



Star-P®: Multilingual Platform for High Performance Computing

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INTERACTIVE
supercomputing

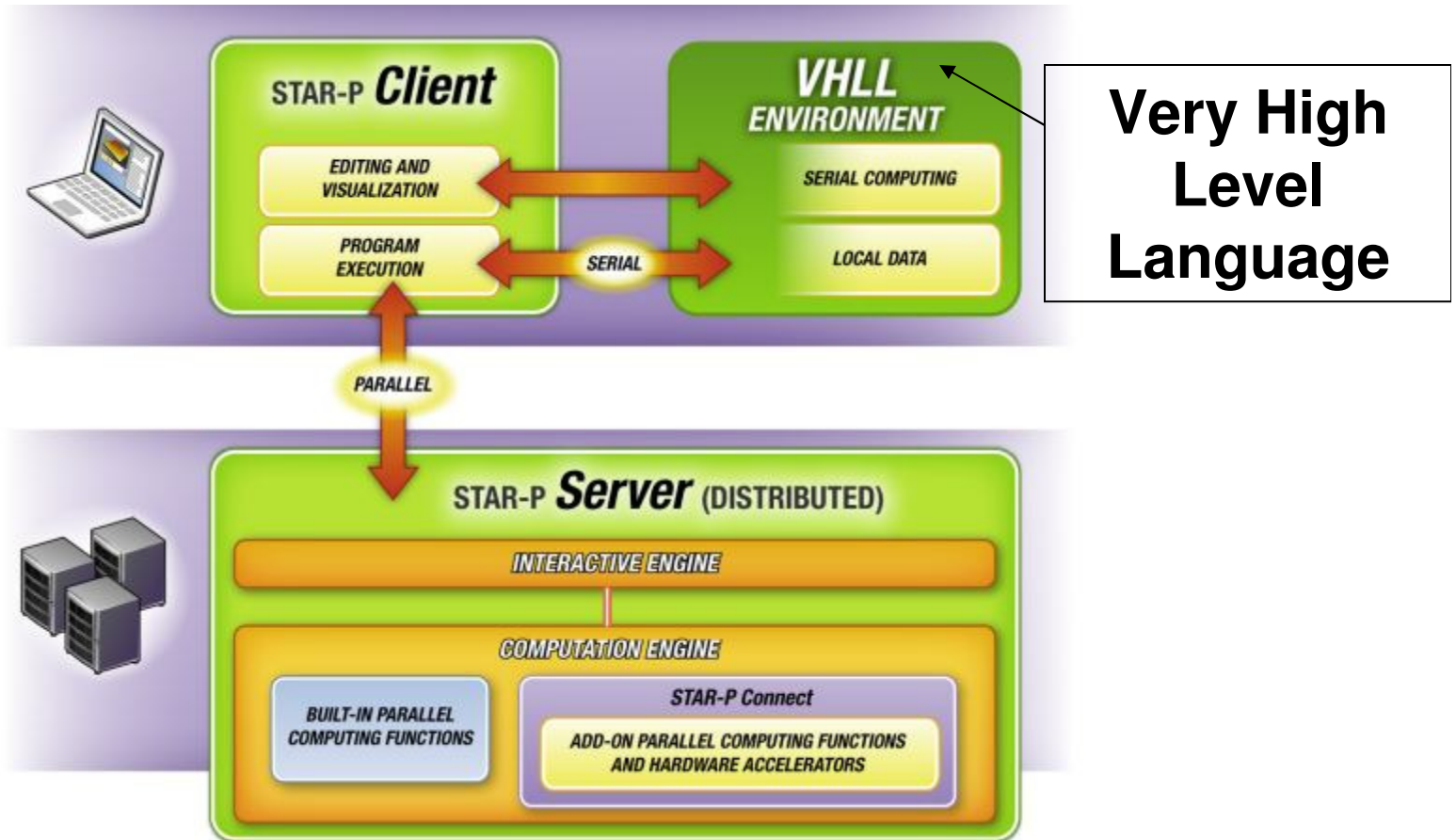


Star-P Functional Overview

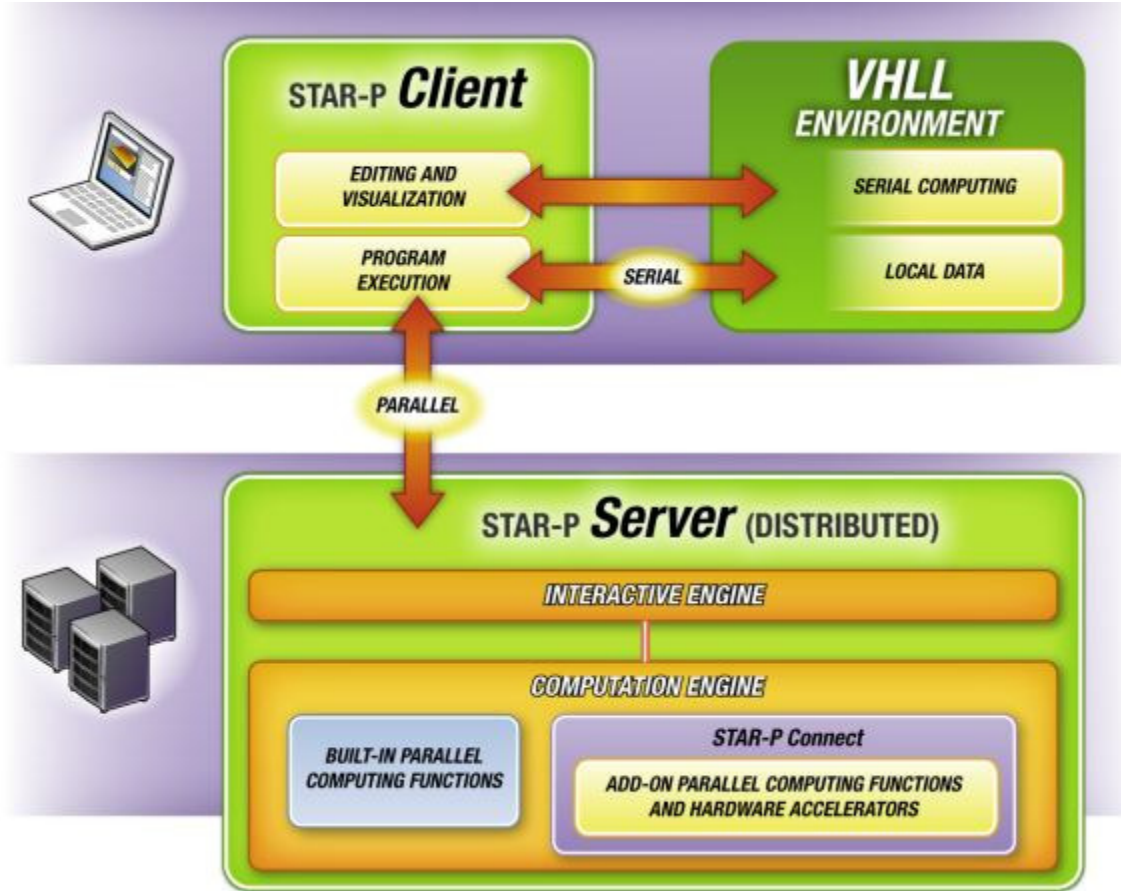




Star-P Functional Overview

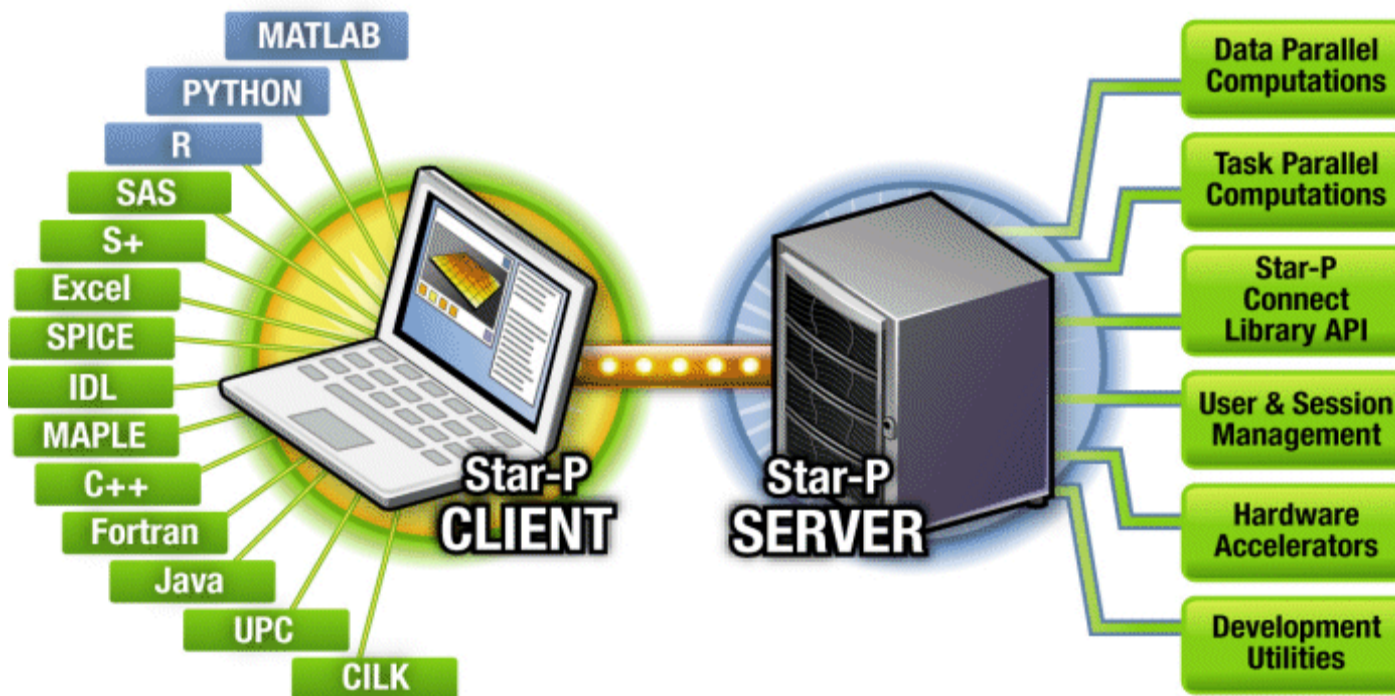


Star-P Functional Overview



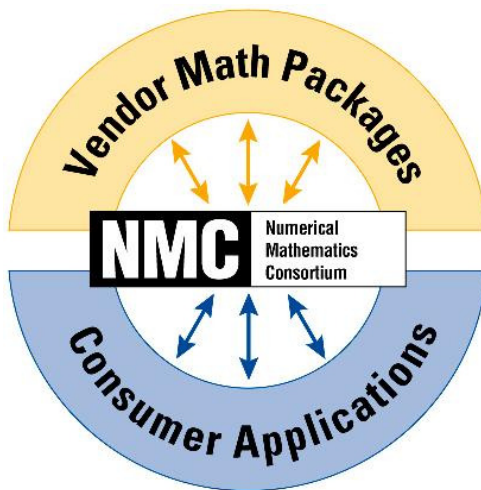
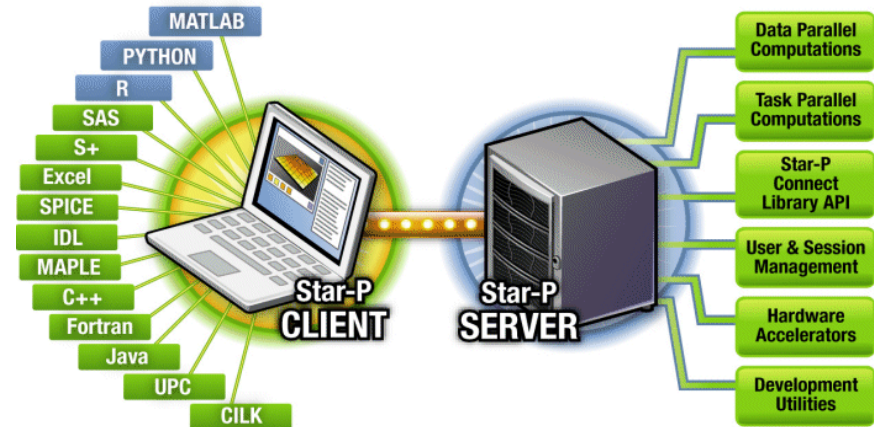
Multilingual Computing

- As ISC built the multilingual platform, what did we learn?



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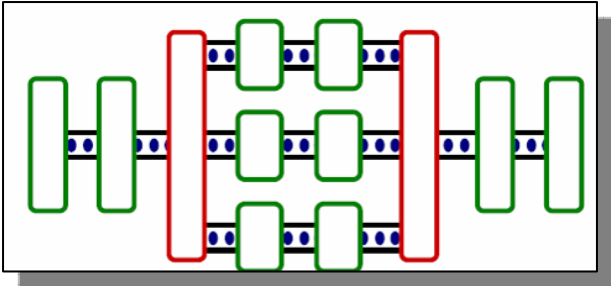
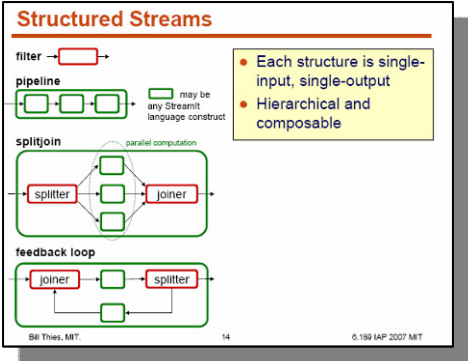


- All languages sort of the same
- All languages sort of different
 - Time is ripe for standards
 - MATLAB® historical shining leader in floating point, IEEE 754, now time to go beyond floating point.



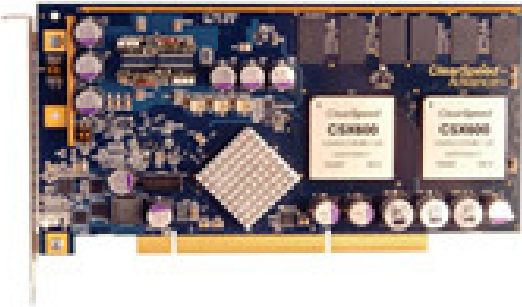
Research @ISC

- Stream processing



Saman Amarasinghe: StreamIt

- Hardware Accelerators: FPGAs, GPUs



Multilingual Examples

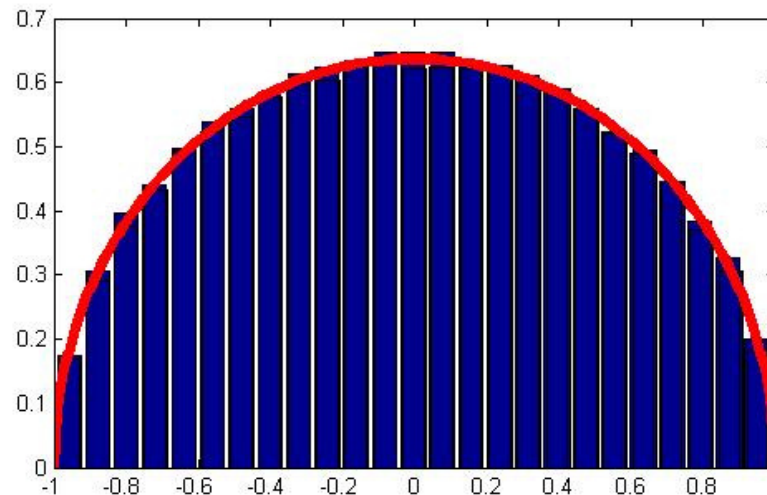
- Wigner's Semicircle Law



Example: Star-P with the M language of Mathworks MATLAB®



```
File Edit Debug Desktop Window Help
c:\progra~1\starp-2.3
Shortcuts How to Add What's New
>> n=2000;
>> a=randn(n*p); s=(a+a')/(sqrt(8*n)); e=eig(s,'sym');
>> [y,x]=hist(ppfront(e),25); bar(x, (y/n)/(x(2)-x(1)))
>> x=-1:.01:1; hold on; plot(x,(2/pi)*sqrt(1-x.^2),'r','LineWidth',5)
```



Example: Star-P with Python®



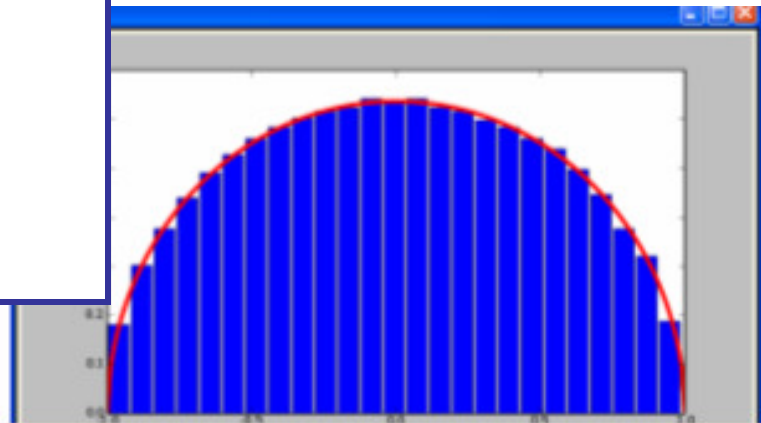
```
import starp, numpy, pylab, matplotlib
starp.defaultConnect('kong', '/usr/local/starp-
versions/7790', nodashboard=1)

n = 2000
a = starp.random.randn(n, n)
s = (a+a.T)/numpy.sqrt(8*n)
e = starp.linalg.eigvals(s)

# Create histogram plot
x = numpy.linspace(-1, 1, 21)-.04
(h, bins) = starp.histogram(e, 21, normed=True)
pylab.bar(x, h.ppfront(), width = 0.08)

# Create solid line
y = (2/numpy.pi)*numpy.sqrt(1 - x*x)
pylab.plot(x, y, 'r', lw=3)

# Show plots
pylab.show()
```





Example: Star-P with R®

(In Development)

The screenshot displays the R environment. The R Console window shows the version information (2.4.0) and a series of help messages. The R Graphics window shows a histogram titled "Histogram of e" with a density curve overlaid. The histogram bars are blue, and the curve is red. The x-axis is labeled "e" and ranges from -1.0 to 1.0. The y-axis is labeled "Density" and ranges from 0.0 to 0.6.

```
R Console
R version 2.4.0 (2006-10-03)
Copyright (C) 2006 The R Foundation
ISBN 3-900051-07-0

R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.

Natural language support but running in an English locale

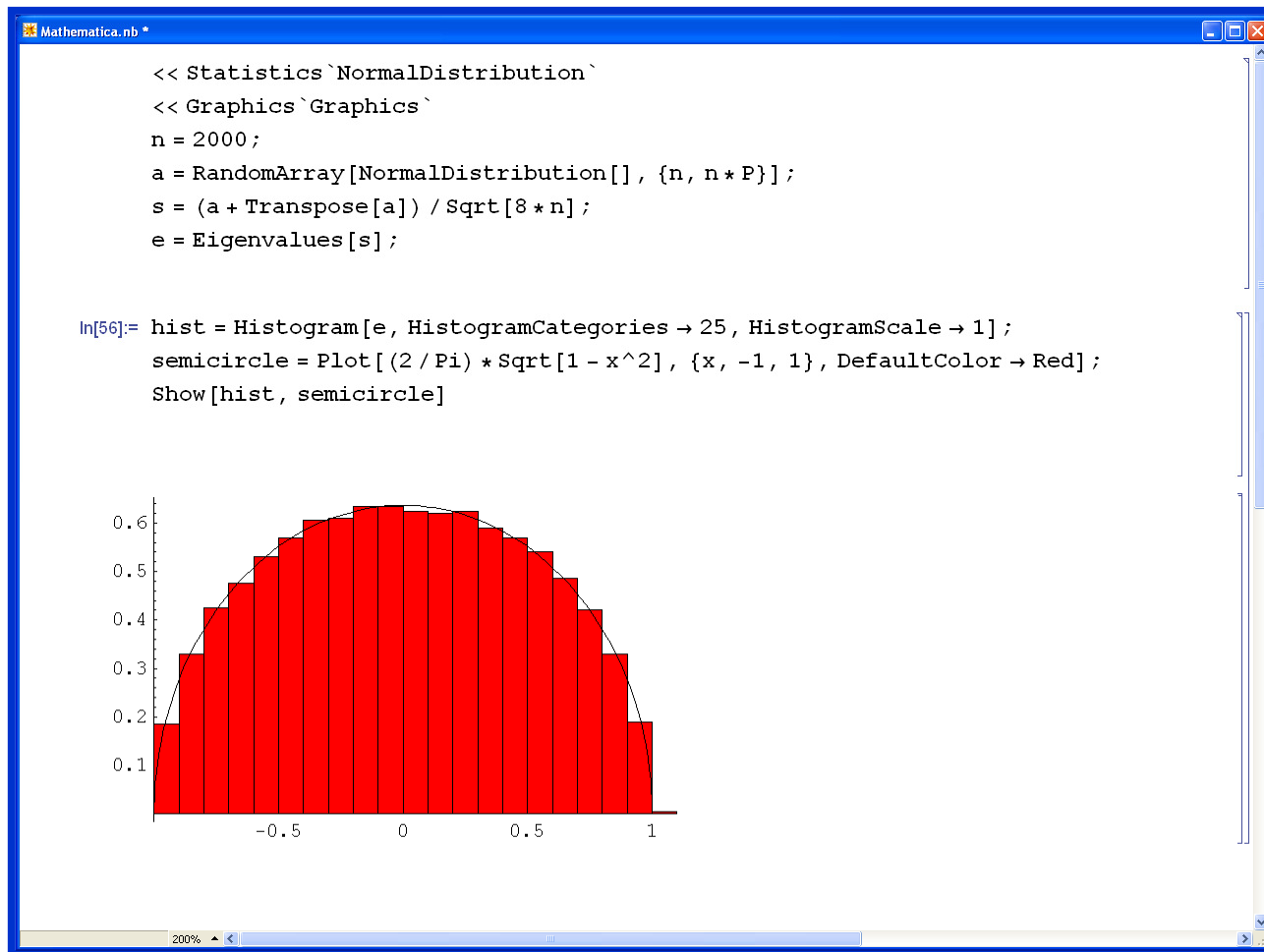
R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

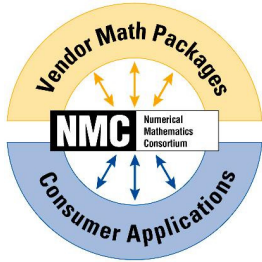
> n<-2000;
> a<-matrix(rnorm(n*n),ncol=n*p);s<-(a+t(a))/sqrt(8*n);
> e=eigen(s,symmetric=T,only.values=T)$values;
>
> hist(e,25,freq=F,col='blue');curve((2/pi)*sqrt(1-x^2),-1,1,col='red',lwd=5,add=T)
```

Example: Star-P with Mathematica®

(In Development)



The need for language standards



The views here are my own at the moment and not that of ISC or the NMC, but based heavily on what I have learned from the experience of these groups

The “transparent market” for high level languages

IEEE 754 story for floating point
Needs repetition for library functions

Goals

1. Some mathematical standards are set by mathematics e.g. $\text{prod}([\])=1$ other answers just wrong
2. Some standards are arbitrary and some committee ought to fix
3. Some should allow for a portfolio of solutions, nobody should dictate and users should be able to readily compare
– main point: more information

Optimization is my “poster child” example.
Need a consumer magazine style comparison.

Cholesky: upper or lower?



Answer: It doesn't matter of course, but

Cholesky: upper or lower?



Answer: It doesn't matter of course, but

```
>> chol(a)

ans =

    9.9970    0.0380   -0.1875    0.0569    0.0315    0.0212    0.0088
     0      9.9493    0.0438   -0.0259    0.1450    0.0238   -0.0639
     0       0      10.0428   -0.0364   -0.0350   -0.1001   -0.0553
     0       0       0       9.9849    0.0625   -0.0747    0.0440
     0       0       0       0      10.0385    0.1075   -0.0942
     0       0       0       0       0       9.9920    0.0791
     0       0       0       0       0       0      10.0272
```

Sorting



```
>> x=[-1 1 2]
x =
    -1     1     2
>> sort(x)
ans =
    -1     1     2
>> x=[-1 1 2*i]
x =
    -1.0000    1.0000    0 + 2.0000i
>> sort(x)
ans =
    1.0000   -1.0000    0 + 2.0000i
>> 1 < (2*i)
ans =
     0
>> 1 > (2*i)
ans =
     1
>> max(1,i)
ans =
     1
>> min(1,i)
ans =
     1
>> max(i,1)
ans =
     0 + 1.0000i
>> min(i,1)
ans =
     0 + 1.0000i
```

```
>> x=[1 -1 i]'; y=[1;-1;-i]; [x y x-y]
ans =
    1.0000    1.0000     0
   -1.0000   -1.0000     0
    0 - 1.0000i    0 - 1.0000i     0
```

```
>> [sort(x) sort(y)]
ans =
   -1.0000    0 - 1.0000i
    0 - 1.0000i    1.0000
    1.0000   -1.0000
```

```
>> a=[-2 -1 1 2 3]; roots(poly(a))'
ans =
    3.0000   -2.0000   -1.0000    2.0000    1.0000
```




Branch cuts

- $\text{Arctan}(i*x)$ (for x large)
 $\pi/2$ or $-\pi/2$??
- Standard proposes counterclockwise continuity

```
>> atan( i * 1e100 )  
ans =  
1.5708 + 0.0000i  
  
>> atan( i * 1e200 )  
ans =  
-1.5708 + 0.0000i
```

Conclusions

- Star-P Multilingual Platform
 - MATLAB®, Python®, R®
- All functionality available from all languages!
- Organizations want multilingual service, individuals often do not realize they can have choice, but the “download, next, next, next” languages are catching on
- Visit ISC at booth 370.