
Subject: Re: Matrix algebra and index order, A # B vs A ## B
Posted by [Craig Markwardt](#) on Tue, 27 Mar 2012 13:11:17 GMT
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On Tuesday, March 27, 2012 3:45:40 AM UTC-4, Mats Löfdahl wrote:

> Den tisdagen den 27:e mars 2012 kl. 00:41:18 UTC+2 skrev Craig Markwardt:

>> On Monday, March 26, 2012 9:45:51 AM UTC-4, Mats Löfdahl wrote:

>>> On Monday, March 26, 2012 3:00:05 PM UTC+2, David Fanning wrote:

>>>> Mats Löfdahl writes:

>>>>

>>>> > IDL has two operators for matrix multiplication, # and ##.

>>>> > The former assumes the matrices involved have column number as

>>>> > the first index and row number as the second, i.e., $A_{\{rc\}} =$

>>>> > $A[c,r]$ with mathematics on the LHS and IDL on the RHS. The

>>>> > latter operator makes the opposite assumption, $A_{\{rc\}} = A[r,c]$.

>>>> >

>>>> > I believe much headache can be avoided if one chooses one

>>>> > notation and sticks with it. If it were only me, I'd choose

>>>> > the $A_{\{rc\}} = A[r,c]$ notation. But it isn't only me, because

>>>> > I like to take advantage of IDL routines written by others.

>>>> > So, has there emerged some kind of consensus among influential

>>>> > IDL programmers (those that write publicly available

>>>> > routines that are widely used - thank you BTW!) for

>>>> > which convention to use?

>>>>

>>>> Yes, the consensus that has emerged is that no operation

>>>> is more fraught with ambiguity, anguish, and frustration

>>>> than trying to translate a section of linear algebra code

>>>> from a paper or textbook (say on Principle Components

>>>> Analysis) to IDL than almost anything you can imagine!

>>>> It's like practicing backwards writing in the mirror.

>>>>

>>>> And, of course, while you are doing it you have the

>>>> growing realization that there is no freaking way you

>>>> are EVER going to be able to write the on-line

>>>> documentation to explain this dog's dish of a program

>>>> to anyone else. :-(

>>>>

>>>> The solution, of course, is to stick with the ##

>>>> notation for as long as it makes sense, then throw

>>>> in a couple of # signs whenever needed to make the

>>>> math come out right. :-)

>>>

>>> It's that bad? :o)

>>>

>>> One thing that had me wondering is the documentation for Craig Markwardt's qrfac routine:

>>>

>>>

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>>> ; Given an MxN matrix A (M>N), the procedure QRFAC computes the QR
>>> ; decomposition (factorization) of A. This factorization is useful
>>> ; in least squares applications solving the equation, A # x = B.
>>> ; Together with the procedure QRSOLV, this equation can be solved in
>>> ; a least squares sense.
>>> ;
>>> ; The QR factorization produces two matrices, Q and R, such that
>>> ;
>>> ; A = Q ## R
>>> ;
>>> ; where Q is orthogonal such that TRANSPOSE(Q)##Q equals the identity
>>> ; matrix, and R is upper triangular.
>>>
>>> The ## operator for the matrix-matrix multiplications but # for matrix-vector multiplication! But
then I thought this might be IDL 1D arrays being interpreted as row vectors so x # A is actually just
another way of writing A ## transpose(x). And the former would be more efficient. Am I on the
right track here...?
>>
>> I believe I double checked the notation of QRFAC when I wrote it way back when.
>>
>> Maybe you need to read this part of the documentation as well....
>>
>> ; Note that the dimensions of A in this routine are the
>> ; *TRANSPOSE* of the conventional appearance in the least
>> ; squares matrix equation.
>
> Yes, but that doesn't help much when "the conventional appearance" is not defined...
>
>> The transposed matrix means you flip all the #'s: # <--> ##.
>>
>> I realize this is very confusing, but unfortunately I inherited this code from somewhere else
(MPFIT), so it retains the warts of the original.
>>
>> By the way, there's an example provided with the documentation, which you could test the
notation for yourself.
>
> Yes, of course. Sorry, I realize I gave the impression that I had problems running the qrfac
program. I don't, trial and error solved that problem. But it got me thinking about it and I thought it
might be nice to find out the most common convention and then perhaps stay sane by writing
wrappers around routines that use the opposite convention (if I stumble upon any). At least when
that can be done without much time penalty.
>
> Anyway, if my notation on the math side is right I believe qrfac uses the A[r,c] notation. So
that's one data point in favor of the ## operator. But the comment about "the conventional
appearance" is then a data point against?

```

The statement in the QRFAC documentation is not about array multiplication notation, it's about the typical dimensions of the "A" matrix.

Normally in QR factorization, an "A" matrix is tall and thin. Something like DBLARR(N,M) where $M > N$.

QRFAC accepts the transpose of this matrix, i.e. short and fat. DBLARR(M,N)

My understanding is that

- ## - is what you should always use for standard matrix multiplication (array-array or array-vector)

- # - is what you should use when ## doesn't work right.

Craig
