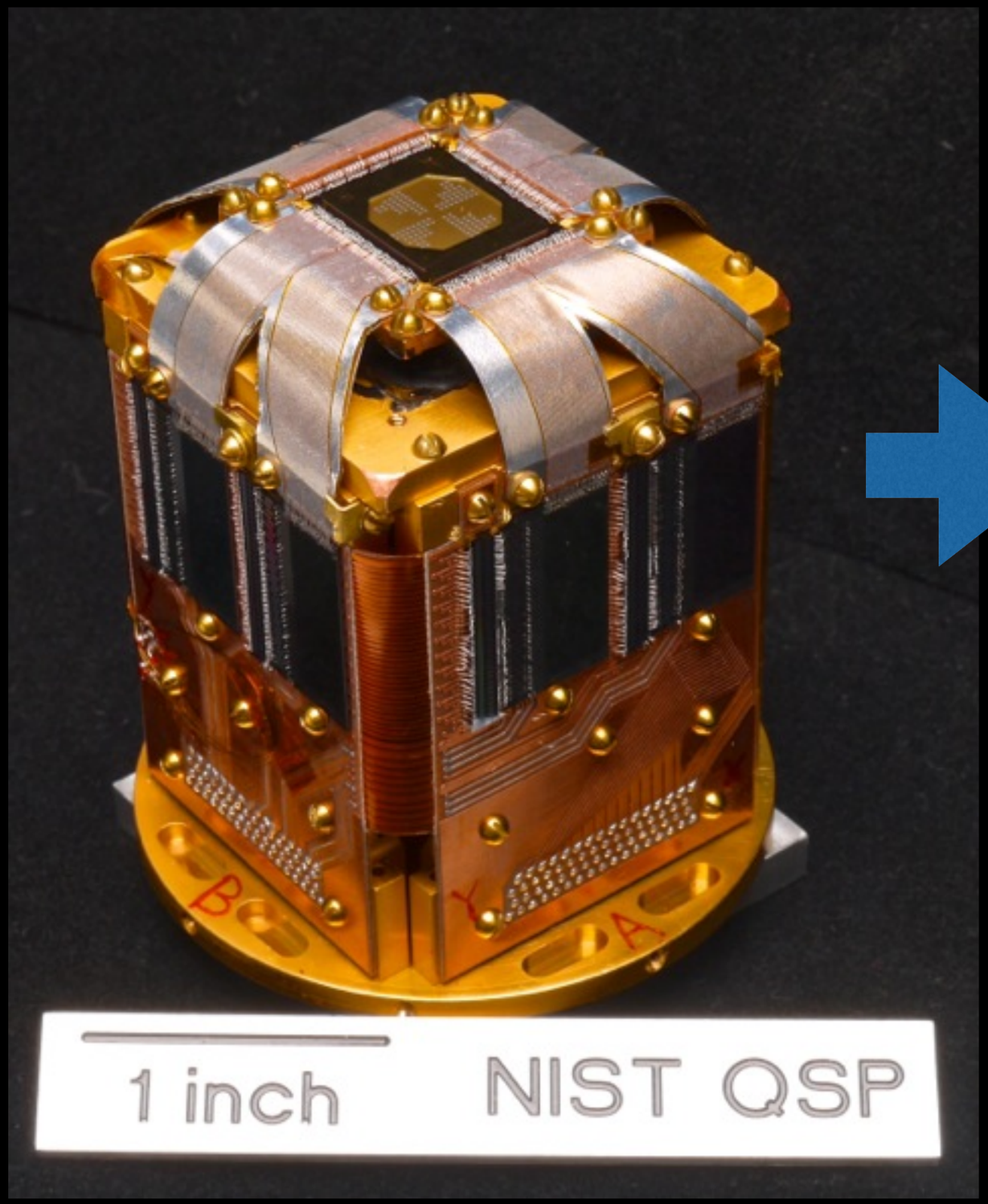
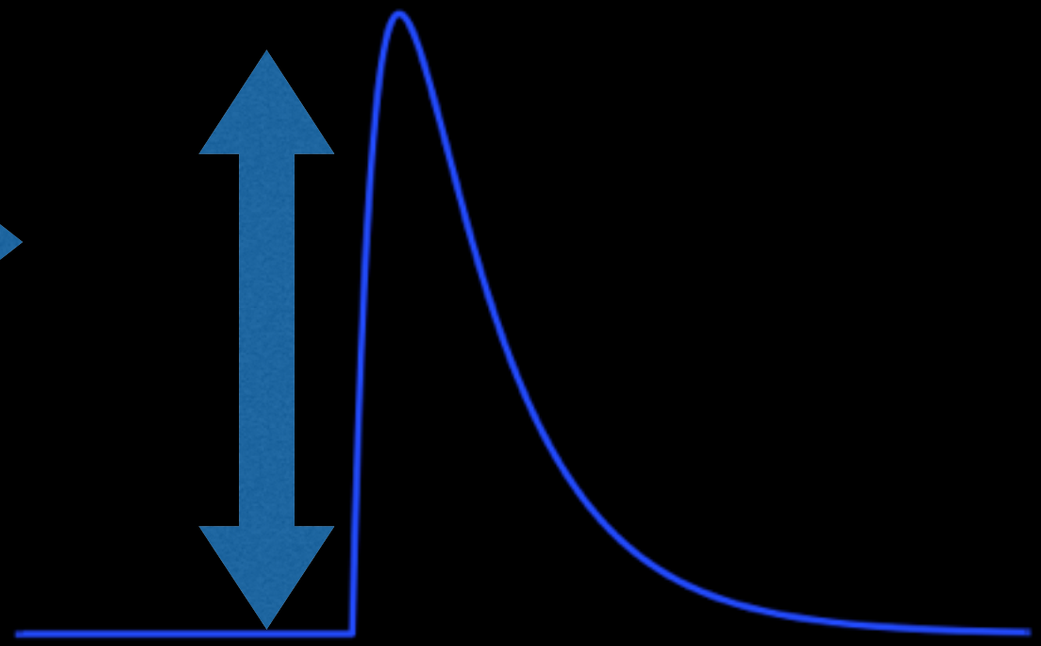
What's up with  ?

Galen O'Neil
Physicist, NIST, Boulder, CO

My background



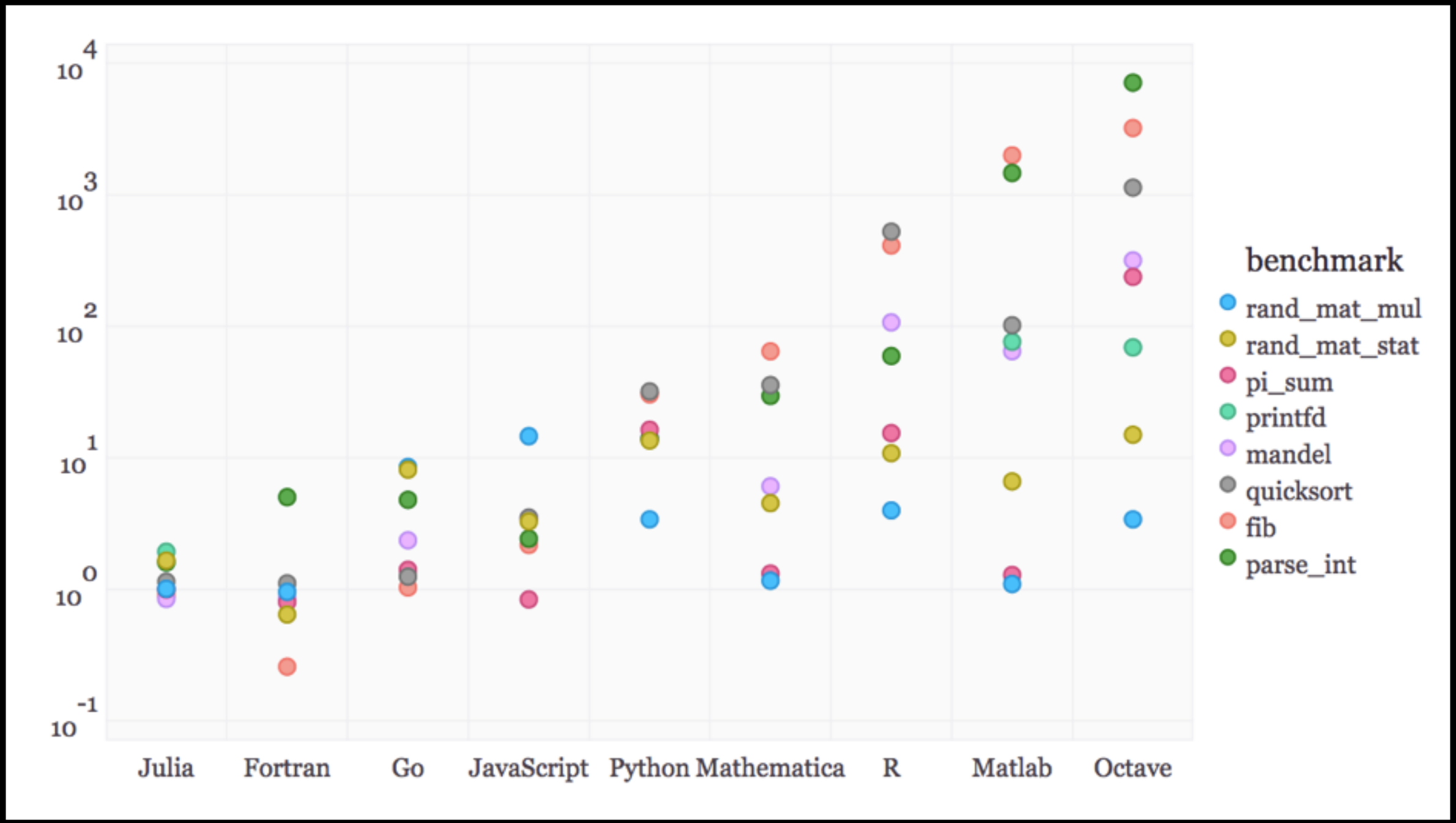
Pulse height ~=
energy/heat capacity



Oversimplification

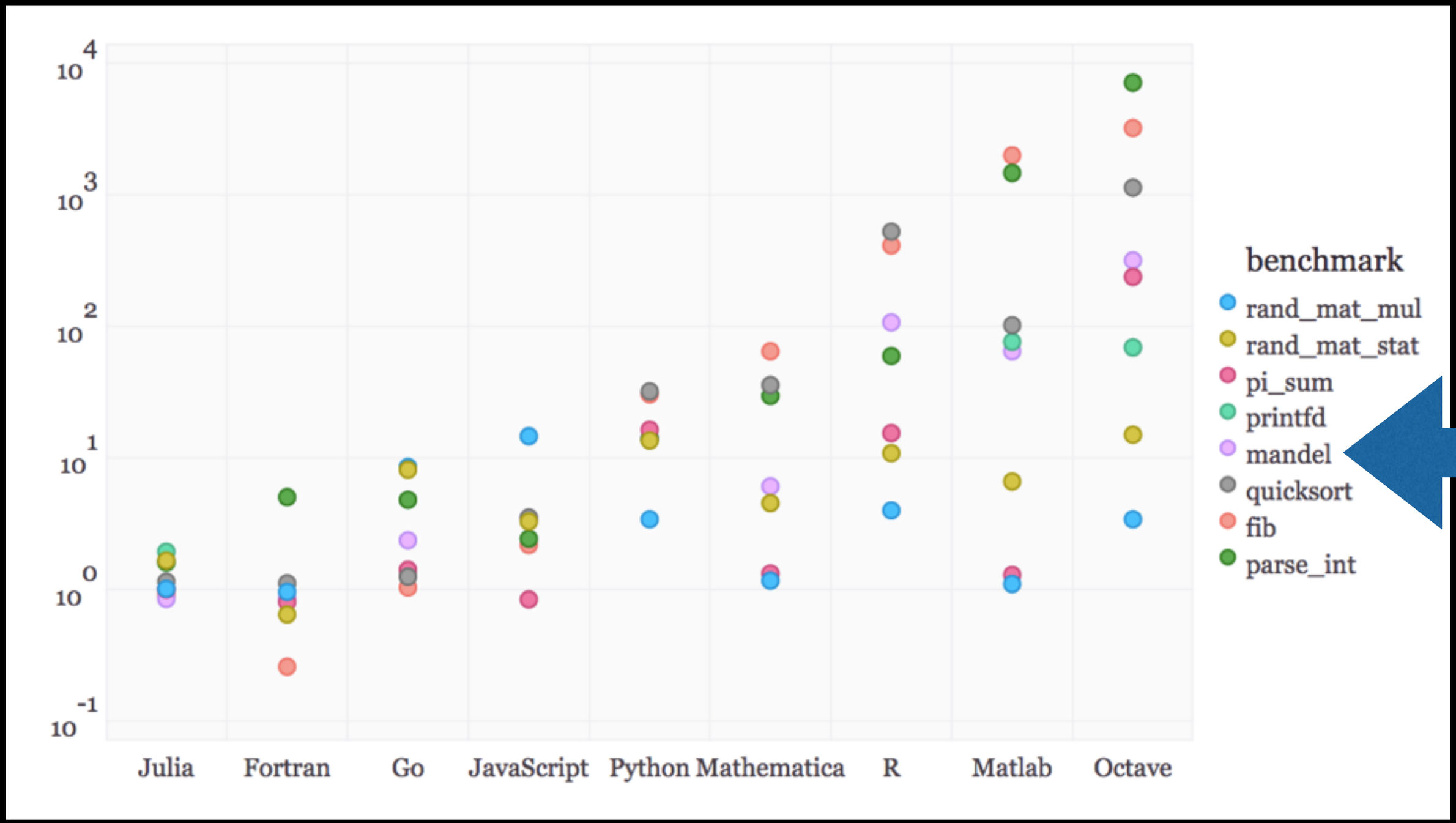
- C and FORTRAN are static and fast.
- Python, R, and MATLAB are dynamic and slow.
    - But it's ok because the functions are written in C or FORTRAN so they're fast. AKA vectorize everything AKA the two language problem.
- Julia is trying to be dynamic and fast. One language.

How fast?



Rough goal: should be able to get within ~2 of c.

How fast?



Rough goal: should be able to get within ~2 of c.

Randmatstat code Python, Julia, FORTRAN

Python

```python
def mandel(z):
    maxiter = 80
    c = z
    for n in range(maxiter):
        if abs(z) > 2:
            return n
        z = z*z + c
    return maxiter
```

Julia

```julia
function mandel(z)
    c = z
    maxiter = 80
    for n = 1:maxiter
        if abs(z) > 2
            return n-1
        end
        z = z^2 + c
    end
    return maxiter
end
```

FORTRAN

```fortran
integer function mandel(z0) result(r)
complex(dp), intent(in) :: z0
complex(dp) :: c, z
integer :: n, maxiter
maxiter = 80
z = z0
c = z0
do n = 1, maxiter
    if (abs(z) > 2) then
        r = n-1
        return
    end if
    z = z**2 + c
end do
r = maxiter
end function
```

How is Julia so fast?

How ~~is~~ can Julia be so fast?
Types

- Type inference: If the compiler knows the types of the variables, it can efficiently use the hardware.

- Type Stability: A function's return type should depend only on the input types (not values!)

```
julia> sqrt(1)
1.0

julia> sqrt(-1) # MATLAB would return 0+1i here
ERROR: DomainError
sqrt will only return a complex result if called with a complex
argument.
try sqrt(complex(x))
 in sqrt at math.jl:131
```

Anything else?

- MIT licensed, free and open source!
- Built in package manager.
- ipython like REPL out of the box.
- Easy to call python.

```
Galen-ONeils-MacBook-Air:Julia galenoneil$ julia
               _
   _       _ _(_)_     |  A fresh approach to technical computing
  (_)     | (_) (_)    |  Documentation: http://docs.julialang.org
   _ _   _| |_  __ _   |  Type "help()" for help.
  | | | | | | |/ _` |  |
  | | |_| | | | (_| |  |  Version 0.3.1 (2014-09-21 21:30 UTC)
 _/ |\__'_|_|_|\__'_|  |
|__/                   |  x86_64-apple-darwin13.3.0

julia> Pkg.add("PyCall")
INFO: Cloning cache of PyCall from git://github.com/stevengj/
PyCall.jl.git
INFO: Installing PyCall v0.4.10
INFO: Package database updated

julia> using PyCall

julia> @pyimport scipy.signal as ss

julia> ss.gaussian(10,1)'
1x10 Array{Float64,2}:
 4.00653e-5  0.00218749  0.0439369  0.324652  …  0.0439369
0.00218749  4.00653e-5
```

Anything else?

- Parallelism
- Profiler
- Mostly (70%+) written in Julia.
- Unicode.

```
julia> a = rand(100);

julia> y = map(sin,a);

julia> y_p = pmap(sin,a); # this way uses multiple processes if you
started with -p flag

julia> y==y_p
true

julia> function α(x)
       s=0.0
       for j=1:1000
       s+=sin(x*j)
       end
       s
       end
α (generic function with 1 method)

julia> @profile for j=1:100000 α(j) end

julia> Profile.print()
2     client.jl; _start; line: 399
 2 REPL.jl; run_repl; line: 170
  2 REPL.jl; run_frontend; line: 818
   2 LineEdit.jl; run_interface; line: 1379
    1 REPL.jl; anonymous; line: 585
     1 REPL.jl; send_to_backend; line: 571
      1 REPL.jl; send_to_backend; line: 574
    1 REPL.jl; anonymous; line: 586
56526 task.jl; anonymous; line: 96
 56526 REPL.jl; eval_user_input; line: 54
  56524 profile.jl; anonymous; line: 1
   30494 none; f; line: 4
   26028 none; α; line: 4
   1     none; α; line: 6
  1     profile.jl; anonymous; line: 12
  1     profile.jl; anonymous; line: 14
```

Anything else?

- Your types are equal to built in types.
- Multiple dispatch.
- Easy to call c.
- Just in time compiling.

```
julia> type MyType
       a
       end

julia> Base.show(io::IO, m::MyType) = print(io, "MyType with a = $(m.a)")
show (generic function with 82 methods)

julia> MyType(4)
MyType with a = 4

julia> f(x,y) = x-y
f (generic function with 1 method)

julia> f(x,y::Int) = x+y
f (generic function with 2 methods)

julia> f(1.0,1.0)
0.0

julia> f(1.0,1)
2.0

julia> t = ccall( (:clock, "libc"), Int32, ()) # no glue code needed
192995652
```

Python to Julia Example

Python

```python
import numpy, time
r = numpy.random.rand(10000000)

def summarize(r):
     return r.mean(), numpy.amax(r), numpy.amin(r)

def summarize_loop(r):
     maxval = -numpy.inf
     minval = numpy.info
     s = 0.0
     for i in range(len(r)):
          d = r[i]
          s+=d
          if d > maxval:
               maxval = d
          elif d < minval:
               minval = d
     return s/length(r), maxval, minval

tstart = time.time()
meanval, maxval, minval = summarize_loop(r)
tend=time.time()
print(10*(tend-tstart))

tstart = time.time()
for i in range(10):
     meanval, maxval, minval = summarize(r)
tend=time.time()
print(tend-tstart)
```

Julia

```julia
r = rand(10000000)

summarize(r) = mean(r), maximum(r), minimum(r)

function summarize_loop(r)
     maxval = realmin(eltype(r))
     minval = realmax(eltype(r))
     s = zero(eltype(r))
     for i = 1:length(r)
          d = r[i]
          s+=d
          if d > maxval
               maxval = d
          elseif d < minval
               minval = d
          end
     end
     s/length(r), maxval, minval
end

@time for i=1:10 summarize(r) end
@time for i=1:10 summarize_loop(r) end
```

	python	julia
vectorized	54 ms	54 ms
loop	7400 ms	31 ms

What's the catch?

- Julia just released version 0.3. It is a new and young (v0.1 released Feb 2013) language under rapid development. Breaking changes will happen.
- Package ecosystem isn't at the python or R level, but it's pretty good and growing fast.
- IDE support is in the early stages.
- Upcoming in version 0.4 (aka currently missing)
  - Debugger
  - Array views by default (aka a=b[5:500] will be fast because it doesn't make a copy)
  - Static compilation
  - Faster strings

What's the catch?

```
function summarize_loop(r)
     maxval = realmin(eltype(r))
     minval = realmax(eltype(r))
     s = zero(eltype(r))
     for i = 1:length(r)
          d = r[i]
          s+=d
          if d > maxval
               maxval = d
          elseif d < minval
               minval = d
          end
     end
     s/length(r), maxval, minval
end
```

```
function summarize_loop2(r)
     maxval = realmin(eltype(r))
     minval = realmax(eltype(r))
     s = 0
     for i = 1:length(r)
          d = r[i]
          s+=d
          if d > maxval
               maxval = d
          elseif d < minval
               minval = d
          end
     end
     s/length(r), maxval, minval
end
```

What's the catch?

```
function summarize_loop(r)
     maxval = realmin(eltype(r))
     minval = realmax(eltype(r))
     s = zero(eltype(r))
     for i = 1:length(r)
          d = r[i]
          s+=d
          if d > maxval
               maxval = d
          elseif d < minval
               minval = d
          end
     end
     s/length(r), maxval, minval
end
```

```
function summarize_loop2(r)
     maxval = realmin(eltype(r))
     minval = realmax(eltype(r))
     s = 0
     for i = 1:length(r)
          d = r[i]
          s+=d
          if d > maxval
               maxval = d
          elseif d < minval
               minval = d
          end
     end
     s/length(r), maxval, minval
end
```

	python	julia
vectorized	54 ms	54 ms
loop	7400 ms	~~31~~ 1200 ms

What's the catch?

```
function summarize_loop(r)
     maxval = realmin(eltype(r))
     minval = realmax(eltype(r))
     s = zero(eltype(r))
     for i = 1:length(r)
          d = r[i]
          s+=d
          if d > maxval
               maxval = d
          elseif d < minval
               minval = d
          end
     end
     s/length(r), maxval, minval
end
```

```
function summarize_loop2(r)
     maxval = realmin(eltype(r))
     minval = realmax(eltype(r))
     s = 0
     for i = 1:length(r)
          d = r[i]
          s+=d
          if d > maxval
               maxval = d
          elseif d < minval
               minval = d
          end
     end
     s/length(r), maxval, minval
end
```

	python	julia
vectorized	54 ms	54 ms
loop	7400 ms	~~31~~ 1200 ms

julia

Search docs

Getting Started

google that

Julia installation is straightforward, whether using precompiled binaries or compiling from source. Download and install Julia by following the instructions at http://julialang.org/downloads/.

The easiest way to learn and experiment with Julia is by starting an interactive session (also known as a read-eval-print loop or "repl"):

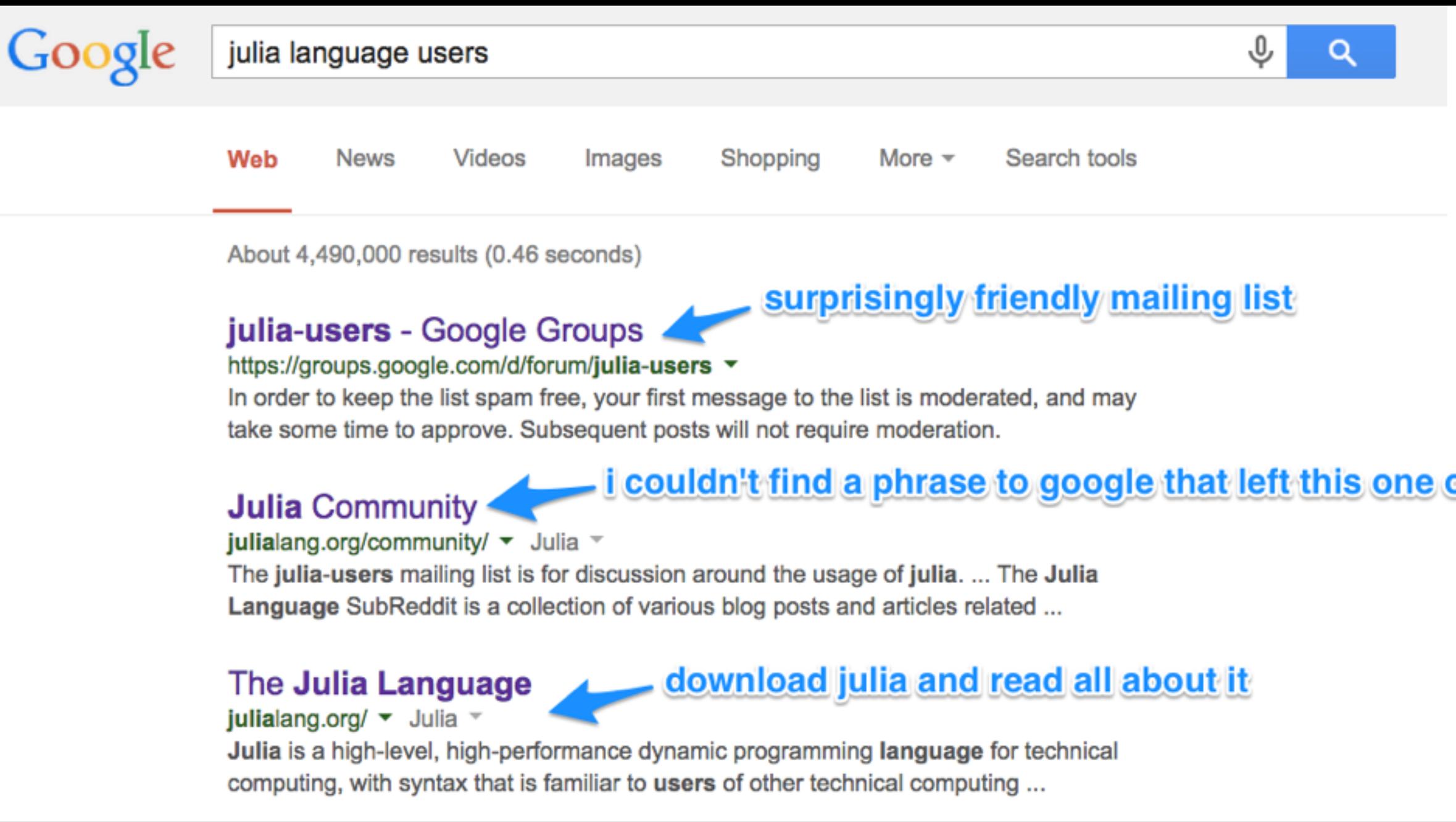
```
$ julia
               _
   _       _ _(_)_     |  A fresh approach to technical computing
  (_)     | (_) (_)    |  Documentation: http://docs.julialang.org
   _ _   _| |_  __ _   |  Type "help()" to list help topics
  | | | | | | |/ _` |  |
  | | |_| | | | (_| |  |  Version 0.3.0-prerelease+3690 (2014-06-16 05:11 UTC)
 _/ |\__'_|_|_|\__'_|  |  Commit 1b73f04* (0 days old master)
|__/                   |  x86_64-apple-darwin13.1.0

julia> 1 + 2
3

julia> ans
3
```

useful links way down at the bottom

topics

To exit the interactive session, type `^D` — the control key together with the `d` key or type `quit()`. When run in interactive mode, `julia` displays a banner and prompts the user for input. Once the user has entered a complete expression, such as `1 + 2`, and hits enter, the interactive session evaluates the expression and shows its value. If an expression is entered into an interactive session with a trailing semicolon, its value is not shown. The variable `ans` is bound to the value of the last

More info?


Google
julia language users
Web
News
Videos
Images
Shopping
More
Search tools
About 4,490,000 results (0.46 seconds)
julia-users - Google Groups
surprisingly friendly mailing list
https://groups.google.com/d/forum/julia-users
In order to keep the list spam free, your first message to the list is moderated, and may take some time to approve. Subsequent posts will not require moderation.
Julia Community
i couldn't find a phrase to google that left this one out
julialang.org/community/ Julia
The julia-users mailing list is for discussion around the usage of julia. ... The Julia Language SubReddit is a collection of various blog posts and articles related ...
The Julia Language
download julia and read all about it
julialang.org/ Julia
Julia is a high-level, high-performance dynamic programming language for technical computing, with syntax that is familiar to users of other technical computing ...

The First Rule of Program Optimization:
Don't do it.

The Second Rule of Program Optimization
(for experts only!): Don't do it yet.

-Michael A. Jackson

goto IJulia Demo

link