

Interoperability using R

Joining forces instead of separating

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- Cross-debugging
- Performance overhead
- Cognitive effort due to increased complexity

Interop directions

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- Magic (next-gen VMs)

Historical perspective

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- Second example: `rpy`, now `rpy2` for Python 3

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 - Low-level, callable from C (or FORTRAN!)

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- Mathematical functions and constants
- Numerical optimization, integration

- An integration between R and C++ that is easy to use

Intro

rJava

Rserve

R to Py to R

GraalVM

References

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- Rcpp (\rightarrow R) is accompanied by RInside ($R\rightarrow$)

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- R→Java also exists and is called JRI
- Requires both JRE and JDK to be installed
- Installation is a bit non-trivial (paths, flags, env. vars)

Example: dxFeed API

```
library(rJava)
rjava_obj <- R6::R6Class('rJavaObject',
  public = list(jobject = NULL,
    get_orders = function() {
      .jcall(self$jobject, '[[D',
        method = 'getOrders', simplify = TRUE)
    },
    initialize = function(symbol) {
      .jinit(classpath = '/path/to/dxfeed-samples-
        rjava.jar')
      self$jobject <- .jnew('com.dxfeed.sample._
        simple_/OrderBookR', symbol)
    }
  )
)
tsla <- rjava_obj$new("TSLA"); Sys.sleep(2)
tsla$get_orders()
```

Example: dxFeed API

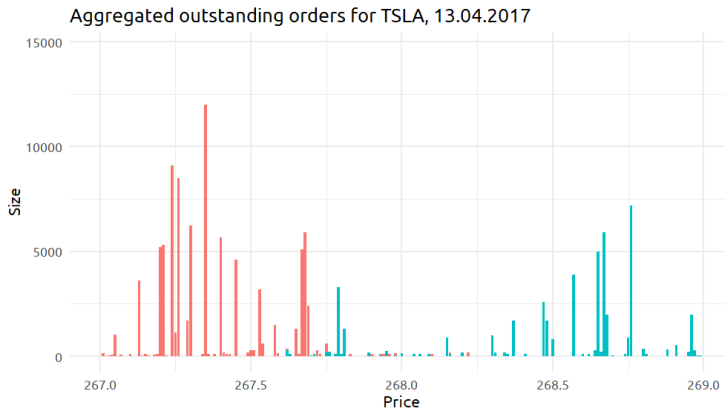


Figure 1: Markets are closed!

Urbanek [2003]

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- client/server, multiple connections, authentication
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- clients for Java, C++, C#, Python, R, Haskell, JavaScript, Ruby, ...
- binary transport, file transfer
- Rserve runs as a (remote) separate process!

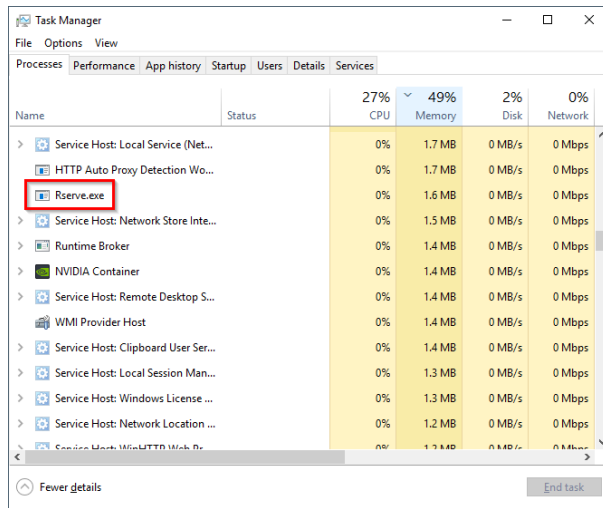


Figure 2: Rserve, ready to serve

Rserve example (Java code)

```
import org.rosuda.REngine.*;
import org.rosuda.REngine.Rserve.*;

public class Main {
    public static void main(String[] args)
        throws RserveException, REXPMismatchException {
        RConnection c = new RConnection();
        REXP x = c.eval("R.version.string");
        System.out.println(x.asString());
        double d[] = c.eval("rnorm(10)").asDoubles();
        for (int i = 0; i < d.length; i++) {
            System.out.println(d[i]);
        }
    }
}
```


Rserve example (output)

```
"C:\Program Files\Java\jdk1.8.0_181\bin\java.exe" (...)  
R version 3.5.1 (2018-07-02)  
1.1970643462988602  
-0.5769699503103762  
-0.3684006009955729  
0.06546082679467544  
1.2032233686962528  
-0.04087141177944551  
1.7461656480450007  
1.8672363049908611  
-1.1040409417073296  
-0.6567773875872637
```

```
Process finished with exit code 0
```

Rserve example (plotting)

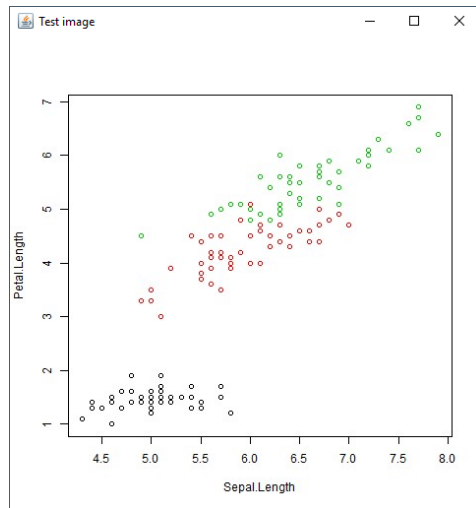


Figure 3: Beloved flowers, now in Java

R and Python

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- $R \rightarrow$: pyRserve, rpy2, ...
- $\rightarrow R$: reticulate, ...

```
>>> import pyRserve
>>> conn = pyRserve.connect()
>>> conn.voidEval('doubleit <- function(x) { x*2 }')
>>> conn.eval('doubleit(2)')
4.0
>>> conn.voidEval('tripleit <- function(y) { y*3 }')
>>> conn.r.tripleit(5)
15.0
```

```
R> t.test(c(1,2,3,1), c(1,6,7,8))
```

Welch Two Sample t-test

```
data: c(1, 2, 3, 1) and c(1, 6, 7, 8)
```

```
t = -2.3054, df = 3.564, p-value = 0.09053
```

```
alternative hypothesis: true difference in means is not  
equal to 0
```

```
95 percent confidence interval:
```

```
-8.4926941 0.9926941
```

```
sample estimates:
```

```
mean of x mean of y
```

```
1.75      5.50
```

```
>>> conn.r.t.test(numpy.array([1,2,3,1]), numpy.array  
    ([1,6,7,8]))
```

```
<TaggedList  
(statistic=TaggedArray([-2.30541984], key=['t']),  
parameter=TaggedArray([3.56389482], key=['df']),  
p.value=0.09053264073333127,  
conf.int=AttrArray([-8.49269413, 0.99269413],  
attr={'conf.level': array([0.95])}),  
estimate=TaggedArray([1.75, 5.5 ],  
key=['mean of x', 'mean of y']),  
null.value=TaggedArray([0.],  
key=['difference in means']),  
alternative='two.sided',  
method='Welch Two Sample t-test',  
data.name='arg_0_ and arg_1_')>
```


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 - Bindings for functions, environments, arbitrary R objects

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 - Extended bindings for vectors, matrices, data frames (incl. R-style subsetting and assigning)

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- `rpy2.robj` provides more high-level facilities:
 - Bindings for functions, environments, arbitrary R objects
 - Extended bindings for vectors, matrices, data frames (incl. R-style subsetting and assigning)
 - Bindings between `rpy2` and `numpy`, `pandas`

```
from rpy2.robjects.packages import importr, data
datasets = importr('datasets')
mtcars_env = data(datasets).fetch('mtcars')
mtcars = mtcars_env['mtcars']
from rpy2.robjects.lib.dplyr import (DataFrame, filter,
                                     mutate, group_by, summarize)

dataf = (DataFrame(mtcars) >>
         filter('gear>3') >>
         mutate(powertoweight='hp*36/wt') >>
         group_by('gear') >>
         summarize(mean_ptw='mean(powertoweight)'))
```

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```
R> library(reticulate)
R> np <- import("numpy")
R> a <- np$array(c(1:4))
R> cumsum(a)
[1]  1  3  6 10
```

- GraalVM: extension of the JVM, supporting polyglot programming

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- Catch: it uses a different R implementation, FastR

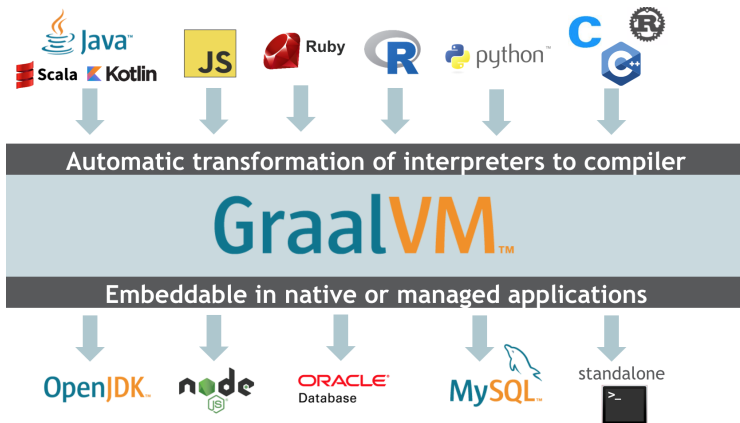


Figure 4: Pure magic in one image

Java/JavaScript/R example

Run container

```
docker run -p 3000:3000 -it -v C:/dxfeed/graalvm-demos:/home oracle/graalvm-ce:1.0.0-rc15 bash
```

Execute in the container

```
gu install r  
cd /home/polyglot-javascript-java-r/  
node --jvm --polyglot server.js
```

```
# In server.js
const express = require('express')
const app = express()
const BigInteger = Java.type('java.math.BigInteger')
app.get('/', function (req, res) {
  // Using Java standard library classes
  text += BigInteger.valueOf(10).pow(100)
    .add(BigInteger.valueOf(43)).toString() + '<br>'
  // Using R interoperability to create graphs
  text += Polyglot.eval('R',
    'svg(); require(lattice)
    x <- 5 * 1:1000; y <- sin(x); z <- cos(x)
    print(cloud(x~y*z, main="cloud plot"))
    grDevices:::svg.off() ');
  res.send(text)
})
app.listen(3000)
```

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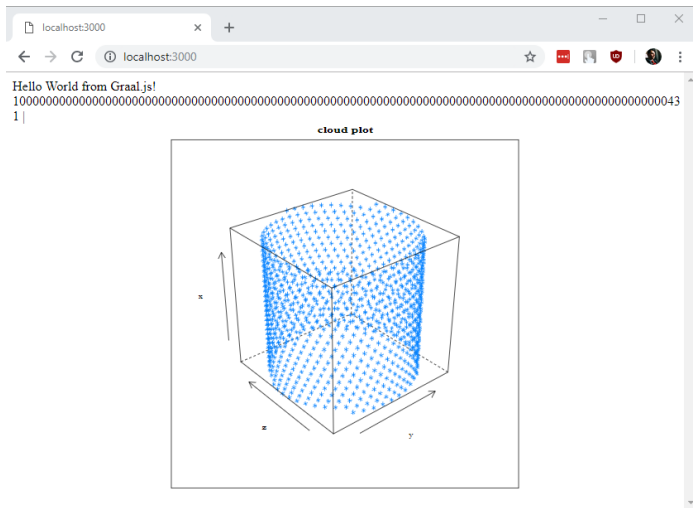


Figure 5: Drawing with R in your browser

Takeaway

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Thanks!

<https://github.com/tonytonov/talks>

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