

# Re: comparing products of integers

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*Source:* <http://sci.tech-archive.net/Archive/sci.math.num-analysis/2005-04/msg00360.html>

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- *From:* [analyst41@xxxxxxxxxxx](mailto:analyst41@xxxxxxxxxxx)
  - *Date:* 27 Apr 2005 17:30:00 -0700
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Peter L. Montgomery wrote:

> In article <1114606012.207570.165560@xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx>  
> analyst41@xxxxxxxxxxx writes:  
>> I want to compare A.B with C.D where A,B,C,D are 32 bit integers.  
Is  
>> there a way to do the comparison without creating the potentially 64  
>> bit products ?  
>>  
>> Thanks for any help.  
>>  
> A (slow) method manipulates 2 x 2 determinants.  
> Start with  
>  
>  $M = \begin{pmatrix} A & C \\ D & B \end{pmatrix}$  sign = +1  
> (D B)  
>  
> Then  $A*B - C*D = \text{sign} * \det(M)$ .  
>  
> If  $A < 0$  or  $D < 0$ , negate the corresponding row and  
> replace sign by  $-\text{sign}$ . Swap rows and change the sign,  
> if necessary, to make  $A \geq D \geq 0$ .  
>  
> If  $D = 0$ , then  $\det(M)$  has the same sign as  $A*B$ .  
> Otherwise A and D are positive.  
>  
> If  $C < 0$ , negate the second column and the sign.  
>  
> If  $B < 0$ , then  $A*B < 0$  and  $C*D \geq 0$ , so you know the sign of  
det(M).  
>  
> If  $B > C$ , then  $A*B > C*D$ .  
>  
> Otherwise let  $q = \text{MIN}(\text{FLOOR}(A/D), \text{FLOOR}(C/B))$  (an integer).  
> Subtract  $q * (\text{second row})$  from (first row).  
>

Thank you – I'll try to work out if the coefficients decrease rapidly as  
in the Euclidean Algorithm. Using an all-integer approach seems more

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elegant.

>  
> You can instead write A, B, C, D each in the form  
>  $a_1 * 2^{16} + a_0$ . If your variables are unsigned, then  
>  $a_1, a_0$  are nonnegative. Manipulate  
>  
>  $(a_1 * 2^{16} + a_0) * (b_1 * 2^{16} + b_0)$   
>  $- (c_1 * 2^{16} + c_0) * (d_1 * 2^{16} + d_0)$   
>  
> algebraically. If you have 53-bit floating point  
> mantissas, you can cast  $a_1, a_0, \dots$  to floating point,  
> then evaluate the coefficients of  
>  
>  $(a_1 * b_1 - c_1 * d_1) * 2^{32} + \dots$   
>  
> and soon get the determinant accurately.  
>  
> --  
> If same-sex marriages are so bad, why do most  
> college dormitories assign same-sex roommates?  
>  
> pmontgom@xxxxxx Microsoft Research and CWI Home: Bellevue, WA

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• **References:**

- ◆ **[comparing products of integers](#)**  
    ◇ From: analyst41
- ◆ **[Re: comparing products of integers](#)**  
    ◇ From: Peter L. Montgomery

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