Subject: Re: Problem discovered in bandpass_filter.pro
Posted by chris_torrence@NOSPAM on Fri, 13 Nov 2015 18:25:23 GMT
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On Wednesday, November 11, 2015 at 11:58:58 AM UTC-7, kagol...@lbl.gov wrote:
> I just alerted Exelisvis to an error with BANDPASS_FILTER() on IDL 8.4.
> I found that for 2D array, the high-frequency cutoff changes by sqrt(2) when the low frequency argument changes from 0 to 0.000001. The program uses different expressions to calculate the filter, based on the lowFreq argument.
>
> Consider the following 2 cases.
>
> **CASE 1
> a = randomu(seed, 1000,1000) - 0.5
> b = bandpass_filter(a, 0., 0.1, /ideal) ;--- lowFreq is zero
> c = abs(fft(b))
> window
> tvscl, c
>
> **CASE 2
> a = randomu(seed, 1000,1000) - 0.5
> b = bandpass_filter(a, 0.000001, 0.1, /ideal) ;--- changed lowFreq to something very small
> c = abs(fft(b))
> window
> tvscl, c
>
> Notice that the different lowFreq value here changes the HIGH frequency cutoff
> in the output by sqrt(2) because there is an error in the way the function is coded.
>
> In fact, the behavior of the function with lowFrequency NE 0 is incorrect
> and leads to cutoff frequencies that are sqrt(2) smaller than they should be.
>
> Say you have a 1000 pixel array, and you set
> b = bandpass_filter(a, 0., 0.1, /ideal)
>
> Here, we expect the high frequency cutoff to occur at 0.1 * 1000 = 100 cycles.
> Instead, a quick test will show that the cutoff occurs at 70 cycles ~ 100/sqrt(2).
> This occurs with /butterworth and /ideal, maybe /gaussian but I didn't test it.
>
> I discovered it in the difference that occurs with filtered an array using a BUTTERWORTH() and 2 FFTs, versus just using BANDPASS_FILTER(... BUTTERWORTH=N)

Hi,
Thanks for reporting this! I think the "Ideal" filter is actually okay, but there is something fishy with the Butterworth. Here's a different reproduce case:

; Ideal
a = randomu(seed, 1000,1000) - 0.5

```
b1 = bandpass_filter(a, 0., 0.4, /ideal)
c1 = abs(fft(b1)/fft(a))
b2 = bandpass_filter(a, 0.000001, 0.4, /ideal)
c2 = abs(fft(b2)/fft(a))

p = plot(c1[*,0], '2', dim=[800,800], yrange=[0,1.1], $
  layout=[1,2,1], title='Ideal')
p = plot(c2[*,0], /overplot, color='red')

; Butterworth
b1 = bandpass_filter(a, 0., 0.4, butterworth=20)
c1 = abs(fft(b1)/fft(a))
b2 = bandpass_filter(a, 0.000001, 0.4, butterworth=20)
c2 = abs(fft(b2)/fft(a))

p = plot(c1[*,0], '2', layout=[1,2,2], yrange=[0,1.1], $
  /current, title='Butterworth')
p = plot(c2[*,0], /overplot, color='red')
```

Notice that for the Ideal filter there is no significant difference between using lowFreq=0 and lowFreq=0.000001, but for Butterworth there is definitely a discontinuity. As an aside, for the Ideal case I believe that the sqrt(2) just comes from the fact that it is a "circle".

I'll take a look at the code and see what's up.
Thanks again,
Chris
