

[R] Cholesky Decomposition in R

Douglas Bates bates@stat.wisc.edu

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On Tue, Mar 10, 2009 at 4:33 PM, Manli Yan <manliyanrhelphelp@gmail.com> wrote:

```
> Hi everyone:
> I try to use r to do the Cholesky Decomposition, which is  $A=LDL'$ , so far I
> only found how to decompose A into  $LL'$  by using chol(A), the function
> Cholesky(A) doesn't work, any one know other command to decompose A into
>  $LDL'$ 
>
> My r code is:
> library(Matrix)
> A=matrix(c(1,1,1,1,5,5,1,5,14),nrow=3)
>
>> chol(A)
>      [,1] [,2] [,3]
> [1,]    1    1    1
> [2,]    0    2    2
> [3,]    0    0    3
>
>> Cholesky(A)
> Error in function (classes, fdef, mtable) :
> unable to find an inherited method for function "Cholesky", for signature
> "matrix"
>
> whatz wrong???
```

The answer, surprisingly, is in the documentation, accessible as

?Cholesky

which says that the first argument has to be a sparse, symmetric matrix. Because the Cholesky function is intended for sparse matrices it is not the best approach. The object returned is rather obscure

```
> Cholesky(as(A, "dsCMatrix"), LDL = TRUE)
'MatrixFactorization' of Formal class 'dCHMsimpl' [package "Matrix"]
with 10 slots
..@ x      : num [1:6] 1 1 1 4 1 9
..@ p      : int [1:4] 0 3 5 6
..@ i      : int [1:6] 0 1 2 1 2 2
..@ nz      : int [1:3] 3 2 1
..@ nxt     : int [1:5] 1 2 3 -1 0
..@ prv     : int [1:5] 4 0 1 2 -1
..@ colcount: int [1:3] 3 2 1
..@ perm    : int [1:3] 0 1 2
..@ type    : int [1:4] 2 0 0 1
..@ Dim     : int [1:2] 3 3
```

It turns out that the factorization you want is encoded in the 'x' slot but not in an obvious way. Even if you ask for an expansion

```
> expand(Cholesky(as(A, "dsCMatrix"), LDL = TRUE))
$P
```

```
[1,] | . .
[2,] . | .
[3,] . . |
```

\$L

```
[1,] 1 . .  
[2,] 1 2 .  
[3,] 1 2 3
```

the result is converted from the LDL' factor to the LL' factor.

A better approach is to consider how the LDL' factorization is related to the R'R form of the factorization returned by chol()

```
> ch <- chol(A)  
> dd <- diag(ch)  
> L <- t(ch/dd)  
> DD <- dd^2  
> L  
      [,1] [,2] [,3]  
[1,]    1    0    0  
[2,]    1    1    0  
[3,]    1    1    1  
> DD  
[1] 1 4 9
```

This is all rather backwards in that the whole purpose of the LDL' form of the factorization is to avoid taking square roots to get the diagonal elements and to contend with positive semidefinite matrices. In other words, the LDL' form avoids some of the possible problems of the LL' form but not if you go through the LL' form to get to it.

I think the underlying reason that an LDL' form is not directly available in R is because there is no Lapack subroutine for it.

Let me know what our grade on the homework is.

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