

FINC-672 – WORKSHOP IN FINANCE: EMPIRICAL RESEARCH

OVERVIEW OF THE JULIA PROGRAMMING LANGUAGE

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GOALS

- Get a sense of what the Julia Programming language is, its origins and design, and how it is used in the financial industry.

THE JULIA PROGRAMMING LANGUAGE

- The Julia programming language is a relatively new language, first released in 2012 and aims to be **both easy and fast**.¹
- It "runs like C but reads like Python."²
- It was made for scientific computing, capable of handling *large amounts of data and computation* while still being fairly *easy to manipulate, create and prototype code*.

¹Jeff Bezanson et al. "Julia: A Fresh Approach to Numerical Computing". In: *SIAM review* 59.1 (2017), pp. 65–98.

²Jeffrey M. Perkel. "Julia: Come for the Syntax, Stay for the Speed". en. In: *Nature* 572.7767 (July 2019), pp. 141–142.

THE JULIA PROGRAMMING LANGUAGE (CONT'D)

- The creators of Julia explained why they created Julia in a [2012 blogpost](#).

We are greedy: we want more. We want a language that's open source, with a liberal license. We want the speed of C with the dynamism of Ruby. We want a language that's homoiconic, with true macros like Lisp, but with obvious, familiar mathematical notation like Matlab. We want something as usable for general programming as Python, as easy for statistics as R, as natural for string processing as Perl, as powerful for linear algebra as Matlab, as good at gluing programs together as the shell. Something that is dirt simple to learn, yet keeps the most serious hackers happy. We want it interactive and we want it compiled.

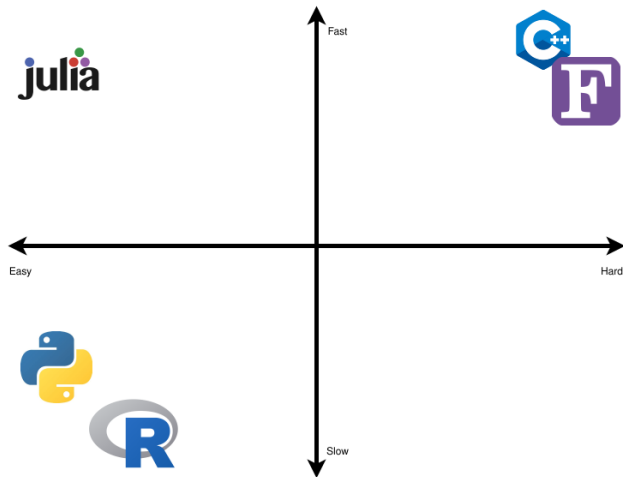
THE JULIA PROGRAMMING LANGUAGE (CONT'D)

- Most users are attracted to Julia because of the **superior speed**.³
- After all, Julia is a member of a prestigious and exclusive club.
- The **petaflop club** is comprised of languages who can exceed speeds of **one petaflop per second at peak performance**.⁴
- Currently only C, C++, Fortran and Julia belong to the *petaflop club*.
- You can find benchmarks for Julia and several other languages [▶ here](#).

³If you like to learn more about how Julia is designed, you should definitely check Bezanson et al., “Julia: A Fresh Approach to Numerical Computing”.

⁴A petaflop is one thousand trillion, or one quadrillion, operations per second.

JULIA VERSUS OTHER PROGRAMMING LANGUAGES



WHY JULIA?



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Nobel Laureate Thomas J. Sargent

Next-generation macroeconomic models require high-performance computing: enter julia

NOBEL LAUREATE

Macroeconomics

Nobel Laureate Thomas J. Sargent can't get enough of julia.

Professor Sargent is the founder of **QuantEcon**, a platform that advances pedagogy in quantitative economics using both julia and Python. His team at NYU uses julia for macroeconomic modeling and contributes to the julia ecosystem.

Speaking at JuliaCon at MIT in June 2016, Professor Sargent explained that the reason julia is so important for his work is because the next generation of macroeconomic models is very computationally intensive with large datasets and large numbers of variables. These macroeconomic models and their forecasts help solve large constrained optimization problems using massive datasets to inform policy analysis.

The complexity stems from a large number of different economic actors - including individuals, governments and businesses - each with a different welfare maximization function, plus a number of different resource and information constraints. Consider that each economic actor makes decisions based on expectations of the future, which means that each economic actor also has their own forecasting model.

It may come as no surprise that such models can become very complicated mathematically. According to Professor Sargent, this is why he and his team require julia.

"Why are macroeconomists like myself so interested in and excited by julia? Because our models are complicated. It's easy to write the problem down, but it's hard to solve it - especially if our model is high dimension. That's why we need julia."

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Aladdin Analytics Platform

The world's largest asset manager is using Julia to upgrade its trademark Aladdin analytics platform

BLACKROCK

Asset Management



BlackRock: Using Julia for its next generation analytics platform

BlackRock is the world's largest asset manager, with nearly \$5 trillion under management.

BlackRock quants have been using Julia since 2014. They have been greatly impressed with the performance gains, ease of use, and single-language deployment capabilities.

BlackRock has written analytics modules for its flagship product Aladdin in Julia, and uses Julia for time series data analytics and big data applications.

BlackRock was a Platinum Sponsor of [JuliaCon 2015](#) and spoke at length at this conference about why they love Julia.



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WHY JULIA?

The screenshot shows the Julia Computing website. At the top is the navigation bar with links: PRODUCTS, INDUSTRIES, CASE STUDIES, EVENTS, MEDIA, RESOURCES, BLOG, CAREERS, and a hamburger menu icon. The main banner features a dark teal background with a financial candlestick chart and the text "Foreign Exchange Trade Analysis" and "State Street is using Julia to identify best execution for foreign exchange trading". Below the banner is a section titled "STATE STREET Foreign Exchange Analytics". The text in this section reads: "State Street: Using Julia to Identify Best Execution for Foreign Exchange Trading", "Every day, \$5 trillion changes hands in global foreign exchange markets.", "How do traders know whether they are getting the best deal?", "They turn to State Street.", "State Street is one of America's 15 largest banks, and their BestX division provides independent trade technology and analytics to define, achieve and demonstrate the best execution of a foreign exchange trade.", and a video player titled "Julia at BestX - Powering Financial Analytics" with a play button. To the right of the main content is a sidebar with the Julia logo, "OUR ENTERPRISE PRODUCTS", and the "JuliaHub Julia SURE" logo. A purple circular icon is located at the bottom right of the page.

Julia computing

PRODUCTS INDUSTRIES CASE STUDIES EVENTS MEDIA RESOURCES BLOG CAREERS

Foreign Exchange Trade Analysis

State Street is using Julia to identify best execution for foreign exchange trading

STATE STREET Foreign Exchange Analytics

State Street: Using Julia to Identify Best Execution for Foreign Exchange Trading

Every day, \$5 trillion changes hands in global foreign exchange markets.

How do traders know whether they are getting the best deal?

They turn to State Street.

State Street is one of America's 15 largest banks, and their BestX division provides independent trade technology and analytics to define, achieve and demonstrate the best execution of a foreign exchange trade.

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Julia Watch on YouTube

Julia at BestX - Powering Financial Analytics

How does State Street do this?

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WHY JULIA?

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Risk Modeling Solutions

Conning is using Julia in large scale Monte Carlo simulations for insurance risk assessment solutions

CONNING

Asset Management

Conning is a hundred year old global asset management firm managing more than half a trillion dollars in financial assets for the insurance industry. Conning's Economic Scenario Generator (ESG) generates the financial and macroeconomic variables that underpin risk modeling.

Conning's platform undertakes very large scale multi-period Monte Carlo simulations involving a tremendous number of variables and periodicity varying from a single day to 50 years, which can amount to 4 million calculations per second per core. Languages like C are not an option because of the sheer complexity of the models and the amount of time it would take to code.



David Weiss

Large Scale Stochastic Simulation Using Julia



Watch on YouTube

The legacy solution used interpreted array-based K, but as the size of data sets and complexity of models is growing fast, K was found to be inadequate for their needs.



OUR ENTERPRISE PRODUCTS



JuliaHub



Julia SURE

"Julia provides performance, ease of use, elegance and scalability; we could not have got these from any other choice of language" - David Weiss, Managing Director, Conning



GOALS

- ☑ Get a sense of what the Julia Programming language is, its origins and design, and how it is used in the financial industry.

REFERENCES

- Bezanson, Jeff et al. “Julia: A Fresh Approach to Numerical Computing”. In: *SIAM review* 59.1 (2017), pp. 65–98.
- Perkel, Jeffrey M. “Julia: Come for the Syntax, Stay for the Speed”. en. In: *Nature* 572.7767 (July 2019), pp. 141–142. DOI: [10.1038/d41586-019-02310-3](https://doi.org/10.1038/d41586-019-02310-3).