to_delete
    age = calculate_age(os.path.join(db_dir, d, meap_to_keep))
    print(colored(f"{d} : Latest MEAP: {meap_to_keep} {age}", "yellow"))
elif status == DirResult.PDF_PUBLISHED:
    print(colored(f"{d} : Latest PDF MEAP: {result[3]}", "magenta"))
elif status == DirResult.EMPTY:
    print(colored(f"{d} : EMPTY", "red"))
else:
    print(colored(f"{d} : UNKNOWN", "red"))
```

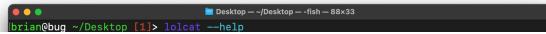
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```
Tiny C Projects : +
    Dan Gookin
Tiny Python Projects : +
    Ken Youens-Clark
Transfer Learning for Natural Language Processing : +
    Paul Azunre
Trust in Machine Learning : Latest MEAP: Trust_in_Machine_Learning_v6_MEAP.epub ****
    Kush R. Varshney
Unity in Action : +
    Joseph Hocking
Unity in Action, Second Edition : Latest PDF MEAP: ['Unity_in_Action,_Second_Edition.pdf']
Unsupervised Learning with Generative AI : Latest MEAP: Unsupervised_Learning_with_Generative_AI_v8_MEAP.epub
    Vaibhav Verdhan
Visualizing Graph Data : +
    Corey L. Lanum
WebAssembly in Action : +
    Gerard Gallant
```

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<https://github.com/busyloop/lolcat>

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```
brian@bbug ~/Desktop [1]> lolcat --help
```

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Networking Tools

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List all TCP connections with netstat

```
brian@bug ~/Desktop> netstat -a
Active Internet connections (including servers)
Proto Recv-Q Send-Q Local Address          Foreign Address        (state)
tcp4       0      0  192.168.4.87.55624    server-18-238-19.https ESTABLISHED
tcp4       0      0  192.168.4.87.55623    server-108-139-8.http ESTABLISHED
tcp4       0      0  192.168.4.87.55621    ec2-54-89-16-175.https ESTABLISHED
tcp4       0      0  192.168.4.87.55620    162.247.241.14.https ESTABLISHED
tcp4       0      0  192.168.4.87.55619    151.101.194.137.https ESTABLISHED
tcp4       0      0  192.168.4.87.55618    server-65-8-161-.https ESTABLISHED
tcp4       0      0  192.168.4.87.55617    server-13-227-74.https ESTABLISHED
tcp4       0      0  192.168.4.87.55616    server-65-8-161-.https ESTABLISHED
tcp4       0      0  192.168.4.87.55612    sfo03s24-in-f3.1.https ESTABLISHED
tcp4       0      0  192.168.4.87.55604    a23-39-0-228.dep.https ESTABLISHED
.
.
.
```

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List all UDP connections with netstat

```
brian@bug ~/Desktop > netstat -au
Active LOCAL (UNIX) domain sockets
Address      Type    Recv-Q Send-Q   Inode      Conn          Refs      Nextref Addr
15dfa24dce6695b1 stream    0    0      0 15dfa24dce6694e9      0          0
15dfa24dce6694e9 stream    0    0      0 15dfa24dce6695b1      0          0
15dfa24dce665669 stream    0    0      0 15dfa24dce66df4f9      0          0
15dfa24dce66d4f9 stream    0    0      0 15dfa24dce665669      0          0
15dfa24dce668931 stream    0    0      0 15dfa24dce6686d9      0          0
15dfa24dce6686d9 stream    0    0      0 15dfa24dce668931      0          0
15dfa24dce669421 stream    0    0      0 15dfa24dce669359      0          0
15dfa24dce669359 stream    0    0      0 15dfa24dce669421      0          0
.
.
.
```

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List Active Listening Ports with netstat

```
brian@bug ~/Desktop> netstat -l
Active Internet connections
Proto Recv-Q Send-Q Local Address          Foreign Address        (state)
tcp4     0      0 192.168.4.87.55713    162.247.241.14.https ESTABLISHED
tcp4     0      0 192.168.4.87.55710    172.67.74.167.https ESTABLISHED
tcp6     0      0 bug.55696            tweezer.http-alt    ESTABLISHED
tcp6     0      0 bug.55695            tweezer.http-alt    ESTABLISHED
tcp6     0      0 bug.55694            tweezer.http-alt    ESTABLISHED
tcp6     0      0 bug.55693            tweezer.http-alt    ESTABLISHED
tcp4     0      0 192.168.4.87.55691    172.64.103.11.https ESTABLISHED
tcp4     0      0 192.168.4.87.55689    104.17.24.14.https ESTABLISHED
tcp4     0      0 192.168.4.87.55688    104.21.62.48.https ESTABLISHED
tcp6     0      0 bug.55687            tweezer.http-alt    ESTABLISHED
tcp4     0      0 192.168.4.87.55681    172.64.102.11.https ESTABLISHED
tcp4     0      0 192.168.4.87.55675    104.17.24.14.https ESTABLISHED
tcp4     0      0 192.168.4.87.55674    104.21.62.48.https ESTABLISHED
.
.
.
```

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Show Protocol Statistics with netstat

```
brian@bug ~/Desktop> netstat -s
tcp:
  0 packet sent
    0 data packet (0 byte)
    0 data packet (0 byte) retransmitted
    0 resend initiated by MTU discovery
    0 ack-only packet (0 delayed)
    0 URG only packet
    0 window probe packet
    0 window update packet
    0 control packet
    0 data packet sent after flow control
    0 challenge ACK sent due to unexpected SYN
    0 challenge ACK sent due to unexpected RST
    0 checksummed in software
      0 segment (0 byte) over IPv4
      0 segment (0 byte) over IPv6
.
.
```

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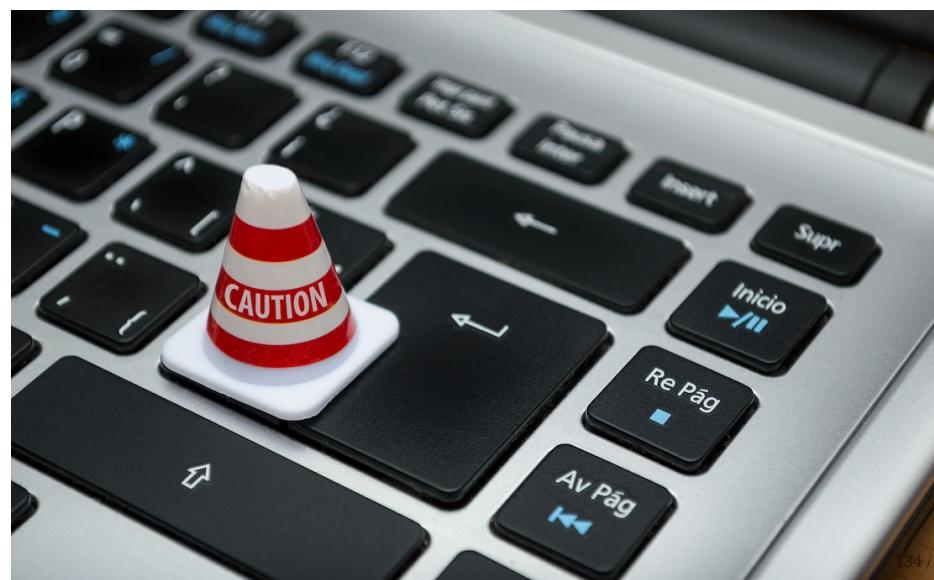
Show Statistics Based on Interface with netstat

Name	Mtu	Network Address	Ipkts	Ierrs	Opkts	Oerrs	Coll
lo0	16384	<Link#1>	897027	0	897027	0	0
lo0	16384	127 localhost	897027	-	897027	-	-
lo0	16384	localhost ::1	897027	-	897027	-	-
lo0	16384	bug.local fe80:1::1	897027	-	897027	-	-
gif0*	1280	<Link#2>	0	0	0	0	0
stf0*	1280	<Link#3>	0	0	0	0	0
en6	1500	<Link#8> 8a:71:47:ad:06:82	0	0	0	0	0
en7	1500	<Link#9> 8a:71:47:ad:06:83	0	0	0	0	0
en8	1500	<Link#10> 8a:71:47:ad:06:84	0	0	0	0	0
en9	1500	<Link#11> 8a:71:47:ad:06:85	0	0	0	0	0
en2	1500	<Link#12> 36:f1:11:3e:1d:49	0	0	0	0	0
en3	1500	<Link#13> 36:f1:11:3e:1d:44	0	0	0	0	0
en4	1500	<Link#14> 36:f1:11:3e:1d:48	0	0	0	0	0
en5	1500	<Link#15> 36:f1:11:3e:1d:4c	0	0	0	0	0
en10	1500	<Link#16> ee:e6:33:99:9b:0d	1193383	0	931268	328	0
en10	1500	bug.local fe80:10::ec6:33f	1193383	-	931268	-	-
en11	1500	<Link#17> 76:33:50:3e:4a:4f	1195106	0	996315	284	0
en11	1500	bug.local fe80:11::7433:50f	1195106	-	996315	-	-
.							
.							
.							

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<https://nc110.sourceforge.io/>

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Port Scanning with nc

```
brian@bug /v/logs> nc -v -w2 -z tweezer.local 20-25
nc: connectx to tweezer.local port 20 (tcp) failed: Connection refused
nc: connectx to tweezer.local port 20 (tcp) failed: Connection refused
nc: connectx to tweezer.local port 20 (tcp) failed: Connection refused
nc: connectx to tweezer.local port 21 (tcp) failed: Connection refused
nc: connectx to tweezer.local port 21 (tcp) failed: Connection refused
nc: connectx to tweezer.local port 21 (tcp) failed: Connection refused
Connection to tweezer.local port 22 [tcp/ssh] succeeded!
nc: connectx to tweezer.local port 23 (tcp) failed: Connection refused
nc: connectx to tweezer.local port 23 (tcp) failed: Connection refused
nc: connectx to tweezer.local port 23 (tcp) failed: Connection refused
nc: connectx to tweezer.local port 24 (tcp) failed: Connection refused
nc: connectx to tweezer.local port 24 (tcp) failed: Connection refused
nc: connectx to tweezer.local port 24 (tcp) failed: Connection refused
nc: connectx to tweezer.local port 25 (tcp) failed: Connection refused
nc: connectx to tweezer.local port 25 (tcp) failed: Connection refused
nc: connectx to tweezer.local port 25 (tcp) failed: Connection refused
```

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What's Running on a Port?

```
brian@bug /v/logs [SIGINT]> nc -v -n 192.168.4.157 22
Connection to 192.168.4.157 port 22 [tcp/*] succeeded!
SSH-2.0-OpenSSH_9.4
```

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Copying Files with nc

```
# Receiving host  
brian@tweezer ~/s/c/c/net > nc -l 12345 > file.out
```

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Copying Files with nc

```
# Receiving host  
brian@tweezer ~/s/c/c/net > nc -l 12345 > file.out
```

```
# Sending host  
brian@bug ~/s/c/c/net> nc tweezer.local 12345 < echo_server.ts
```

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Copying Files with nc

```
# Receiving host
brian@tweezer ~/s/c/c/net > nc -l 12345 > file.out

# Sending host
brian@bug ~/s/c/c/net> nc tweezer.local 12345 < echo_server.ts

# Receiving host
brian@tweezer ~/s/c/c/net> cat file.out
/** 
 * echo_server.ts
 */
const listener = Deno.listen({ port: 8080 });
console.log("listening on 0.0.0.0:8080");
for await (const conn of listener) {
    conn.readable.pipeTo(conn.writable);
}
```

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Deno TCP echo Server

```
/** 
 * echo_server.ts
 */
const listener = Deno.listen({ port: 8080 });
console.log("listening on 0.0.0.0:8080");
for await (const conn of listener) {
    conn.readable.pipeTo(conn.writable);
}
```

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Deno TCP echo Server

```
/**  
 * echo_server.ts  
 */  
const listener = Deno.listen({ port: 8080 });  
console.log("listening on 0.0.0.0:8080");  
for await (const conn of listener) {  
    conn.readable.pipeTo(conn.writable);  
}  
  
brian@bug ~/s/c/c/net> sed s/8080/9000/ < echo_server.ts > echo_server2.ts  
brian@bug ~/s/c/c/net> deno run --allow-net echo_server2.ts
```

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Deno TCP echo Server

```
/**  
 * echo_server.ts  
 */  
const listener = Deno.listen({ port: 8080 });  
console.log("listening on 0.0.0.0:8080");  
for await (const conn of listener) {  
    conn.readable.pipeTo(conn.writable);  
}  
  
brian@bug ~/s/c/c/net> sed s/8080/9000/ < echo_server.ts > echo_server2.ts  
brian@bug ~/s/c/c/net> deno run --allow-net echo_server2.ts  
  
# From another window  
brian@bug ~> nc localhost 9000  
Hello.  
Hello.
```

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Issue HTTP Requests via nc

```
brian@bug ~/s/c/c/net> printf "HEAD / HTTP/1.1\r\nUser-Agent: curl/7.74.0\r\n\r\n" | nc neverssl.com 80
HTTP/1.1 200 OK
Date: Mon, 30 Oct 2023 22:12:25 GMT
Server: Apache/2.4.57 ()
Upgrade: h2,h2c
Connection: Upgrade
Last-Modified: Wed, 29 Jun 2022 00:23:33 GMT
ETag: "f79-5e28b29d38e93"
Accept-Ranges: bytes
Content-Length: 3961
Vary: Accept-Encoding
Content-Type: text/html; charset=UTF-8
```

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Issue HTTP Requests via nc

```
brian@bug ~/s/c/c/net> printf "HEAD / HTTP/1.1\r\nUser-Agent: curl/7.74.0\r\n\r\n" | nc neverssl.com 80
HTTP/1.1 200 OK
Date: Mon, 30 Oct 2023 22:12:25 GMT
Server: Apache/2.4.57 ()
Upgrade: h2,h2c
Connection: Upgrade
Last-Modified: Wed, 29 Jun 2022 00:23:33 GMT
ETag: "f79-5e28b29d38e93"
Accept-Ranges: bytes
Content-Length: 3961
Vary: Accept-Encoding
Content-Type: text/html; charset=UTF-8
```

```
brian@bug ~/s/c/c/net> printf "OPTIONS / HTTP/1.1\r\nUser-Agent: curl/7.74.0\r\n\r\n" | nc neverssl.com 80
HTTP/1.1 200 OK
Date: Mon, 30 Oct 2023 22:12:44 GMT
Server: Apache/2.4.57 ()
Upgrade: h2,h2c
Connection: Upgrade
Allow: POST,OPTIONS,HEAD,GET,TRACE
Content-Length: 0
Content-Type: text/html; charset=UTF-8
```

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<https://nmap.org/>

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Berkeley Packet Filter (BPF) Syntax

Primitive	Description	Examples
type	What kind of thing is being identified	<i>host, net, port, portrange</i>
dir	The direction of traffic	<i>src, dst</i>
proto	Which protocols are under consideration	<i>ether, ip, ip6, arp, tcp, udp</i>

Basic BPF Examples

```
# Matches if either src or destination of a packet is from the hostname or address
host <hostname or address>
```

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Basic BPF Examples

```
# Matches if either src or destination of a packet is from the hostname or address
host <hostname or address>
```

```
# Matches if the destination of a packet is the hostname or address
dst host <hostname or address>
```

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Basic BPF Examples

```
# Matches if either src or destination of a packet is from the hostname or address  
host <hostname or address>
```

```
# Matches if the destination of a packet is the hostname or address  
dst host <hostname or address>
```

```
# Matches if the source of a packet is the hostname or address  
src host <hostname or address>
```

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Basic BPF Examples

```
# Matches if either src or destination of a packet is from the hostname or address  
host <hostname or address>
```

```
# Matches if the destination of a packet is the hostname or address  
dst host <hostname or address>
```

```
# Matches if the source of a packet is the hostname or address  
src host <hostname or address>
```

```
# Matches if the src or destination of a packet is the specified network  
net 128.3
```

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Basic BPF Examples

```
# Matches if either src or destination of a packet is from the hostname or address  
host <hostname or address>
```

```
# Matches if the destination of a packet is the hostname or address  
dst host <hostname or address>
```

```
# Matches if the source of a packet is the hostname or address  
src host <hostname or address>
```

```
# Matches if the src or destination of a packet is the specified network  
net 128.3
```

```
# Matches if the src or destination port of the packet is 22  
port 22
```

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Basic BPF Examples

```
# Matches if either src or destination of a packet is from the hostname or address  
host <hostname or address>
```

```
# Matches if the destination of a packet is the hostname or address  
dst host <hostname or address>
```

```
# Matches if the source of a packet is the hostname or address  
src host <hostname or address>
```

```
# Matches if the src or destination of a packet is the specified network  
net 128.3
```

```
# Matches if the src or destination port of the packet is 22  
port 22
```

```
# Matches if the src or destination port is in the range specified  
portrange 5000-5100
```

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BPF Protocol Qualifiers

```
# Matches if the protocol is TCP and the port of the source or destination of the packet is 21
tcp port 21
```

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BPF Protocol Qualifiers

```
# Matches if the protocol is TCP and the port of the source or destination of the packet is 21
tcp port 21
```

```
# Matches if the protocol is udp and the source or destination port is in the specified range
udp portrange 5000-5100
```

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BPF Boolean Operators

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BPF Boolean Operators

```
# Actually implies src or dst host 192.168.1.1  
host 192.168.1.1
```

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BPF Boolean Operators

```
# Actually implies src or dst host 192.168.1.1  
host 192.168.1.1
```

```
# Actually implies ether proto ip and host 192.168.1.1  
ip host 192.168.1.1
```

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BPF Boolean Operators

```
# Actually implies src or dst host 192.168.1.1  
host 192.168.1.1
```

```
# Actually implies ether proto ip and host 192.168.1.1  
ip host 192.168.1.1
```

```
# Matches any traffic not to port 80  
!port 80
```

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BPF Boolean Operators

```
# Actually implies src or dst host 192.168.1.1  
host 192.168.1.1  
  
# Actually implies ether proto ip and host 192.168.1.1  
ip host 192.168.1.1  
  
# Matches any traffic not to port 80  
!port 80  
  
# Ignore IPv6 traffic  
!ip6
```

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BPF Boolean Operators

```
# Actually implies src or dst host 192.168.1.1  
host 192.168.1.1  
  
# Actually implies ether proto ip and host 192.168.1.1  
ip host 192.168.1.1  
  
# Matches any traffic not to port 80  
!port 80  
  
# Ignore IPv6 traffic  
!ip6  
  
# Matches broadcast or multicast traffic  
broadcast or multicast
```

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Exercise

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Come up with BPF expressions for the following

- Capturing all packets to/from 10.0.0.1
- Capturing all packets to/from www.neverssl.com
- Capturing all packets to 10.0.0.1
- Capturing all packets from 10.0.0.1
- Capturing all packets to/from network 192.168.1.0/24
- Capturing all non-broadcast traffic
- Capturing all non-broadcast and all non-multicast traffic
- Capturing all traffic to/from IPv6 host 2001::1

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Solutions

- Capturing all packets to/from 10.0.0.1
 - host 10.0.0.1
- Capturing all packets to/from www.neverssl.com
 - host www.neverssl.com
- Capturing all packets to 10.0.0.1
 - dst host 10.0.0.1
- Capturing all packets from 10.0.0.1
 - src host 10.0.0.1
- Capturing all packets to/from network 192.168.1.0/24
 - net 192.168.1.0
 - net 192.168.1.0 mask 255.255.255.0
 - net 192.168.1.0/24
- Capturing all non-broadcast traffic
 - not broadcast
- Capturing all non-broadcast and all non-multicast traffic
 - not broadcast or not multicast
- Capturing all traffic to/from IPv6 host 2001::1
 - host 2001::1

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Command Line Interface

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Command Line Interface

- tcpdump <https://www.tcpdump.org>

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Command Line Interface

- tcpdump <https://www.tcpdump.org>
 - Linux (Ubuntu): sudo apt update && sudo apt install tcpdump

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Command Line Interface

- tcpdump <https://www.tcpdump.org>
 - Linux (Ubuntu): sudo apt update && sudo apt install tcpdump
 - macOS: brew install tcpdump

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Command Line Interface

- tcpdump <https://www.tcpdump.org>
 - Linux (Ubuntu): sudo apt update && sudo apt install tcpdump
 - macOS: brew install tcpdump
 - Windows: <https://www.winpcap.org/windump>

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Command Line Interface

- tcpdump <https://www.tcpdump.org>
 - Linux (Ubuntu): sudo apt update && sudo apt install tcpdump
 - macOS: brew install tcpdump
 - Windows: <https://www.winpcap.org/windump>
- Tshark

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<https://wizardzines.com/zines/tcpdump/>

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Basic tcpdump Usage

```
~> tcpdump
tcpdump: ioctl(SIOCIFCREATE): Operation not permitted
```

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Basic tcpdump Usage

```
~> sudo tcpdump
Password:
tcpdump: data link type PKTAP
tcpdump: verbose output suppressed, use -v or -vv for full protocol decode
listening on pktap, link-type PKTAP (Apple DLT_PKTAP), capture size 262144 bytes
14:36:42.236218 IP 192.168.1.168.2480 > 192.168.1.195.5376: Flags [.], ack 3889907999, win 8186
14:36:42.236404 IP 192.168.1.168.2480 > 192.168.1.195.5376: Flags [.], ack 66, win 8178
14:36:42.237604 IP 192.168.1.195.5839 > router.asus.com.domain: 59099+ PTR? 168.1.168.192.in-addr.arpa.
14:36:42.261187 IP router.asus.com.domain > 192.168.1.195.5839: 59099 NXDomain 0/0/0 (44)
14:36:42.262544 IP 192.168.1.195.61320 > router.asus.com.domain: 48202+ PTR? 195.1.16.19.in-addr.arpa. (
```

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Specifying Interface

```
# Matches any interface traffic  
~> tcpdump -i any
```

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Specifying Interface

```
# Matches any interface traffic  
~> tcpdump -i any
```

```
# Matches a named interface (use ifconfig or ipconfig)  
~> tcpdump -i eth0
```

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Specifying Interface

```
# Matches any interface traffic  
~> tcpdump -i any  
  
# Matches a named interface (use ifconfig or ipconfig)  
~> tcpdump -i eth0  
  
# MacOS Loopback, lo on Linux  
~> tcpdump -i lo0
```

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Controlling the Level of Detail

```
# Slightly more detail  
~> tcpdump -i lo0 -v
```

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Controlling the Level of Detail

```
# Slightly more detail  
~> tcpdump -i lo0 -v
```

```
# Even more detail  
~> tcpdump -i lo0 -vv
```

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Controlling the Level of Detail

```
# Slightly more detail  
~> tcpdump -i lo0 -v
```

```
# Even more detail  
~> tcpdump -i lo0 -vv
```

```
# Still yet more detail  
~> tcpdump -i lo0 -vvv
```

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Controlling the Level of Detail

```
# Slightly more detail  
~> tcpdump -i lo0 -v  
  
# Even more detail  
~> tcpdump -i lo0 -vv  
  
# Still yet more detail  
~> tcpdump -i lo0 -vvv  
  
# Print each packet in ASCII  
~> tcpdump -i en0 -A
```

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Controlling the Level of Detail

```
# Slightly more detail  
~> tcpdump -i lo0 -v  
  
# Even more detail  
~> tcpdump -i lo0 -vv  
  
# Still yet more detail  
~> tcpdump -i lo0 -vvv  
  
# Print each packet in ASCII  
~> tcpdump -i en0 -A  
  
# Print each packet in HEX and ASCII  
~> tcpdump -i en0 -X
```

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Controlling the Level of Detail

```
# Slightly more detail  
~> tcpdump -i lo0 -v  
  
# Even more detail  
~> tcpdump -i lo0 -vv  
  
# Still yet more detail  
~> tcpdump -i lo0 -vvv  
  
# Print each packet in ASCII  
~> tcpdump -i en0 -A  
  
# Print each packet in HEX and ASCII  
~> tcpdump -i en0 -X  
  
# Print each packet in HEX and ASCII and link level header  
~> tcpdump -i en0 -XX
```

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Controlling Name Resolution with tcpdump

```
# Don't resolve hostnames  
~> tcpdump -i en0 -n
```

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Controlling Name Resolution with tcpdump

```
# Don't resolve hostnames  
~> tcpdump -i en0 -n
```

```
# Don't resolve hostnames or ports  
~> tcpdump -i en0 -nn
```

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Writing and Reading PCAP Files

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Writing and Reading PCAP Files

```
# Write the file out  
~> tcpdump -i any -w packets.pcap
```

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Writing and Reading PCAP Files

```
# Write the file out  
~> tcpdump -i any -w packets.pcap
```

```
# Write the first 1000 packets out to the specified file  
~> tcpdump -i any -w packets.pcap -c 1000
```

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Writing and Reading PCAP Files

```
# Write the file out  
~> tcpdump -i any -w packets.pcap  
  
# Write the first 1000 packets out to the specified file  
~> tcpdump -i any -w packets.pcap -c 1000  
  
# Read the file back in  
~> tcpdump -i any -r packets.pcap
```

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Writing and Reading PCAP Files

```
# Write the file out  
~> tcpdump -i any -w packets.pcap  
  
# Write the first 1000 packets out to the specified file  
~> tcpdump -i any -w packets.pcap -c 1000  
  
# Read the file back in  
~> tcpdump -i any -r packets.pcap  
  
# Read the file back in but only show the first 20 packets  
~> tcpdump -i any -r packets.pcap -c 20
```

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Basic Tshark Usage

```
~> tshark
Capturing on 'Wi-Fi: en0'
1  0.000000 192.168.1.195 -> 17.142.171.6 TLSv1.2 85 Encrypted Alert
2  0.001457 192.168.1.195 -> 17.142.171.6 TCP 54 62681 -> 443 [FIN, ACK] Seq=32 Ack=1 Win=4096 Len=0
3  0.044578 17.142.171.6 -> 192.168.1.195 TCP 60 443 -> 62681 [ACK] Seq=1 Ack=32 Win=319 Len=0
4  0.045416 17.142.171.6 -> 192.168.1.195 TCP 60 443 -> 62681 [FIN, ACK] Seq=1 Ack=33 Win=319 Len=0
5  0.045618 192.168.1.195 -> 17.142.171.6 TCP 54 62681 -> 443 [ACK] Seq=33 Ack=2 Win=4096 Len=0
6  0.469367 192.168.1.195 -> 224.0.0.251 IGMPv2 46 Membership Report group 224.0.0.251
7  0.490891 192.168.1.195 -> 17.248.128.177 TLSv1.2 97 Encrypted Alert
8  0.491717 192.168.1.195 -> 17.248.128.177 TCP 66 62613 -> 443 [FIN, ACK] Seq=32 Ack=1 Win=2048 Len=0
9  0.512639 17.248.128.177 -> 192.168.1.195 TCP 66 443 -> 62613 [FIN, ACK] Seq=1 Ack=33 Win=1210 Len=0
10 0.512784 192.168.1.195 -> 17.248.128.177 TCP 66 62613 -> 443 [ACK] Seq=33 Ack=2 Win=2048 Len=0 TS=
```

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Querying Interfaces With Tshark

```
~> tshark -D
1. en0 (Wi-Fi)
2. p2p0
3. awdl0
4. llw0
5. utun0
6. utun1
7. utun2
8. utun3
9. utun4
10. utun5
11. lo0 (Loopback)
12. bridge0 (Thunderbolt Bridge)
13. en1 (Thunderbolt 1)
14. en2 (Thunderbolt 2)
...
```

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Querying Interfaces With Tshark

```
~> tshark -D
1. en0 (Wi-Fi)
2. p2p0
3. awdl0
4. llw0
5. utun0
6. utun1
7. utun2
8. utun3
9. utun4
10. utun5
11. lo0 (Loopback)
12. bridge0 (Thunderbolt Bridge)
13. en1 (Thunderbolt 1)
14. en2 (Thunderbolt 2)
...
```

```
# Using a particular interface
~> tshark -i 11
```

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Reading and Writing PCAP Files with Tshark

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Reading and Writing PCAP Files with Tshark

```
# Write out the capture file  
~> tshark -i 1 -w packets.pcap
```

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Reading and Writing PCAP Files with Tshark

```
# Write out the capture file  
~> tshark -i 1 -w packets.pcap
```

```
# Write the first 10 packets out to the capture file  
~> tshark -i 1 -w packets.pcap -c10
```

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Reading and Writing PCAP Files with Tshark

```
# Write out the capture file  
~> tshark -i 1 -w packets.pcap  
  
# Write the first 10 packets out to the capture file  
~> tshark -i 1 -w packets.pcap -c10  
  
# Read the capture file in  
~> tshark -i 1 -r packets.pcap
```

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Controlling the Level of Detail

```
# Write Out One Packet  
~> tshark -i 1 -V -c1 -w onepacket.pcap
```

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tcpdump Level of Detail

```
brian@light ~% /g/2/u/c/i/wireshark> tcpdump -vvv -r onepacket.pcap
reading from PCAP-NG file onepacket.pcap
19:25:04.228718 IP (tos 0x0, ttl 118, id 36284, offset 0, flags [none], proto TCP (6), length 99)
    74.125.109.109.imaps > 192.168.1.195.63085: Flags [P.], csum 0xcd3f (correct), seq 1653460757:1653460804
, ack 977572070, win 265, options [nop,nop,TS val 4029799827 ecr 1226481679], length 47
brian@light ~% /g/2/u/c/i/wireshark>
```

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Tshark Level of Detail

```
brian@light ~% /g/2/u/c/i/wireshark> tshark -i 1 -V -c1 -r onepacket.pcap
Frame 21: 110 bytes on wire (904 bits), 110 bytes captured (904 bits) on interface en0, id 0
    Interface Id: 0 (en0)
    Interface name: en0
    Description: Intel PRO/100 MT Desktop
    Encapsulation type: Ethernet (1)
    ...
```

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Controlling Name Resolution with Tshark

```
>> tshark -i 1 -c1 -r example.pcap
1  0.000000 54.85.240.191 > 192.168.1.195 TCP 66 443 > 63498 [FIN, ACK]
Seq=1 Ack=1 Win=14 Len=0 TSval=2155774261 TSecr=1227877454
```

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Controlling Name Resolution with Tshark

```
>> tshark -i 1 -c1 -r example.pcap
1  0.000000 54.85.240.191 > 192.168.1.195 TCP 66 443 > 63498 [FIN, ACK]
Seq=1 Ack=1 Win=14 Len=0 TSval=2155774261 TSecr=1227877454

>> tshark -i 1 -NNn -c1 -r example.pcap
1  0.000000 ec2-54-85-240-191.compute-1.amazonaws.com > 192.168.1.195 TCP 66 443 > 63498
[FIN, ACK] Seq=1 Ack=1 Win=14 Len=0 TSval=2155774261 TSecr=1227877454
```

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Controlling Name Resolution with Tshark

```

~> tshark -i 1 -c1 -r example.pcap
1 0.000000 54.85.240.191->192.168.1.195 TCP 66 443->63498 [FIN, ACK]
Seq=1 Ack=1 Win=14 Len=0 TSval=2155774261 TSecr=1227877454

~> tshark -i 1 -NNn -c1 -r example.pcap
1 0.000000 ec2-54-85-240-191.compute-1.amazonaws.com->192.168.1.195 TCP 66 443->63498
[FIN, ACK] Seq=1 Ack=1 Win=14 Len=0 TSval=2155774261 TSecr=1227877454

~> tshark -i 1 -NNnt -c1 -r example.pcap
1 0.000000 ec2-54-85-240-191.compute-1.amazonaws.com->192.168.1.195 TCP 66 https(443)
->63498 [FIN, ACK] Seq=1 Ack=1 Win=14 Len=0 TSval=2155774261 TSecr=1227877454

```

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Tshark -N Name Resolution Options

Option	Description
m	MAC address resolution
n	Network address resolution
t	Transport layer (port name) resolution
N	Use external resolvers
C	Concurrent DNS lookups

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Exercise

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Use Tshark to...

- Query the available interfaces on your computer
- Run briefly and capture all traffic to a particular interface specified by number
- Run briefly and capture all traffic to a particular interface specified by interface name
- Run for a while on the same interface but write the results to a capture file
- Run for a while but write no more than 1000 packets to a capture file
- Run for a while but write no more than 1000 packets to a capture file with hostname and protocol resolution
- Read the first two packets from the previous capture file and make sure name resolution worked

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Solutions

- Query the available interfaces on your computer
 - tshark -D
- Run briefly and capture all traffic to a particular interface specified by number
 - tshark -i 1 (for example)
- Run briefly and capture all traffic to a particular interface specified by interface name
 - tshark -i en0 (for example)
- Run for a while on the same interface but write the results to a capture file
 - tshark -i en0 -w example.pcap
- Run for a while on the same interface but write no more than 1000 packets to a capture file
 - tshark -i en0 -w example.pcap -c1000 (for example)
- Read the first two packets from the previous capture file and print them out verbosely
 - tshark -r example.pcap -V -c2
- Run for a while but write no more than 1000 packets to a capture file with hostname and protocol resolution
 - tshark -i en0 -NNnt -w example2.pcap -c1000
- Read the first two packets from the previous capture file and make sure name resolution worked
 - tshark -r example2.pcap -c2

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<https://github.com/imsnif/bandwhich>

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glances

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gping

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Basic dig

```
brian@bug ~/s/c/c/hello> dig bosatsu.net
; <>> DiG 9.10.6 <>> bosatsu.net
;; global options: +cmd
;; Got answer:
;; ->HEADER<<- opcode: QUERY, status: NOERROR, id: 49180
;; flags: qr rd ra; QUERY: 1, ANSWER: 1, AUTHORITY: 0, ADDITIONAL: 1
;; OPT PSEUDOSECTION:
;; EDNS: version: 0, flags:; udp: 1232
;; QUESTION SECTION:
;bosatsu.net.           IN      A
;; ANSWER SECTION:
bosatsu.net.      3599    IN      A      74.50.55.129
;; Query time: 676 msec
;; SERVER: 8.8.8.8#53(8.8.8.8)
;; WHEN: Tue Oct 31 05:32:12 PDT 2023
;; MSG SIZE rcvd: 56
```

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More dig examples

```
brian@bug ~/s/c/c/hello> dig bosatsu.net +short
74.50.55.129
```

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More dig examples

```
brian@bug ~/s/c/c/hello> dig bosatsu.net +short
74.50.55.129

brian@bug ~/s/c/c/hello> dig bosatsu.net +noall +answer
; <>> DiG 9.10.6 <>> bosatsu.net +noall +answer
;; global options: +cmd
bosatsu.net.      1895     IN      A      74.50.55.129
```

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Look Up Specific Records with dig

```
brian@bug ~/s/c/c/hello> dig bosatsu.net MX
; <>> DiG 9.10.6 <>> bosatsu.net MX
;; global options: +cmd
;; Got answer:
;; ->>HEADER<- opcode: QUERY, status: NOERROR, id: 63650
;; flags: qr rd ra; QUERY: 1, ANSWER: 2, AUTHORITY: 0, ADDITIONAL: 1
;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 1232
;; QUESTION SECTION:
;bosatsu.net.      IN      MX

;; ANSWER SECTION:
bosatsu.net.      3599     IN      MX      0 mail.bosatsu.org.
bosatsu.net.      3599     IN      MX      0 mail.bosatsu.net.

;; Query time: 443 msec
;; SERVER: 8.8.8.8#53(8.8.8.8)
;; WHEN: Tue Oct 31 06:02:09 PDT 2023
;; MSG SIZE rcvd: 93
```

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Specifying DNS Server with dig

```
brian@bug ~/s/c/c/hello> dig @1.1.1.1 bosatsu.net
; <>> DiG 9.10.6 <>> @1.1.1.1 bosatsu.net
; (1 server found)
; global options: +cmd
; Got answer:
; ->>HEADER<- opcode: QUERY, status: NOERROR, id: 33058
; flags: qr rd ra; QUERY: 1, ANSWER: 1, AUTHORITY: 0, ADDITIONAL: 1
;
; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 4096
; QUESTION SECTION:
;bosatsu.net.      IN      A
;
; ANSWER SECTION:
bosatsu.net.    1866    IN      A      74.50.55.129
;
; Query time: 9 msec
; SERVER: 1.1.1.1#53(1.1.1.1)
; WHEN: Tue Oct 31 06:01:06 PDT 2023
; MSG SIZE rcvd: 56
```

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Reverse Lookup with dig

```
brian@bug ~/s/c/c/hello> dig +answer -x 74.50.55.129
; <>> DiG 9.10.6 <>> +answer -x 74.50.55.129
; global options: +cmd
; Got answer:
; ->>HEADER<- opcode: QUERY, status: NOERROR, id: 58979
; flags: qr rd ra; QUERY: 1, ANSWER: 1, AUTHORITY: 0, ADDITIONAL: 1
;
; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 1232
; QUESTION SECTION:
;129.55.50.74.in-addr.arpa. IN      PTR
;
; ANSWER SECTION:
129.55.50.74.in-addr.arpa. 3599    IN      PTR      mail.bosatsu.net.
;
; Query time: 571 msec
; SERVER: 8.8.8.8#53(8.8.8.8)
; WHEN: Tue Oct 31 06:17:26 PDT 2023
; MSG SIZE rcvd: 84
```

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Reverse Lookup, Short Results

```
brian@bug ~/s/c/c/hello> dig +answer -x 74.50.55.129 +short  
mail.bosatsu.net.
```

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<https://dns.lookup.dog>

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<https://github.com/jarun/ddgr>

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Command Line Tools

- wget
- curl
- httpie
- aria2

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wget (<https://www.gnu.org/software/wget>)

- Released in 1995
- Robust over slow and flaky network connections
- Supported ftp and http
- Designed to be non-interactive
- Recursive download
- Download through proxies
- Uses persistent HTTP connections where possible

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Basic Usage

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Basic Usage

```
> wget http://example.com
```

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Basic Usage

```
> wget http://example.com
```

```
> wget -r http://example.com
```

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Basic Usage

```
> wget http://example.com  
> wget -r http://example.com  
> wget --post-data 'name=Brian' https://example.com/account
```

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Basic Usage

```
> wget http://example.com  
> wget -r http://example.com  
> wget --post-data 'name=Brian' https://example.com/account  
> wget --post-file params.txt https://example.com/account
```

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Basic Usage

```
> wget http://example.com  
> wget -r http://example.com  
> wget --post-data 'name=Brian' https://example.com/account  
> wget --post-file params.txt https://example.com/account  
> wget --header="Content-Type: text/json" --post-file=config.json https://example.com/account  
-O account.json
```

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curl (<https://curl.haxx.se>)

- Initially released in 1997 by Daniel Stenberg
- Multi-Protocol Support
- Widely Portable
- Support for HTTP/2 and HTTP/3

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Basic Usage

```
> curl https://w3id.org/people/bsletten
```

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Basic Usage

```
> curl https://w3id.org/people/bsletten
```

```
<!DOCTYPE HTML PUBLIC "-//IETF//DTD HTML 2.0//EN">
<html><head>
<title>303 See Other</title>
</head><body>
<h1>See Other</h1>
<p>The answer to your request is located <a href="http://bosatsu.net/foaf/brian.rdf">here</a>.</p>
<br>
<address>Apache/2.4.29 (Ubuntu) Server at w3id.org Port 443</address>
</body></html>
```

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Options

```
# Verbose Mode  
> curl -v https://w3id.org/people/bsletten
```

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Options

```
# Verbose Mode  
> curl -v https://w3id.org/people/bsletten
```

```
# Verbose Mode and Follow Redirects  
> curl -vL https://w3id.org/people/bsletten
```

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Options

```
# Verbose Mode  
> curl -v https://w3id.org/people/bsletten  
  
# Verbose Mode and Follow Redirects  
> curl -vL https://w3id.org/people/bsletten  
  
> curl -v -X POST --header "Content-Type: text/json"  
    --data-binary @config.json https://example.com/account
```

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Options

```
# Verbose Mode  
> curl -v https://w3id.org/people/bsletten  
  
# Verbose Mode and Follow Redirects  
> curl -vL https://w3id.org/people/bsletten  
  
> curl -v -X POST --header "Content-Type: text/json"  
    --data-binary @config.json https://example.com/account  
  
> export ACCESS_TOKEN=`curl http://localhost:9999/oauth/token \  
    -d"grant_type=password&username=habuma&password=password" \  
    -H"Content-type:application/x-www-form-urlencoded; charset=utf-8" \  
    -u myclient:secret --silent | jq -r ".access_token"'
```

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Verbose Redirected Output

```
# Verbose Mode and Follow Redirects
> curl -vL https://w3id.org/people/bsletten

Trying 162.209.11.63...
TCP_NODELAY set
Connected to w3id.org (162.209.11.63) port 443 (#0)
ALPN, offering h2
ALPN, offering http/1.1
successfully set certificate verify locations:
  CAfile: /etc/ssl/cert.pem
  CApth: none
TLSV1.2 (OUT), TLS handshake, Client hello (1):
TLSV1.2 (IN), TLS handshake, Server hello (2):
TLSV1.2 (IN), TLS handshake, Certificate (11):
TLSV1.2 (IN), TLS handshake, Server key exchange (12):
TLSV1.2 (IN), TLS handshake, Server finished (14):
TLSV1.2 (OUT), TLS handshake, Client key exchange (16):
TLSV1.2 (OUT), TLS change cipher, Change cipher spec (1):
TLSV1.2 (OUT), TLS handshake, Finished (20):
TLSV1.2 (IN), TLS change cipher, Change cipher spec (1):
TLSV1.2 (IN), TLS handshake, Finished (20):
SSL connection using TLSv1.2 / ECDHE-RSA-AES256-GCM-SHA384
```

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Verbose Redirected Output (cont)

```
ALPN, server accepted to use http/1.1
Server certificate:
subject: CN=w3id.org
start date: Oct 12 02:10:43 2020 GMT
expire date: Jan 10 02:10:43 2021 GMT
subjectAltName: host "w3id.org" matched cert's "w3id.org"
issuer: C=US; O=Let's Encrypt; CN=Let's Encrypt Authority X3
SSL certificate verify ok.
> GET /people/bsletten HTTP/1.1
> Host: w3id.org
> User-Agent: curl/7.64.1
> Accept: */*
>
< HTTP/1.1 303 See Other
< Date: Mon, 19 Oct 2020 21:15:32 GMT
< Server: Apache/2.4.29 (Ubuntu)
< Access-Control-Allow-Origin: *
< Location: http://bosatsu.net/foaf/brian.rdf
< Content-Length: 315
< Content-Type: text/html; charset=iso-8859-1
<
```

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Verbose Redirected Output (cont)

```

Ignoring the response-body
Connection #0 to host w3id.org left intact
Issue another request to this URL: 'http://bosatsu.net/foaf/brian.rdf'
  Trying 74.50.55.129...
TCP_NODELAY set
Connected to bosatsu.net (74.50.55.129) port 80 (#1)
> GET /foaf/brian.rdf HTTP/1.1
> Host: bosatsu.net
> User-Agent: curl/7.64.1
> Accept: */*
>
< HTTP/1.1 301 Moved Permanently
< Date: Mon, 19 Oct 2020 21:15:32 GMT
< Server: Apache/2.4.38 (Debian)
< Location: https://bosatsu.net/foaf/brian.rdf
< Content-Length: 319
< Content-Type: text/html; charset=iso-8859-1
<

```

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Verbose and Redirected Output (cont)

```

Ignoring the response-body
Connection #1 to host bosatsu.net left intact
Issue another request to this URL: 'https://bosatsu.net/foaf/brian.rdf'
  Trying 74.50.55.129...
TCP_NODELAY set
Connected to bosatsu.net (74.50.55.129) port 443 (#2)
ALPN, offering h2
ALPN, offering http/1.1
successfully set certificate verify locations:
  CAfile: /etc/ssl/cert.pem
  CPath: none
TLSv1.2 (OUT), TLS handshake, Client hello (1):
TLSv1.2 (IN), TLS handshake, Server hello (2):
TLSv1.2 (IN), TLS handshake, Certificate (11):
TLSv1.2 (IN), TLS handshake, Server key exchange (12):
TLSv1.2 (IN), TLS handshake, Server finished (14):
TLSv1.2 (OUT), TLS handshake, Client key exchange (16):
TLSv1.2 (OUT), TLS change cipher, Change cipher spec (1):
TLSv1.2 (OUT), TLS handshake, Finished (20):
TLSv1.2 (IN), TLS change cipher, Change cipher spec (1):
TLSv1.2 (IN), TLS handshake, Finished (20):
SSL connection using TLSv1.2 / ECDHE-RSA-CHACHA20-POLY1305

```

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Verbose and Redirected Output (cont)

```
> ...
> GET /foaf/brian.rdf HTTP/1.1
> Host: bosatsu.net
> User-Agent: curl/7.64.1
> Accept: */*
>
< HTTP/1.1 200 OK
< Date: Mon, 19 Oct 2020 21:15:32 GMT
< Server: Apache/2.4.38 (Debian)
< Last-Modified: Tue, 15 Sep 2020 00:17:12 GMT
< ETag: "1f2b-5af4f128c1200"
< Accept-Ranges: bytes
< Content-Length: 7979
< Access-Control-Allow-Origin: *
< Content-Type: application/rdf+xml
<

... RDF Output

Connection #2 to host bosatsu.net left intact
Closing connection 0
Closing connection 1
Closing connection 2
```

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httpie (<https://httpie.org>)

- Extremely simple usage
- Built-in support for JSON
- Reasonable defaults
- Colorized terminal output
- Extensions API

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Basic Usage

```
> http https://example.com/account
```

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Basic Usage

```
> http https://example.com/account
```

```
> http PUT httpbin.org/put X-API-Token:123 name=John
```

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Basic Usage

```
> http https://example.com/account  
> http PUT httpbin.org/put X-API-Token:123 name=John  
> http -f POST httpbin.org/post hello=World
```

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Basic Usage

```
> http https://example.com/account  
> http PUT httpbin.org/put X-API-Token:123 name=John  
> http -f POST httpbin.org/post hello=World  
> http --offline httpbin.org/post hello=offline
```

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Basic Usage

```
> http https://example.com/account  
> http PUT httpbin.org/put X-API-Token:123 name=John  
> http -f POST httpbin.org/post hello=World  
> http --offline httpbin.org/post hello=offline  
> http httpbin.org/post < files/data.json
```

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Basic Usage

```
> http https://example.com/account  
> http PUT httpbin.org/put X-API-Token:123 name=John  
> http -f POST httpbin.org/post hello=World  
> http --offline httpbin.org/post hello=offline  
> http httpbin.org/post < files/data.json  
> http --session=logged-in -a username:password httpbin.org/get API-Key:123
```

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Basic Usage

```
> http https://example.com/account  
> http PUT httpbin.org/put X-API-Token:123 name=John  
> http -f POST httpbin.org/post hello=World  
> http --offline httpbin.org/post hello=offline  
> http httpbin.org/post < files/data.json  
> http --session=logged-in -a username:password httpbin.org/get API-Key:123  
> http --session=logged-in httpbin.org/headers
```

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aria2 (<https://aria2.github.io>)

- Multi-Connection download
- Lightweight
- Multi-Protocol
- Metalink Enabled
- Remote Control

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Basic Usage

```
# Download a file
> aria2c ftp://ftp1.freebsd.org/pub/FreeBSD/releases/ISO-IMAGES/12.2/FreeBSD-12.2-RC1-i386-disc1.iso
10/19 13:35:04 [NOTICE] Downloading 1 item(s)
[#715dcc 0B/0B CN:1 DL:0B]

10/19 13:35:05 [NOTICE] Allocating disk space. Use --file-allocation=none to disable it.
See --file-allocation option in man page for more details.
[#715dcc 2.9MiB/761MiB(0%) CN:1 DL:384KiB ETA:33m42s]
```

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Basic Usage

```
# Download a file
> aria2c ftp://ftp1.freebsd.org/pub/FreeBSD/releases/ISO-IMAGES/12.2/FreeBSD-12.2-RC1-i386-disc1.iso
10/19 13:35:04 [NOTICE] Downloading 1 item(s)
[#715dcc 0B/0B CN:1 DL:0B]

10/19 13:35:05 [NOTICE] Allocating disk space. Use --file-allocation=none to disable it.
See --file-allocation option in man page for more details.
[#715dcc 2.9MiB/761MiB(0%) CN:1 DL:384KiB ETA:33m42s]
```

```
# Download multiple files
> aria2c http://a/f.iso ftp://b/f.iso
```

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Download Using 2 connections per host

```
> aria2c -x2 ://ftp1.freebsd.org/pub/FreeBSD/releases/ISO-IMAGES/12.2/FreeBSD-12.2-RC1-i386-disc1.iso  
10/19 13:39:18 [NOTICE] Downloading 1 item(s)  
10/19 13:39:19 [NOTICE] Allocating disk space.  
Use --file-allocation=none to disable it. See --file-allocation option in man page for more details.  
[#e91a21 159MiB/761MiB(20%) CN:2 DL:8.9MiB ETA:1m7s]
```

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Download the URIs in a File

```
> aria2c -i uris.txt
```

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BitTorrent

```
> aria2c http://etree.org/download.php/610561/ph1998-07-01.honecker.ecm155.flac16.torrent
10/19 13:43:42 [NOTICE] Downloading 1 item(s)
10/19 13:43:42 [NOTICE] Download complete: /Users/brian/dl/ph1998-07-01.honecker.ecm155.flac16.torrent
10/19 13:43:42 [NOTICE] IPv4 DHT: listening on UDP port 6982
10/19 13:43:42 [NOTICE] Allocating disk space. Use --file-allocation=none to disable it.
See --file-allocation option in man page for more details.
[#b19660 0B/877MiB(0%) CN:0 SD:0 DL:0B] [FileAlloc:#b19660 29MiB/39MiB(74%)]
10/19 13:43:43 [NOTICE] IPv4 BitTorrent: listening on TCP port 6943
10/19 13:43:43 [NOTICE] IPV6 BitTorrent: listening on TCP port 6943
[#b19660 24MiB/877MiB(2%) CN:5 SD:2 DL:0.9MiB ETA:15m38s]
```

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BitTorrent

```
> aria2c http://etree.org/download.php/610561/ph1998-07-01.honecker.ecm155.flac16.torrent
10/19 13:43:42 [NOTICE] Downloading 1 item(s)
10/19 13:43:42 [NOTICE] Download complete: /Users/brian/dl/ph1998-07-01.honecker.ecm155.flac16.torrent
10/19 13:43:42 [NOTICE] IPv4 DHT: listening on UDP port 6982
10/19 13:43:42 [NOTICE] Allocating disk space. Use --file-allocation=none to disable it.
See --file-allocation option in man page for more details.
[#b19660 0B/877MiB(0%) CN:0 SD:0 DL:0B] [FileAlloc:#b19660 29MiB/39MiB(74%)]
10/19 13:43:43 [NOTICE] IPv4 BitTorrent: listening on TCP port 6943
10/19 13:43:43 [NOTICE] IPV6 BitTorrent: listening on TCP port 6943
[#b19660 24MiB/877MiB(2%) CN:5 SD:2 DL:0.9MiB ETA:15m38s]

# BitTorrent Magnet File
> aria2c 'magnet:?xt=urn:btih:248D0A1CD08284299DE78D5C1ED359BB46717D8C'
```

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Metalink

<https://tools.ietf.org/html/rfc5854>

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Metalink

<https://tools.ietf.org/html/rfc5854>

```
> aria2c http://example.org/mylinux.metalink
```

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<https://wttr.in>

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Fetching the Weather

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<https://jqlang.github.io/jq/>

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Future Fun

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<https://www.jqkungfu.com/>

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<https://tbfleming.github.io/cib/#gist=e4c2cc66a6606aa92ff>

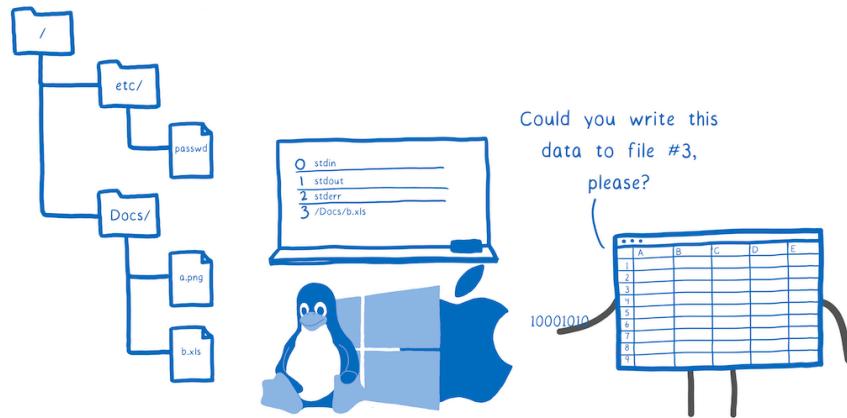
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<https://wasi.dev>

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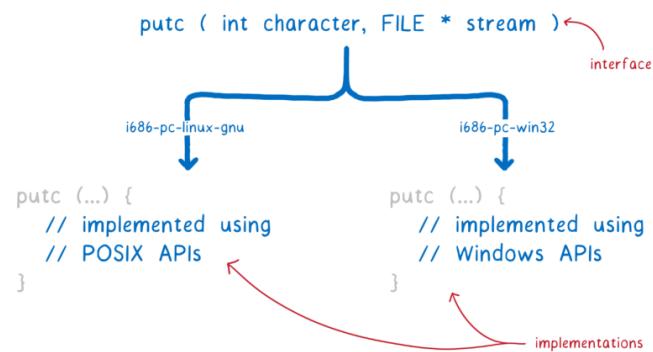
<https://hacks.mozilla.org/2019/03/standardizing-wasi-a-webassembly-system-interface-applications>

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<https://hacks.mozilla.org/2019/03/standardizing-wasi-a-webassembly-system-interface>

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<https://hacks.mozilla.org/2019/03/standardizing-wasi-a-webassembly-system-interface>

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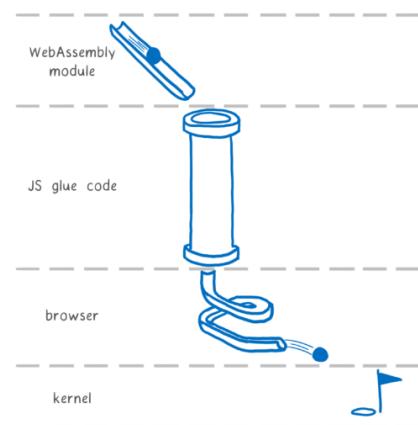
```
putc ( int character, FILE * stream )
```

```
putc (...) {  
    ?  
}
```

If you don't know what system
you're targeting, how do you know
which system interface to use?

<https://hacks.mozilla.org/2019/03/standardizing-wasi-a-webassembly-system-interface>

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<https://hacks.mozilla.org/2019/03/standardizing-wasi-a-webassembly-system-interface>

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```
read ( int fd, void *buffer, size_t length );
```

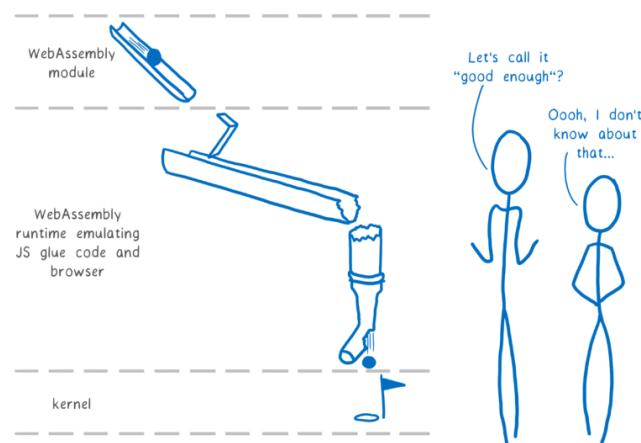
VS.

```
__syscall3 ( which, varargs )
```

same value (3)
always passed

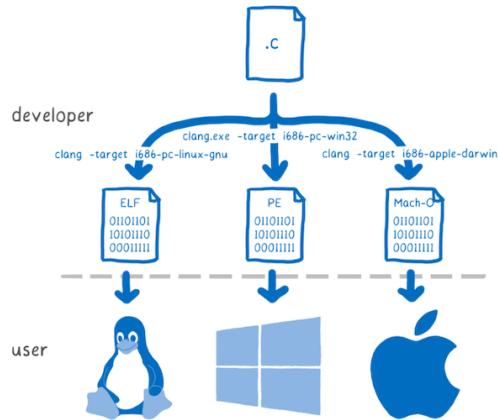
<https://hacks.mozilla.org/2019/03/standardizing-wasi-a-webassembly-system-interface>

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<https://hacks.mozilla.org/2019/03/standardizing-wasi-a-webassembly-system-interface>

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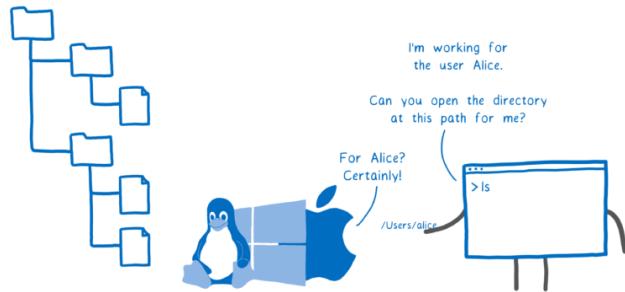


<https://hacks.mozilla.org/2019/03/standardizing-wasi-a-webassembly-system-interface>

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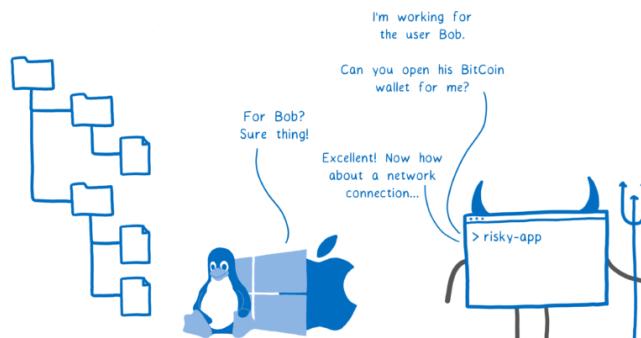
<https://hacks.mozilla.org/2019/03/standardizing-wasi-a-webassembly-system-interface>

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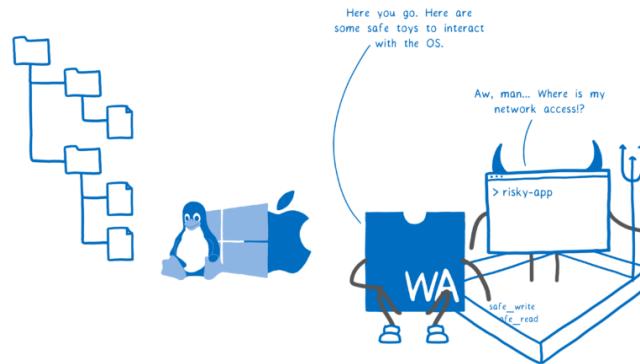
<https://hacks.mozilla.org/2019/03/standardizing-wasi-a-webassembly-system-interface>

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<https://hacks.mozilla.org/2019/03/standardizing-wasi-a-webassembly-system-interface>

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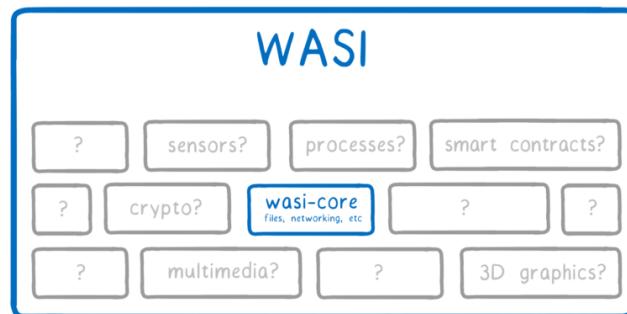


<https://hacks.mozilla.org/2019/03/standardizing-wasi-a-webassembly-system-interface>

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Create a modular set of standards
<https://hacks.mozilla.org/2019/03/standardizing-wasi-a-webassembly-system-interface>

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<https://hacks.mozilla.org/2019/03/standardizing-wasi-a-webassembly-system-interface>

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Rust C

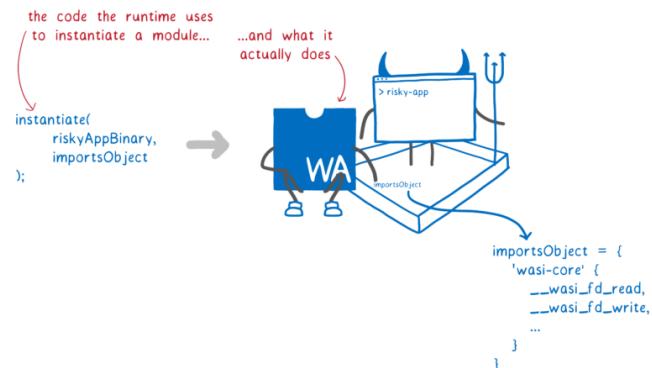
```
pub fn open(...) -> io::Result<WasiFd> {
    unsafe {
        ...
        cvt_wasi(libc::__wasi_path_open(...))?;
        ...
    }
}

int openat(...) {
    ...
    error = __wasi_path_open(...);
    ...
}
```

standard libraries implemented with WASI

<https://hacks.mozilla.org/2019/03/standardizing-wasi-a-webassembly-system-interface>

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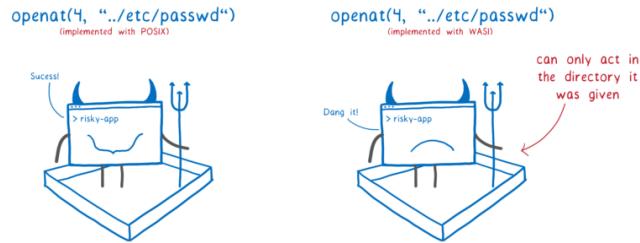
<https://hacks.mozilla.org/2019/03/standardizing-wasi-a-webassembly-system-interface>

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<https://hacks.mozilla.org/2019/03/standardizing-wasi-a-webassembly-system-interface>

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<https://hacks.mozilla.org/2019/03/standardizing-wasi-a-webassembly-system-interface>

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Here's a directory you can work in with read/write & execute permissions.
<https://hacks.mozilla.org/2019/03/standardizing-wasi-a-webassembly-system-interface>

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```
fn main() {
    println!("Hello, world!");
}
```

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```
fn main() {
    println!("Hello, world!");
}

~/s/wasi-test> rustup target add wasm32-wasi --toolchain nightly
~/s/wasi-test> rustc hello.rs --target wasm32-wasi
```

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```
fn main() {
    println!("Hello, world!");
}

~/s/wasi-test> rustup target add wasm32-wasi --toolchain nightly
~/s/wasi-test> rustc hello.rs --target wasm32-wasi

~/s/git> git clone --recurse-submodules https://github.com/CraneStation/wasmtime.git
~/s/git> cd wasmtime
~/s/git/wasmtime> cargo build
~/s/git/wasmtime> cargo install --path .
```

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```
fn main() {
    println!("Hello, world!");
}

~/s/wasi-test> rustup target add wasm32-wasi --toolchain nightly
~/s/wasi-test> rustc hello.rs --target wasm32-wasi

~/s/git> git clone --recurse-submodules https://github.com/CraneStation/wasmtime.git
~/s/git> cd wasmtime
~/s/git/wasmtime> cargo build
~/s/git/wasmtime> cargo install --path .

~/s/wasi-test> wasmtime hello.wasm
Hello, World!
```

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```

;; demo.wat
(module
  ; Import the required fd_write WASI function which will write the given io vectors to stdout
  ; The function signature for fd_write is:
  ; (File Descriptor, *iovs, iovs_len, nwritten) -> Returns number of bytes written
  (import "wasi_unstable" "fd_write" (func $fd_write (param i32 i32 i32 i32) (result i32)))

  (memory 1)
  (export "memory" (memory 0))

  ; Write 'hello world\n' to memory at an offset of 8 bytes
  ; Note the trailing newline which is required for the text to appear
  (data (i32.const 8) "hello world\n")

  (func $main (export "_start")
    ; Creating a new io vector within linear memory
    (i32.store (i32.const 0) (i32.const 8)) ; iov.iov_base - A pointer to the start of 'hello world\n'
    (i32.store (i32.const 4) (i32.const 12)) ; iov.iov_len - The length of the 'hello world\n' string

    (call $fd_write
      (i32.const 1) ; file_descriptor - 1 for stdout
      (i32.const 0) ; *iovs - The pointer to the iov array, which is stored at memory location 0
      (i32.const 1) ; iovs_len - We're printing 1 string stored in an iov - so one.
      (i32.const 20) ; nwritten - A place in memory to store the number of bytes written
    )
    drop ; Discard the number of bytes written from the top the stack
  )
)

```

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```

;; demo.wat
(module
  ; Import the required fd_write WASI function which will write the given io vectors to stdout
  ; The function signature for fd_write is:
  ; (File Descriptor, *iovs, iovs_len, nwritten) -> Returns number of bytes written
  (import "wasi_unstable" "fd_write" (func $fd_write (param i32 i32 i32 i32) (result i32)))

  (memory 1)
  (export "memory" (memory 0))

  ; Write 'hello world\n' to memory at an offset of 8 bytes
  ; Note the trailing newline which is required for the text to appear
  (data (i32.const 8) "hello world\n")

  (func $main (export "_start")
    ; Creating a new io vector within linear memory
    (i32.store (i32.const 0) (i32.const 8)) ; iov.iov_base - A pointer to the start of 'hello world\n'
    (i32.store (i32.const 4) (i32.const 12)) ; iov.iov_len - The length of the 'hello world\n' string

    (call $fd_write
      (i32.const 1) ; file_descriptor - 1 for stdout
      (i32.const 0) ; *iovs - The pointer to the iov array, which is stored at memory location 0
      (i32.const 1) ; iovs_len - We're printing 1 string stored in an iov - so one.
      (i32.const 20) ; nwritten - A place in memory to store the number of bytes written
    )
    drop ; Discard the number of bytes written from the top the stack
  )
)

~/s/wasi-test> wasmtime demo.wat
hello world

```

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<https://wasmer.io>

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```
~/g/wasmtime> curl https://get.wasmer.io -sSfL | sh
```

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```
~/g/wasmtime> curl https://get.wasmer.io -sSfL | sh
```

```
~/g/wasmtime> wasmer run hello.wasm
Hello, World!
```

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```
~/g> git clone https://github.com/wasmerio/wasmer.git
~/g> cd wasmer
~/g/wasmer> wasmer run examples/lua.wasm
Lua 5.4.0 Copyright (C) 1994-2018 Lua.org, PUC-Rio
>
```

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```
~/g> git clone https://github.com/wasmorio/wasmer.git  
~/g> cd wasmer  
~/g/wasmer> wasmer run examples/lua.wasm  
Lua 5.4.0 Copyright (C) 1994-2018 Lua.org, PUC-Rio  
>
```

```
~/g/wasmer> wasmer run examples/sqlite.wasm  
SQLite version 3.27.2 2019-02-25 16:06:06  
Enter ".help" for usage hints.  
Connected to a transient in-memory database.  
Use ".open FILENAME" to reopen on a persistent database.  
sqlite>
```

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<https://wapm.io>

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```
brian@petrichor ~/g/wasmer> wapm install -g cowsay
[INFO] Installing ./cowsay@0.1.3
Global package installed successfully!
brian@petrichor ~/g/wasmer> wapm run cowsay "Webassembly is amazing!"

< Webassembly is amazing: >
-----  
 \ ^__^
  (oo)\_____
    (__)\       )\/\
     ||----w |
     ||     ||
```

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```
~> wapm install -g jsc
```

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```
~> wapm install -g jsc

~> wapm run jsc
>>> function multiply(a, b) { return a * b; }
undefined
>>> multiply(10, 20)
200
>>> 0.1 + 0.2
0.3000000000000004
>>> Date();
Sun Jun 16 2019 14:52:35 GMT-0100 (UTC)
>>>
```

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<https://github.com/CraneStation/wasmtime/blob/master/docs/tutorial.md>

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```
~/s/wasi-test> cargo new --bin demo
    Created binary (application) demo package
```

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```
~/s/wasi-test> cargo new --bin demo
    Created binary (application) demo package
```

```
~/s/wasi-test> cd demo
~/s/w/demo> cat > src/main.rs
<paste in the Rust file>
```

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```
~/s/wasi-test> cargo new --bin demo
    Created binary (application) demo package

~/s/wasi-test> cd demo
~/s/w/demo> cat > src/main.rs
<paste in the Rust file>

~/s/w/demo> cargo build
Compiling demo v0.1.0 (/Users/brian/src/wasi-test/demo)
Finished dev [unoptimized + debuginfo] target(s) in 4.01s
```

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```
~/s/wasi-test> cargo new --bin demo
    Created binary (application) demo package

~/s/wasi-test> cd demo
~/s/w/demo> cat > src/main.rs
<paste in the Rust file>

~/s/w/demo> cargo build
Compiling demo v0.1.0 (/Users/brian/src/wasi-test/demo)
Finished dev [unoptimized + debuginfo] target(s) in 4.01s

~/s/w/demo> cargo run
    Finished dev [unoptimized + debuginfo] target(s) in 0.01s
        Running target/debug/demo
target/debug/demo <input_file> <output_file>
```

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```
~/s/w/demo> cat > hello.txt  
Wasm and Wasi and Wasmer, Oh my!
```

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```
~/s/w/demo> cat > hello.txt  
Wasm and Wasi and Wasmer, Oh my!
```

```
brian@petrichor ~/s/w/demo> cargo run hello.txt /tmp/raw-rust.txt  
Finished dev [unoptimized + debuginfo] target(s) in 0.00s  
Running target/debug/demo hello.txt /tmp/raw-rust.txt
```

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```
~/s/w/demo> cat > hello.txt  
Wasm and Wasi and Wasmer, Oh my!
```

```
brian@petrichor ~/s/w/demo> cargo run hello.txt /tmp/raw-rust.txt  
Finished dev [unoptimized + debuginfo] target(s) in 0.00s  
Running target/debug/demo hello.txt /tmp/raw-rust.txt
```

```
~/s/w/demo> cat /tmp/raw-rust.txt  
Wasm and Wasi and Wasmer, Oh my!
```

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```
~/s/w/demo> cargo +nightly build --target wasm32-wasi  
Compiling demo v0.1.0 (/Users/brian/src/wasi-test/demo)  
Finished dev [unoptimized + debuginfo] target(s) in 2.95s
```

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```
~/s/w/demo> cargo +nightly build --target wasm32-wasi
Compiling demo v0.1.0 (/Users/brian/src/wasi-test/demo)
Finished dev [unoptimized + debuginfo] target(s) in 2.95s
```

```
~/s/w/demo> wasmer run target/wasm32-wasi/debug/demo.wasm
target/wasm32-wasi/debug/demo.wasm <input_file> <output_file>
```

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```
~/s/w/demo> cargo +nightly build --target wasm32-wasi
Compiling demo v0.1.0 (/Users/brian/src/wasi-test/demo)
Finished dev [unoptimized + debuginfo] target(s) in 2.95s
```

```
~/s/w/demo> wasmer run target/wasm32-wasi/debug/demo.wasm
target/wasm32-wasi/debug/demo.wasm <input_file> <output_file>
```

```
~/s/w/demo>
wasmer run target/wasm32-wasi/debug/demo.wasm hello.txt /tmp/wasi-rust.txt
error opening input: failed to find a preopened file descriptor through which "hello.txt" could be opene
```

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```
~/s/w/demo> cargo +nightly build --target wasm32-wasi
Compiling demo v0.1.0 (/Users/brian/src/wasi-test/demo)
Finished dev [unoptimized + debuginfo] target(s) in 2.95s

~/s/w/demo> wasmer run target/wasm32-wasi/debug/demo.wasm
target/wasm32-wasi/debug/demo.wasm <input_file> <output_file>

~/s/w/demo>
wasmer run target/wasm32-wasi/debug/demo.wasm hello.txt /tmp/wasi-rust.txt
error opening input: failed to find a preopened file descriptor through which "hello.txt" could be opened

~/s/w/demo> wasmer run --dir=. --dir=/tmp target/wasm32-wasi/debug/demo.wasm hello.txt /tmp/wasi-rust.txt
```

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```
~/s/w/demo> cargo +nightly build --target wasm32-wasi
Compiling demo v0.1.0 (/Users/brian/src/wasi-test/demo)
Finished dev [unoptimized + debuginfo] target(s) in 2.95s

~/s/w/demo> wasmer run target/wasm32-wasi/debug/demo.wasm
target/wasm32-wasi/debug/demo.wasm <input_file> <output_file>

~/s/w/demo>
wasmer run target/wasm32-wasi/debug/demo.wasm hello.txt /tmp/wasi-rust.txt
error opening input: failed to find a preopened file descriptor through which "hello.txt" could be opened

~/s/w/demo> wasmer run --dir=. --dir=/tmp target/wasm32-wasi/debug/demo.wasm hello.txt /tmp/wasi-rust.txt

~/s/w/demo> cat /tmp/wasi-rust.txt
Wasm and Wasi and Wasmer, Oh my!
```

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```
~/s/w/demo> cargo +nightly build --target wasm32-wasi
Compiling demo v0.1.0 (/Users/brian/src/wasi-test/demo)
Finished dev [unoptimized + debuginfo] target(s) in 2.95s

~/s/w/demo> wasmer run target/wasm32-wasi/debug/demo.wasm
target/wasm32-wasi/debug/demo.wasm <input_file> <output_file>

~/s/w/demo>
wasmer run target/wasm32-wasi/debug/demo.wasm hello.txt /tmp/wasi-rust.txt
error opening input: failed to find a preopened file descriptor through which "hello.txt" could be opened

~/s/w/demo> wasmer run --dir=. --dir=/tmp target/wasm32-wasi/debug/demo.wasm hello.txt /tmp/wasi-rust.txt

~/s/w/demo> cat /tmp/wasi-rust.txt
Wasm and Wasi and Wasmer, Oh my!

~/s/w/demo> wasmtime --dir=. --dir=/tmp target/wasm32-wasi/debug/demo.wasm hello.txt /tmp/wasi2-rust.txt
```

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```
~/s/w/demo> cargo +nightly build --target wasm32-wasi
Compiling demo v0.1.0 (/Users/brian/src/wasi-test/demo)
Finished dev [unoptimized + debuginfo] target(s) in 2.95s

~/s/w/demo> wasmer run target/wasm32-wasi/debug/demo.wasm
target/wasm32-wasi/debug/demo.wasm <input_file> <output_file>

~/s/w/demo>
wasmer run target/wasm32-wasi/debug/demo.wasm hello.txt /tmp/wasi-rust.txt
error opening input: failed to find a preopened file descriptor through which "hello.txt" could be opened

~/s/w/demo> wasmer run --dir=. --dir=/tmp target/wasm32-wasi/debug/demo.wasm hello.txt /tmp/wasi-rust.txt

~/s/w/demo> cat /tmp/wasi-rust.txt
Wasm and Wasi and Wasmer, Oh my!

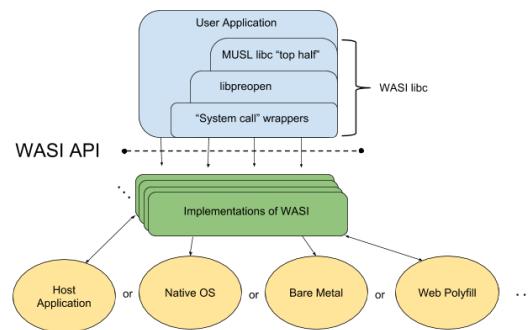
~/s/w/demo> wasmtime --dir=. --dir=/tmp target/wasm32-wasi/debug/demo.wasm hello.txt /tmp/wasi2-rust.txt

~/s/w/demo> cat /tmp/wasi2-rust.txt
Wasm and Wasi and Wasmer, Oh my!
```

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<https://wasi.dev/polyfill/>

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<https://webassembly.sh>

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<https://webassembly.sh/?run-command=wasm%20install%20sqlite@0.2.2>

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<https://webassembly.sh/?run-command=wasm%20install%20qr2text@0.0.1>

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<http://tweezer.local:8080/demo1/>

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<https://github.com/jlevy/the-art-of-command-line>

<https://github.com/k4m4/terminals-are-sexy>

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<https://github.com/alebcay/awesome-shell>

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<https://github.com/agarrharr/awesome-cli-apps>

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Questions

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