
Subject: Re: Seasonal Variation in Trend Analysis
Posted by [R.G.Stockwell](#) on Wed, 26 Sep 2007 22:42:46 GMT
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"David Fanning" <news@dfanning.com> wrote in message
news:MPG.2164877cbc85365998a09c@news.frii.com...

> Folks,
>
> Does anyone happen to have an IDL example of some
> code that might remove seasonal variation in a time
> series? Or some suggestions for how to proceed in IDL?
> I can see that I might want to use a model that has
> sin and cosine terms, but I can't see how to find the
> coefficients of such a model in IDL.
>
> Cheers,
>
> David

Just Least Squares fit the cos and sine functions (0 phase in both
those, you get phase from the amplitudes).

$Ax=b$
where
 $[c,s] [x] = [data]$
 x is the unknown. c , s are your sine and cosine terms.

Use the choledky (faster) or SVD solver routines.

interesting note, if the total length of the time series is a
multiple of the length of the season, just FFT and read off those
values (real = cos, imag = sin for the appropriate frequency)
It is a 'fast' way of solving the least squares fit problem

Cheers,
bob

Subject: Re: Seasonal Variation in Trend Analysis
Posted by [Kenneth P. Bowman](#) on Thu, 27 Sep 2007 03:01:44 GMT
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In article <MPG.2164877cbc85365998a09c@news.frii.com>,
David Fanning <news@dfanning.com> wrote:

> Folks,
>
> Does anyone happen to have an IDL example of some

- > code that might remove seasonal variation in a time
- > series? Or some suggestions for how to proceed in IDL?
- > I can see that I might want to use a model that has
- > sin and cosine terms, but I can't see how to find the
- > coefficients of such a model in IDL.

There are several ways to do this, David, depending on exactly what you are trying to do.

Let's assume that you have evenly-spaced data, say monthly, and you have complete years of data (12*nyears data points). Those assumptions are not essential, but make the analysis simpler.

One approach is to remove the climatological annual cycle. This is done by computing the average of all the Januaries, all the Februaries, etc. Then subtract the average January from each of the individual Januaries. The residual is called the "anomaly".

Another approach is to remove the annual harmonic (a perfect sinusoid). This can be done with an FFT, but is usually easier to do with simple regression. (FFT and regression are equivalent for evenly-spaced data with no missing values.)

The difference between these two methods is that the second method removes only the first harmonic of the annual cycle. The first method removes the first *six* harmonics. In many cases the annual cycle is dominated by the first harmonic, so the results of the two methods are similar. In some cases, the semi-annual harmonic might be important, in which case the second method would not work as well. The second method, however, guarantees a smooth estimate of the annual cycle. (Note that you could also compute the higher harmonics, with FFT or REGRESS, and then remove as many harmonics as you want.)

Here is a sample program that illustrates both approaches using some synthetic monthly data. The values are assumed to be located at the centers of the months.

Cheers, Ken

; Removing the climatological mean

```
nyears = 4                      ;Number of years
nmonths = 12*nyears             ;Number of months
t = (0.5 + FINDGEN(nmonths))/12 ;Time in years
```

```
z = COS(2.0*!PI*t) + 0.2*RANDOMN(seed, n)      ;Data with an annual cycle
z = REFORM(z, 12, nyears)                    ;Rearrange for convenience
zclim = REBIN(TOTAL(z, 2)/nyears, 12, nyears) ;Compute climatological mean
```

```
PLOT, t, z, PSYM = 1                        ;Plot original data
OPLOT, t, zclim                            ;Plot climatological mean
OPLOT, t, z - zclim, LINESTYLE = 1         ;Plot anomaly
```

```
cr = "
READ, cr, PROMPT = 'Enter <cr> to continue : '
```

; Removing the annual harmonic

```
z = COS(2.0*!PI*t - 0.75) + 0.2*RANDOMN(seed, n) ;Data with an annual cycle
x = TRANSPOSE([SIN(2.0*!PI*t), [COS(2.0*!PI*t)]]);Create predictor variables
```

```
coeffs = REGRESS(x, z, CONST = zmean, YFIT = yfit) ;Fit the sinusoids
PRINT, SQRT(TOTAL(coeffs^2)), ATAN(coeffs[0], coeffs[1]) ;Amplitude and phase
```

```
PLOT, t, z, PSYM = 1                        ;Plot original data
OPLOT, t, yfit                             ;Plot climatological mean
OPLOT, t, z - yfit, LINESTYLE = 1         ;Plot anomaly
```

Subject: Re: Seasonal Variation in Trend Analysis
Posted by [Ingo von Borstel](#) on Thu, 27 Sep 2007 12:04:00 GMT
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Hi,
>
> Does anyone happen to have an IDL example of some
> code that might remove seasonal variation in a time
> series? Or some suggestions for how to proceed in IDL?
> I can see that I might want to use a model that has
> sin and cosine terms, but I can't see how to find the
> coefficients of such a model in IDL.

I'd do a Fourier transform, filter out the terms that correspond to the seasonal frequency/ies and possibly do a back-transform.

Best regards,
Ingo

--

Ingo von Borstel <newsgroups@planetmaker.de>
Public Key: <http://www.planetmaker.de/ingo.asc>

If you need an urgent reply, replace newsgroups by vgap.

Subject: Re: Seasonal Variation in Trend Analysis
Posted by [David Fanning](#) on Thu, 27 Sep 2007 13:12:20 GMT
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Ingo von Borstel writes:

> I'd do a Fourier transform, filter out the terms that correspond to the
> seasonal frequency/ies and possibly do a back-transform.

Well, I can see this is what I **want** to do, but I
am still having some trouble with the **how** to do. :-)

For example, how, exactly, would I construct such
a filter. To knock out the first harmonic, would
I construct a circular filter near the origin? How
near? I take it from both your post and Bob's that
this is pretty much common knowledge, but if it is,
I must have been asleep in that class. The books I
have been using to understand regression and trend
analysis have not mentioned FFT filtering at all.
And although I think I have at least a limited grasp
of the theory, a practical understanding of the IDL
code to implement it still eludes me.

Cheers,

David

--

David Fanning, Ph.D.
Fanning Software Consulting, Inc.
Coyote's Guide to IDL Programming: <http://www.dfanning.com/>
Sepore ma de ni thui. ("Perhaps thou speakest truth.")

Subject: Re: Seasonal Variation in Trend Analysis
Posted by [David Fanning](#) on Thu, 27 Sep 2007 13:13:09 GMT
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Kenneth P. Bowman writes:

> There are several ways to do this, David, depending on exactly what
> you are trying to do.

Thanks, Ken. Very helpful. I appreciate it. :-)

Cheers,

David

--

David Fanning, Ph.D.

Fanning Software Consulting, Inc.

Coyote's Guide to IDL Programming: <http://www.dfanning.com/>

Sepore ma de ni thui. ("Perhaps thou speakest truth.")

Subject: Re: Seasonal Variation in Trend Analysis

Posted by [R.G.Stockwell](#) on Thu, 27 Sep 2007 17:26:02 GMT

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"David Fanning" <news@dfanning.com> wrote in message
news:MPG.21655a1d1487d44b98a09d@news.frii.com...

> Ingo von Borstel writes:

>

>> I'd do a Fourier transform, filter out the terms that correspond to the
>> seasonal frequency/ies and possibly do a back-transform.

>

> Well, I can see this is what I *want* to do, but I
> am still having some trouble with the *how* to do. :-)

>

> For example, how, exactly, would I construct such
> a filter. To knock out the first harmonic, would
> I construct a circular filter near the origin? How
> near?

As a quick answer, FFT the data (assuming regular sampling etc)
and find the frequency corresponding to the seasonal signal.
(frequencies are i/NT where T is the sampling interval - for instance
one measurement each day).

Multiply your spectrum with zero at that point (and 1 every other point)
(also do that for the negative frequency component - assuming real data).
Invert the FFT.

You have removed the precise seasonal frequency.

You can perhaps improve that by multiplying the adjacent frequencies
by 0.5 above (i.e. your mask is 1,1,1,1,1,1....1,1,0.5,0,0.5,1,1.....)

That is equivalent to applying a hanning window filter to remove the
seasonal signal.

Sorry for brief description, I am taking care of a 2.5 yr old with the flu right now so I have to be quick.

Cheers,
bob

Subject: Re: Seasonal Variation in Trend Analysis
Posted by [wita](#) on Thu, 27 Sep 2007 19:09:05 GMT
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David,

>
> Well, I can see this is what I *want* to do, but I
> am still having some trouble with the *how* to do. :-)

You may want to have a look at the IDL implementation of the HANTS (Harmonic Analyses of NDVI Time Series) algorithm I wrote. The code is available at: <http://www.itvis.com/codebank/search.asp?FID=333>

Basically HANTS searches for the seasonality rather than removing it, but the principle is the same.

with best regards,

Allard

Subject: Re: Seasonal Variation in Trend Analysis
Posted by [David Fanning](#) on Thu, 27 Sep 2007 19:27:07 GMT
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wita writes:

> You may want to have a look at the IDL implementation of the HANTS
> (Harmonic Analyses of NDVI Time Series) algorithm I wrote. The code is
> available at: <http://www.itvis.com/codebank/search.asp?FID=333>
>
> Basically HANTS searches for the seasonality rather than removing it,
> but the principle is the same.

Alas, when I hit the Download button there, I get the picture, but not the code. I already have the picture, sorta. :-)

Cheers,

David

--

David Fanning, Ph.D.

Fanning Software Consulting, Inc.

Coyote's Guide to IDL Programming: <http://www.dfanning.com/>

Subject: Re: Seasonal Variation in Trend Analysis

Posted by [wita](#) on Fri, 28 Sep 2007 12:09:45 GMT

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David,

This is indeed stupid by itvis, putting the picture under the download button.

Anyway try this one: <ftp://sc:image1@ftp.alterra.nl/pub/adewit/hants.zip>

with best regards,

Allard

Subject: Re: Seasonal Variation in Trend Analysis

Posted by [David Fanning](#) on Fri, 28 Sep 2007 14:34:57 GMT

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wita writes:

- > You may want to have a look at the IDL implementation of the HANTS
- > (Harmonic Analyses of NDVI Time Series) algorithm I wrote. The code is
- > available at: <http://www.itvis.com/codebank/search.asp?FID=333>
- >
- > Basically HANTS searches for the seasonality rather than removing it,
- > but the principle is the same.

Thank you. This is very helpful.

When I initially ran the example program in `cgi_fftnvdi.pro` I got thrown into an infinite loop. I killed the process and moved the `CATCH, /CANCEL` in your error handler to the `*first*` line after the `CATCH`, and then the program ran perfectly.

To test, I set it back where it was before, and the program `*still*` ran fine! So, I don't know what that is all about. But I do feel more comfortable having that `CANCEL` as the

first line after a CATCH to avoid these kinds of problems. :-)

Cheers,

David

--

David Fanning, Ph.D.

Fanning Software Consulting, Inc.

Coyote's Guide to IDL Programming: <http://www.dfanning.com/>

Sepore ma de ni thui. ("Perhaps thou speakest truth.")

Subject: Re: Seasonal Variation in Trend Analysis

Posted by [David Fanning](#) on Fri, 28 Sep 2007 16:13:30 GMT

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Allard de Wit writes:

> Anyway try this one: <ftp://sc:image1@ftp.alterra.nl/pub/adewit/hants.zip>

Wow! This has even caused me to go dig out that E. Oran Brigham book on the FFT that Bob suckered me into buying several years ago.

Oddly enough, some of it is starting to make sense to me now. :-)

Cheers,

David

--

David Fanning, Ph.D.

Fanning Software Consulting, Inc.

Coyote's Guide to IDL Programming: <http://www.dfanning.com/>

Sepore ma de ni thui. ("Perhaps thou speakest truth.")

Subject: Re: Seasonal Variation in Trend Analysis

Posted by [R.G.Stockwell](#) on Fri, 28 Sep 2007 16:35:28 GMT

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"David Fanning" <news@dfanning.com> wrote in message

news:MPG.2166d611a2078c5498a0a0@news.frii.com...

> Allard de Wit writes:

>

>> Anyway try this one: <ftp://sc:image1@ftp.alterra.nl/pub/adewit/hants.zip>

>

> Wow! This has even caused me to go dig out that E. Oran Brigham book

> on the FFT that Bob suckered me into buying several years ago.

:O

"suckered"? That is one of the best books of all time!
Better than War and Peace, and Lord of the Rings combined.
Rumour has it that Angelina Jolie is in talks to play DFT in
the movie version of it.

Seriously, anyone who has ever used the `fft()` routine must
read that book first (imho) :)

Cheers,
bob

Subject: Re: Seasonal Variation in Trend Analysis
Posted by [wita](#) on Mon, 01 Oct 2007 19:16:38 GMT
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> When I initially ran the example program in `cgi_fftnv.pro`
> I got thrown into an infinite loop. I killed the process and
> moved the CATCH, /CANCEL in your error handler to the *first*
> line after the CATCH, and then the program ran perfectly.

Thanks for the tip, I will change this in the next version of HANTS.

best regards,

Allard
