
REvolution
computing
We do the math

# foreach + iterators

foreach

- A for-loop/lapply hybrid
- Similar to foreach and list comprehensions in Python and other languages

iterators

- Similar to Java iterators
- nextElem ()

```
foreach (iterator) %dopar%

{
    statements
}
```

```
> foreach (j=1:4) %dopar% {sqrt (j)}

[[1]]
[1] 1

[[2]]
[1] 1.414214

[[3]]
[1] 1.732051

[[4]]
[1] 2
```

## Aggregation/reduction wih .combine:

```
> foreach(j=1:4, .combine=c) %dopar% {sqrt(j)}
[1] 1.000000 1.414214 1.732051 2.000000
```

```
> foreach(j=1:4, .combine='+') %dopar% sqrt(j)
[1] 6.146264
```

Foreach is more general than most implementations of parallel lapply. The following typically doesn't work with miscellaneous parLapplys:

```
> z <- 2
> f <- function (x) sqrt (x + z)
> foreach (j=1:4, .combine='+') %dopar% f(j)
[1] 8.417609
```

Here is a simple simulation:

```
birthday <- function(n) {
  ntests <- 1000
  pop <- 1:365
  anydup <- function(i)
      any(duplicated(
          sample(pop, n, replace=TRUE)))
  sum(sapply(seq(ntests), anydup)) / ntests
}

x <- foreach (j=1:100) %dopar% birthday (j)
```

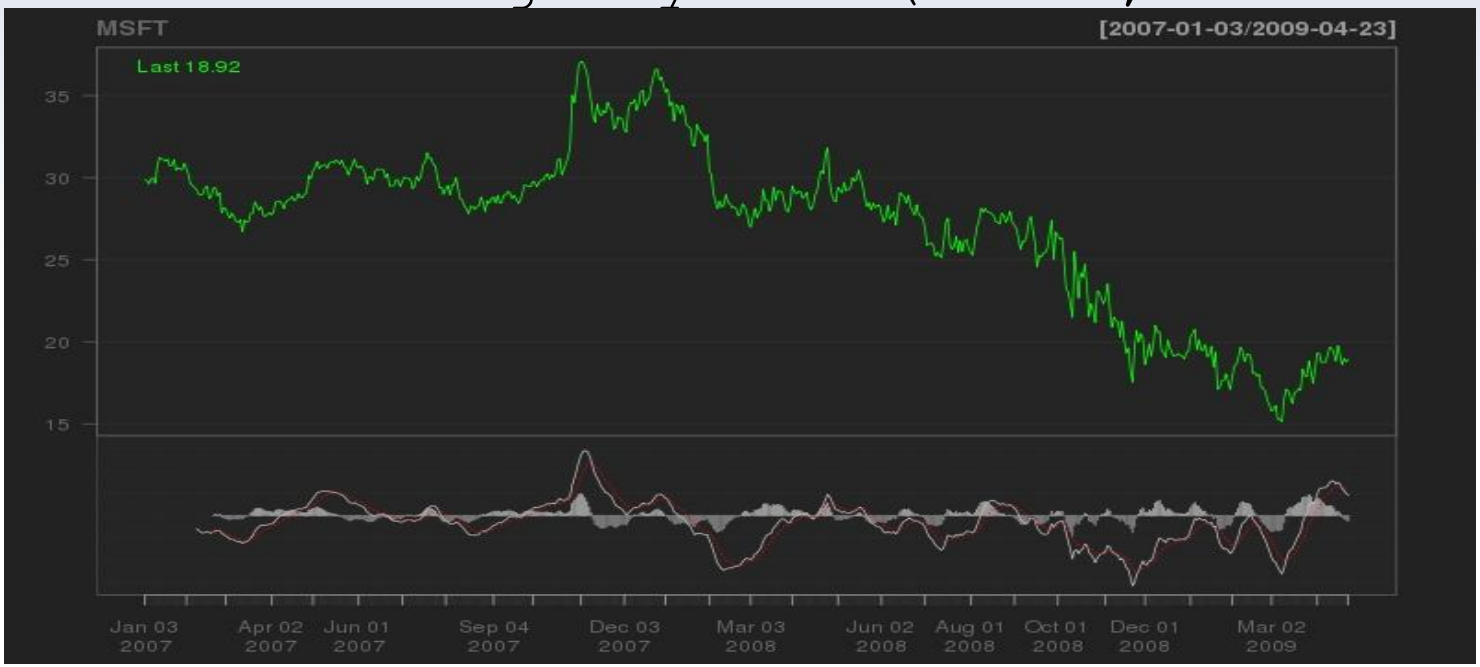
# %dopar%

*Modular* parallel backends:

- doSEQ (the default)
- doNWS (NetWorkSpaces)
- doSNOW
- doRMPI
- doSMP
- doMulticore

# A simple example: backtesting a technical trading rule (with TTR, quantmod, PerformanceAnalytics and foreach):

```
startDate <- "2007-01-01"
endDate   <- Sys.Date()
MSFT      <- getSymbols("MSFT", …
IEF       <- getSymbols("IEF", …
```



```
Ra <- Return.calculate (Cl(MSFT))
Rb <- Return.calculate (Cl(IEF))
chart.CumReturns (cbind (Ra,Rb))
```

## A very simple trading rule:

```
simpleRule <- function (z, fast=12, slow=26,
                        signal=9, instr, benchmark)
{
  x <- MACD (z, nFast=fast, nSlow=slow,
                        nSig=signal, maType="EMA")
  position <- sign(x[,1]-x[,2])
  s <- xts(position,order.by=index(z))
  return (instr*(s>0) + benchmark*(s<=0))
}
```

# Brute-force optimization of the fast and slow parameters:

```
M <- 100
S <- matrix(0,M,M)

for (j in 1:(M-1)) {
  for (k in min ((j+2),M):M) {
    R <- simpleRule (Cl (MSFT),j,k,9, Ra, Rb)
    Dt <- na.omit (R - Rb)
    S[j,k] <- mean (Dt)/sd(Dt)
  }
}
```

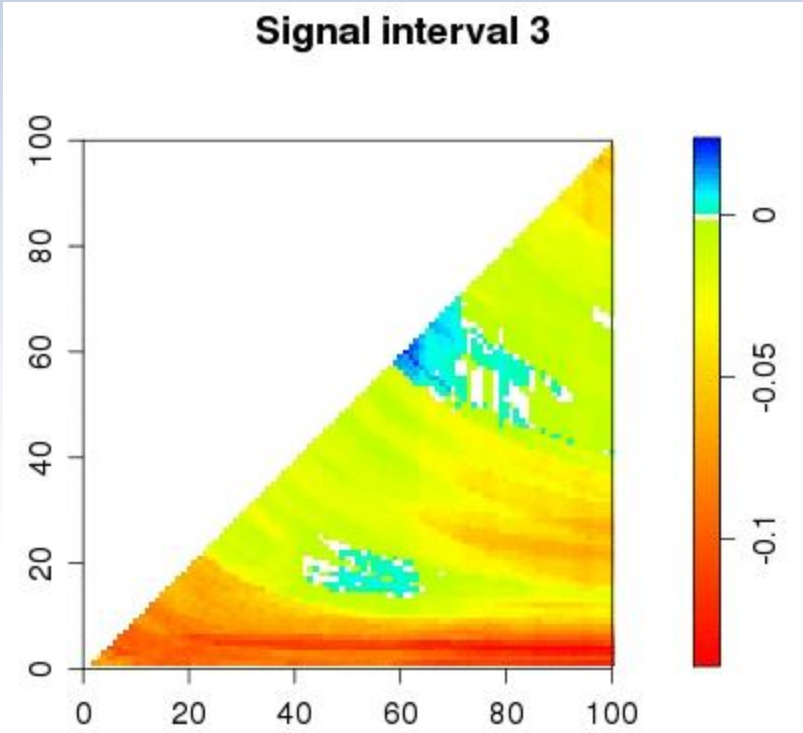
With foreach:

```
M <- 100

S <- foreach (j=1:(M-1), .combine=rbind,
              .packages=c('xts','TTR')) %dopar% {
    x <- rep(0,M)
    for (k in min ((j+2),M):M) {
      R <- simpleRule (Cl (MSFT),j,k,9,Ra,Rb)
      Dt <- na.omit (R - Rb)
      x[k] <- mean (Dt)/sd( Dt)
    }
    return(x)
  }
```

```
j <- which (S==max(S), arr.ind=TRUE)
Ropt <- simpleRule (Cl (MSFT),j[1],j[2],9,Ra,Rb)
chart.CumReturns (cbind (Ra,Rb,Ropt))
```

# Thee parameters are nicely visualized with the spatstat package

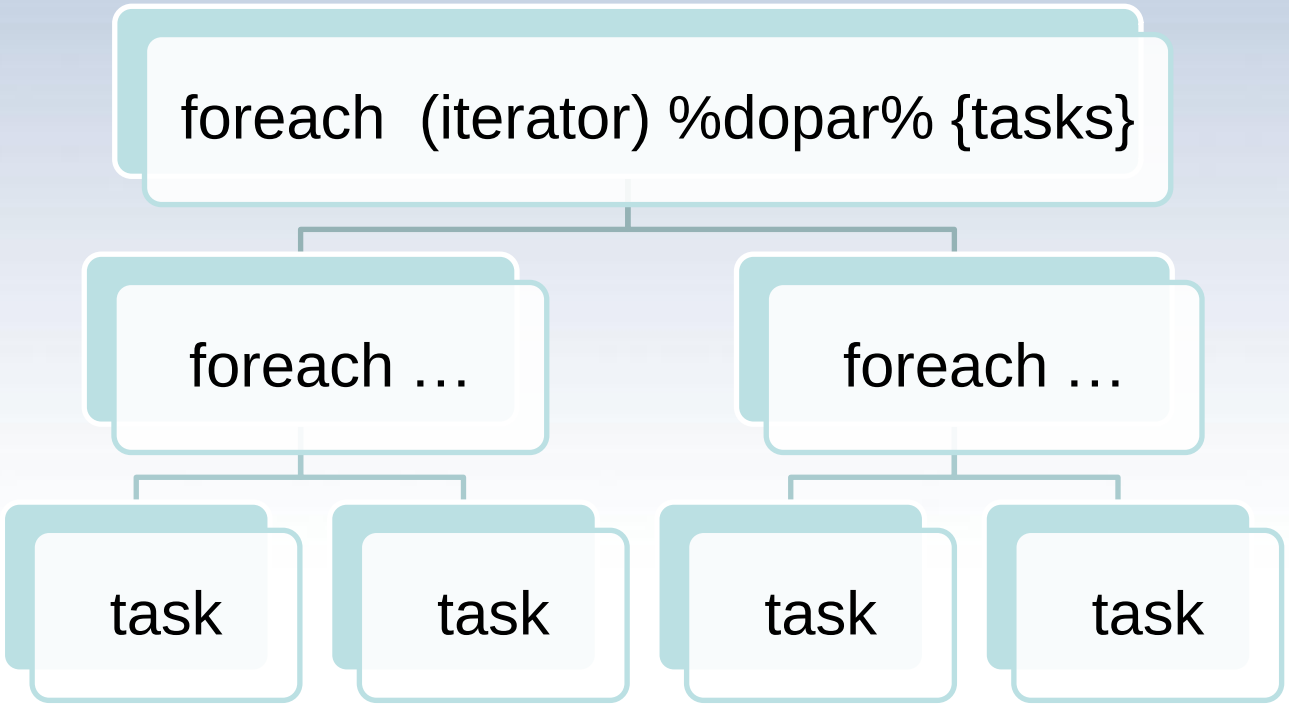
```
require ("spatstat")

function showIm (S) {
   (wrapper for image) … }

for (j in 3:20) {
 S <- S3[,,j]
 showIm(S)
}
```



# An example of explicit multi-paradigm ||ism

**CLUSTER**

**SMP**



```
require ('snow')
require ('foreach')
require ('doSNOW')

cl <- makeCluster (c ('n1', 'n2'))
registerDoSNOW ()

foreach (iterator,
     .packages=c ('foreach', 'doMETHOD')
%dopar%
     {
       registerMETHOD ()
       foreach (iterator) %dopar% {
          tasks…
       }
     }
```

# Summary

Foreach is a simple approach to parallel computing with R that maps naturally on to a number of existing systems for distributed computing.