Jason Byrne <jbyrne6@gmail.com>

kinematics simulation

11 messages

Peter Gallagher <peter.gallagher@tcd.ie> **9 February 2009 23:12**
To: dlong@tcd.ie, Jason Byrne <jbyrne6@gmail.com>, Shane Maloney <shane.maloney98@gmail.com>, james mcateer <james.mcateer@tcd.ie>, Shaun Bloomfield <shaun.bloomfield@tcd.ie>

Hi guys,

I decided to do a quick Monte-Carlo simulation for the typical distance-time data that we have been working with.

The model I've chosen has a form h = h0 + v0 * t + 0.5 * a0 * t^2. This and its associated theoretical velocity and acceleration curves are shown as continuous white lines. I have chosen typical values for the constants.

I then took this theoretical curve and added ~10% noise to it. This "observational" height-time curve was then used to calculate v(t) and a(t) curves using the DERIV function.

Please run SIM_VEL.PRO and let me know what you think.

I have also written a code, SIM_VEL2.PRO, which uses a simple reverse first-differencing scheme (calls REVERSE_DIFF.PRO). It gives similar scatter to the 3-point differencing routine.

These are very worrying. They show (yet again!) that the numerical derivative cannot be used to make reasonable estimates of v(t) and a(t) curves.

In the case of your work, Dave, we need to modify these codes to more accurately reflect your position measurements and associated uncertainties. We can then add in an additional error to see what the tolerances of your kinematic curves are.

Talk tomorrow.

Peter.

P.S. As the codes were written pretty quickly, please feel free to check them before we meet tomorrow afternoon for our Working Group on Kinematics!

Peter T Gallagher PhD
Astrophysics Research Group
School of Physics
Trinity College Dublin
Dublin 2
Ireland
W: www.physics.tcd.ie/astrophysics
T: +353 (0)1 896 1300

F: +353 (0)1 671 1759
Skype: petertgallagher

3 attachments

reverse_diff.pro
1K

sim_vels.pro
2K

sim_vels2.pro
2K

Jason Byrne <jbyrne6@gmail.com> **10 February 2009 10:16**
To: Peter Gallagher <peter.gallagher@tcd.ie>
Cc: dlong@tcd.ie, Shane Maloney <shane.maloney98@gmail.com>, james mcateer <james.mcateer@tcd.ie>, Shaun Bloomfield <shaun.bloomfield@tcd.ie>

2009/2/9 Peter Gallagher <peter.gallagher@tcd.ie>

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I'm not sure I agree with you here Peter. Within errors it looks like the majority of plots give a reasonable estimate of linear v(t) and constant a(t). Granted there will be outliers but these may be statistically sound, since the errors you input are a 'perfect' minimum.

> In the case of your work, Dave, we need to modify these codes to more accurately reflect your position measurements and associated uncertainties. We can then add in an additional error to see what the tolerances of your kinematic curves are.

Talk tomorrow.

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Trinity College Dublin
Dublin 2
Ireland
W: www.physics.tcd.ie/astrophysics
T: +353 (0)1 896 1300
F: +353 (0)1 671 1759
Skype: petertgallagher

Shaun Bloomfield <shaun.bloomfield@tcd.ie> **10 February 2009 10:49**
To: Jason Byrne <jbyrne6@gmail.com>

Hi Jason,

Can you send me on the simulation code that you wrote up the other week? I have the older version which didn't have the right interatively increasing velocity from the input acceleration form.

Cheers,

Shaun.

D. Shaun Bloomfield, PhD

Astrophysics Research Group
School of Physics
3.03a SNIAM Building
Trinity College Dublin
Dublin 2
Ireland

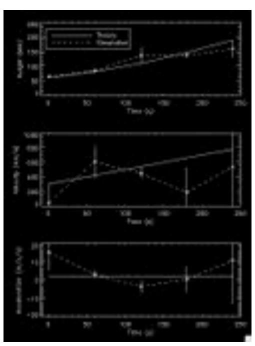
Phone: +353 1 896 3257
Skype: d.shaun.bloomfield

Peter Gallagher <peter.gallagher@tcd.ie> **10 February 2009 11:01**
To: Jason Byrne <jbyrne6@gmail.com>
Cc: dlong@tcd.ie, Shane Maloney <shane.maloney98@gmail.com>, james mcateer <james.mcateer@tcd.ie>, Shaun Bloomfield <shaun.bloomfield@tcd.ie>

> I'm not sure I agree with you here Peter. Within errors it looks like the majority of plots give a reasonable estimate of linear v(t) and constant a(t). Granted there will be outliers but these may be statistically sound, since the errors you input are a 'perfect' minimum.

Yep, I agree that the uncertainties overlap for the most part with the model v(t) and a(t) curves. A problem arises when you do not have any idea of the shape of the theoretical v(t) and a(t) curves are trying to estimate them blindly from data. For example, in the attached file you could easily convince yourself that the observationally determined a(t) has a parabolic shape, even though we know that it should be a flat line.

PG



1.jpg
126K

Jason Byrne <jbyrne6@gmail.com> **10 February 2009 11:33**
To: Shaun Bloomfield <shaun.bloomfield@tcd.ie>

Here it is.

2009/2/10 Shaun Bloomfield <shaun.bloomfield@tcd.ie>
[Quoted text hidden]

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Jason P. Byrne,
Astrophysics Research Group,

School of Physics,
Trinity College,
Dublin 2,
Ireland.
Tel: +353-(0)1-8962157
Mob: +353-(0)87-6325173
www.physics.tcd.ie/Astrophysics

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deriv_test.pro
2K

Shaun Bloomfield <shaun.bloomfield@tcd.ie> **10 February 2009 11:34**
To: Jason Byrne <jbyrne6@gmail.com>

Grand. Thanks for that.

Shaun.

D. Shaun Bloomfield, PhD

Astrophysics Research Group
School of Physics
3.03a SNIAM Building
Trinity College Dublin
Dublin 2
Ireland

Phone: +353 1 896 3257
Skype: d.shaun.bloomfield

[Quoted text hidden]

> [Quoted text hidden]
> <deriv_test.pro>

David Long <long.daithi@gmail.com> **10 February 2009 15:17**
To: Peter Gallagher <peter.gallagher@tcd.ie>
Cc: Jason Byrne <jbyrne6@gmail.com>, dlong@tcd.ie, Shane Maloney <shane.maloney98@gmail.com>, james mcateer <james.mcateer@tcd.ie>, Shaun Bloomfield <shaun.bloomfield@tcd.ie>

Just before the meeting, I added another line to the plots, showing the variation obtained when the smoothing function I'm using is applied. It appears to produce a consistent shape for the velocity and acceleration that is very worrying.

2009/2/10 Peter Gallagher <peter.gallagher@tcd.ie>

> > I'm not sure I agree with you here Peter. Within errors it looks like the majority of plots give a reasonable estimate of linear v(t) and constant a(t). Granted there will be outliers but these may be statistically sound, since the errors you input are a 'perfect' minimum.

> Yep, I agree that the uncertainties overlap for the most part with the model v(t) and a(t) curves. A problem arises when you do not have any idea of the shape of the theoretical v(t) and a(t) curves are trying to estimate them blindly from data. For example, in the attached file you could easily convince yourself that the observationally determined a(t) has a parabolic shape, even though we know that it should be a flat line.
>
> PG

--
David Long
Astrophysics Research Group
School of Physics
Trinity College
College Green
Dublin 2
www.maths.tcd.ie/~dlong

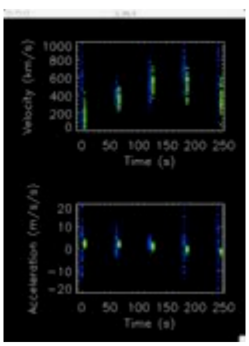
---

sim_vels_smooth.pro
2K

Shane Maloney <shane.maloney98@gmail.com> **10 February 2009 15:46**
To: David Long <long.daithi@gmail.com>
Cc: Peter Gallagher <peter.gallagher@tcd.ie>, Jason Byrne <jbyrne6@gmail.com>, dlong@tcd.ie, james mcateer <james.mcateer@tcd.ie>, Shaun Bloomfield <shaun.bloomfield@tcd.ie>

Hay I just did a scatter plot of all 40 odd runs for the velocity and acceleration smoothed and non-smoothed data I think it quite telling.

2009/2/10 David Long <long.daithi@gmail.com>
[Quoted text hidden]



vels_scatter.tiff
35K

Jason Byrne <jbyrne6@gmail.com> **11 February 2009 10:38**
To: Shaun Bloomfield <shaun.bloomfield@tcd.ie>

Eh, I think I just found that the classic equations of motion only describe constant acceleration and so using them in the procedures I was writing are not appropriate anyway!

Shaun Bloomfield <shaun.bloomfield@tcd.ie> **11 February 2009 10:47**
To: Jason Byrne <jbyrne6@gmail.com>

> Eh, I think I just found that the classic equations of motion only describe constant acceleration and so using them in the procedures I was writing are not appropriate anyway!

I think that you can still use them if you assume that between your discrete points in time the acceleration doesn't change. That way you are applying a form of instantaneous change in acceleration which applies to the next time interval. I modified your code to look like the following,

```
FOR k=0, n-2 DO BEGIN
    v[k+1] = v[k] + a[k]*(t[k+1]-t[k])
    h[k+1] = h[k] + v[k]*(t[k+1]-t[k]) + 0.5*a[k]*((t[k+1]-t[k])^2.)
ENDFOR
```

It isn't a strictly continually varying acceleration, as it means that the acceleration at a particular point in time is applied as being constant over the next time interval.

[Quoted text hidden]

Jason Byrne <jbyrne6@gmail.com> **11 February 2009 11:00**
To: Shaun Bloomfield <shaun.bloomfield@tcd.ie>

Ah sorry that's what you were trying to tell me yesterday! Ah yes I getcha now.

2009/2/11 Shaun Bloomfield <shaun.bloomfield@tcd.ie>

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Jason P. Byrne,
Astrophysics Research Group,

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