

Julia tutorial for SF2524

Giampaolo Mele

KTH Royal Institute of technology



SF2524

Why Julia?

“Julia has the performance of a statically compiled language like C, C++, etc while providing interactive dynamic behavior and productivity like Python, Matlab , LISP or Ruby.”

— Bezanson et al, Julia: A Fast Dynamic Language for Technical Computing

Why Julia?

“Julia has the performance of a statically compiled language like C, C++, etc while providing interactive dynamic behavior and productivity like Python, Matlab , LISP or Ruby.”

— Bezanson et al, Julia: A Fast Dynamic Language for Technical Computing

Features and characteristics

- Multiple dispatch
 - ▶ allows overloading of functions
 - ▶ call types determine what code is executed
- Dynamic typing
 - ▶ “duck-typing”
 - ▶ allowing to indicate types
- Just-in-time compilation
- Moreover: easy parallel programming, easy high-precision computations, etc.

Technical information

- *Julia: A Fresh Approach to Numerical Computing*, J. Bezanson, A. Edelman, S. Karpinski and V. B. Shah (2017) SIAM Review, 59: 65-98
- *Julia: A Fast Dynamic Language for Technical Computing*, J. Bezanson, S. Karpinski, V. B. Shah and A. Edelman (2012) arXiv: 1209.5145
- Open source (MIT License)
GitHub: <https://github.com/JuliaLang/julia>
- Current release 1.0.1 (October 2018)

Install and run Julia (Ubuntu)

https://julialang.org/downloads/

90%

Download Julia

If you like Julia, please consider starring us [on GitHub](#) and spreading the word!

Star 18,101

We provide several ways for you to run Julia:

- In the terminal using the built-in Julia command line.
- In the browser on [JuliaBox.com](#) with Jupyter notebooks. No installation is required – just point your browser there, login and start computing.
- [JuliaPro](#) by [Julia Computing](#) includes Julia and the [Juno IDE](#), along with access to a curated set of packages for plotting, optimization, machine learning, databases and much more (requires registration).

Current stable release (v1.0.1)

Windows Self-Extracting Archive (.exe) [help]	32-bit	64-bit
	Windows 7/Windows Server 2012 users also require TLS "Easy Fix" update , and Windows Management Framework 3.0 or later	
macOS Package (.dmg) [help]	10.8+ 64-bit	
Generic Linux Binaries for x86 [help]	32-bit (GPG)	64-bit (GPG)
Generic FreeBSD Binaries for x86 [help]	64-bit (GPG)	
Source	Tarball (GPG)	Tarball with dependencies (GPG)
		GitHub

Interactive usage

- (Ubuntu) open a terminal and execute the command
“your_path/julia-1.0.0/bin/julia”
- Getting help: type “? name_of_function”

Which editor?

ATOM: <https://atom.io/>



- Editor+Console (interactive mode)
- Julia package: auto autocompletion, colors, formatting, etc
- Latex package: Greek letters, symbols, etc
- Many more package: git, other languages, etc
- Personalization

Script example

Create a file example_script.jl

```
# comments what this script does
# define two numbers and sum them
a=2; b= $\pi$ 
c=a+b
# define two matrices and sum them
A=[ 1 2
    2 3]
B=[ 2 -4
    -2 3 ]
C=A+B
# define a function that sum of the elements of a matrix
function sum_matrix_el(M)
    m,n=size(M) # get the size of the matrix
    sumM=0
    for i=1:n
        for j=1:m
            sumM=sumM+M[i,j]
        end
    end
    return sumM
end
println("The sum of the el. of C is ",sum_matrix_el(C))
```

Hands on

We will now see

- Interactive usage
- Scripts
- Anonymous function
- Functions
- Load functions from a file
- multiple dispatch example

Package systems

Julia is based on a package system. Many functions are available by installing and loading these packages.

Examples of packages:

- *LinearAlgebra*: norms, linear systems, eigenvalues, etc
- *PyPlot, Plots*: graphics, plots, etc
- *Revise*: software development
- *BenchmarkTools*: profiling
- *DifferentialEquations, JuliaFEM*: solve differential equations
- Many more: ...

Package systems

Julia is based on a package system. Many functions are available by installing and loading these packages.

Examples of packages:

- *LinearAlgebra*: norms, linear systems, eigenvalues, etc
 - *PyPlot, Plots*: graphics, plots, etc
 - *Revise*: software development
 - *BenchmarkTools*: profiling
 - *DifferentialEquations, JuliaFEM*: solve differential equations
 - Many more: ...
- Load a package: `using name_of_package`
 - Download a package (two ways):
 - ▶ Package mode: press `]` and then: `add name_of_package`
 - ▶ Load the Package manager: `using Pkg; Pkg.add("name_of_package")`

Package systems

Julia is based on a package system. Many functions are available by installing and loading these packages.

Examples of packages:

- *LinearAlgebra*: norms, linear systems, eigenvalues, etc
 - *PyPlot, Plots*: graphics, plots, etc
 - *Revise*: software development
 - *BenchmarkTools*: profiling
 - *DifferentialEquations, JuliaFEM*: solve differential equations
 - Many more: ...
- Load a package: `using name_of_package`
 - Download a package (two ways):
 - ▶ Package mode: press `]` and then: `add name_of_package`
 - ▶ Load the Package manager: `using Pkg; Pkg.add("name_of_package")`

Hands on: LinearAlgebra package and matrix computation in Julia

Factorize

```
factorize(A)
```

Compute a convenient factorization of `A`, based upon the type of the input matrix. `factorize` checks `A` to see if it is symmetric/triangular/etc. if `A` is passed as a generic matrix, `factorize` checks every element of `A` to verify/rule out each property. It will short-circuit as soon as it can rule out symmetry/triangular structure. The return value can be reused for efficient solving of multiple systems. For example: `A=factorize(A); x=A\b; y=A\C.`

Properties of A	type of factorization
Positive-definite	Cholesky (see cholfact)
Dense Symmetric/Hermitian	Bunch-Kaufman (see bkfact)
Sparse Symmetric/Hermitian	LDLt (see ldltfact)
Triangular	Triangular
Diagonal	Diagonal
Bidiagonal	Bidiagonal
Tridiagonal	LU (see lufact)
Symmetric real tridiagonal	LDLt (see ldltfact)
General square	LU (see lufact)
General non-square	QR (see qrfact)

If `factorize` is called on a Hermitian positive-definite matrix, for instance, then `factorize` will return a Cholesky factorization.