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Subject: Re: Complications with variance using FFTs  
Posted by [Craig Markwardt](#) on Fri, 16 Jul 2004 21:21:41 GMT  
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olde\_english33@hotmail.com (Eric) writes:

> First I computed the FFT of a recorded time series. I then computed  
> the spectrum of this time series to keep the amplitudes of the  
> original data. I then wanted to tie in a random phase because I want  
> to give variables the same kind of shape when I inverse transform.  
> Here is a sample of my code:  
...  
> My dilemma is that the average sample variances of the generated time  
> series ddd1 and ddd2 are nowhere close to the average sample variance  
> of the original time series xf1 and xf2. A colleague and I have  
> narrowed it down to the fact that we are multiplying the spectrum by a  
> random phase which is throwing off the variance but I don't know how  
> to counteract this problem. Can anyone help???

Greetings, it's hard to comment, since your code snippets don't actually connect to each other, but I can ask some probing questions.

Have you considered that for a pure real signal, the negative frequency components should actually be multiplied by  $\exp(-\phi)$ ?

Did you check that the magnitude of the Fourier components was preserved? And the corollary, are you sure that IMAG is purely imaginary and doesn't have a real component?

Good luck,  
Craig

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Craig B. Markwardt, Ph.D.    EMAIL: [craigmnet@REMOVEcow.physics.wisc.edu](mailto:craigmnet@REMOVEcow.physics.wisc.edu)  
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Subject: Re: Complications with variance using FFTs  
Posted by [olde\\_english33](#) on Mon, 19 Jul 2004 16:19:03 GMT  
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Craig Markwardt <[craigmnet@REMOVEcow.physics.wisc.edu](mailto:craigmnet@REMOVEcow.physics.wisc.edu)> wrote in message news:<[oniscn642i.fsf@cow.physics.wisc.edu](mailto:oniscn642i.fsf@cow.physics.wisc.edu)>...  
> olde\_english33@hotmail.com (Eric) writes:  
>

```

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> Did you check that the magnitude of the Fourier components was
> preserved? And the corollary, are you sure that IMAG is purely
> imaginary and doesn't have a real component?
>
> Good luck,
> Craig

```

Hello. First, I don't understand what you mean by "multiplied by  $\exp(-\phi)$ ? Secondly, consider the following code instead:

```

for i=0,12 do begin
  Xf1[* ,i]=fft(xf1[* ,i]-mean(xf1[* ,i]))*31.0
  Xf2[* ,i]=fft(xf2[* ,i]-mean(xf2[* ,i]))*31.0
  specx1[* ,i]=Xf1[* ,i]*conj(Xf1[* ,i])/31.0
  specx2[* ,i]=Xf2[* ,i]*conj(Xf2[* ,i])/31.0
endfor

for i=0,30 do begin
  avgspec1=mean(spec1[i,*])
  avgspec2=mean(spec2[i,*])
endfor

for j=0,99 do begin
  rp=randomu(5*j,15)
  e[0]=0.0
  e[1:15]=rp
  for k=0,14 do begin
    e[30-k]=rp[k]

```

```

endfor
Hf1=avgspec1*exp(e)
Hf2=avgspec2*exp(e)
whtnoise[* ,j]=(randomu(2*j+3,31)-0.5)*sqrt(12.0)
wn[* ,j]=fft(whtnoise[* ,j])
yf1[* ,j]=Hf*wn[* ,j]
yf2[* ,j]=Hf*wn[* ,j]
ddd1[* ,j]=(fft(yf1[* ,j],1))
ddd2[* ,j]=(fft(yf2[* ,j],1))
endfor

```

Now I think all the code snippets are related correctly. I checked the the average variance of all the `xf1[* ,i]` was equal to `sum(avgspec1)/31.0` and that the average variance of `xf2[* ,i]` was equal to `sum(avgspec2)/31.0`. This check held. It works if I don't throw in the symmetric random phase `exp(e)`. Does this phase throw off the variance? Is there any way to account for inputting this random phase?

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Subject: Re: Complications with variance using FFTs  
 Posted by [Craig Markwardt](#) on Tue, 20 Jul 2004 13:54:47 GMT  
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olde\_english33@hotmail.com (Eric) writes:

>  
 > Hello. First, I don't understand what you mean by "multiplied by  
 > `exp(-phi)`? Secondly, consider the following code instead:

I mean, that for a real signal, the Fourier components at negative frequencies are the complex conjugate of those at positive frequencies. Thus, `EXP(IMAG*PHI)` at positive frequencies becomes `EXP(-IMAG*PHI)` at negative frequencies, for arbitrary PHI. Since you are not changing to the complex conjugate at negative frequencies, I think that's where your problem lies.

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 > the average variance of all the `xf1[* ,i]` was equal to  
 > `sum(avgspec1)/31.0` and that the average variance of `xf2[* ,i]` was equal  
 > to `sum(avgspec2)/31.0`. This check held. It works if I don't throw in  
 > the symmetric random phase `exp(e)`. Does this phase throw off the  
 > variance? Is there any way to account for inputting this random  
 > phase?

Well, it's still worth investigating the original questions I posed...

Craig

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Craig B. Markwardt, Ph.D.    EMAIL: craigmnet@REMOVEcow.physics.wisc.edu  
Astrophysics, IDL, Finance, Derivatives | Remove "net" for better response  
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Subject: Re: Complications with variance using FFTs  
Posted by [olde\\_english33](#) on Wed, 21 Jul 2004 17:53:30 GMT  
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Craig Markwardt <craigmnet@REMOVEcow.physics.wisc.edu> wrote in message  
news:<onllheeqc8.fsf@cow.physics.wisc.edu>...

> olde\_english33@hotmail.com (Eric) writes:

>>

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>> Now I think all the code snippets are related correctly. I checked the  
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> Well, it's still worth investigating the original questions I posed...

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> Craig

From what I can gather from my program, the positive frequencies are  
those from 1:15. Then the frequencies from 16:30 are the complex  
conjugates of the frequencies from 15:1. Therefore, I think that IDL  
is already accounting for the complex conjugate in the negative  
frequencies, unless I am missing something.

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Subject: Re: Complications with variance using FFTs  
Posted by [Craig Markwardt](#) on Wed, 21 Jul 2004 18:30:54 GMT  
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olde\_english33@hotmail.com (Eric) writes:

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> frequencies, unless I am missing something.

I think you are missing that when you multiply the positive frequency components by a complex phase, then you must also multiply the negative frequency components by the complex conjugate, i.e. the negative of that phase. To preserve a real signal that is.

That's another probing question, is the final result of your technique real or complex?

Craig

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Craig B. Markwardt, Ph.D.    EMAIL: [craigmnet@REMOVEcow.physics.wisc.edu](mailto:craigmnet@REMOVEcow.physics.wisc.edu)  
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Subject: Re: Complications with variance using FFTs  
Posted by [olde\\_english33](#) on Thu, 22 Jul 2004 17:06:12 GMT  
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Craig Markwardt <[craigmnet@REMOVEcow.physics.wisc.edu](mailto:craigmnet@REMOVEcow.physics.wisc.edu)> wrote in message news:<[onbri943hd.fsf@cow.physics.wisc.edu](mailto:onbri943hd.fsf@cow.physics.wisc.edu)>...

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> That's another probing question, is the final result of your technique  
> real or complex?  
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> Craig

Using my technique of making the phase symmetric produces results that are real, or very nearly real considering machine eps. I also tried it using the technique you suggested above, but was again unsuccessful. For example, one of the returned numbers was (30.3417, -3.79635e-15). So I do not think that is the problem, but still have no idea what the problem is. Do you have any more suggestions on things to check? My colleague believes that inserting a random phase is throwing off the ability to INVERSE FFT the data. Do you know if this could be a possibility?

Eric

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