

Bridging the gap between data and models

Matthew Plumlee
Industrial and Operations Engineering, University of Michigan

data+computational model → inference

Data

- Observational data
- Experimental data
- Subsystem data
- Other comp. models

Computational Models

- ODEs, PDEs → FEA
- Discrete event
- Agent based simulation
- Optimization models

Some goals of model/data comparison:

Validation Determining if a model is an accurate representation of the real world from the perspective of the intended uses of the model.

Calibration Improving a model to better represent the real world for the intended uses of the model.

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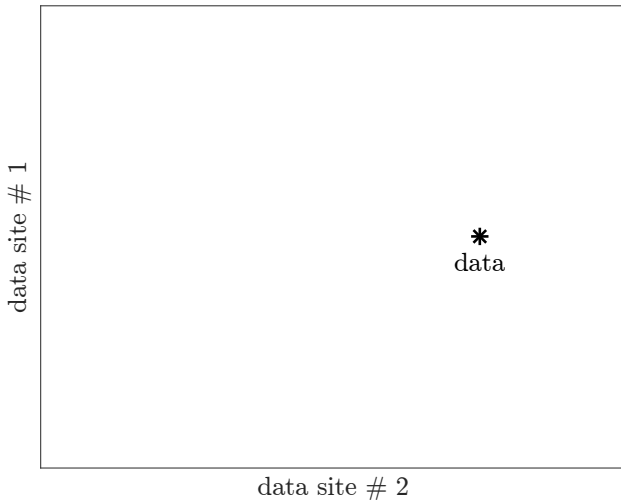
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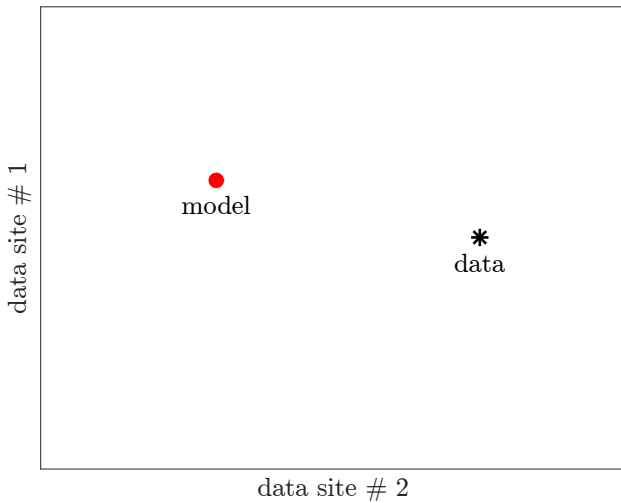
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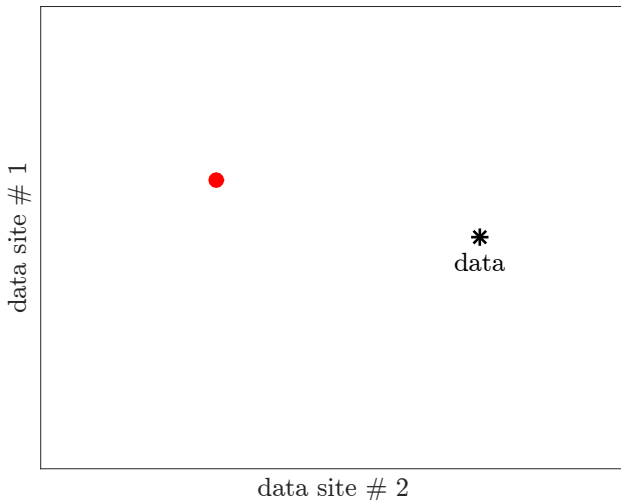
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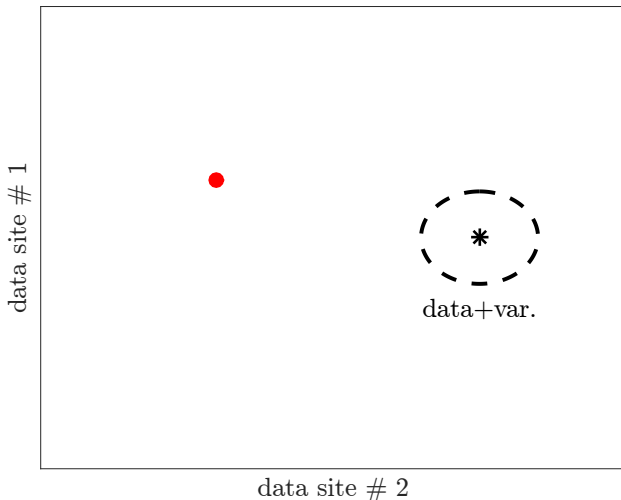






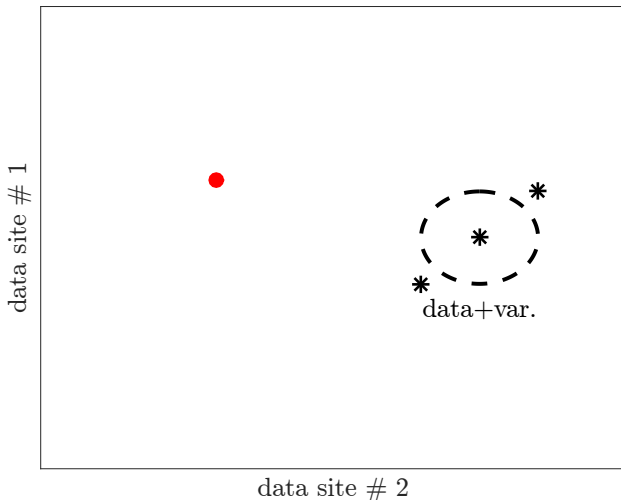
Variance Replication error, precision. Often apparent in datasets.

Bias Offset, systematic errors. Often not apparent in data.



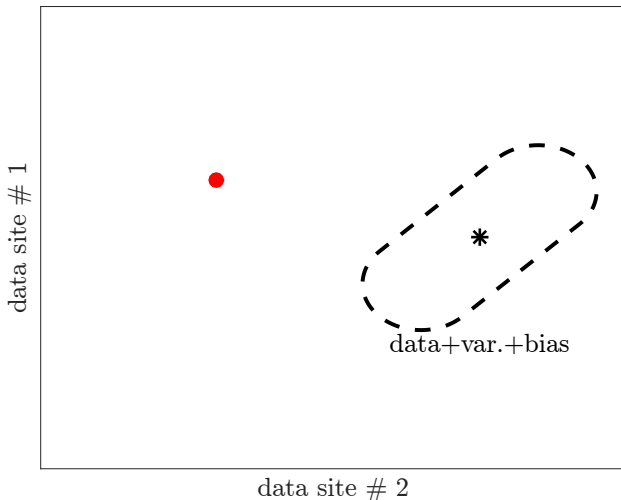
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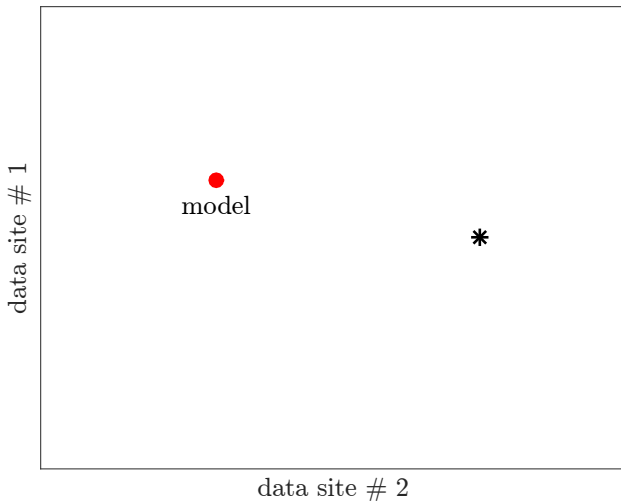
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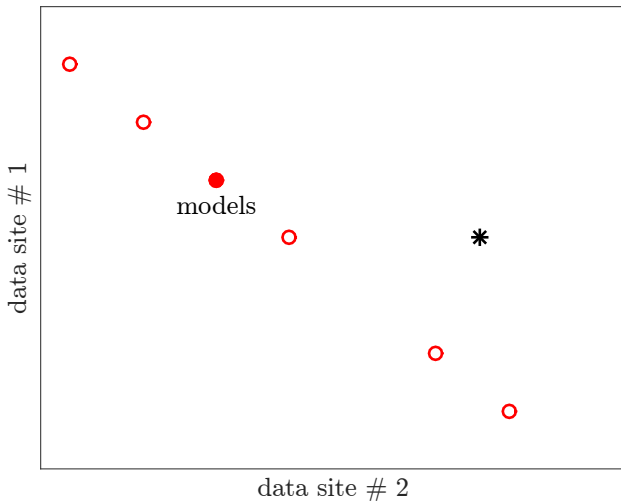


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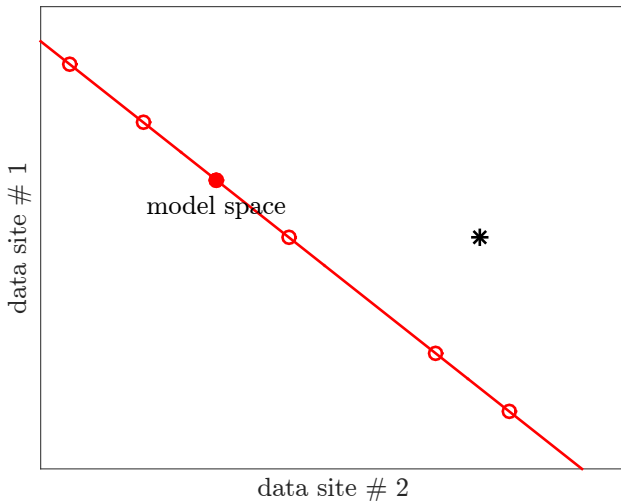
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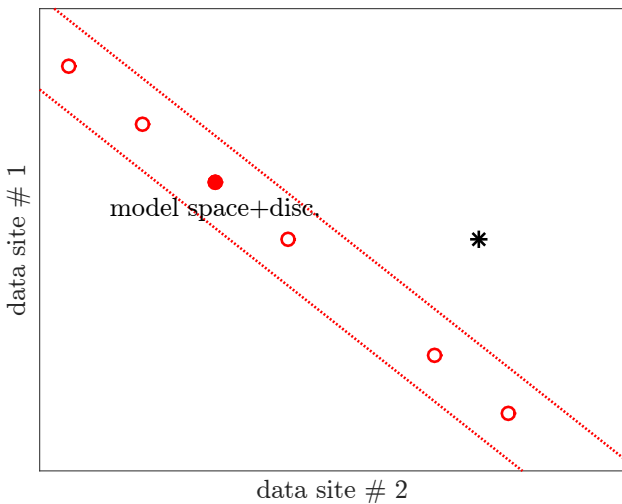
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Discrepancy model risk, model error, acceptable error. Often not apparent while modelling.



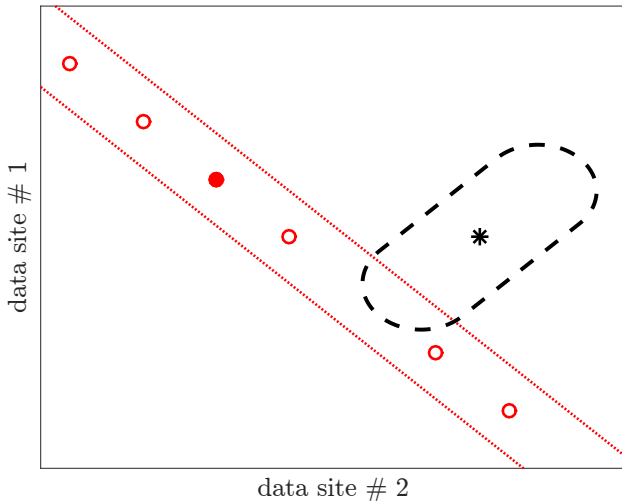
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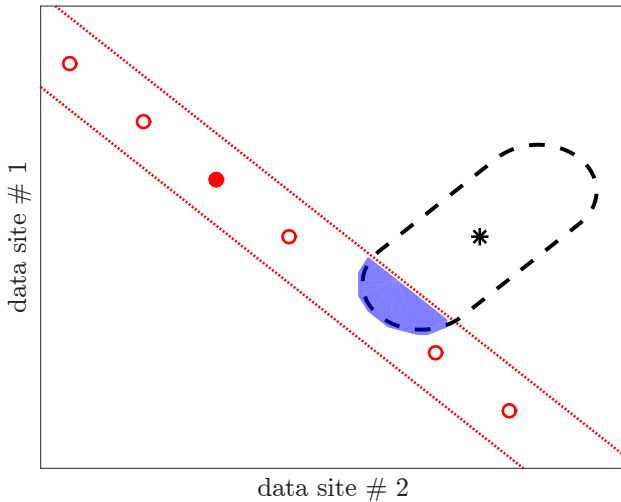


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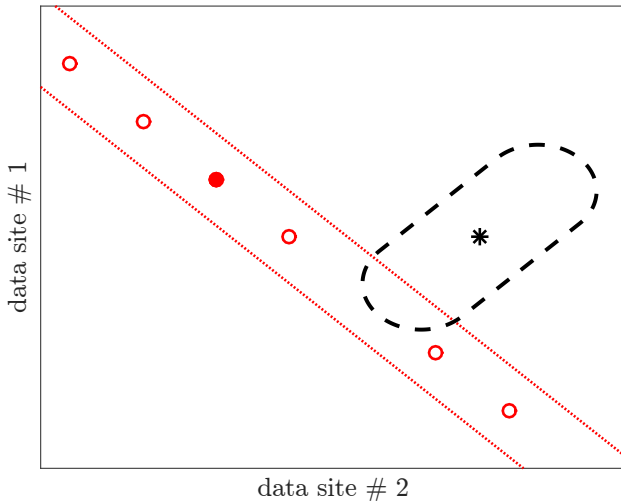
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Calibration Find best models to match data.

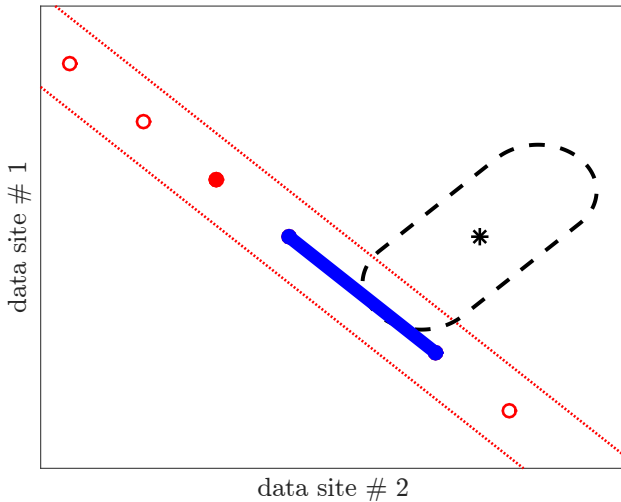


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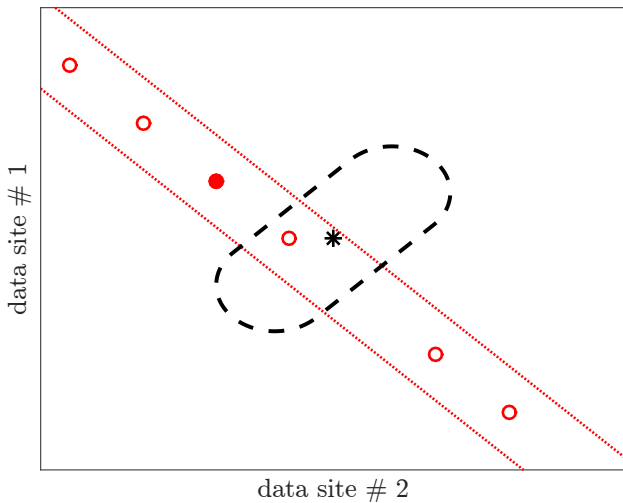
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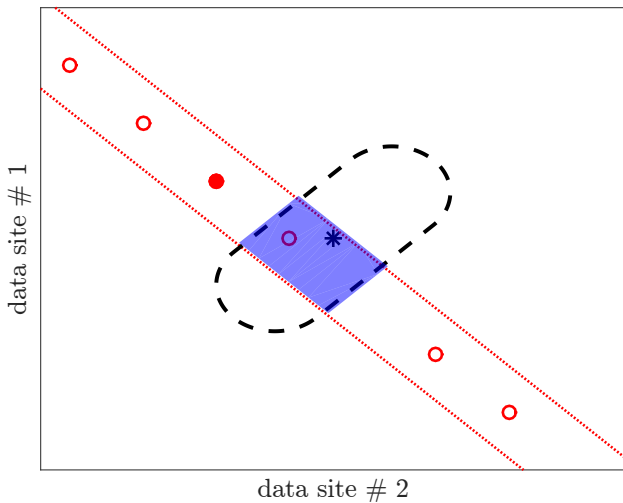
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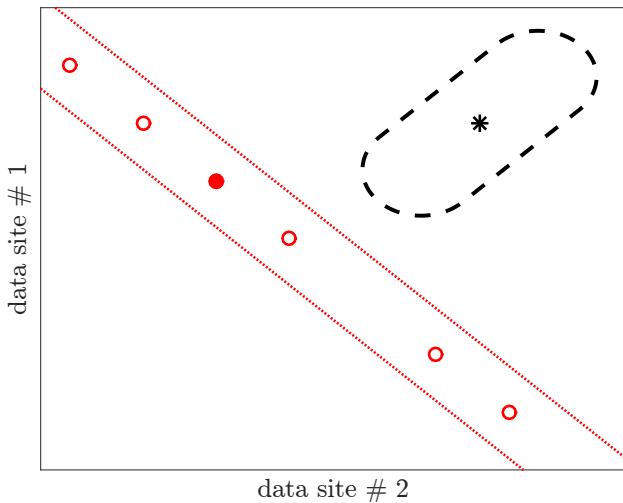
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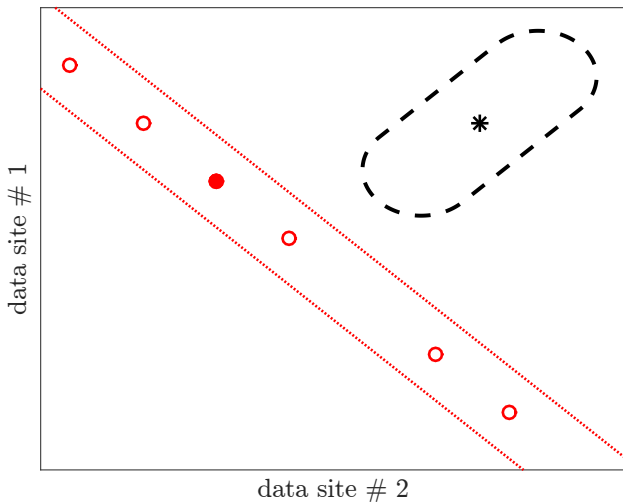
Better match.



Better match.



Worse match.



Worse match.

- **Less variance** improves validation and improves calibration.
- **Less bias** improves validation and improves calibration.
- **Fewer unknowns** improves validation and degrades calibration.
- **Less discrepancy** improves validation and improves calibration.

What can everyone do to improve this interface?

Data Providers

- Provide variance analysis
- Attempt to estimate or describe potential bias

Modelers

- Investigate model space
- Admit your model could have a discrepancy

Most tools are not yet “textbook” level, but feel free to reach out to people! Highlight: **Journal of Uncertainty Quantification** co-sponsored by ASA and SIAM. Biannual SIAM UQ conference (coming up next Spring).

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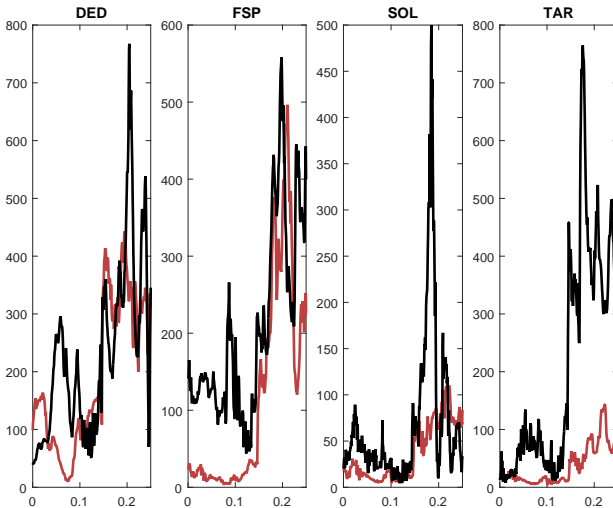
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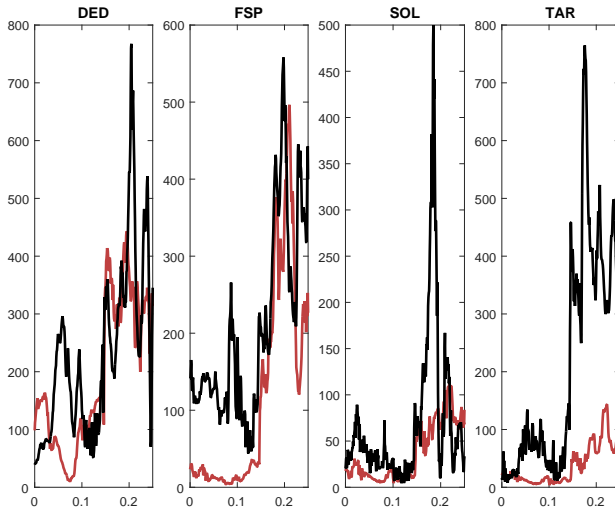
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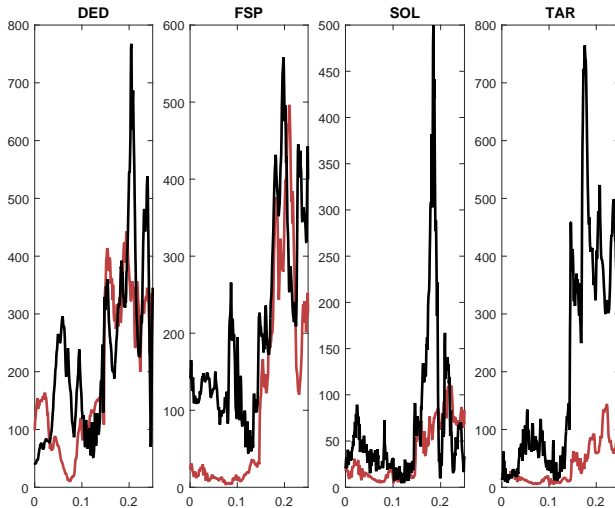
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15 interfaced components, can predict the change in ground potential.
Compare to vector magnetometer data. 192 magnetometers for 300
time points.



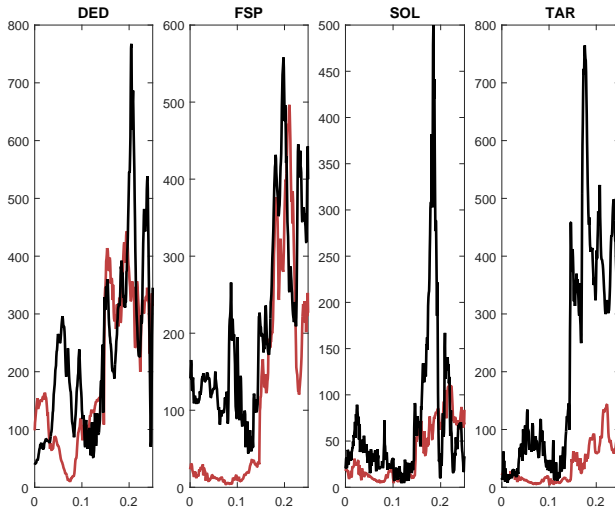
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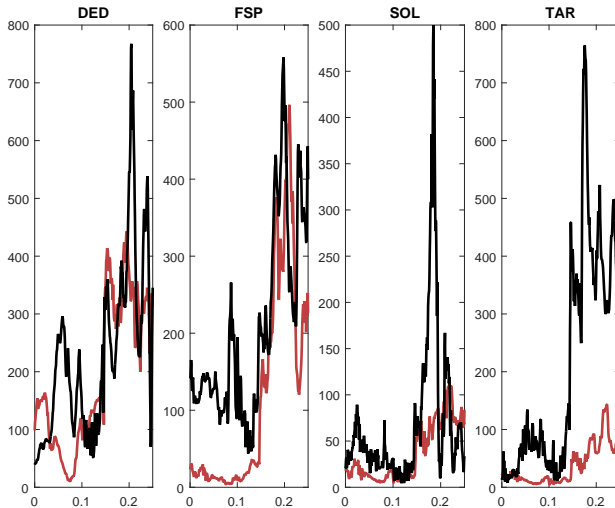
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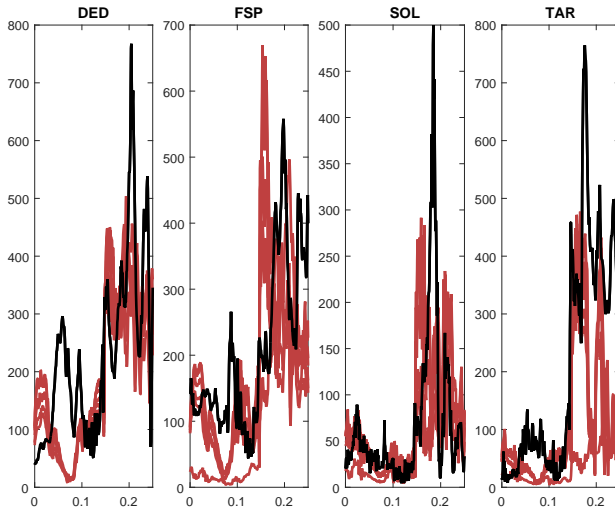
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