Jason Byrne <jbyrne6@gmail.com>

kinematics

8 messages

Peter Gallagher <peter.gallagher@tcd.ie> **14 August 2009 17:52**

To: Shane Maloney <shane.maloney98@gmail.com>, james mcateer <james.mcateer@tcd.ie>, Jason Byrne <jbyrne6@gmail.com>

Cc: David Long <dlong@tcd.ie>

Guys,

Below is an email from Eduard Kontar detailing an inversion code he has developed to estimate first and second order derivatives of noisy data. I've seen it in operation for RHESSI spectra, but it can also be used for kinematic work. Manuela Temmer has recently used it for EIT wave kinematics. Does a proper treatment of errors and includes smoothing constraints to optimize the likelihood or the derivatives.

Might be work trying for the CME work were doing? Could Shane or Jason have a shot to see what you get?

Peter.

Peter T Gallagher
School of Physics, Trinity College Dublin

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Begin forwarded message:

> **From:** Eduard Kontar <eduard@astro.gla.ac.uk>
> **Date:** 14 August 2009 11:24:54 GMT-05:00
> **To:** Peter Gallagher <peter.gallagher@tcd.ie>
> **Subject: Re: kinematics**
>
> Hi Peter,
>
> I have never had time to make it publicly available and well documented,
> but i will be happy to email you (attached the idl version I sent to Manuela).
> It was originally developed to find the energy dependent spectral
> index of X-ray spectra
> http://adsabs.harvard.edu/abs/2005SoPh..227..299K
> the math background can be found there.

> The idea of the code is to find the first or second derivative
> from a noisy data set with the smallest errors.
>
> The code first loads the data to analyse then calculates the second
> order integral (first order to find the first derivative) in such a way that
> you can write it as a matrix multiplication.
> integral:
> Data_i(x_i)= \int \int 2nd_deriv (time_j) dt_j
> matrix form
> data_i(x_i) = INT2_i,j ## 2nd_deriv_j (time_j)
>
> After that we invert the solution using inversion software
> http://adsabs.harvard.edu/abs/2004SoPh..225..293K
>
> There are two parameters to play around:
>
> 1) Nx_out=93 (current value) - is the number of output time bins = generally
> it is recommended to take this number larger than the number
> of input time measurements by the order of 10 or so.
> The results are only weakly dependent on this.
> General rule - our matrix representation of the integral should be
> quite precise - hence smaller integration step.
> Too large number does not make sense because other factors are more important.
>
> 2) reg_tweak=.3 (current value)
> This is important parameter telling the code how far you trust the uncertainties
> on the input data. If reg_tweak is one meaning that the errors are purely normal
> with no systematics or correlation or etc ...
>
> You increase reg_tweak if the input errors are underestimated
> and decrease if they are overestimated in general.
>
> From practical point it is good to look at the residuals produced by the code
> (normalised and cumulative). If they look nice - it is a good choice of reg_tweak.
> Generally reg_tweak should be between 0.1 and 10...
>
> hope it is helpful
>
> cheers
> Eduard
>
> Peter Gallagher wrote:
>
>> Hi Eduard,
>> I was talking with Manuela Temmer recently about some inversion code she was using to determine velocity and acceleration profiles from experimentally determined position measurements. Apparently you were the author of the code and I was wondering if it was publicly available or if you would be willing to let me test it on some CME height data I've been working with. As you may be aware, we've being going a lot of work of kinematics of both CMEs (Byrne et al., A&A, 2009) and EUV waves (Long et al., ApJ., 2008), but we have always been concerned about a proper treatment of the propagation of uncertainties and numerical effects of particular differencing schemes. David Long in particular has been

> focusing on this topic recently as we are concerned about the validity of some of the results in is 2008 paper. Cheers,
> Peter.
> ---
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deriv_inv_cme.zip
27K

Jason Byrne <jbyrne6@gmail.com> **17 August 2009 13:56**
To: Peter Gallagher <peter.gallagher@tcd.ie>
Cc: Shane Maloney <shane.maloney98@gmail.com>, james mcateer <james.mcateer@tcd.ie>, David Long <dlong@tcd.ie>

Hi,

I've gone through the inversion stuff a bit... it would take me a good while to understand the codes though, so I've just applied them to the kinematics for the middle of the CME and assumed an error of 10% on each distance - I don't know how such errors should be quantified. I left reg_tweak=0.3 though changing it doesn't affect the results too much, and Nx_out=300.
Attached is the resulting acceleration profile (lower plot is the height-time in metres v seconds). It looks to me like it reproduces well the high initial acceleration and then scatters about 0 with the jump from COR2 to HI1 still apparent. I imagine we want to take velocity profiles out of this... I'll look into it some more.

Jason.

2009/8/14 Peter Gallagher <peter.gallagher@tcd.ie>
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deriv2.pdf
23K

Peter Gallagher <peter.gallagher@tcd.ie> **17 August 2009 15:55**
To: Jason Byrne <jbyrne6@gmail.com>
Cc: Shane Maloney <shane.maloney98@gmail.com>, james mcateer <james.mcateer@tcd.ie>

Hi Jason,

Could you send me the input data shown in that plot (heights and times) so that I can have a play with it as well?

That an interesting plot you sent though.

- Considering the minimal scatter in the height measurements at large distances, the experimental uncertainties must be much, much smaller (I understand that you just guessed them).

- The acceleration plot seems to show 2 or 3 regimes depending on how you treat the uncertainties.

Option 1:
1) ~06:30 - 09:30: a(t) decreasing
2) ~09:30 - 17:00: a(t) ~ const ~10 m/s/s
3) ~16:00 - 01:00: a(t) ~ const ~ 0 m/s/s

Option 2:
1) ~06:30 - 09:30: a(t) decreasing
2) ~09:30 - 01:00: a(t) ~ const ~ 5 m/s/s

Will be interested in seeing what you come up with for vels.

Peter.

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> [Quoted text hidden]
> <deriv2.pdf>

Jason Byrne <jbyrne6@gmail.com> **17 August 2009 16:07**
To: Peter Gallagher <peter.gallagher@tcd.ie>
Cc: Shane Maloney <shane.maloney98@gmail.com>, james mcateer <james.mcateer@tcd.ie>

Hi,

I've attached the distances.txt and edited version of deriv_inv.pro though you might have to change places in the other codes like where set_plot, 'win' I made it set_plot, 'x'.

I've gone through the maths somewhat to get an idea of how inversion works. Basically minimises the distance between the end points with the smoothest version of the spline allowable within the constraints of the data. But I'm not yet sure if/how the velocity profiles can be taken out since the codes are quite complicated to read... What paper had the work by Temmer on this?

2009/8/17 Peter Gallagher <peter.gallagher@tcd.ie>

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2 attachments

distances.txt
11K

deriv_inv.pro
5K

Jason Byrne <jbyrne6@gmail.com> **17 August 2009 16:36**
To: Peter Gallagher <peter.gallagher@tcd.ie>
Cc: Shane Maloney <shane.maloney98@gmail.com>, james mcateer <james.mcateer@tcd.ie>

Ok I think the only thing I had to do to get out the velocity profile was comment out line 76 in deriv_inv.pro !
This produces the attached velocity profile for a chosen error of 5% on each height this time. The curve decides to drop the velocity at the end which is interesting...

Dave just turned to me and said he is after reproducing the exact same acceleration curve on his own data set so we'll have to test how real this is!?!

2009/8/17 Jason Byrne <jbyrne6@gmail.com>

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deriv1.pdf
20K

David Long <long.daithi@gmail.com> **17 August 2009 16:41**
To: Jason Byrne <jbyrne6@gmail.com>
Cc: Peter Gallagher <peter.gallagher@tcd.ie>, Shane Maloney <shane.maloney98@gmail.com>, james mcateer <james.mcateer@tcd.ie>, David Long <dlong@tcd.ie>

Hi

I've been looking through the code aswell. I'm not entirely sure what it's doing - it can be a bit hard to follow the code at times, but I tried putting in data from my simulation work and seeing how it reacted. All I did was change the inputted data file to one of my own, and made sure that the x, y and x_err parameters pointed to my data. The attached pdf shows the results.

I'm getting a similar initial peak in the acceleration despite the lack of any acceleration in the original data. This is for the ideal simulated data of the form r(t) = 150 + 0.4t.

Either I'm not using the code correctly or there's a problem with it. As I've said, I haven't done anything to the code other than change the input data file and point the code to my variables rather than the ones required by Manuela. However, the variables are straight swaps, so this shouldn't make a difference.

Any ideas?

Thanks

Dave

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www.maths.tcd.ie/~dlong

2009/8/17 Jason Byrne <jbyrne6@gmail.com>
> Hi,
> [Quoted text hidden]

sim_data_test_deriv2_test.pdf
21K

David Long <long.daithi@gmail.com> **17 August 2009 16:52**

To: Jason Byrne <jbyrne6@gmail.com>
Cc: Peter Gallagher <peter.gallagher@tcd.ie>, Shane Maloney <shane.maloney98@gmail.com>, james mcateer <james.mcateer@tcd.ie>, David Long <dlong@tcd.ie>

Sorry. Slight problem with units in the previous attachment (Thank you Jason!). I've fixed that, and the images are attached again.

Thanks

Dave

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www.maths.tcd.ie/~dlong

2009/8/17 David Long <long.daithi@gmail.com>
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sim_data_test_deriv2_test.pdf
21K

Peter Gallagher <peter.gallagher@tcd.ie> **17 August 2009 17:27**
To: David Long <long.daithi@gmail.com>
Cc: Jason Byrne <jbyrne6@gmail.com>, Shane Maloney <shane.maloney98@gmail.com>, james mcateer <james.mcateer@tcd.ie>, David Long <dlong@tcd.ie>

OK, your plot is a little worrying, David. Must be something up with the way we're using the code. I would suspect that the smoothness constrain needs to be tightened up for your data.

Worth playing with for a while though.

Peter.

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> <sim_data_test_deriv2_test.pdf>