

Title: PSI 2015/2016 - COMPUTATIONAL/JULIA TALK

Date: Apr 13, 2016 11:30 AM

URL: <http://pirsa.org/16040102>

Abstract:

 **PSI2016b** Last Checkpoint: 20 minutes ago (autosaved)

Control Panel Logout

File Edit View Insert Cell Kernel Help

Julia 0.4.4-pre

Cell Toolbar: None

The Julia Programming Language

In []:

jupyter PSI2016b Last Checkpoint: 20 minutes ago (unsaved changes)

Control Panel Logout

File Edit View Insert Cell Kernel Help

Julia 0.4.4-pre

Cell Toolbar: None

The Julia Programming Language

In [3]: `2+3`

Out[3]: 5

In [4]: `sqrt(5)`

Out[4]: 2.23606797749979

In []:

```
In [13]: super(Real)
```

```
Out[13]: Number
```

```
In [14]: super(Number)
```

```
Out[14]: Any
```

```
In [15]: super(Any)
```

```
Out[15]: Any
```

```
In [16]: Union{Int,Float64}
```

```
Out[16]: Union{Float64,Int64}
```

```
In [ ]: Untion{Int,Int1}
```

```
In [14]: super(Number)
```

```
Out[14]: Any
```

```
In [15]: super(Any)
```

```
Out[15]: Any
```

```
In [16]: Union{Int,Float64}
```

```
Out[16]: Union{Float64,Int64}
```

```
In [18]: Union{Int,Int}
```

```
Out[18]: Int64
```

```
In [ ]:
```

Functions

```
In [19]: function vsum1(x)
          r = 0
          for a in x
            r += a
          end
          r
        end
```

Out[19]: vsum1 (generic function with 1 method)

```
In [20]: vsum1([1,2,3])
```

Out[20]: 6

```
In [21]: vsum1([1.0,2.0,3.0])
```

Out[21]: 6.0

Julia/ PSI2016b PSI2016 Plotting in Julia GitHub - JuliaDiff/ReverseE Erik

https://compute.pi.local/user/eschnetter/notebooks/Julia/PSI2016b.ipynb#

Apps P I π T A C N G goo.gl news comics f W Wikipedia Google Announcing "Practic Don't Marry Career V Other Bookmarks

File Edit View Insert Cell Kernel Help Julia 0.4.4-pre

Code Cell Toolbar: None

```
In [21]: vsum1([1.0,2.0,3.0])
Out[21]: 6.0

In [22]: function vsum2(x)
           r = zero(eltype(x))
           for a in x
               r += a
           end
           r
       end
Out[22]: vsum2 (generic function with 1 method)

In [23]: vsum2([1.0,2.0,3.0])
Out[23]: 6.0

In [ ]:
```

```
Julia/ x PSI2016b x PSI2016 x Plotting in Julia x GitHub - JuliaDiff/Reverse x SPH.jl/runtests.jl at master x Erik
GitHub, Inc. [US] https://github.com/eschnett/SPH.jl/blob/master/test/runtests.jl
Apps P I π T A C N G goo.gl news comics f W Wikipedia G Google Announcing "Practic Don't Marry Career V Other Bookmarks
12 @test p.rho == [0.0,1.0,2.0,3.0,4.0,5.0,6.0,7.0]
13 @test p.posx == [-0.5,0.5,-0.5,0.5,-0.5,0.5,-0.5,0.5]
14 @test p.posy == [-0.5,-0.5,0.5,0.5,-0.5,-0.5,0.5,0.5]
15 @test p.posz == [-0.5,-0.5,-0.5,-0.5,0.5,0.5,0.5,0.5]
16 @test p.vol == [1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0]
17 @test p.mass == [0.125,0.125,0.125,0.125,0.125,0.125,0.125,0.125]
18 @test p.velx == [0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0]
19 @test p.vely == [0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0]
20 @test p.velz == [0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0]
21 @test p.uint == [1.0,1.0,1.0,1.0,1.0,1.0,1.0,1.0]
22
23 # Test EOS
24 press = SPH.eos(p)
25 @test press == [0.125,0.125,0.125,0.125,0.125,0.125,0.125,0.125]
26
27 # Test kernel
28 const sphpars = SPH.SPHParameters(1.5,
29                                     -2.0, -2.0, -2.0,
30                                     +2.0, +2.0, +2.0)
31 @test SPH.kernel_nonzero(sphpars, 0.0, 0.0, 0.0)
32 @test SPH.kernel_nonzero(sphpars, 1.0, 0.0, 0.0)
33 @test SPH.kernel_nonzero(sphpars, 1.499, 0.0, 0.0)
34 @test !SPH.kernel_nonzero(sphpars, 1.501, 0.0, 0.0)
35 for r in rand(0.0:1.0e-8:+2.0, 20)
36     w = SPH.kernel(sphpars, r, 0.0, 0.0)
37     @test SPH.kernel_nonzero(sphpars, r, 0.0, 0.0) == (w!=0)
38     @test SPH.kernel(sphpars, r, 0.0, 0.0) == w
39     @test SPH.kernel(sphpars, 0.0, r, 0.0) == w
40     @test SPH.kernel(sphpars, 0.0, 0.0, r) == w
41     @test SPH.kernel(sphpars, -r, 0.0, 0.0) == w
42     @test SPH.kernel(sphpars, 0.0, -r, 0.0) == w
43     @test SPH.kernel(sphpars, 0.0, 0.0, -r) == w
44     wx,wy,wz = SPH.grad_kernel(sphpars, r, 0.0, 0.0)
```

Julia/ PSI2016b PSI2016 Plotting in Julia GitHub - JuliaDiff/Reverse eschnett/SPH.jl Erik

https://compute.pi.local/user/eschnett/notebooks/Julia/PSI2016b.ipynb#

File Edit View Insert Cell Kernel Help Notebook saved Julia 0.4.4-pre

Code Cell Toolbar: None

```
closest candidates are:  
+ (::Any, ::Any, !Matched::Any, !Matched::Any...)  
+ {T} (::Point2{T}, !Matched::Point2{T})  
while loading In[40], in expression starting on line 1
```

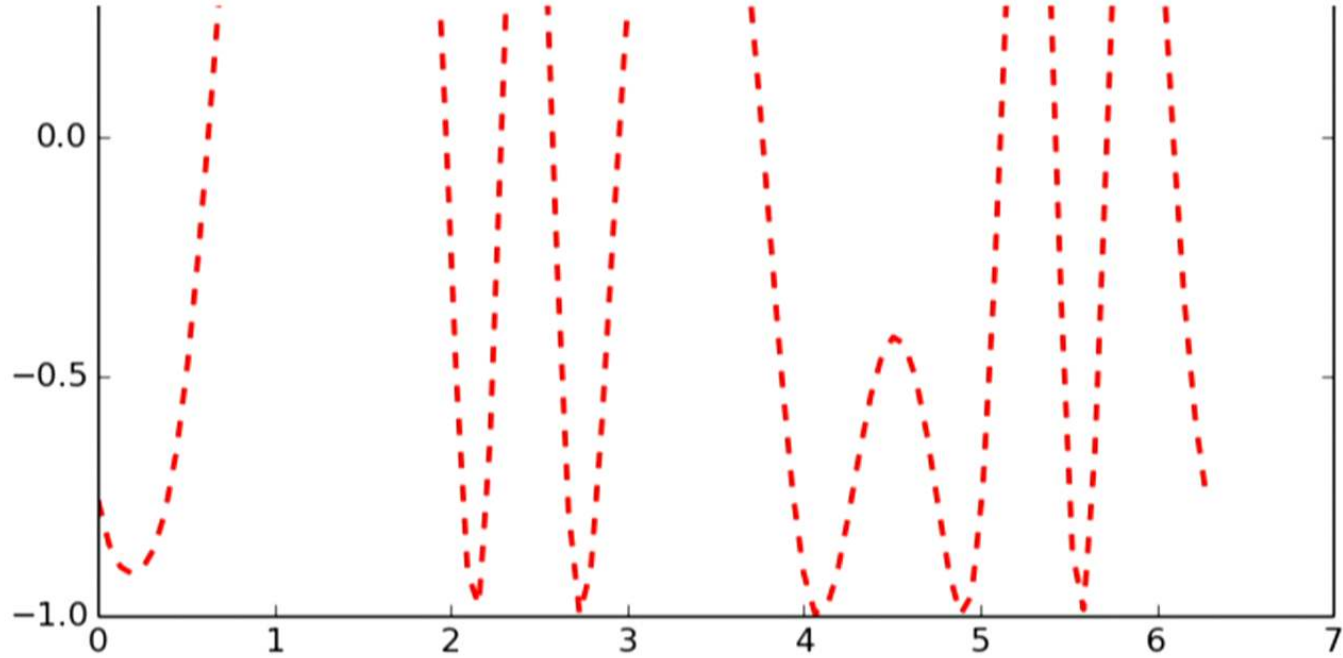
In [43]: `Point2{Vector{Int}}([1,2,3], [4,5,6])`

Out[43]: `Point2{Array{Int64,1}}([1,2,3],[4,5,6])`

Graphics

In [44]: `using PyPlot`

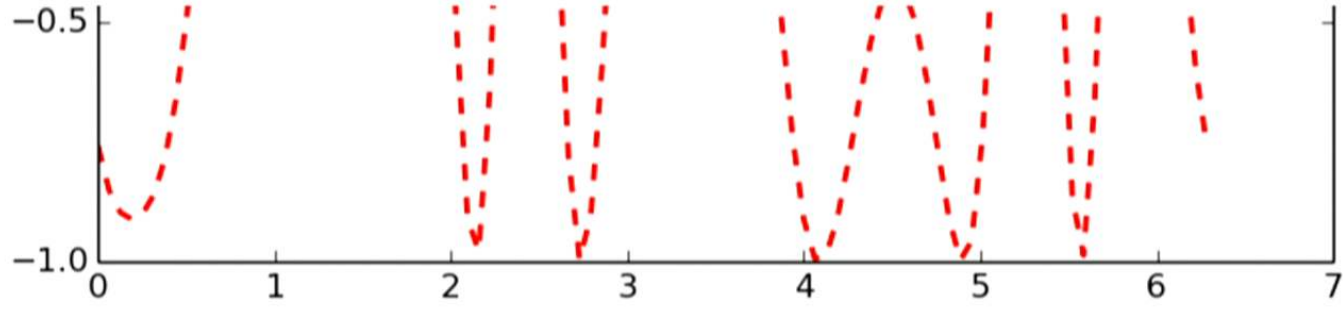
In []:



```
Out[45]: 1-element Array{Any,1}:  
          PyObject <matplotlib.lines.Line2D object at 0x7f6f583b8d90>
```

```
In [ ]:
```

Cell Toolbar: None



```
Out[45]: 1-element Array{Any,1}:  
  PyObject <matplotlib.lines.Line2D object at 0x7f6f583b8d90>
```

Parallel Programming

```
In [ ]: |
```

Julia/ PSI2016b PSI2016 Plotting in Julia GitHub - JuliaDiff/Reverse eschnett/SPH.jl Erik

https://compute.pi.local/user/eschnett/notebooks/Julia/PSI2016b.ipynb#

Apps P I π T A C N G goo.gl news comics f W Wikipedia Google Announcing "Practic Don't Marry Career V Other Bookmarks

File Edit View Insert Cell Kernel Help Julia 0.4.4-pre

Cell Toolbar: None

Parallel Programming

```
In [46]: nworkers()
```

```
Out[46]: 1
```

```
In [47]: addprocs(4)
```

```
Out[47]: 4-element Array{Int64,1}:
         2
         3
         4
         5
```

```
In [48]: nworkers()
```

```
Out[48]: 4
```

```
In [ ]: @everywhere
```


Julia/ PSI2016b PSI2016 Plotting in Julia GitHub - JuliaDiff/Reverse eschnett/SPH.jl Erik

https://compute.pi.local/user/eschnetter/notebooks/Julia/PSI2016b.ipynb#

File Edit View Insert Cell Kernel Help Julia 0.4.4-pre

Code Cell Toolbar: None

```
Out[47]: 4-element Array{Int64,1}:
          2
          3
          4
          5
```

```
In [48]: nworkers()
```

```
Out[48]: 4
```

```
In [49]: myid()
```

```
Out[49]: 1
```

```
In [50]: @everywhere pmyid()
```

```
In [ ]:
```

Julia/ PSI2016b PSI2016 Plotting in Julia GitHub - JuliaDiff/Reverse eschnett/SPH.jl Erik

https://compute.pi.local/user/eschnetter/notebooks/Julia/PSI2016b.ipynb#

File Edit View Insert Cell Kernel Help Julia 0.4.4-pre

Code Cell Toolbar: None

```
Out[47]: 4-element Array{Int64,1}:
          2
          3
          4
          5
```

```
In [48]: nworkers()
```

```
Out[48]: 4
```

```
In [49]: myid()
```

```
Out[49]: 1
```

```
In [50]: @everywhere println(myid())
```

```
In [ ]:
```

Julia/ PSI2016b PSI2016 Plotting in Julia GitHub - JuliaDiff/Reverse eschnett/SPH.jl Erik

https://compute.pi.local/user/eschnetter/notebooks/Julia/PSI2016b.ipynb#

File Edit View Insert Cell Kernel Help Julia 0.4.4-pre

Code Cell Toolbar: None

```
3
4
5
```

In [48]: `nworkers()`

Out[48]: 4

In [49]: `myid()`

Out[49]: 1

In [51]: `@everywhere println(myid())`

```
1
    From worker 2: 2
    From worker 5: 5
    From worker 3: 3
    From worker 4: 4
```

In []:

Julia/ PSI2016b PSI2016 Plotting in Julia GitHub - JuliaDiff/Reverse eschnett/SPH.jl Erik

https://compute.pi.local/user/eschnett/notebooks/Julia/PSI2016b.ipynb#

File Edit View Insert Cell Kernel Help Julia 0.4.4-pre

Code Cell Toolbar: None

```
In [51]: @everywhere println(myid())
1
      From worker 2: 2
      From worker 5: 5
      From worker 3: 3
      From worker 4: 4
```

```
In [52]: @everywhere A = randn(1000,1000)
```

```
In [53]: @everywhere U,S,V = svd(A)
```

```
In [56]: @everywhere println(S[1])
63.00877492064318
      From worker 3: 63.20887233493185
      From worker 2: 62.78178510735606
      From worker 4: 62.954105435562724
      From worker 5: 63.17036077451712
```

```
In [ ]:
```

Julia/ PSI2016b PSI2016 Plotting in Julia GitHub - JuliaDiff/Revers... eschnett/SPH.jl Erik

https://compute.pi.local/user/eschnetter/notebooks/Julia/PSI2016b.ipynb#

File Edit View Insert Cell Kernel Help Julia 0.4.4-pre

Code Cell Toolbar: None

```
In [58]: x -> 2*x
Out[58]: (anonymous function)

In [59]: (x -> 2*x)(4)
Out[59]: 8

In [61]: rrefs = [remotecall(w, () -> (myid(), gethostname(), getpid())) for w in workers()]
Out[61]: 4-element Array{Any,1}:
  RemoteRef{Channel{Any}}(2,1,33)
  RemoteRef{Channel{Any}}(3,1,34)
  RemoteRef{Channel{Any}}(4,1,35)
  RemoteRef{Channel{Any}}(5,1,36)

In [ ]: |
```

Code Cell Toolbar: None

```
remoteref{Channel{Any}}(4,1,35)  
RemoteRef{Channel{Any}}(5,1,36)
```

```
In [63]: map(fetch, rrefs)
```

```
Out[63]: 4-element Array{Any,1}:  
 (2, "compute", 24952)  
 (3, "compute", 24953)  
 (4, "compute", 24954)  
 (5, "compute", 24955)
```

Macros

```
In [64]: x^2
```

```
LoadError: MethodError: `*` has no method matching *(::LinSpace{Float64}, ::LinSpace{Float64})  
Closest candidates are:  
  * (::Any, ::Any, !Matched::Any, !Matched::Any...)  
  * {T} (!Matched::Bidiagonal{T}, ::AbstractArray{T,1})  
  * (!Matched::Number, ::AbstractArray{T,N})  
  ...  
while loading In[64], in expression starting on line 1
```

Julia/ PSI2016b PSI2016 Plotting in Julia GitHub - JuliaDiff/Reverse eschnett/SPH.jl Erik

https://compute.pi.local/user/eschnett/notebooks/Julia/PSI2016b.ipynb#

File Edit View Insert Cell Kernel Help Julia 0.4.4-pre

Code Cell Toolbar: None

```
remoteref{Channel{Any}}(4,1,35)
RemoteRef{Channel{Any}}(5,1,36)
```

In [63]: `map(fetch, rrefs)`

```
Out[63]: 4-element Array{Any,1}:
 (2, "compute", 24952)
 (3, "compute", 24953)
 (4, "compute", 24954)
 (5, "compute", 24955)
```

Macros

In [65]: `:(x^2)`

```
Out[65]: :(x ^ 2)
```

In []:

Julia/ PSI2016b PSI2016 Plotting in Julia GitHub - JuliaDiff/Revers eschnett/SPH.jl Erik

https://compute.pi.local/user/eschnett/notebooks/Julia/PSI2016b.ipynb#

File Edit View Insert Cell Kernel Help Julia 0.4.4-pre

Code Cell Toolbar: None

```
Out[63]: 4-element Array{Any,1}:
 (2, "compute", 24952)
 (3, "compute", 24953)
 (4, "compute", 24954)
 (5, "compute", 24955)
```

Macros

```
In [65]: :(x^2)
```

```
Out[65]: :(x ^ 2)
```

```
In [69]: 2 + @show 3 * 4
```

```
3 * 4 = 12
```

```
Out[69]: 14
```

```
In [ ]:
```

Julia/ PSI2016b PSI2016 Plotting in Julia GitHub - JuliaDiff/Reverse eschnett/SPH.jl Erik

https://compute.pi.local/user/eschnett/notebooks/Julia/PSI2016b.ipynb#

File Edit View Insert Cell Kernel Help Julia 0.4.4-pre

Code Cell Toolbar: None

Macros

```
In [65]: :(x^2)
```

```
Out[65]: :(x ^ 2)
```

```
In [69]: 2 + @show 3 * 4
```

```
          3 * 4 = 12
```

```
Out[69]: 14
```

```
In [*]: using ReverseDiffSource
```

```
In [ ]: |
```

Julia/ PSI2016b PSI2016 Plotting in Julia GitHub - JuliaDiff/Reverse eschnett/SPH.jl Erik

https://compute.pi.local/user/eschnett/notebooks/Julia/PSI2016b.ipynb#

File Edit View Insert Cell Kernel Help Julia 0.4.4-pre

Code Cell Toolbar: None

```
In [65]: :(x^2)
Out[65]: :(x ^ 2)

In [69]: 2 + @show 3 * 4
          3 * 4 = 12
Out[69]: 14

In [70]: using ReverseDiffSource

In [71]: rdiff(:( 1 + 2x + 3x^2 ), x=1.0)
Out[71]: quote
          (1 + (2x + 3 * x ^ 2), 2.0 + 2 * (x * 3.0))
        end

In [ ]:
```



Code



CellToolbar

NCon

```
In [13]: # Install the NCon package if it's not installed  
Pkg.clone("git://github.com/mhauru/NCon.jl.git")
```

```
INFO: Cloning NCon from git://github.com/mhauru/NCon.jl  
.git
```

```
LoadError: NCon already exists  
while loading In[13], in expression starting on line 2
```

```
In [14]: # Update the NCon package  
Pkg.checkout("NCon")
```

```
INFO: Checking out NCon master
```



Code



CellToolbar

In [15]: `using NCon`

```
In [16]: # Contract together a simple network
A = randn(10,10)
B = randn(2000,10,200,2)
C = randn(2000,10,200,2)
I = randn(2000)
J = randn(2000)
# Positive numbers label contraction indices, negative r
#@time result = ncon((A, B, C, I, J), ([1,2], [4,1,3,-2])
```

0.022375 seconds (1.09 k allocations: 160.906 KB)

Out[16]: 2x2 Array{Float64,2}:



Code



CellToolbar

```
In [15]: using NCon
```

```
In [20]:
```

```
], [4,1,3,-2], [5,2,3,-1], [4], [5]); order=[4,5,1,3,2])  
indices, negative numbers label free indices.  
([1,2], [4,1,3,-2], [5,2,3,-1], [4], [5]); order=[4,5,1,
```

```
0.044960 seconds (18.32 k allocations: 997.644 KB)
```

```
Out[20]: 2x2 Array{Float64,2}:  
 1.36188e5 -2.60377e5  
-2.14647e5 -1.3718e5
```



Code



CellToolbar

```
, -1], [4], [5]); order=[4,5,1,3,2], forder=[-2, -1])  
pers label free indices.  
[5,2,3,-1], [4], [5]); order=[4,5,1,2,3], forder=[-2, -1])
```

0.022553 seconds (1.09 k allocations: 160.906 KB)

Out[21]: 2x2 Array{Float64,2}:
-85763.1 -2.32687e5
-329276.0 -1098.28

See documentation at <https://github.com/mhauru/NCon.jl> for more details.



Code



CellToolbar

See documentation at <https://github.com/mhauru/NCon.jl> for more details.



TensorFactorizations

```
In [6]: # Install the TensorFactorizations package if it's not installed
Pkg.clone("git://github.com/mhauru/TensorFactorizations.jl.git")
```

```
INFO: Cloning TensorFactorizations from git://github.com/mhauru/TensorFactorizations.jl.git
```

```
LoadError: TensorFactorizations already exists
while loading In[6], in expression starting on line 2
```



Code



CellToolbar

```
in anonymous at pkg/dir.jl:31
in cd at file.jl:22
in cd at pkg/dir.jl:31
in checkout at pkg.jl:37
```

```
In [22]: using TensorFactorizations
```

```
In [23]: # Singular value decompose a tensor
A = rand(1,4,2,3,5)
U, S, Vt = tensorsvd(A, (1,3,4), (2,5))
#U, S, Vt = tensorsvd(A, (1,3,4), (2,5))
#@show S;
```

```
In [11]: # Truncate the SVD to a fixed number of singular values.
U, S, Vt = tensorsvd(A, (1,3,4), (2,5); chis=3)
```



Code



CellToolbar

See the GitHub sites for more details:

<https://github.com/mhauru/NCon.jl>

<https://github.com/mhauru/TensorFactorizations.jl>

See also: <https://github.com/Jutho/TensorOperations.jl>

And please report all bugs on GitHub or directly to me! (markus@mhauru.org)