Subject: Re: Puzzle with floating point underflow
Posted by Craig Markwardt on Thu, 23 Aug 2001 15:21:25 GMT
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Martin Schultz <martin.schultz@dkrz.de> writes:
...
> How can a float number be something e-42 if the system says it can only
> represent numbers down to 1.e-38 in a float????????
>
> test= 8.1047657d-42
> IDL> tmp=float(test)
> % Program caused arithmetic error: Floating underflow
> % Detected at MGS_RGRID::REGRID 203 /pf/m/m218003/home/IDL/lib/mgs_newobjects
> /mgs_rgrid__define.pro
> IDL> help,tmp
> TMP FLOAT = 8.10511e-42

You have a denormalized number! Internally most floating point
numbers are normalized, which means that the mantissa and exponent are
adjusted so that the leading digit in the mantissa is unity. In a
denormalized quantity the mantissa doesn't have that property.

It's better to make an example, in decimal arithmetic. We all know
that we can change this value:

0.02500 x 10^{-38} Denormalized
Mantissa Exponent

into this value

2.50000 x 10^{-40} Normalized
Mantissa Exponent

That is a good way to do it with floating point numbers since there
are a fixed number of bits that can be used to represent the mantissa.
Normalizing maximizes the number of precision bits available for a
given computation.

But what happens when we also only have a fixed number of bits to
represent the *exponent*? Then it may not be possible to represent
10^{-40} since the smallest is 10^{-38}. In that case one has to be
content with the denormalized quantity, like 0.025 x 10^{-38} above.

You don't get something for nothing, though. The trade-off is that
you start to lose precision in the mantissa. The worst case happens
when you have the number 2.5 x 10^{-38} / 10^5, something like this:

0.00002 x 10^{-38} Normalized

Mantissa Exponent

The "5" in 2.5 just got lost! Because the number of available bits of precision varies with the magnitude of the number, it is best to avoid these kinds of situations. :-)

Craig

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