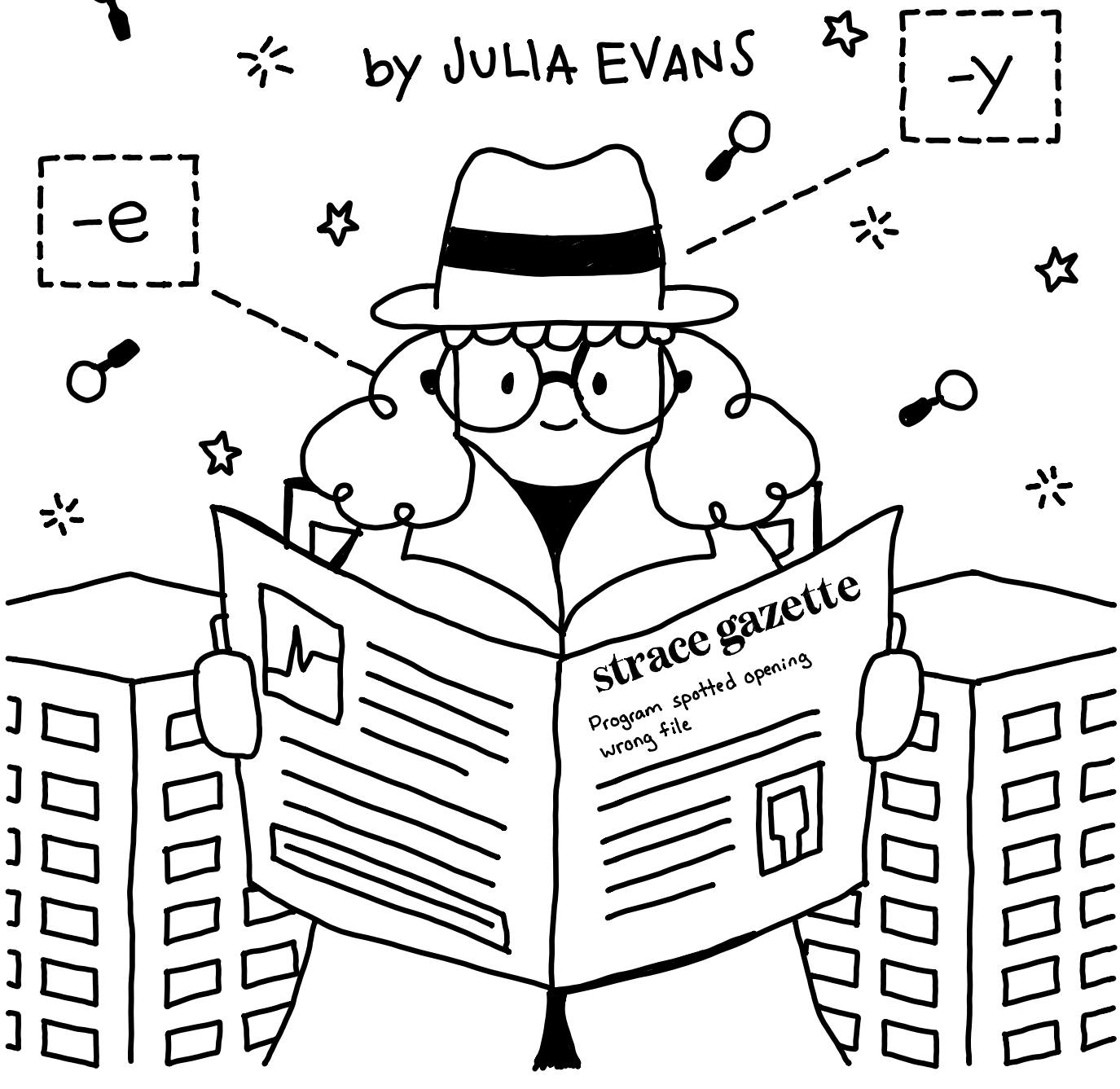
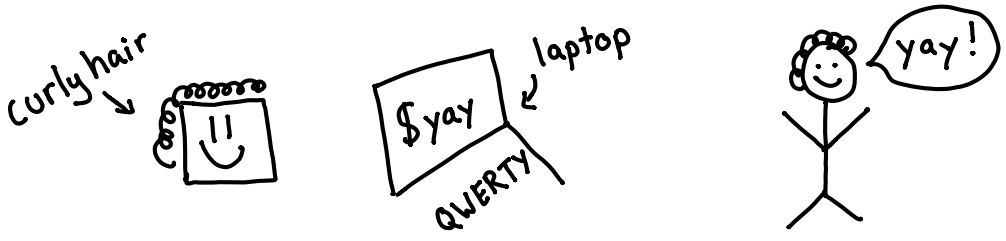
SPYING ON YOUR PROGRAMS WITH STRACE

by JULIA EVANS



Who makes this?

Hi! I'm Julia! I look kind of like this:



I found out last year that understanding your operating system's internals makes you a

It was SO FUN and I wanted to tell EVERYONE. So I'm telling you!

you can find me at:

blog: jvns.ca
twitter: @b0rk
email: julia@jvns.ca

♡ a tiny manifesto ♡

operating systems are

the strace zine thinks:

- your computer is yours
- your OS is yours
- open licenses mean you can READ AND CHANGE THE CODE!!
- Linux is REALLY COOL

→ → → → → → → → → → → → → → → → yaaaaay → → → → → → →

LET'S GO LEARN

→ → → → → → → → → → → → → → → it's really fun → → → → → →

what is this strace thing????

pronounced ess-trace

strace is a program on Linux that lets you ~~inspect~~ spy on what a program is doing without

on OSX you can use dtrace/dtruss

- a debugger
- or the source code
- or even knowing the programming language at all (?!!?! how can it be?)

Basically strace makes you a

To understand how this works, let's talk a little about operating systems

Why you should ♡ your operating system

Some things it does for you:

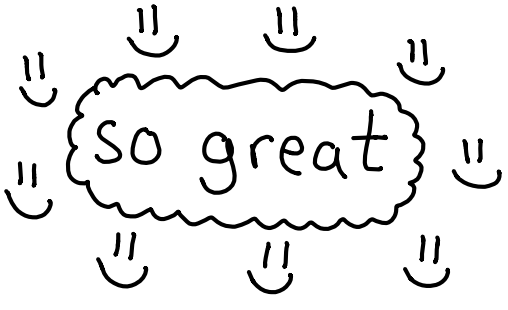
- understands how your hard drive works and how the file system on it organizes the bytes into files so you can just read the file ☺

- runs code every time you press a key so that you can type

- implements networking protocols like TCP/IP so that you can get ~~webpages~~ pictures of cats from the internet

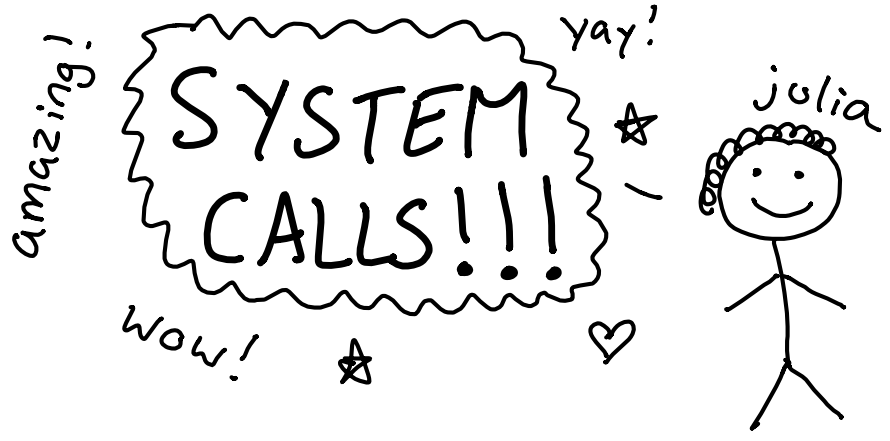
- keeps track of all the memory every process is using

- basically knows everything about how all your hardware works so you can just write programs ♡



but wait, Julia, how do my programs use all this great stuff the operating system does?

you



System calls are the ~~API~~ interface for your operating system.

want to open a file? use `open` and then `read` and `write` to it.

sending data over a network? Use `connect` to open a connection and `send` and `recv` pictures of cats.

Every program on your computer is using system calls all the time to manage memory, write files, do networking, and lots more.

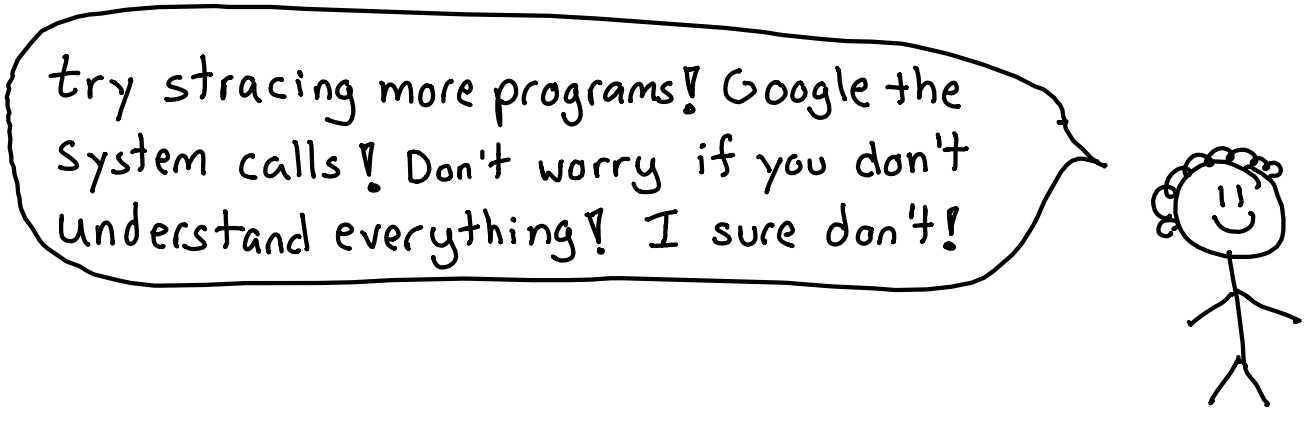
a first cup of strace

You might think with all this talk of operating systems and system calls that using strace is hard.

Getting started is easy! If you have a Linux machine, I want you to try it RIGHT NOW.

Run: `strace ls` wizard time!

There's a LOT of output and it's pretty confusing at first. I've annotated some for you on the next page. :)



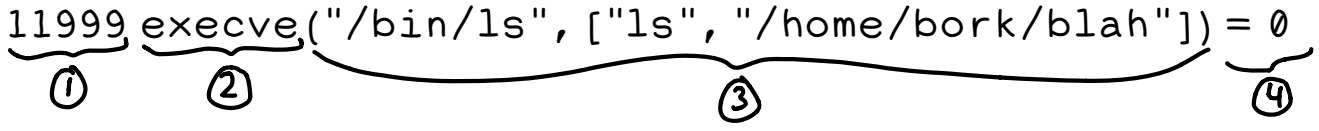
annotated strace

When you run strace, you'll see thousands of lines of output like this:

```
$ strace ls /home/bork/blah
execve("/bin/ls", ["ls", "/home/bork/blah"], [/* 62 vars
*/]) = 0
brk(NULL)                                       = 0xb67000
open("/etc/ld.so.cache", O_RDONLY|O_CLOEXEC) = 3
open("/proc/filesystems", O_RDONLY)             = 3
 ... omitted ...
open("/home/bork/blah", O_RDONLY|O_NONBLOCK|O_DIRECTORY) =
3
fstat(3, {st_mode=S_IFDIR|0775, st_size=168, ...}) = 0
getdents(3, /* 3 entries */, 32768)             = 80
getdents(3, /* 0 entries */, 32768)             = 0
close(3)                                        = 0
fstat(1, {st_mode=S_IFCHR|0620, st_rdev=makedev(136,
5), ...}) = 0
write(1, "awesome_file\n", 13)                  = 13
close(1)                                        = 0
close(2)                                        = 0
exit_group(0)                                   = ?
```

Studies show this is not self-explanatory
(me asking my friends if it makes sense and NOPE NOPE)

★ let's learn how to interpret strace output ★



① The process ID (included when you run strace -f)

② The name of the system call (execve starts programs !!)

③ The system call's arguments, in this case a program to start and the arguments to start it with

④ The return value

Still the name of the syscall

file to open

open with read/write permissions

```
open("awesome.txt", O_RDWR) = 3
```
← file descriptor

The 3 here is a file descriptor number. Internally, Linux tracks open files with numbers! You can see all the file descriptors for process ID 42 and what they point to by doing

```
ls -l /proc/42/fd
```
'fd' is for file descriptor!

file descriptor

what got read

number of bytes read

```
read(3, "wow! yay!") = 9
```

If you don't understand something in your strace output:

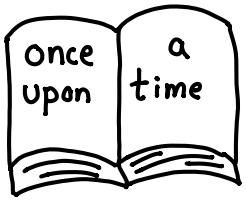
- it's normal! There are lots of syscalls.
- try reading the man page for the system call!

```
man 2 open
```

- remember that just understanding read + write + open + execve can take you a long way ♥

my favorite system calls

open



Have you ever not been sure what configuration files a program is using? THAT NEVER NEEDS TO HAPPEN TO YOU AGAIN 🖖🖖🖖. Skip the docs and head straight for:

```
strace -f -e open mplayer Rick_Astley.mp3
```

write

Programs write logs.

If you're sure your program is writing Very Important Information but don't know what or where, `strace -e write` may be for you.

`read` is pretty great too.

connect

Sometimes a program is sending network requests to another machine and I want to know WHICH MACHINE.

```
strace -e connect
```

shows me every IP address a program connects to.

What's fun? Spying on network activity is fun. If you have an HTTP service and you're debugging and totally at your wits' end, maybe it's time to look at what's REALLY EXACTLY being sent over the network...

these are your pals ♡

execve

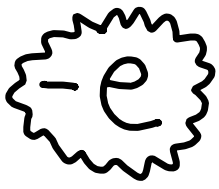
On my first day of work, a Ruby script that ran some ssh commands wasn't working. Oh no!

But who wants to read code to find out why? ugh.

```
strace -f -e execve ./script.rb
```

told us what the problem ssh command was, and we fixed it!

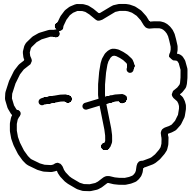
strace command line flags I ♡



overwhelmed by all the system calls you don't understand? Try

```
strace -e open
```

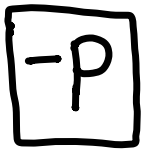
and it'll just show you the opens. much simpler ♡



is for follow

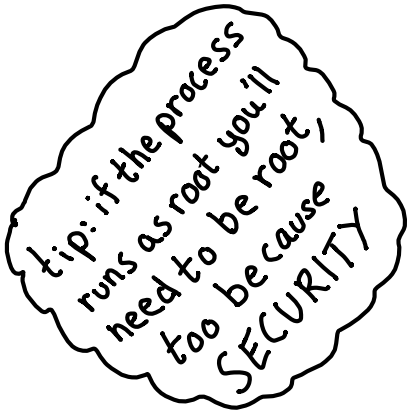
Does your program start subprocesses? ! lots do!

Use `-f` to see what those are doing too. Or just always use -f ! That's what I do.



is for PID

"OH NO I STARTED THE PROGRAM 6 HOURS AGO AND NOW I WANT TO STRACE IT"



Do not worry! Just find your process's PID (like 747) and

```
strace -p 747
```

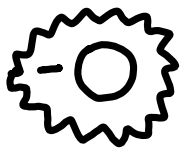
is for strings!!

Sometimes I'm looking at the output of a recvfrom and it's like:

recvfrom(6, "And then the monster...")

and OH NO THE SUSPENSE.

`strace -s 800` will show you the first 800 characters of each string. I use it all the time!



is for output!

Let's get real. No matter what, strace prints too much damn output. Use

```
strace -o too_much_stuff.txt
```

and sort through it later.

Have no idea which file the file descriptor "3" refers to? `-y` is a flag in newer versions of strace, and it'll show you filenames instead of just numbers!

Putting it all together:

Want to spy on an ssh session?

```
strace -f -o ssh.txt ssh juliabox.com
```

Want to see what files a Dropbox sync process is opening? (with PID: 230)

```
strace -f -p 230 -e open
```

That's it! Now you're a

More seriously, there's obviously a TON more to learn about operating systems and many further levels of wizardry. But I find just strace by itself to be an incredibly useful tool.

And so fun! On a 12-hour train ride from New York to Montreal, I had no book and no internet, so I just started stracing programs on my computer and I could totally see how the 'killall' program works without reading the source code or ANYTHING.

and it helps me debug all the time ♡

★ happy stracing ★

Resources + FAQ

I've written like 7 posts about strace because I have an unhealthy obsession. They're at

jvns.ca/categories/strace

(In)frequently asked questions:

Q: Is there strace on OS X?
A: No, but try dtruss/dtrace!

Q: Can I strace strace?
A: Yup! If you do, you'll find out that strace uses the ptrace system call to do its magic.

Q: Should I strace my production database?
A: NONONONO. It will slow down your database a LOT.

Q: Is there a way to trace system calls that won't slow down my programs?
A: Sometimes you can use perf trace on newer Linux versions. Or bpftrace!

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Julia Evans, wizard industries 2018