

Building the Julia Language and its Community

Viral B. Shah

Co-creator, Julia Programming Language
Co-founder and CEO, Julia Computing

And the Broader Julia community...

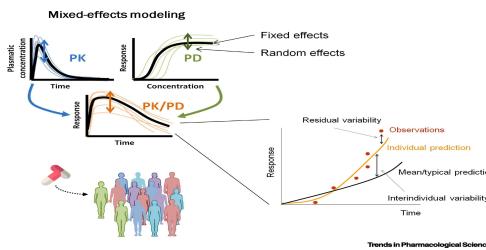
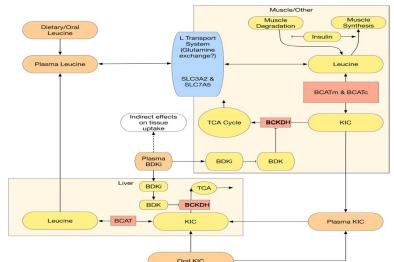
Github Satellite India, March 2021

Julia has been an 11 year journey so far...

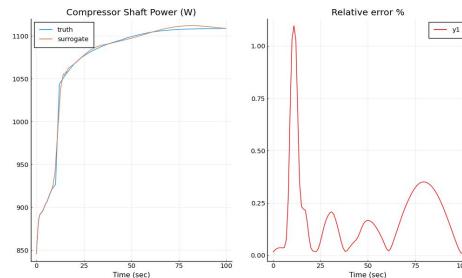
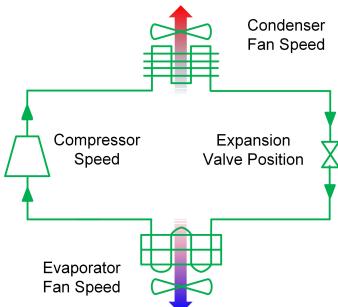
1.	2009	An urge to solve the two language problem
2.	2012	<u>Why we created Julia</u>
3.	2013	Julia becomes the <u>"Ju" in Jupyter</u>
4.	2015	<u>Julia co-creators found Julia Computing, Inc.</u>
5.	2017	<u>1M Julia downloads</u>
5.	2018	<u>Julia 1.0</u> released
6.	2019	10M Julia downloads. <u>Wilkinson Prize</u> . <u>Sidney Fernbach Prize</u> .
7.	2020	24M downloads. <u>Julia 1.5 released</u> .

... And it is making real impact

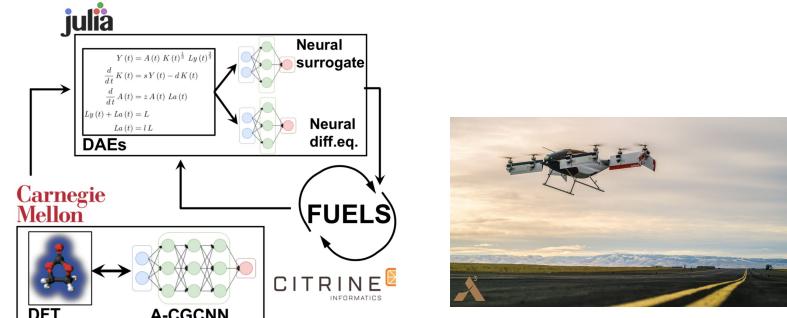
Faster Drug Development



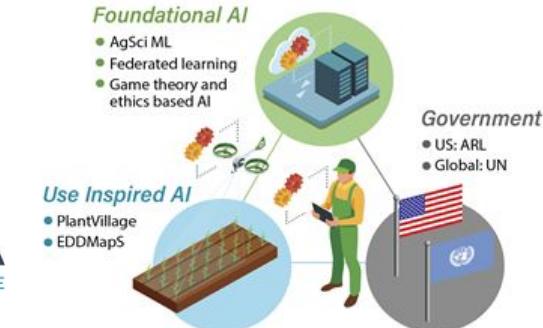
Energy Efficient Buildings



More efficient batteries



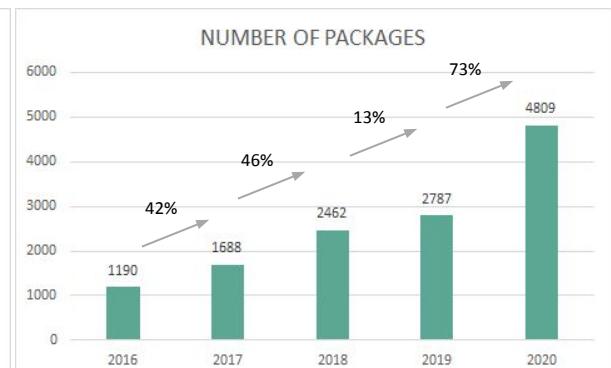
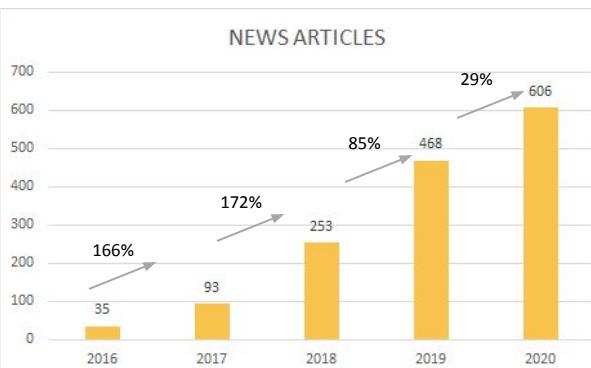
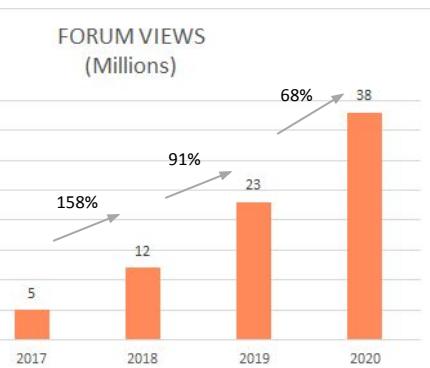
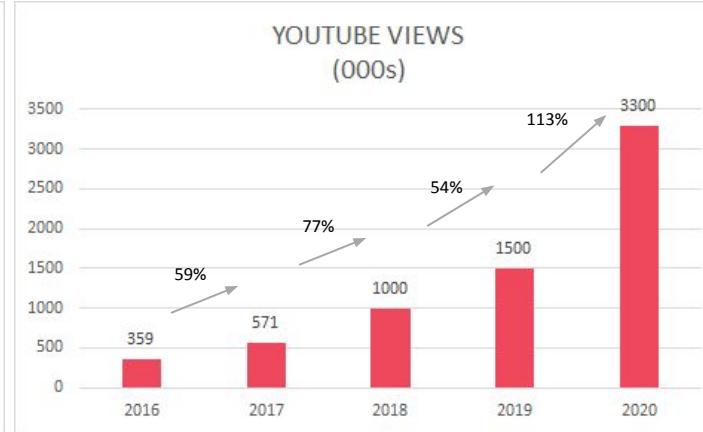
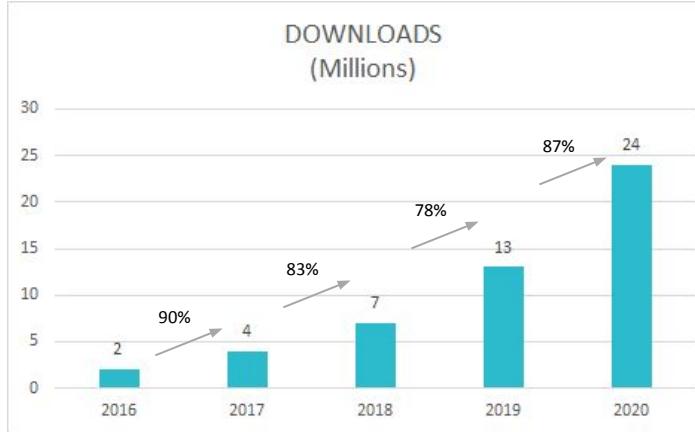
Climate modeling for improved agriculture



JuliaCon India 2015



The Julia community has seen exponential growth



All numbers are cumulative

Julia has entered the mainstream



Julia is rapidly moving up in language popularity rankings

- #19 on IEEE Spectrum
- #23 on Tiobe Index (from #47 to #23 in 2020)
- #24 on PYPL (PopularitY of Programming Language Index)

Community

- Users: roughly 1M
- Used at over 10,000 companies worldwide
- Used & taught at 1,500 universities
 - MIT, Stanford, Berkeley, Cornell, ...

The image contains three separate news snippets from different sources:

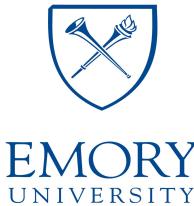
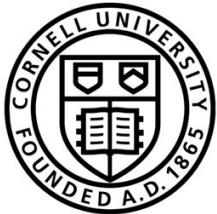
- ars TECHNICA**: A headline from ars Technica reads "The unreasonable effectiveness of the Julia programming language". Below it is another snippet from nature magazine.
- nature**: A headline from nature magazine reads "Julia: come for the syntax, stay for the speed". It includes a brief description: "Researchers often find themselves coding algorithms in one programming language, only to have to rewrite them in a faster one. An up-and-coming language could be the answer."
- ZDNet**: A headline from ZDNet reads "Programming languages: Julia touts its speed edge over Python and R". Below it is a short description: "Benchmarks suggest programming language Julia may be the best choice for big-data analysis using CSV format files."



Over 1,500 universities are using and teaching Julia



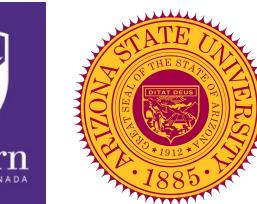
BROWN
UNIVERSITY



TOULOUSE III



CU
NY THE CITY
UNIVERSITY OF
NEW YORK



ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE



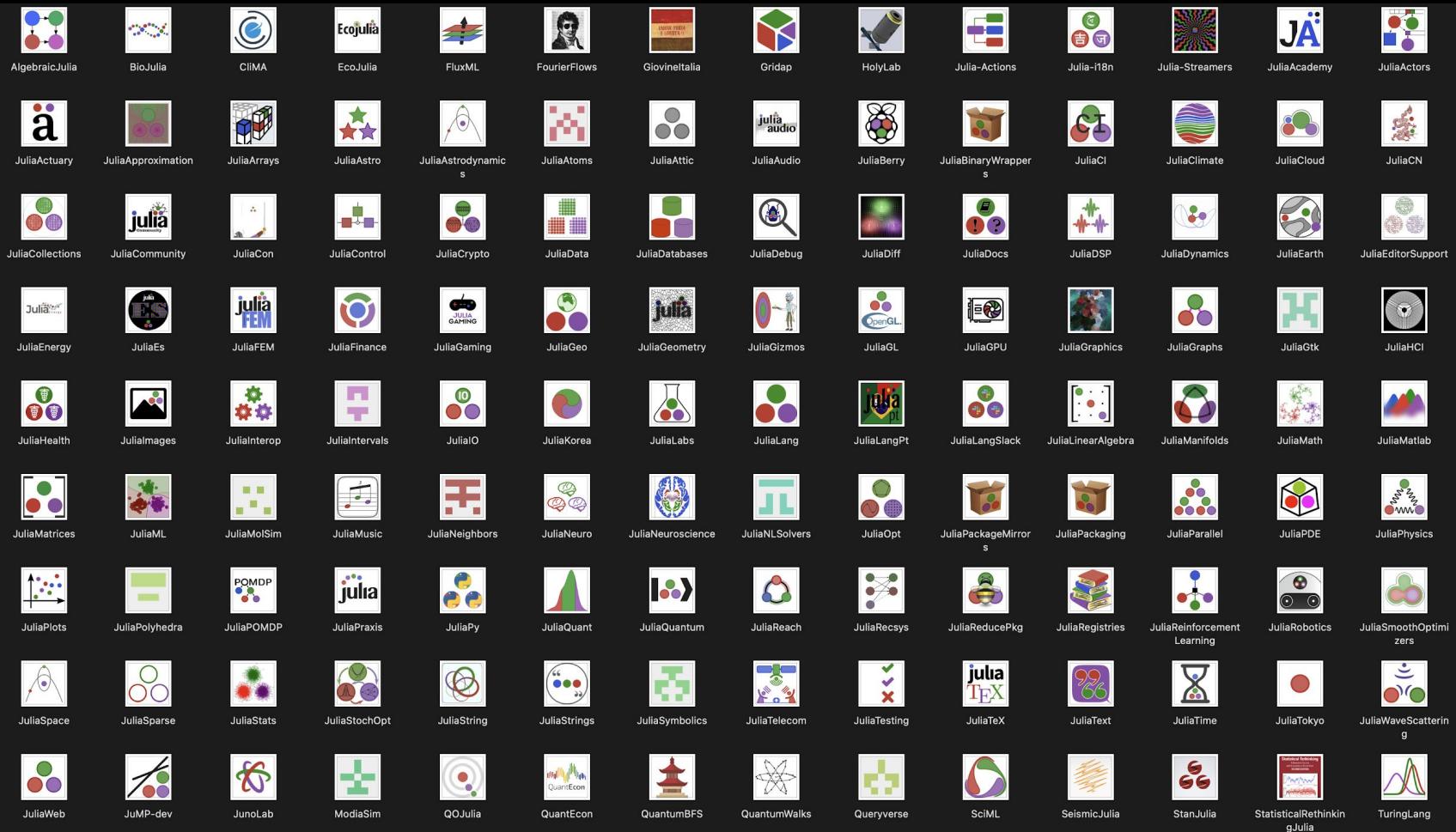
M Ú E G Y E T E M 1 7 8 2

TOKYO METROPOLITAN UNIVERSITY
首都大学東京

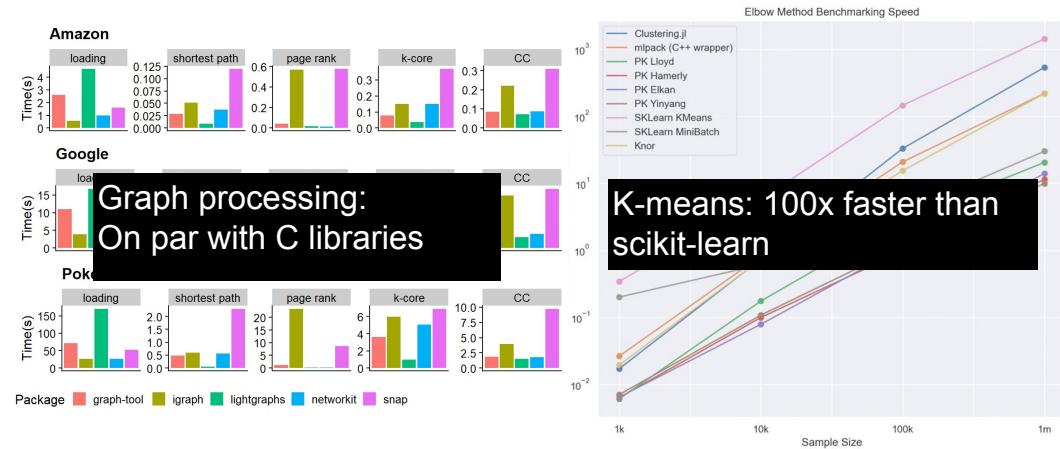
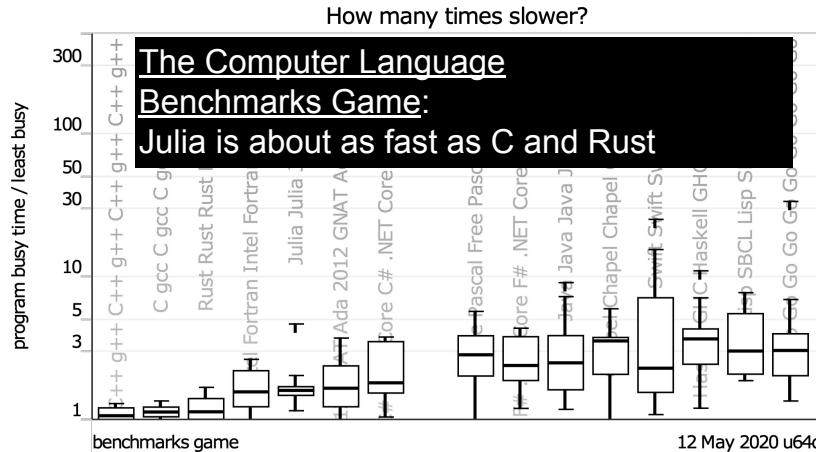


UCLA AGH

Over 100 Julia GitHub organizations



Julia and its package ecosystem keep pushing performance



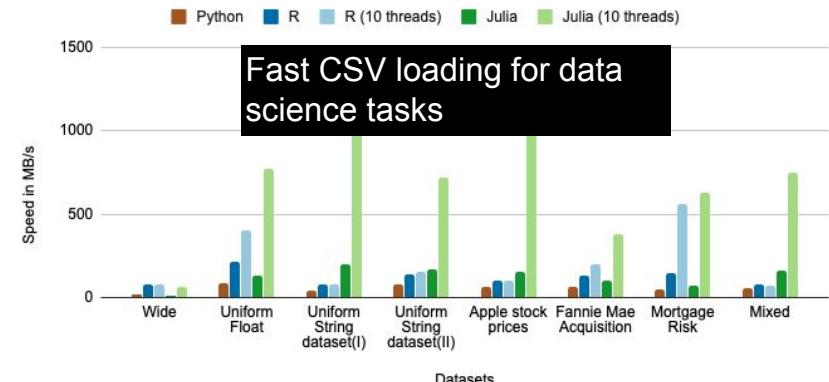
Input table: 1,000,000,000 rows x 9 columns (50 GB)

data.table	1.13.3	2020-11-17
ClickHouse	20.9.3.45	2020-10-27
spark	3.0.1	2020-09-20
DataFrames.jl	0.22.0	2020-11-18
(py)datatable	1.0.0a0	2020-10-25
dplyr	1.0.2	2020-11-18
pandas	1.1.3	2020-10-11
dask		
cuDF		
Modin		

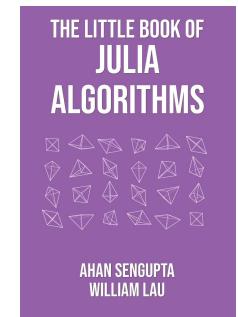
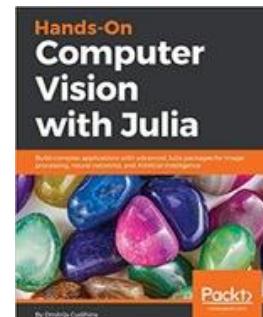
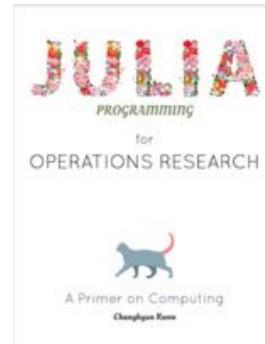
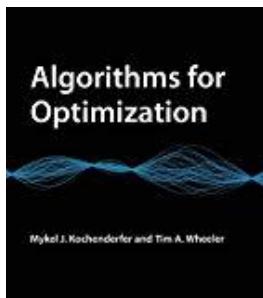
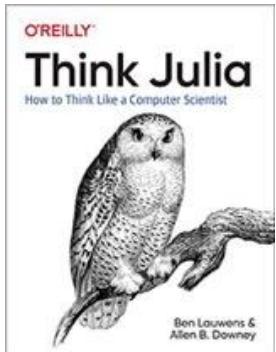
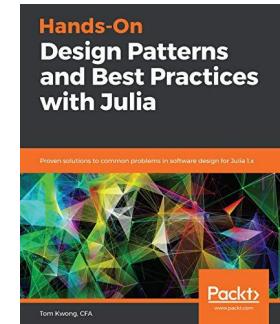
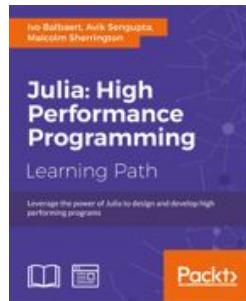
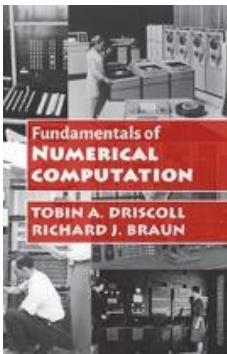
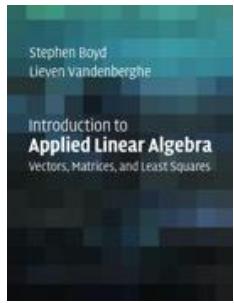
H2O DataFrames benchmark:
Scales to large datasets

internal error
out of memory
timeout
out of memory
pending

CSV reading benchmarks: Python, R, and Julia



A growing collection of Julia books





Pluto Notebooks

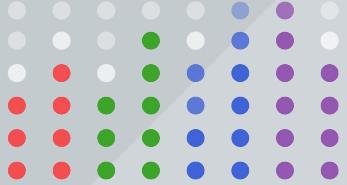
Writing a notebook is not just about writing the final document — Pluto empowers the experiments and discoveries that are essential to getting there.

Explore models and share results in a notebook that is:

- **Reactive** - when changing a function or variable, Pluto automatically updates all affected cells.
- **Lightweight** - Pluto is written in pure Julia and is easy to install.
- **Simple** - no hidden workspace state; friendly UI.

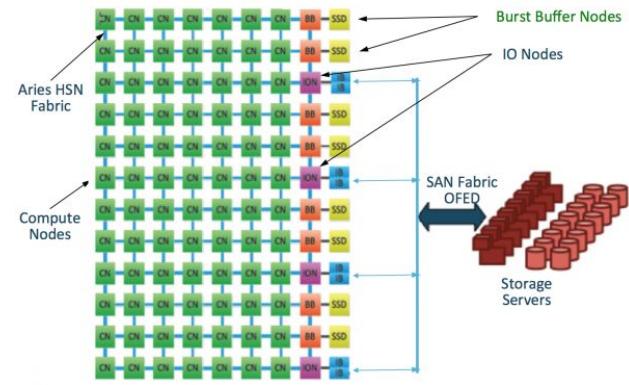
JuliaCon 2020 talk:

<https://www.youtube.com/watch?v=IAF8DjrQSSk>



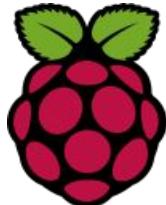
Idea:

Models are really programs, and
ML problems are language problems

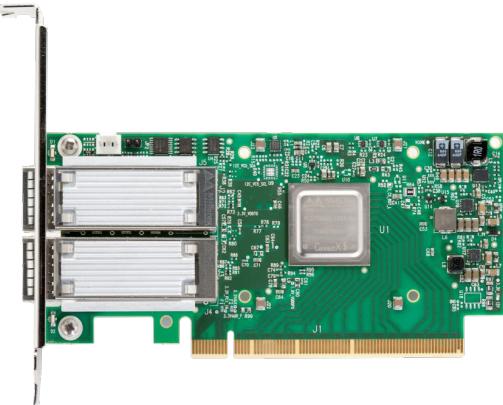


Enormous Datasets

 TensorFlow.js



Deployment



Distributed Compute



$$\frac{\partial}{\partial x}$$

```

for sample in x
    result += process(sample)
end

```

Automatic Differentiation

Novel Hardware



pytorch / pytorch

● Python 32.7% ● C++ 29.3% ● Cuda 17.9% ● C 15.2% ● CMake 3.6% ● Fortran 0.6% ● Other 0.7%



tensorflow / tensorflow

● C++ 47.8% ● Python 40.8% ● HTML 5.7% ● Jupyter Notebook 2.4% ● Go 1.3% ● Java 0.7% ● Other 1.3%



FluxML / Flux.jl

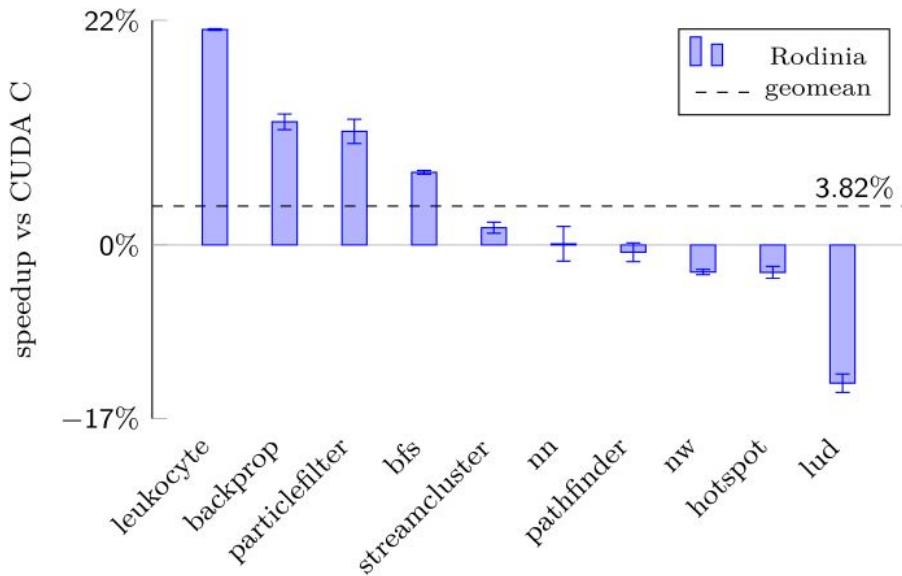
● Julia 100.0%



Fashionable Modelling with Flux
[\(arXiv:1811.01457\)](https://arxiv.org/abs/1811.01457)

Julia on GPUs: <https://juliagpu.org>

Supports NVIDIA GPUs. Early support for AMD and Intel GPUs.



Benchmarks compared to CUDA C

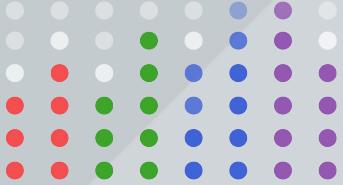
Noteworthy new capabilities

- Multi-GPU programming
- Support for CUDA 11 (and CUDA 10 also)
- CUDNN support
- Multi-tasking and multi-threading

Noteworthy applications

- 300x improvement in pharmaceutical workloads
- 1,000 GPU parallel deployment at CSCS (Switzerland)
- Clima Project – Oceananigans.jl
- Multi-physics simulations
- Reinforcement learning – AlphaZero.jl





Machine Learning

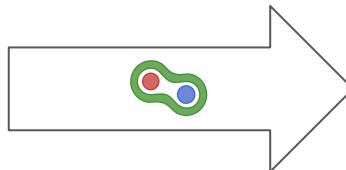
Differentiable Programming



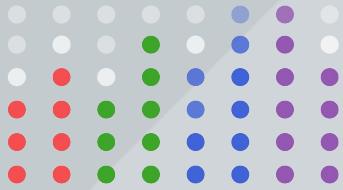
Generalized Physics-Informed Learning through Language-Wide Differentiable Programming.
[AAAI Spring Symposium: MLPS 2020](#)

Zygote.jl - AD is a compiler problem

```
function foo(W, Y, x)
    Z = W * Y
    a = Z * x
    b = Y * x
    c = tanh.(b)
    r = a + c
    return r
end
```



```
function ∇ foo(W, Y, x)
    Z = W * Y
    a = Z * x
    b = Y * x
    c, Jtanh = ∇ tanh.(b)
    a + c, function (Δr)
        Δc = Δr, Δa = Δr
        (Δtanh, Δb) = Jtanh(Δc)
        (ΔY, Δx) = (Δb * x', Y' * Δb)
        (ΔZ = Δa * x', Δx += Z' * Δa)
        (ΔW = ΔZ * Y', ΔY = W * ΔZ')
        (nothing, ΔW, ΔY, Δx)
    end
end
```



Differentiable Programming is disrupting Scientific Modelling and Simulation

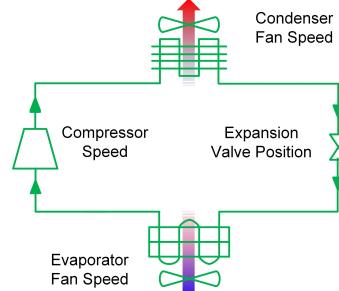
Pharmaceuticals, Engineering, Chemistry, Manufacturing, Batteries, Climate

A Programming Language can change the world!

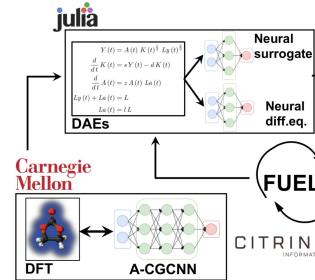
Faster Drug Development



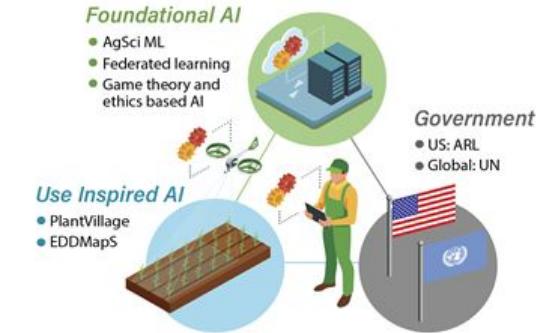
Energy Efficient Buildings



More efficient batteries



Climate modeling for improved agriculture





Explore, Build, Run, Scale, Visualize.
Discover a seamless direct to cloud
experience.

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