Julia tutorial for SF2524

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SF2524

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

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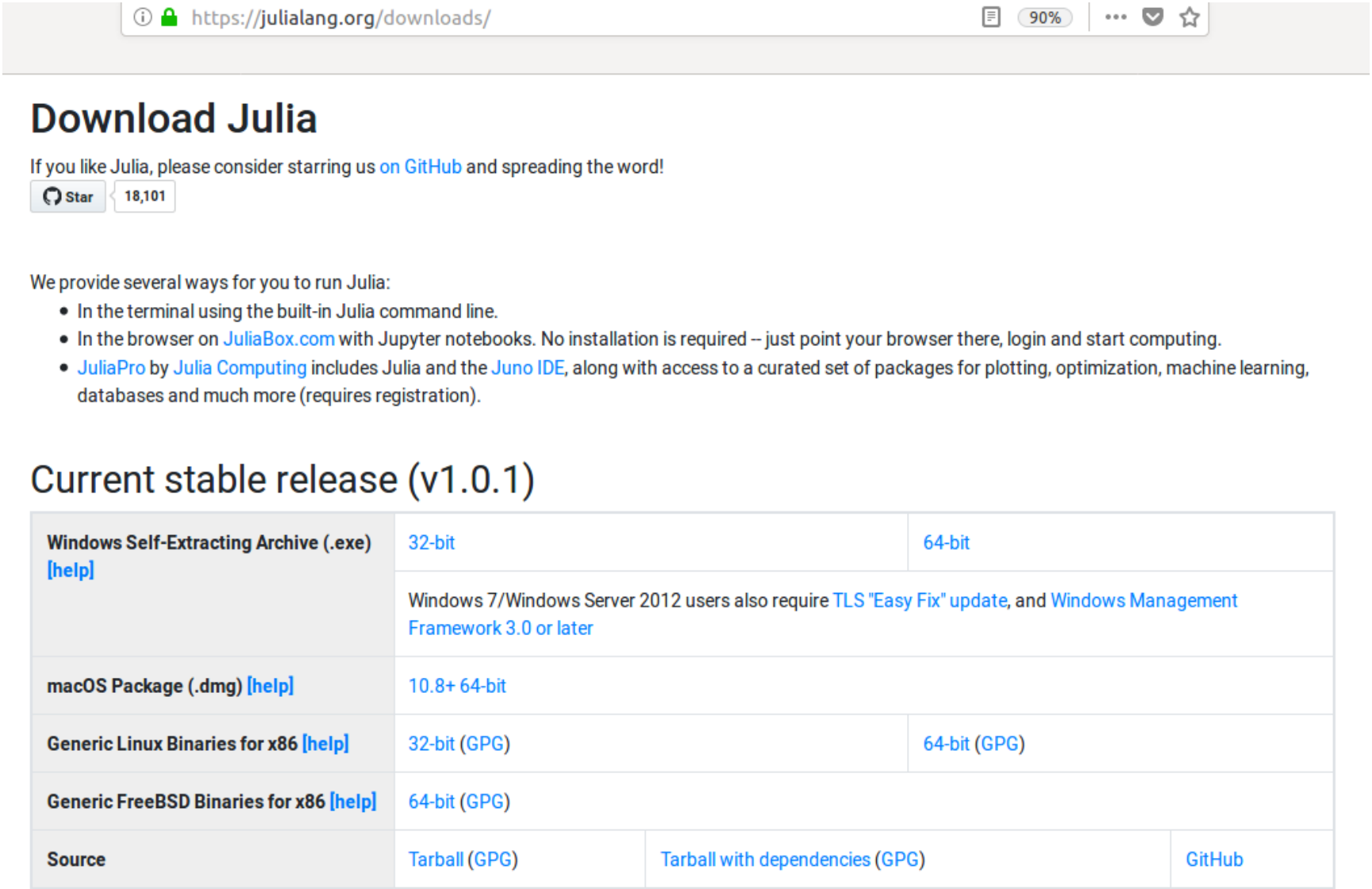
Features and characteristics

- Mutiple 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)



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=π
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: ...

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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.