

Introducing a New Client/Server Framework for Big Data Analytics with the R Language

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Acknowledgements

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- Just got an allocation on Comet! Thank you XSEDE!

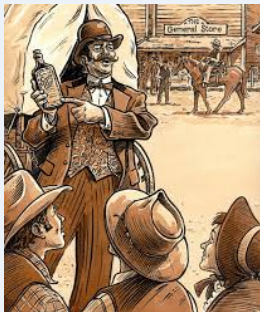
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- 1 Background and Motivation
- 2 pbdR Compute Backend
- 3 The Client/Server
- 4 Challenges and Future Work



Problems with "Big Data" Software



- *Many* frameworks; what do they all do?
- Don't always play nice with HPC systems.
- Often not as "high level" as advertised.
- **Almost exclusively batch!**

Data Analysis Is An Interactive Activity

Data analysis is an interactive activity^a

^aData analysis is an interactive activity

Why am I here?



- XSEDE: a conference for users and service providers.
- I want to talk to you!

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pbdR

Client/Server + **pbdR** = interactive big data analysis

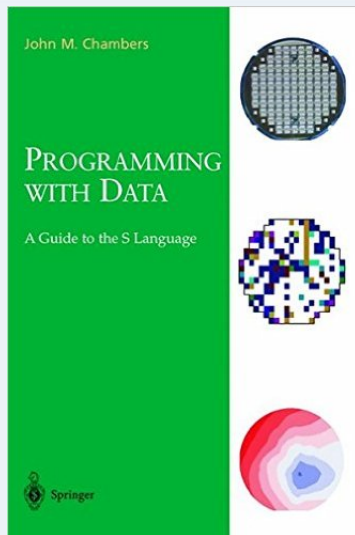
- This talk is not about the old stuff...
- But we have to talk about it!

Programming with Big Data in R (pbdR)



- Free/Open Source R packages.
- Actively maintained, available on CRAN and Github.
- Packages: Library interfaces, high-level frameworks, profiling and vis, ...
- For today: MPI+ScaLAPACK stuff.
- Syntax *identical* to R.

About the Name

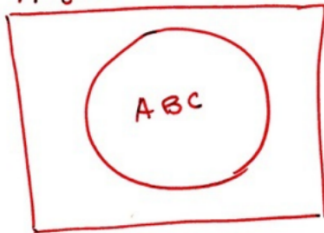


R as an Interface Language

me
①

Algorithm Interface

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XABC

ABC: general
(FORTRAN)
algorithm

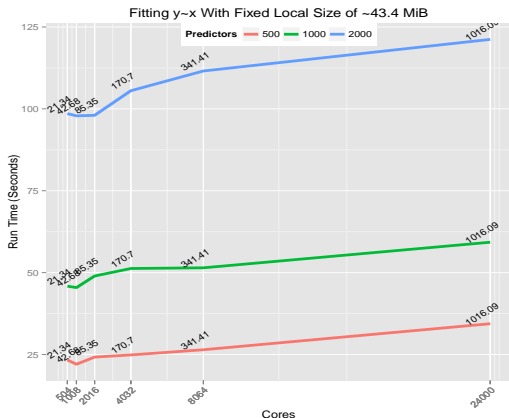
XABC: FORTRAN
subroutine to
provide interface
between ABC &
language and/or
utility programs

XABC (INSTR, OUTSTR)

<http://datascience.la/john-chambers-user-2014-keynote/>



Distributed Matrices and Statistics with pbdDMAT



```
library(pbdDMAT)
init.grid()

x <- ddmatrix("rnorm",
              nrow=m, ncol=n)
y <- ddmatrix("rnorm",
              nrow=m, ncol=1)

mdl <- lm.fit(x=x, y=y)

finalize()
```

pbdR Paradigms/"Opinions"

- In core.
- Focus on dense data.
- Integrates well with traditional HPC.
- C and Fortran for performance; R for the interface.
- Exclusively batch.
- (Mostly) Very different from Hadoop/Spark!

"OLCF Researchers Scale R to Tackle Big Science Data Sets"



- A problem that takes several hours on Apache Spark [was analyzed] in less than a minute using R on OLCF high-performance hardware.
- "...for situations where one needs interactive near-real-time analysis, **the pbdR approach is much better.**"

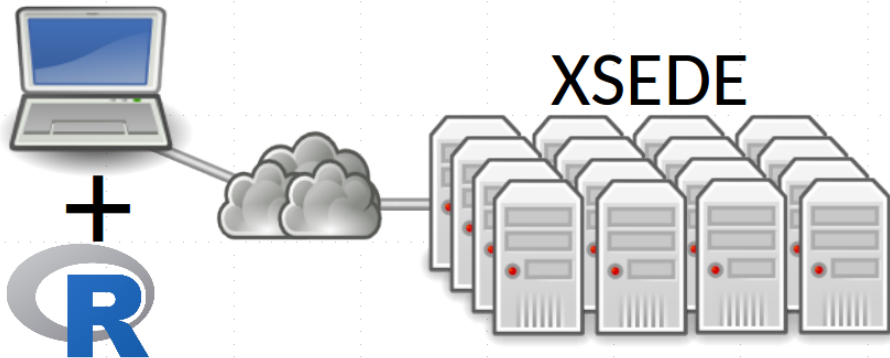
<https://www.hpcwire.com/2016/07/06/olcf-researchers-scale-r-tackle-big-science-data-sets/>

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- 3 The Client/Server
 - Design and Architecture of the Client Server
 - Examples
 - Overhead
- 4 Challenges and Future Work

3 The Client/Server

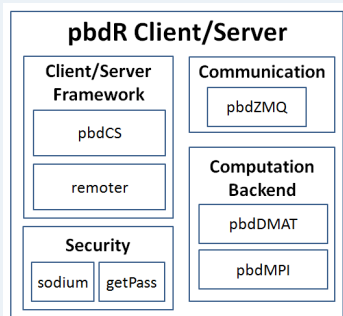
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Motivation



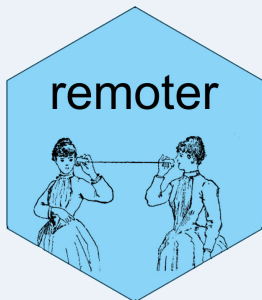
Connect local R session to a remote one.

The C/S Framework



- No specialized software environment; just R packages.
- Designed for the cloud or HPC resources.
- Mostly "un-opinionated"; can use our compute backend, SparkR, whatever.
- Optional security features: passwords and encryption.

A Quick Summary of the Main Components



- **pbdZMQ**: ZeroMQ bindings.
Use: our C/S packages; IRkernel, ...
- **remoter**: client/server core.
Use: cloud computing, "reference" big data framework.
- **pbdCS**: Extension of remoter for the MPI backend stuff.
Use: Bringing interactivity to pbdR "big data" system.

Comparison to Similar Utilities

"Moving computations to a remote machine"

- Web frameworks: **shiny**, **htmlwidgets**, **fiery**, ...
- ~~Revolution~~ Microsoft Analytics: Microsoft R Server and R Client
- Jupyter/notebooks.
- RStudio Server
- **rmote**

3 The Client/Server

- Design and Architecture of the Client Server
- Examples
- Overhead



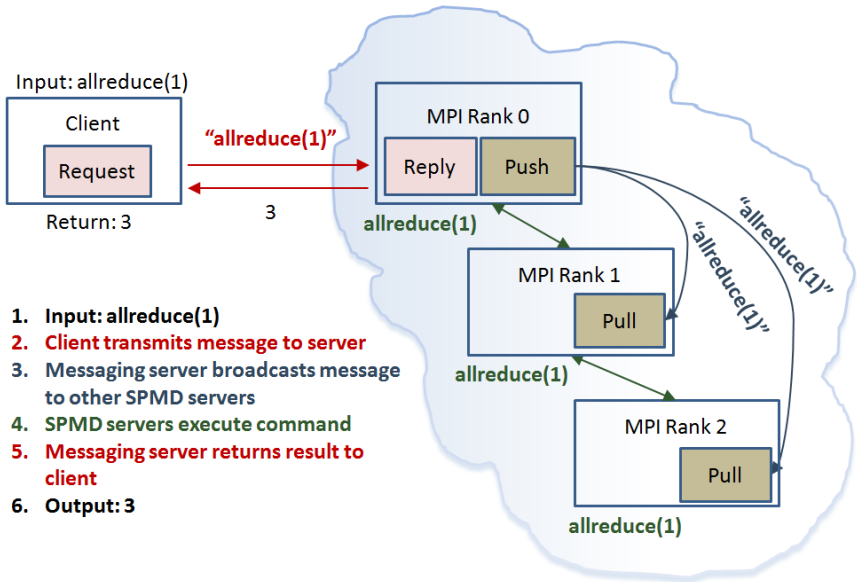
Basics

Elsewhere:

```
1 R> remoter::server()  
2  
3 ## [2016-07-19 12:53:23]: *** Launching secure server ***
```

In your local R session:

```
1 R> remoter::client()  
2 remoter> x = 1  
3 remoter> x  
4 ## [1] 1  
5 remoter> exit()  
6  
7 R> x  
8 ## Error: object 'x' not found  
9 R> remoter::client()  
10  
11 remoter> s2c(x)  
12 remoter> exit()  
13 R> x  
14 [1] 1
```



1. Input: allreduce(1)
2. Client transmits message to server
3. Messaging server broadcasts message to other SPMD servers
4. SPMD servers execute command
5. Messaging server returns result to client
6. Output: 3

A Demo?

- No time for a live demo...
- Any time you see me at XSEDE16, ask and I'll give you one!
- For a non-live demo, see:
<https://github.com/snoweye/user2016.demo>
- More information in the **remoter** vignette:
<https://cran.r-project.org/web/packages/remoter/vignettes/remoter.html>

3 The Client/Server

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- Examples
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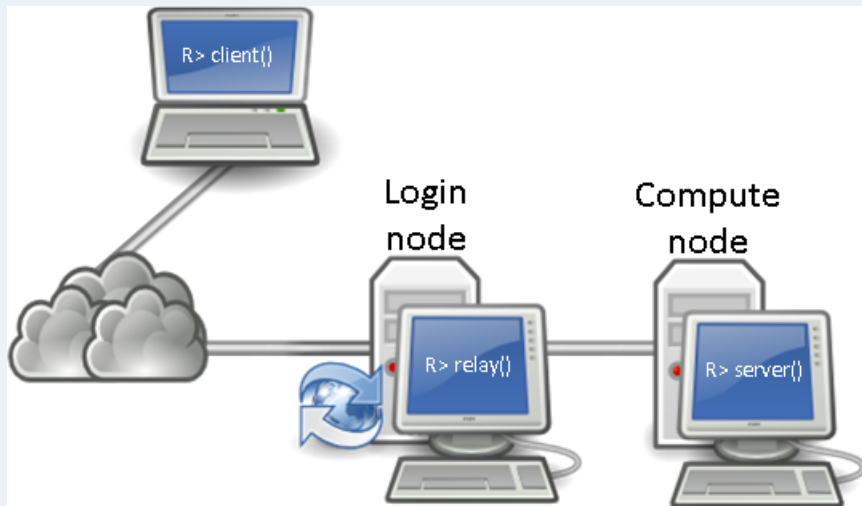


Size Costs

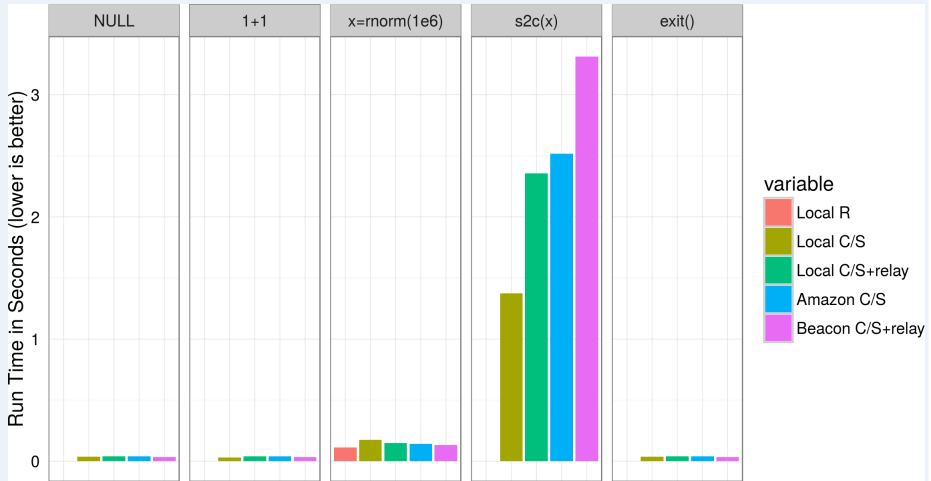
- There is a size overhead in transmitted messages.
- For almost everything you would do, no big deal.
- See paper for full discussion.



Relays



Run Time Costs



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Already done!

- Batch computing with a remote server.
- Graphics and help, integration with **rmote**.
- Many small things we didn't bother to mention.

Object Guarding

Currently possible to send huge amounts of data without realizing it.

```
1 pbdR> print(huge_thing)
2 ## uh-oh!
```

Relays and Integration with the Scheduler

Some day...

```
1 R> bigJob(machine="stampede", nodes=10, interactive=TRUE)
```


References

- Schmidt, D., Chen, W.-C. and Ostrouchov, G. (2016), “Introducing a New Client/Server Framework for Big Data Analytics with the R Language, XSEDE2016.
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~Thanks!~

Questions?



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