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Subject: Re: Old Question

Posted by [Jacques Basson](#) on Thu, 16 Dec 1999 08:00:00 GMT

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William Thompson wrote:

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>
> Ben Tupper <pemaquidriver@tidewater.net> writes:
>
>> Jacques Basson wrote:
>
>>> Hi all
>>>
>>> Sorry, this has got to be an old question, but I can't seem to locate
>>> the answer. What is the way around the following problem?
>>>
>>> IDL> a = -1
>>> IDL> print, -1^(1./3)
>>>      -1.00000
>>> IDL> print, a^(1./3)
>>>      NaN
>>> % Program caused arithmetic error: Floating illegal operand
>>>
>>> Thanks
>>> Jacques
>
> Um, I don't know if you realize this, but the only reason that the first
> example DOESN'T fail is because
>
>      IDL> print, -1^(1./3)
>
> is equivalent to
>
>      IDL> print, -( 1^(1./3))
>
```

My mistake, sorry!

```
> In other words, the minus sign doesn't come into play until after the
> exponentiation is applied. If you typed in
>
>      IDL> print, (-1)^(1./3)
>
> you'd get the NaN result, with the error message, as above. Note that you can
> test this by typing in
>
>      IDL> print, -1^2, -(1^2), (-1)^2
>      -1      -1      1
>
```

```

> Of course, as is implied by the answer below, the proper way to evaluate your
> example would be
>
> IDL> a = -1
> IDL> print, a^complex(1./3, 0)
> ( 0.500000, 0.866025)
>

```

I was trying to find out if IDL had some routine for dealing with rational exponents. If the exponent is irrational then complex numbers are required as you showed above. In some cases for rational exponents (as in the case of  $a^{1/3}$ ,  $a < 0$ ), it is possible to get away without having to use complex numbers. Besides, the point given above  $(1/2, \sqrt{3}/2)$  is only 1 of the 3 roots of  $(-1)^{1/3}$  since  $(-1)^{1/3} = (\exp(\pi i); \exp(-\pi i); \exp(3\pi i))^{1/3} = \exp(\pi/3 i); \exp(-\pi/3 i); \exp(\pi i) = (1/2, \sqrt{3}/2); (1/2, -\sqrt{3}/2); -1$

(apologies for the sloppy mathematical layout)

I am sure that the IDL documentation mentions that only the principal value is returned (I haven't looked that bit up), but in my case, I am interested in the value that lies on the real axis and not the principal value. It makes sense for IDL to get the principal value, since working out all the values becomes a bit of a pain if you have  $a^{0.0001}$  or even  $a^{0.333333}$ , which will have(?) to be treated as  $a^{(333333/1000000)}$ . So I am not complaining about IDL, it is just the equation that I am working with that is unusual(?), and I thought that maybe IDL could somehow deal with it elegantly.

```

> William Thompson
>
>> Hello,
>
>> I now know why it happens. In the documentation I see...
>
>> Exponentiation
>
>> The caret (^) is the exponentiation operator. A^B is equal to A raised to
>> the B power.
>
>> * If A is a real number and B is of integer type, repeated multiplication
>> is applied.
>> * If A is real and B is real (non-integer), the formula A^B = e^(B ln A)
>> is evaluated.
>> * If A is complex and B is real, the formula A^B = (re^(iq))^B = r^B *
>> (cosBq + isinBq) (where r is the real part of A and iq is the imaginary
>> part) is evaluated.

```

>  
>> \* B is complex, the formula  $A^B = e^{(B \ln A)}$  is evaluated. If A is  
>> also complex, the natural logarithm is computed to be  $\ln(A) = \ln(\text{re}^{iq})$   
>>  $= \ln(r) + iq$  (where r is the real part of A and iq is the imaginary  
>> part).  
>> \*  $A^0$  is defined as 1.  
>  
>> Your example falls into the second type of operation. I don't know how  
>> to get around that but would like to know also.  
>  
>> Ben  
>  
>> --  
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