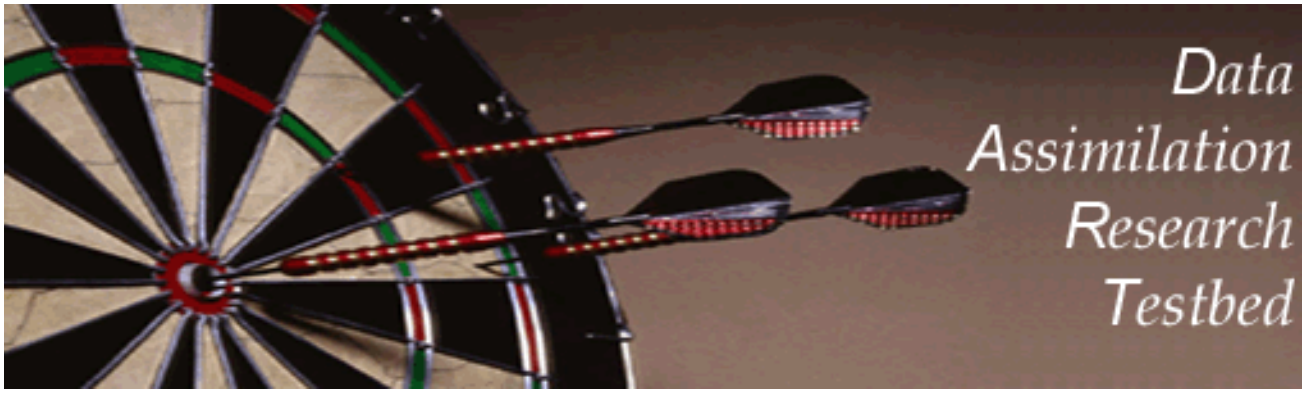
Data Assimilation Research Testbed Tutorial



Section 10: Regression and Non-linear Effects

Version 1.0: June, 2005

Ensemble filters: Updating additional prior state variables:

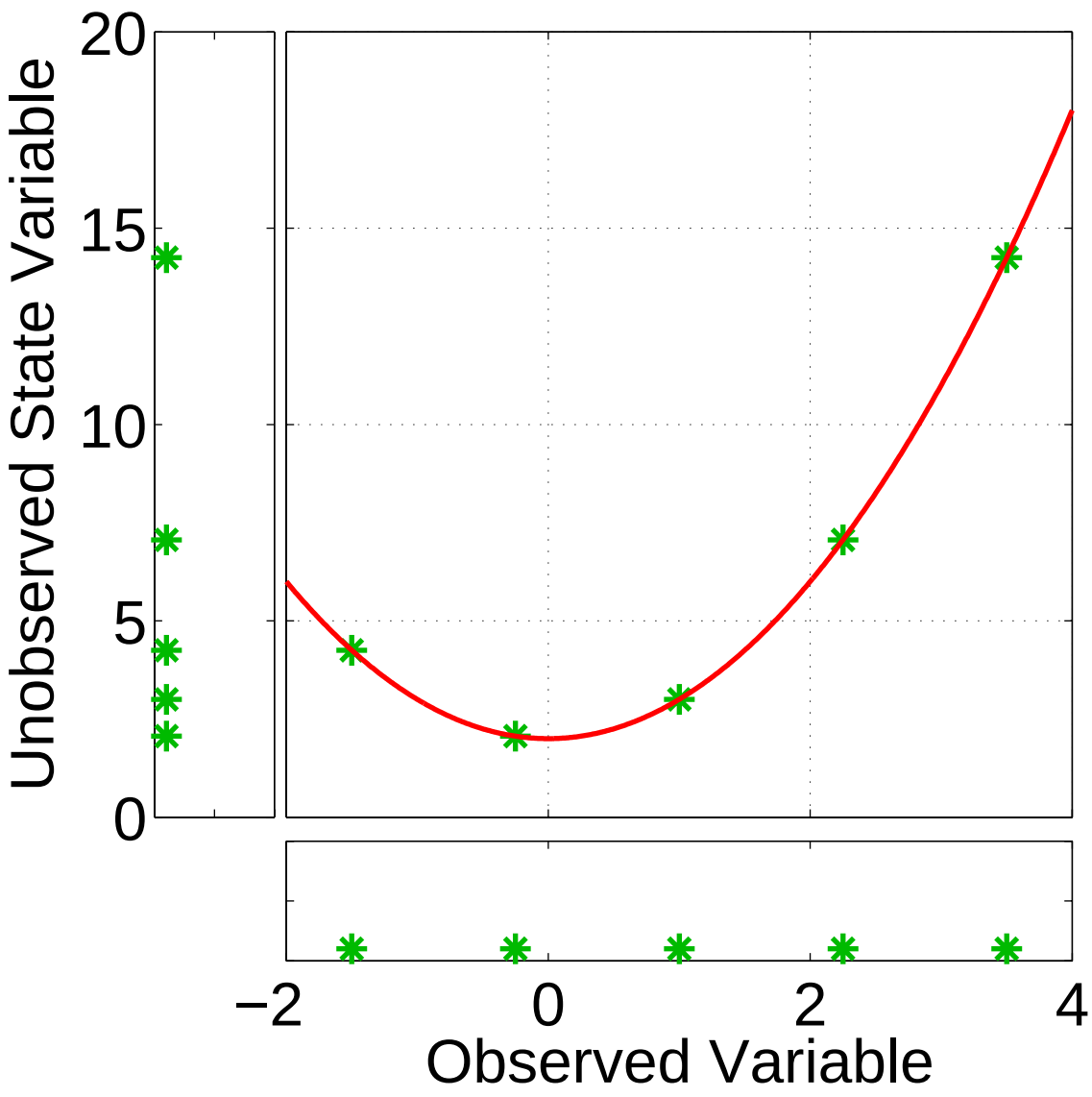
Two primary error sources:

1. Linear approximation is invalid.
   Substantial nonlinearity in ‘true’ relation over range of prior.

2. Sampling error due to noise (we’ve already looked at this).
   Even if linear relation, sample regression coefficient imprecise.

May need to address both issues for good performance.

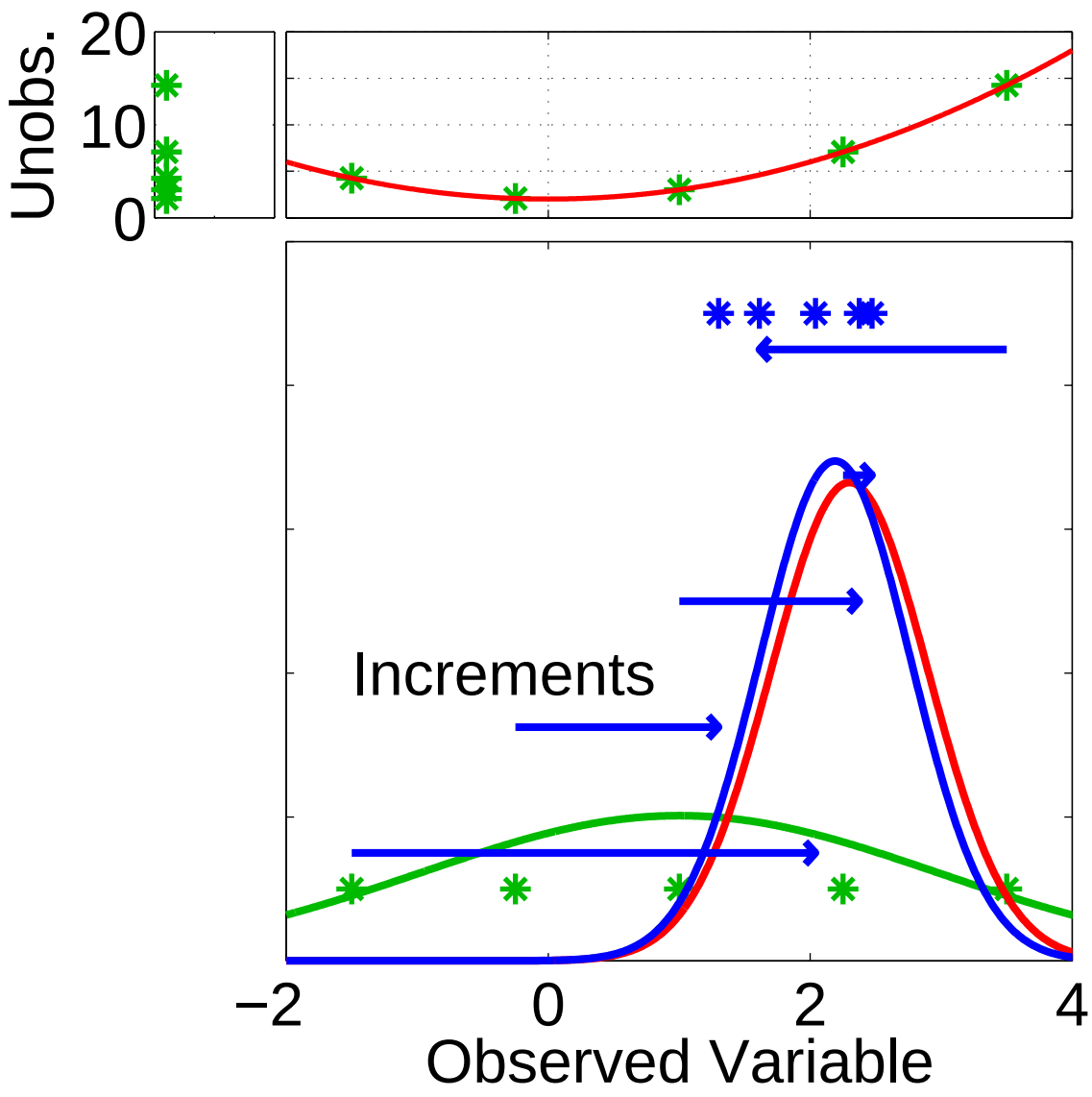
Nonlinear relations between variables; sorting increments



Suppose prior sample has NO noise.

But, relation between un/observed variables is non-linear.

Nonlinear relations between variables; sorting increments



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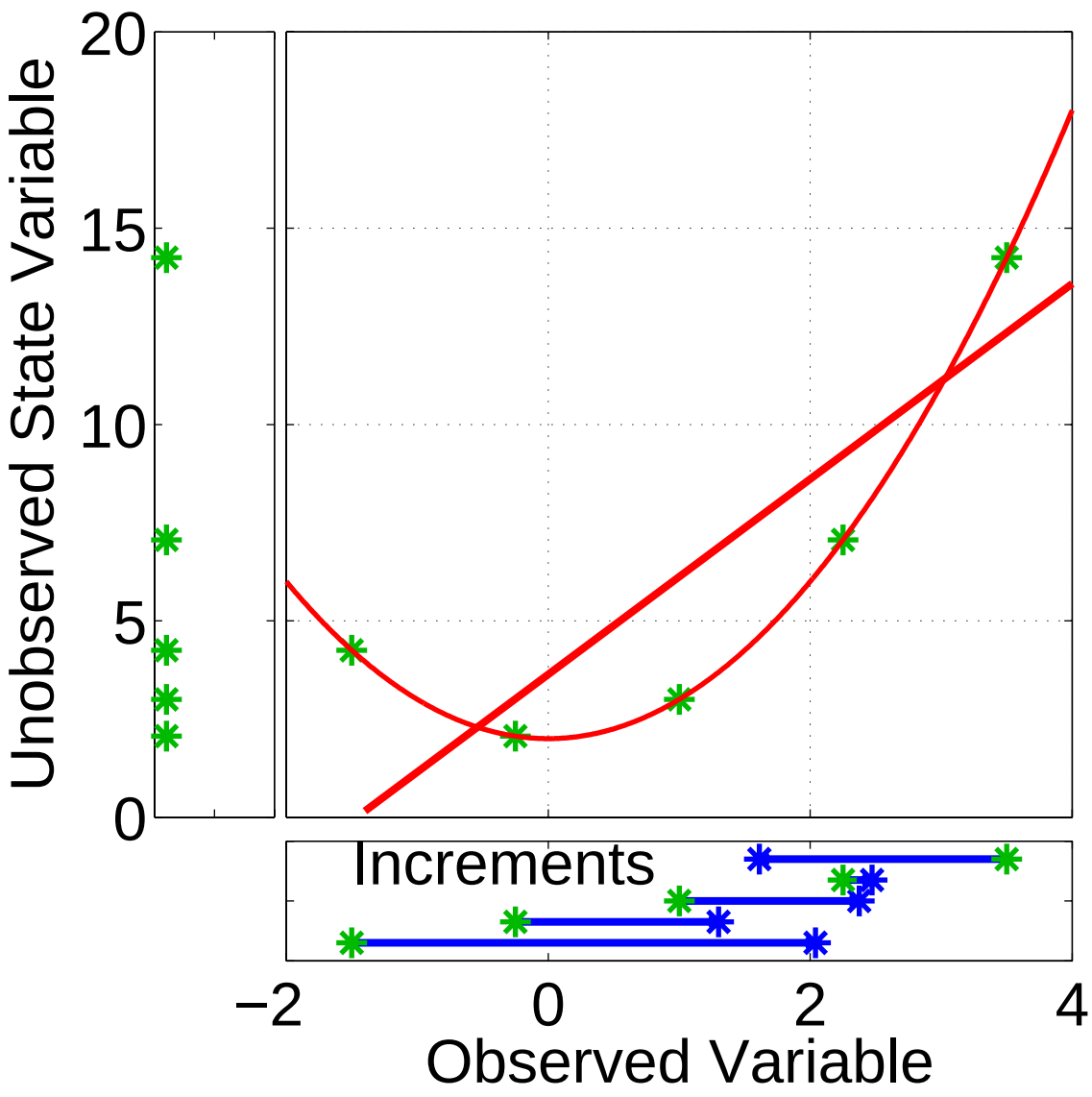
Update observed sample and compute increments.

Nonlinear relations between variables; sorting increments



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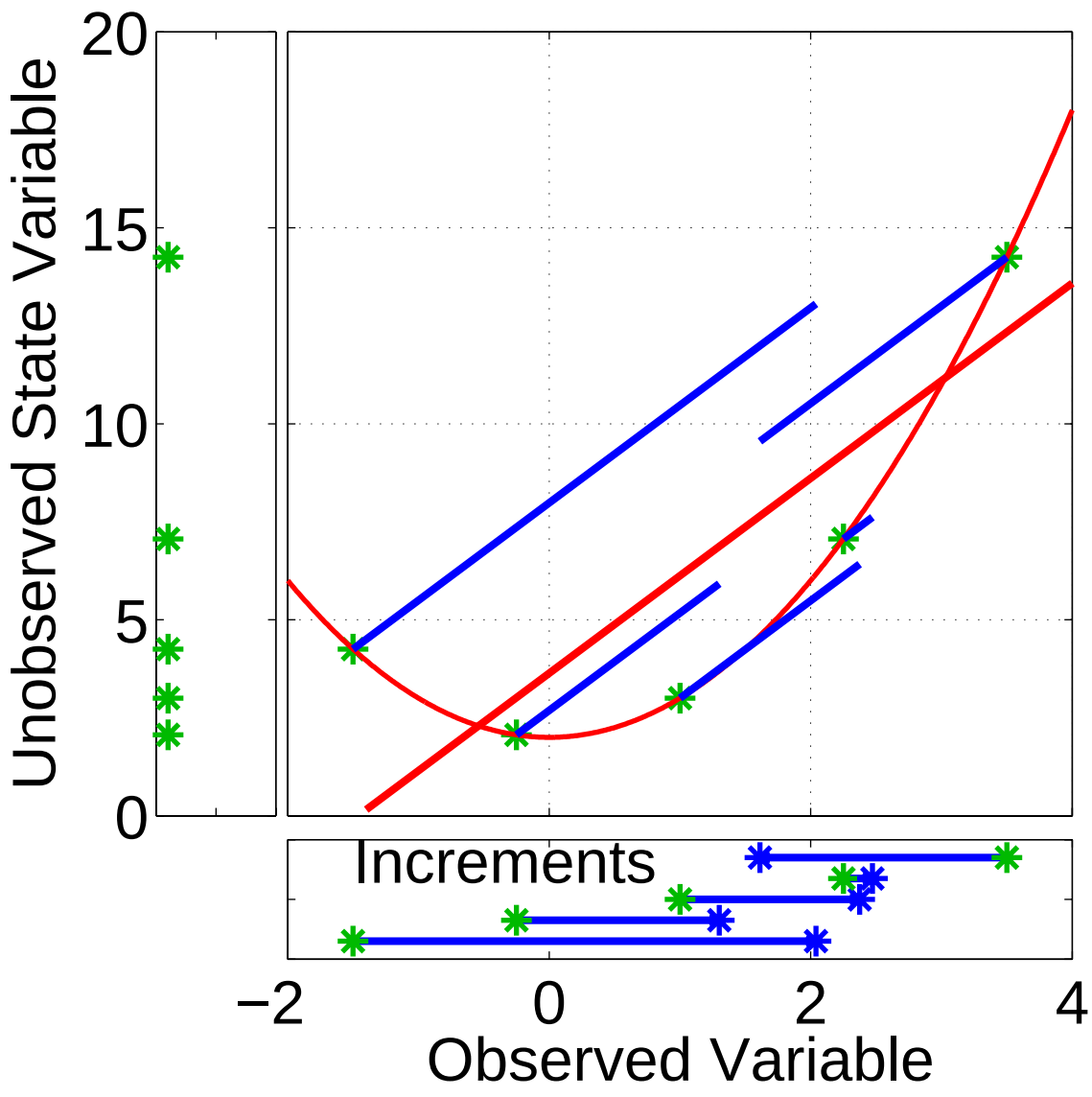
Regression error varies with value of observed variable.

Nonlinear relations between variables; sorting increments



Suppose prior sample has NO noise.

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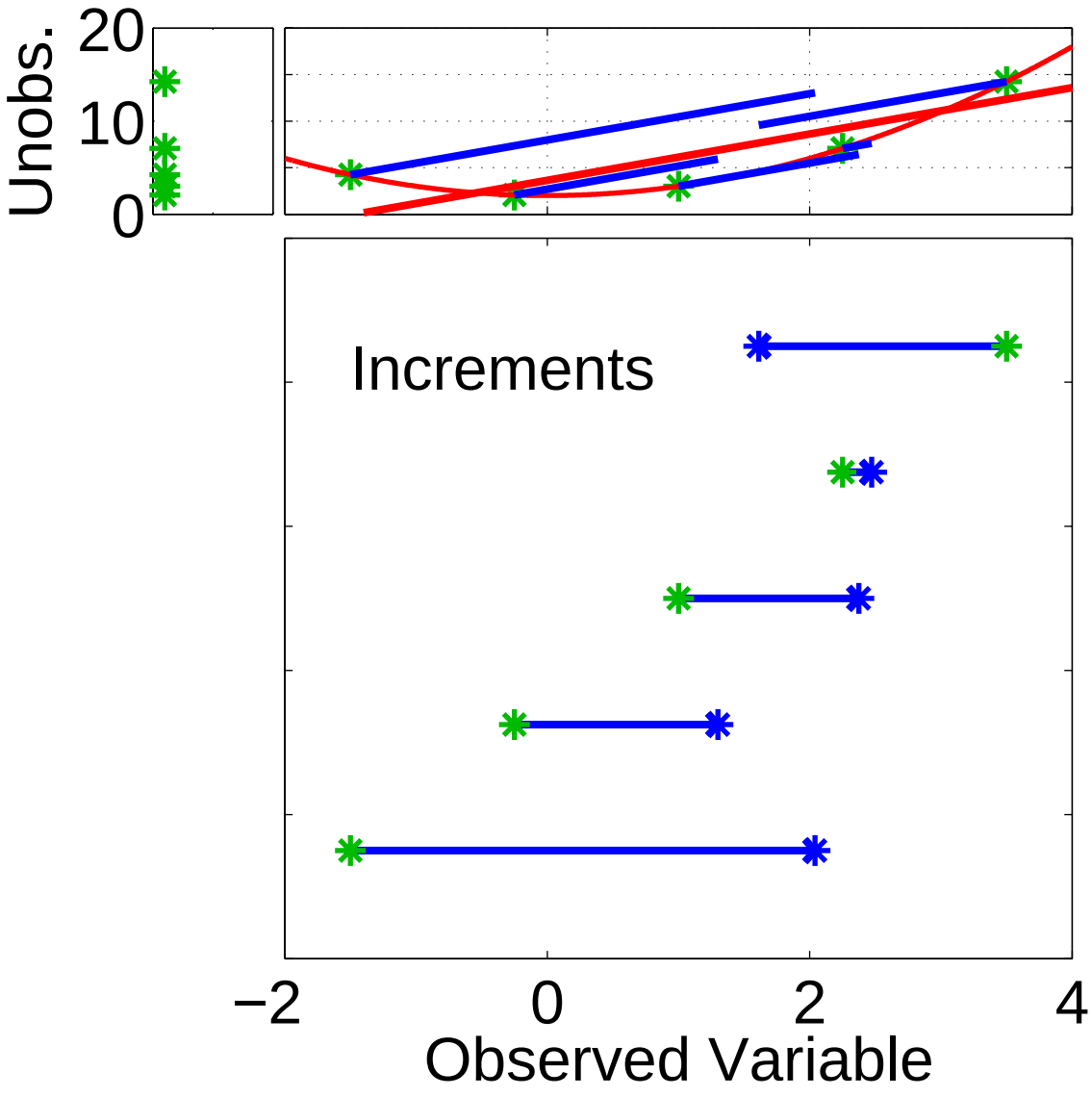
Regression error varies with value of observed variable.

Smaller increments have smaller expected errors.

Nonlinear relations between variables; sorting increments



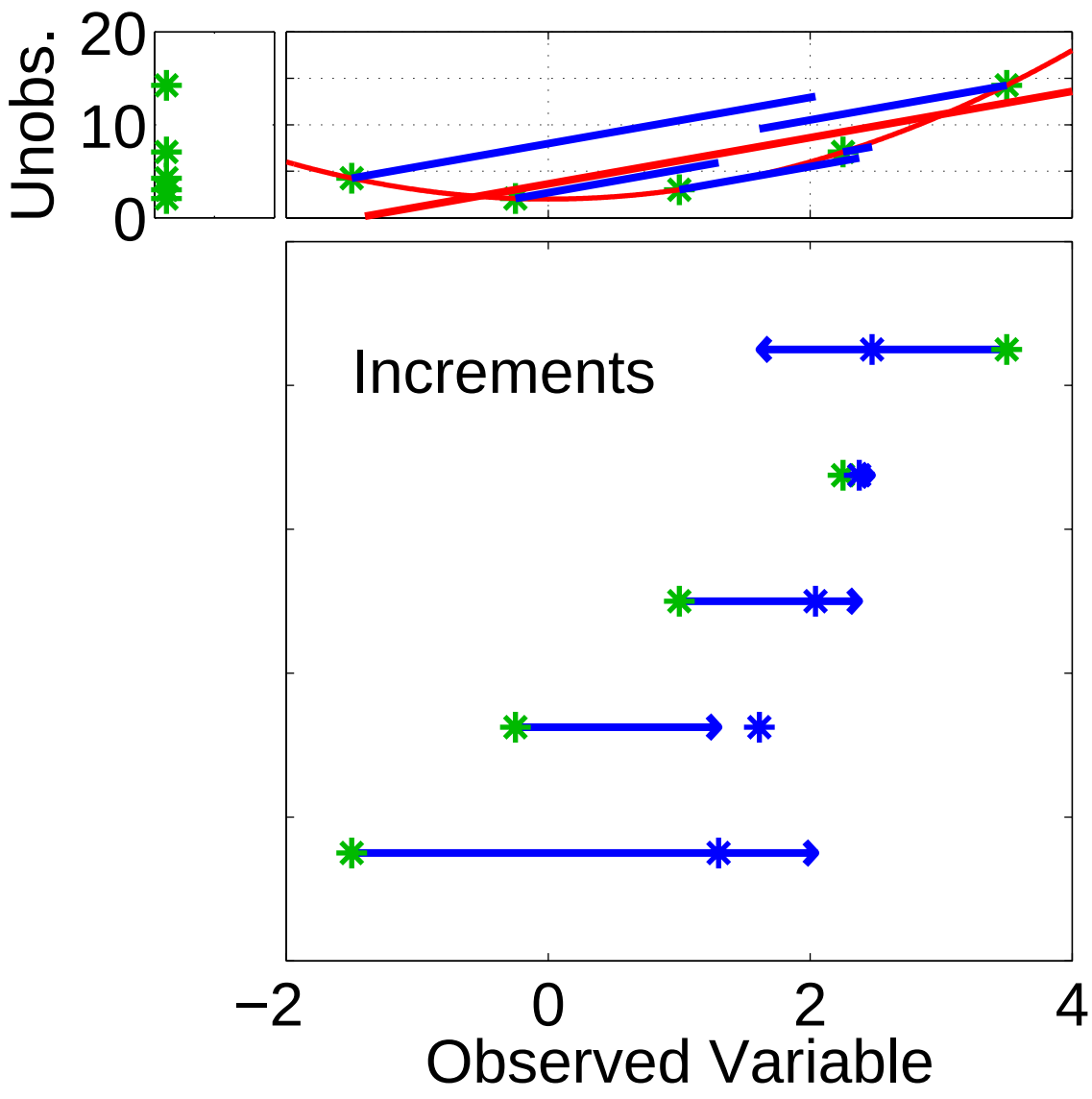
Suppose prior sample has NO noise.

But, relation between un/observed variables is non-linear.

Pairing between prior and posterior sample of observed variable can be viewed as arbitrary.

Posterior is same sample no matter how it is paired.

Nonlinear relations between variables; sorting increments



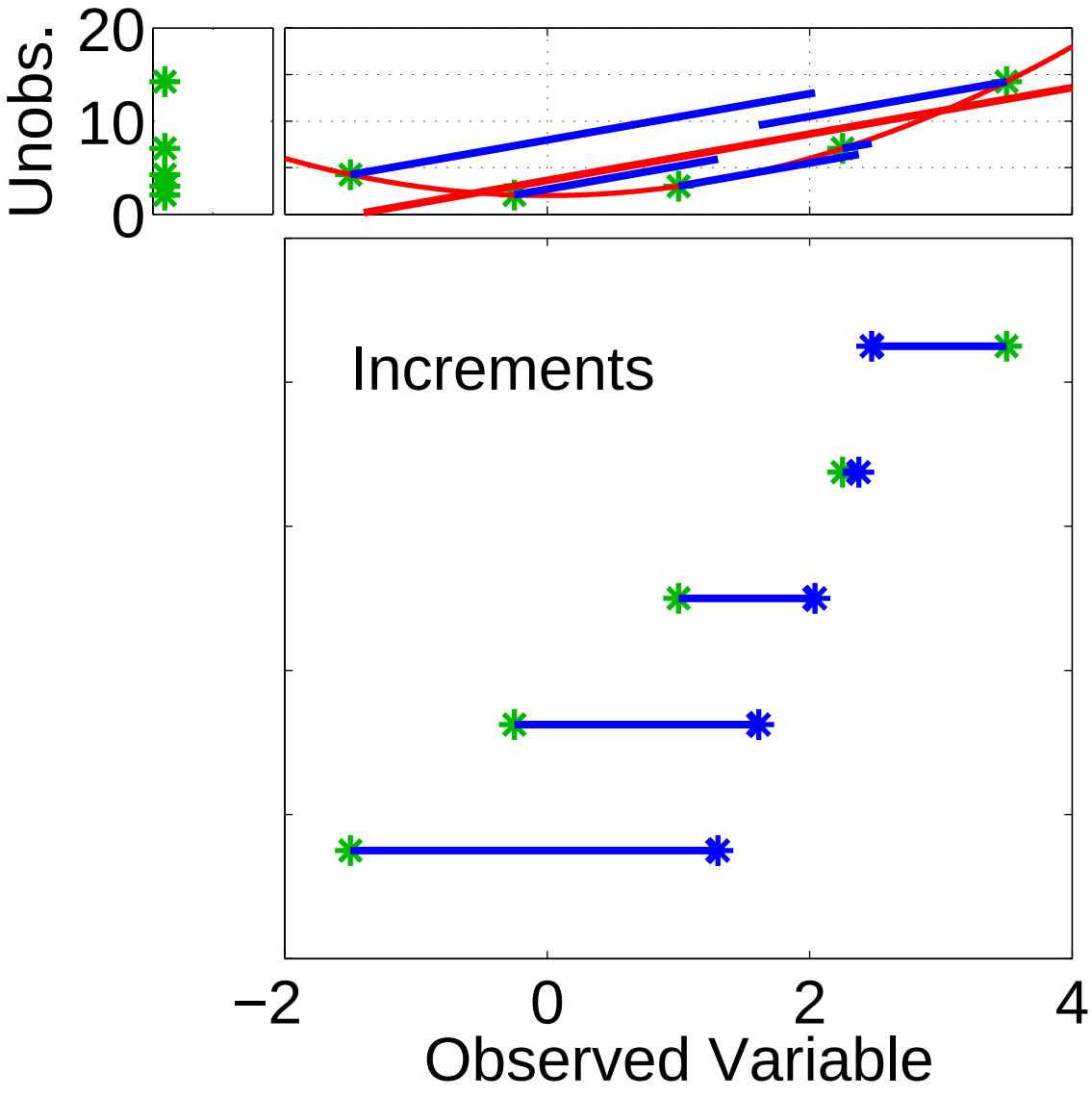
Suppose prior sample has NO noise.

But, relation between un/observed variables is non-linear.

Can minimize increments by changing pairing.

Sorting prior and posterior and pairing samples minimizes one norm of increment size (could do other methods)

Nonlinear relations between variables; sorting increments



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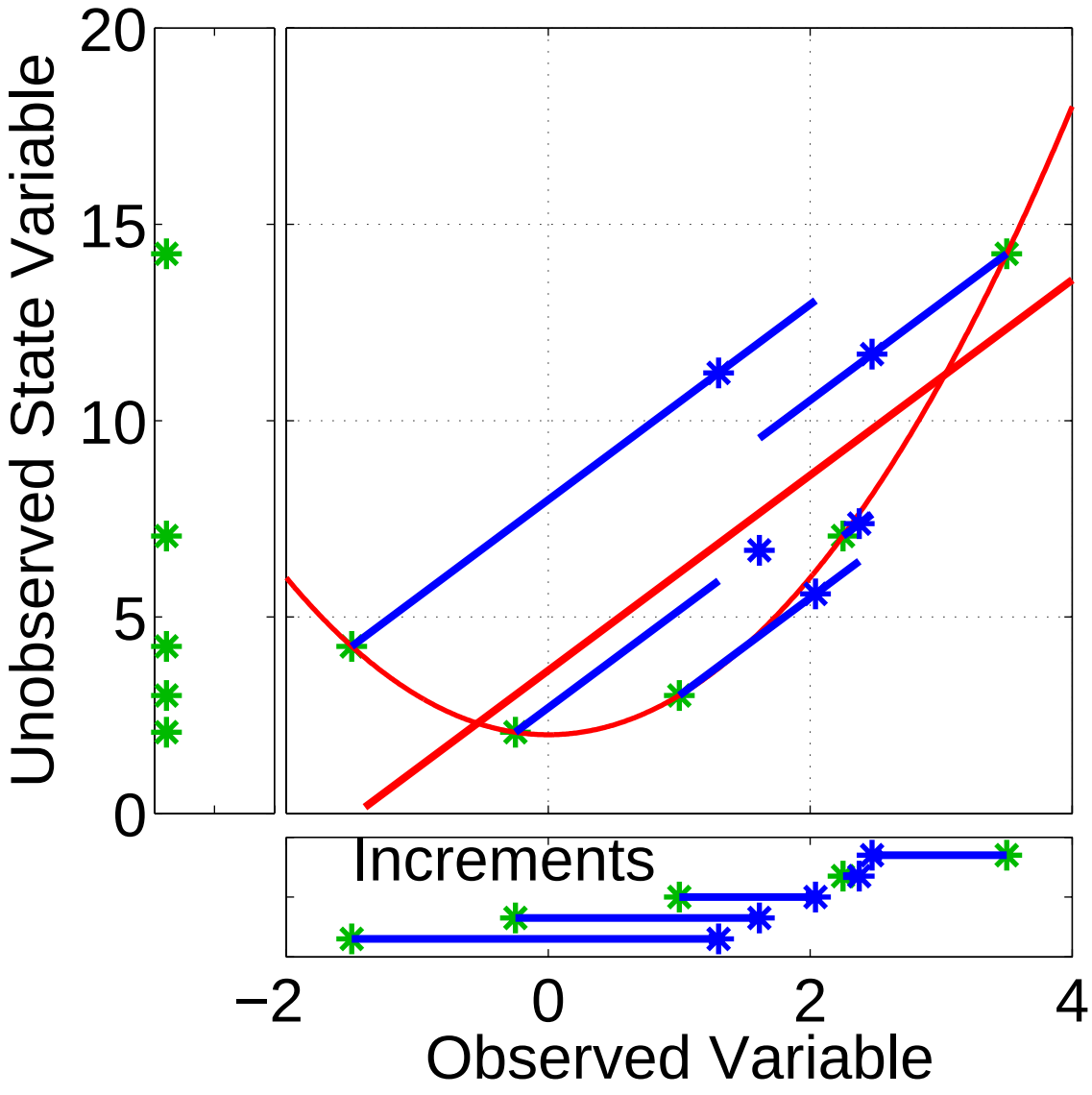


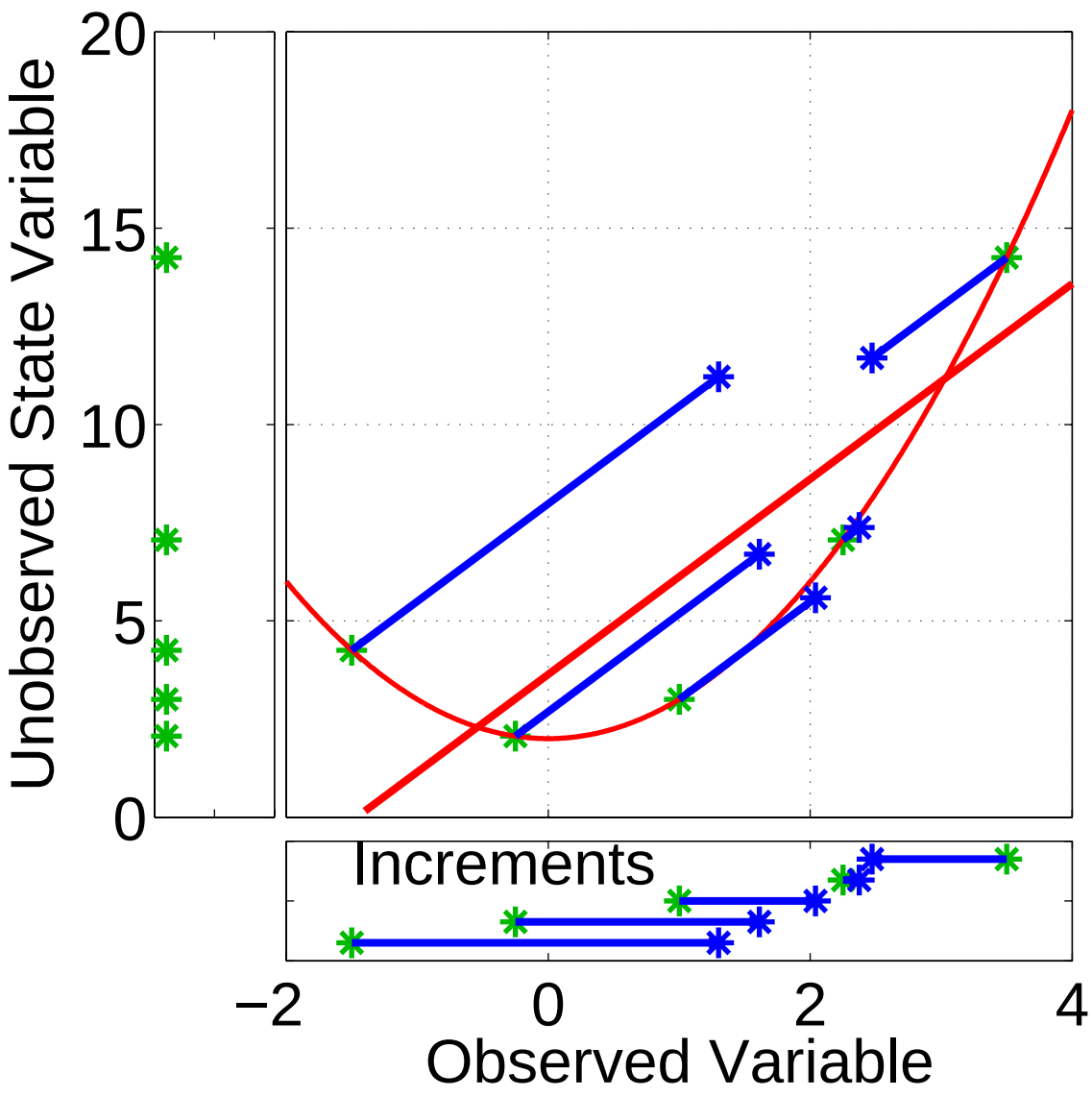
Suppose prior sample has NO noise.

Sorting prior and posterior and pairing samples minimizes one norm of increment size.

Resulting regression error is minimized.

Impact of sorting can be very large when posterior selected by ‘random’ algorithms.

Nonlinear relations between variables; sorting increments



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Impact of sorting can be very large when posterior selected by ‘random’ algorithms.

Nonlinear relations between variables; sorting increments:

Can see this impact nicely in 9var model.

Try *filter_kind = 2* in *assim_tools_nml* with:

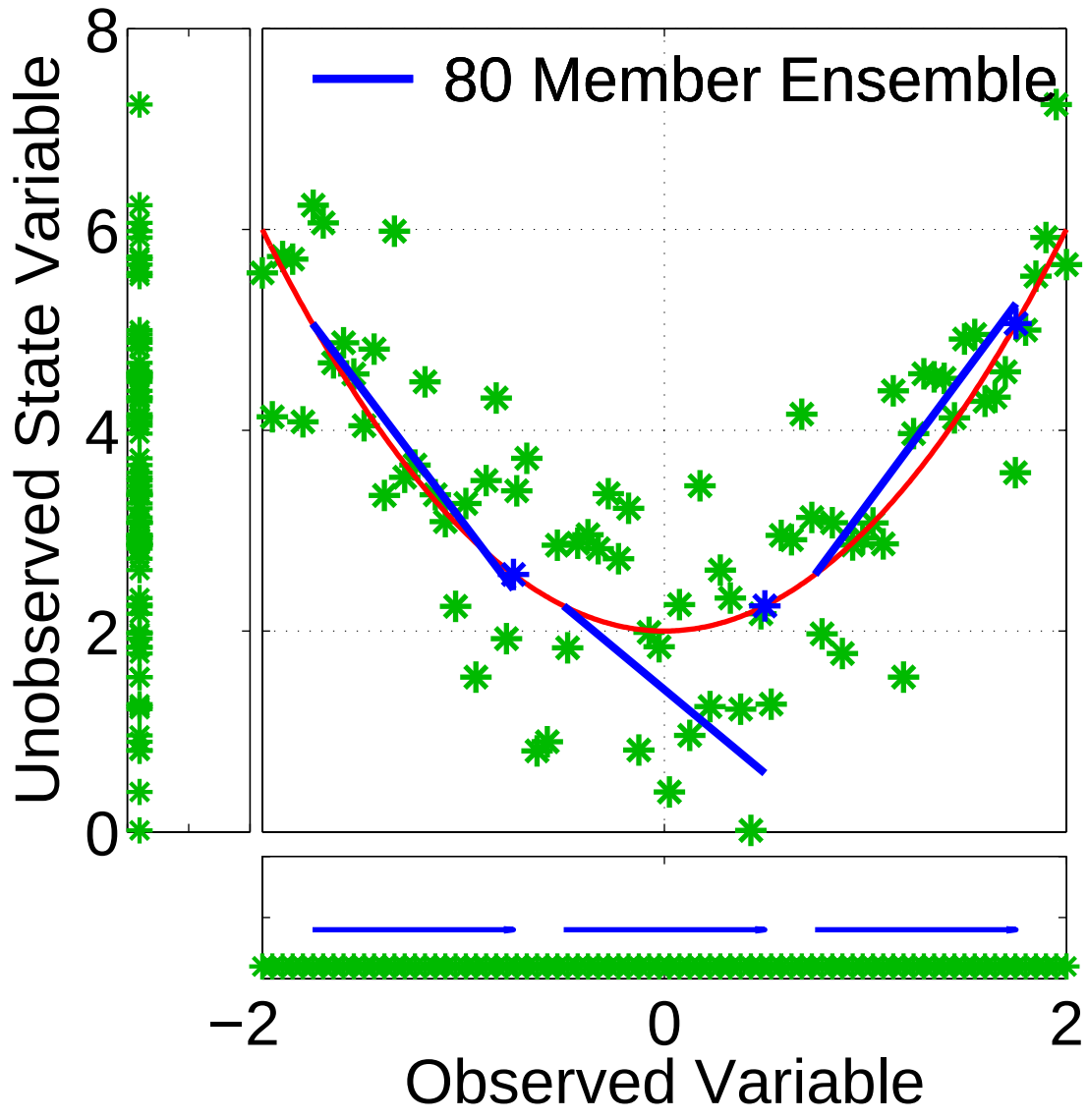
sort_obs_inc = .true. (increments minimized) and

sort_obs_inc = .false.

Compare the performance.

There may be surprises in other low-order models when trying this.

Nonlinear relations between variables: Local regression



Prior sample is noisy.

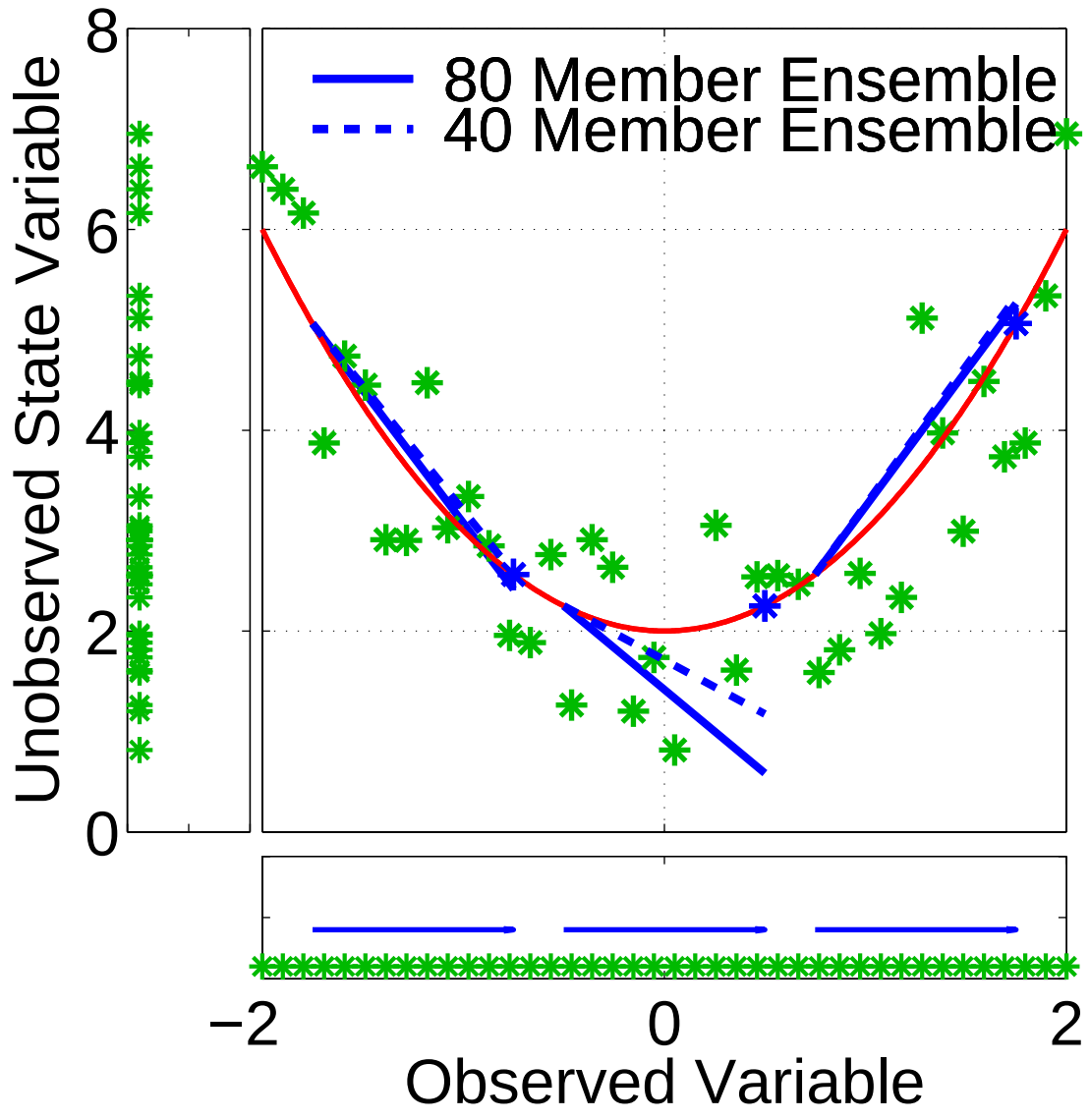
Un/observed relation is non-linear.

Doing global regression would be BAD here.

Can do regression only for points that lie in range of update increment.

Could also pick local sets in other ways.

Nonlinear relations between variables; Local regression



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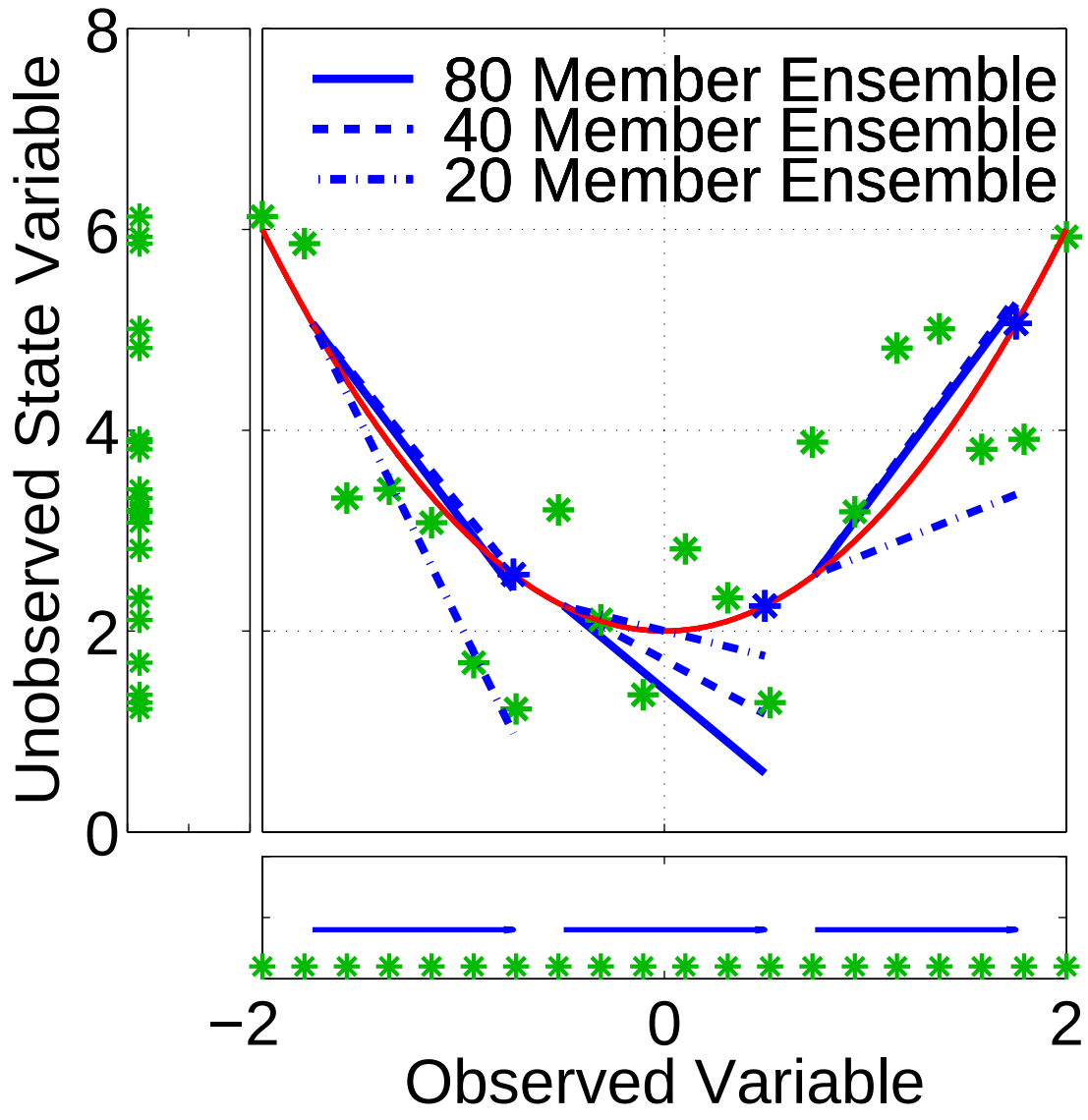
Un/observed relation is non-linear.

For larger ensembles, local regressions can work well.

Error is largest where signal is weakest (near bottom of parabola here).

Nonlinear relations between variables; Local regression



Prior sample is noisy.

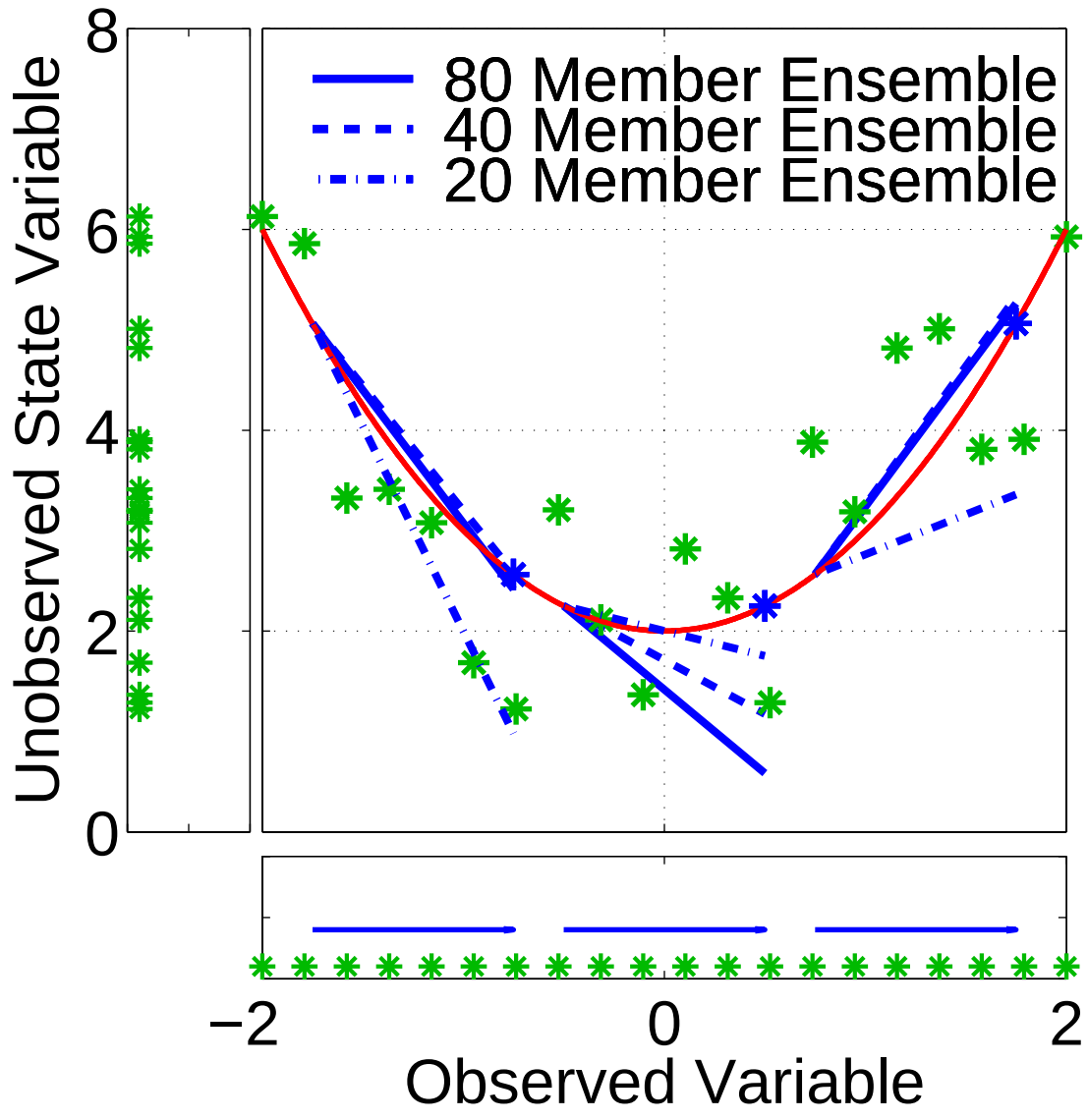
Un/observed relation is non-linear.

As sample size decreases, error grows.

(Except where it was rotten to start).

Applications where local regression is useful are unknown to me.

Nonlinear relations between variables; Local regression



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Un/observed relation is non-linear.

Serious issues may exist if local regression is used with multiple unobserved state variables.