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 orginal 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 corrolary, 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
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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> wrote in message
news:<oniscn642i.fsf@cow.physics.wisc.edu>...
> olde_english33@hotmail.com (Eric) writes:
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> preserved? And the corrolary, 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 snipets 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?

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 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
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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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>> variance? Is there any way to account for inputting this random
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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 thinkt that IDL
is already accounting for the complex conjugate in the negative
frequencies, unless I am missing something.

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
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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> wrote in message news:<onbri943hd.fsf@cow.physics.wisc.edu>...
> olde_english33@hotmail.com (Eric) writes:
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> negative frequency components by the complex conjugate, i.e. the
> negative of that phase. To preserve a real signal that is.
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> real or complex?
>
> 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
