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Testing the fidelity of posterior inference methods for astrophysics

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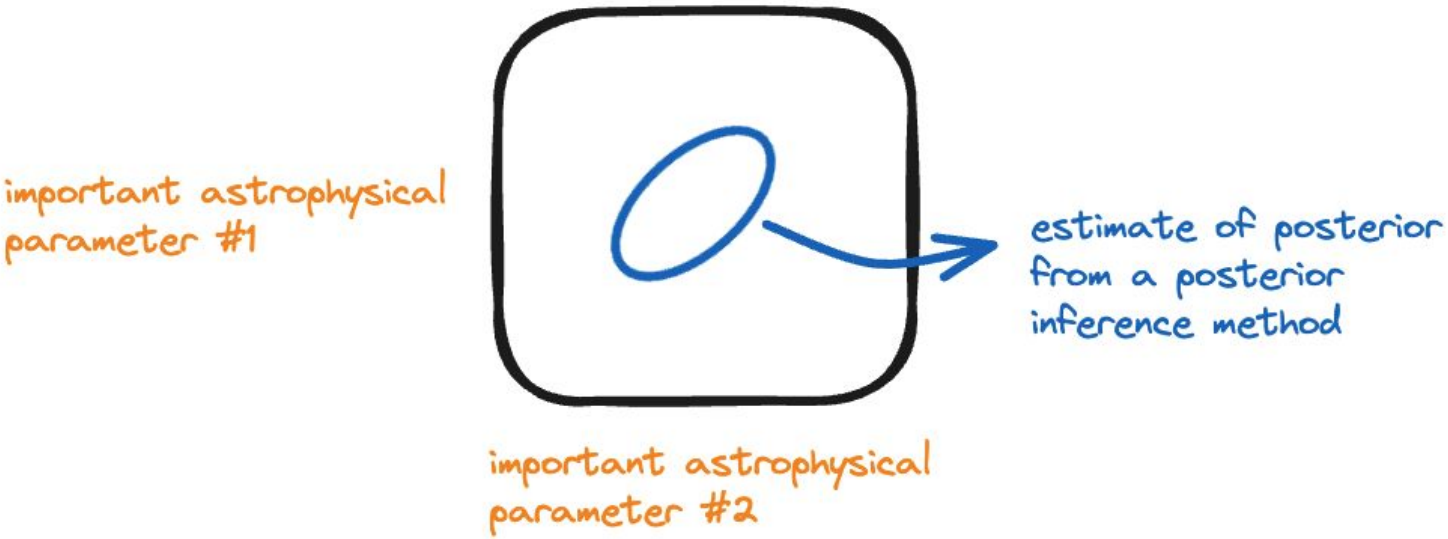
ML-IAP/CCA Debating the potential of ML in astronomical surveys

Why test the fidelity of posterior inference methods?



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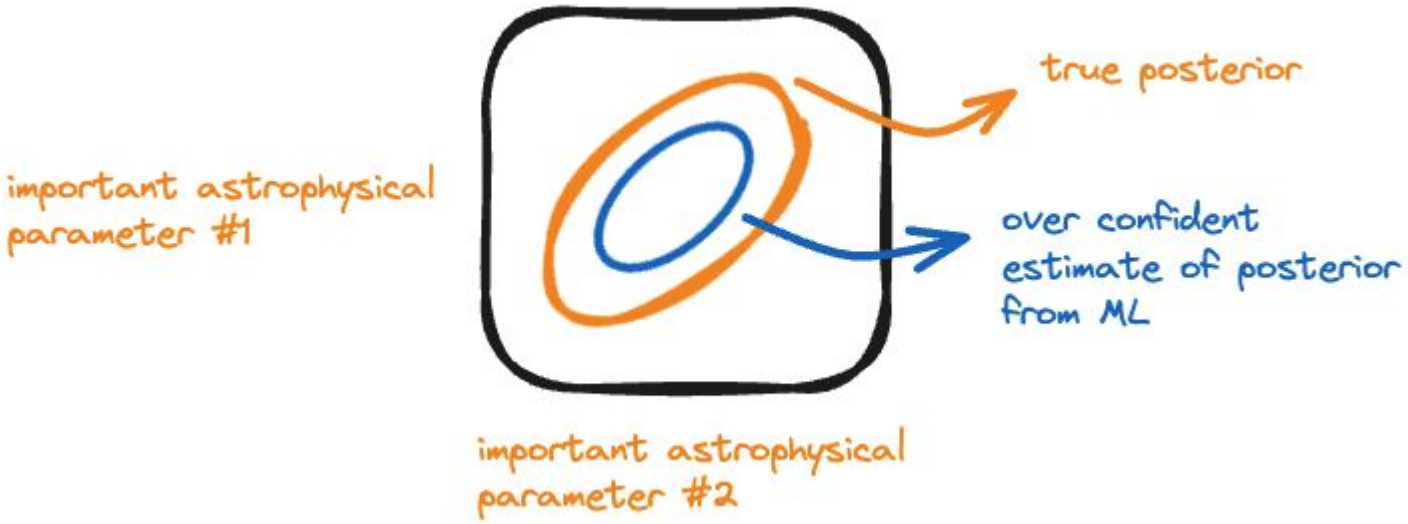

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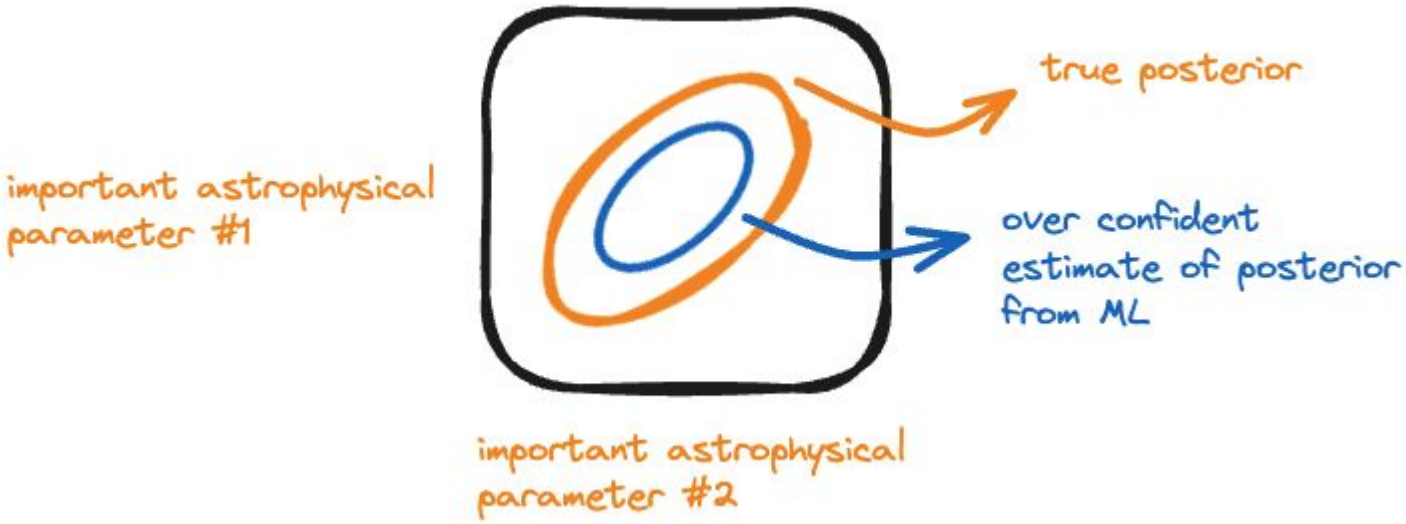
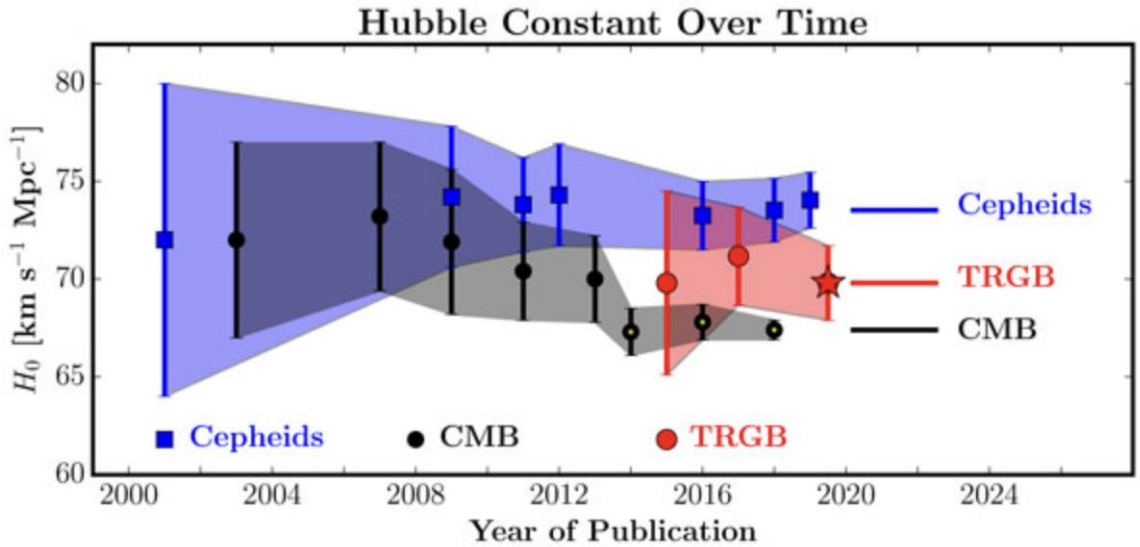


Many ML posterior inference methods are over-confident

([A crisis in simulation-based inference])

What does it mean to **test the fidelity** of these methods?

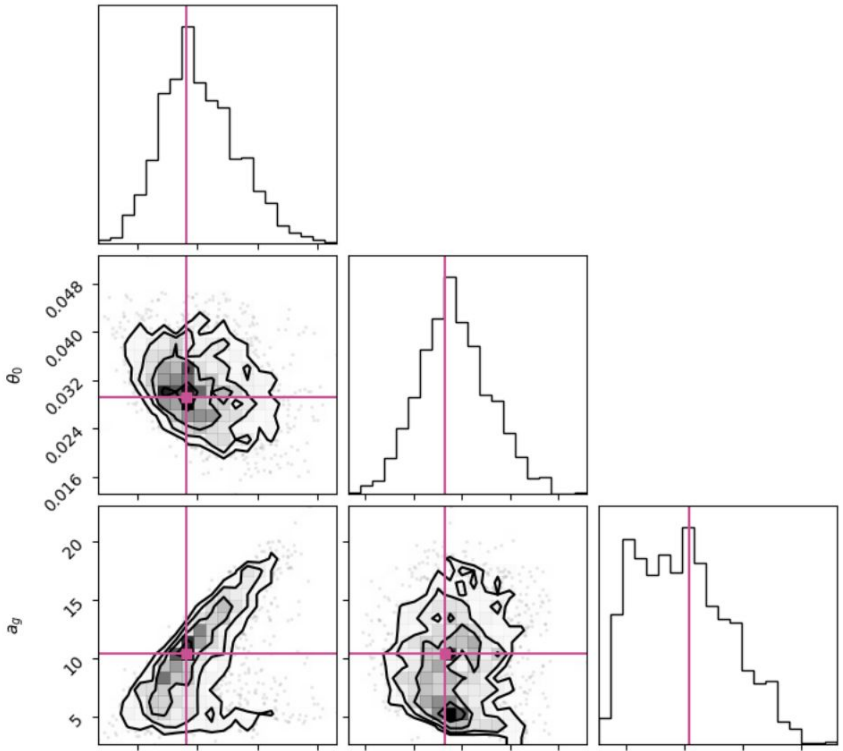
Error is important in astrophysics, people's entire careers depend upon / define these error bars:



Testing the fidelity of **posterior inference methods** for astrophysics

Posterior inference method = determining possible parameter values that make sense for your data, p(θ|X)

distribution of possible parameter values, θs



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Posterior inference methods

Bayesian Inference
Analytic likelihood and HMC sampling

Simulation-based inference
No likelihood needed, uses a density estimator

Deep Ensembles
An amalgamation of neural networks

Posterior inference methods

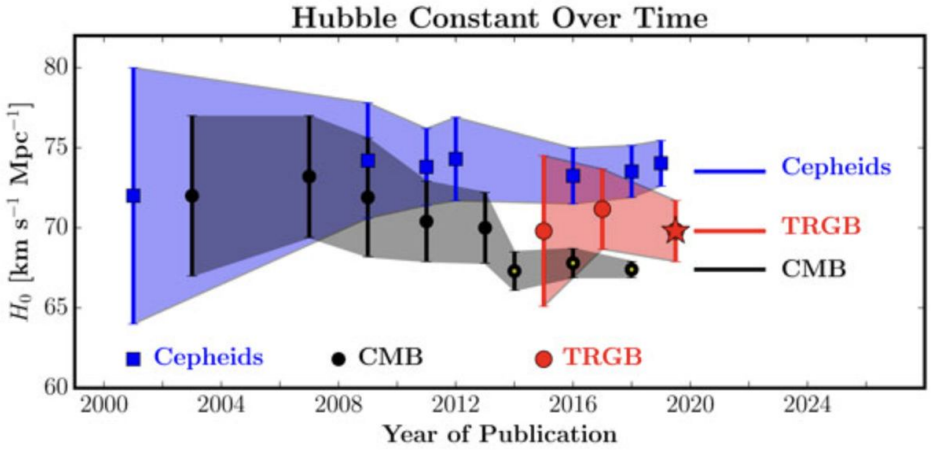
Bayesian Inference + Hierarchical
Analytic likelihood and HMC sampling

Simulation-based inference + Hierarchical
No likelihood needed, uses a density estimator

Deep Ensembles
An amalgamation of neural networks

What does it mean to **test the fidelity** of these methods?

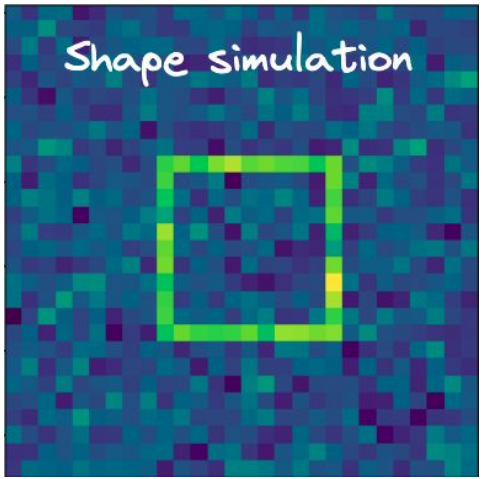
Can we trust the uncertainty prediction of the model?

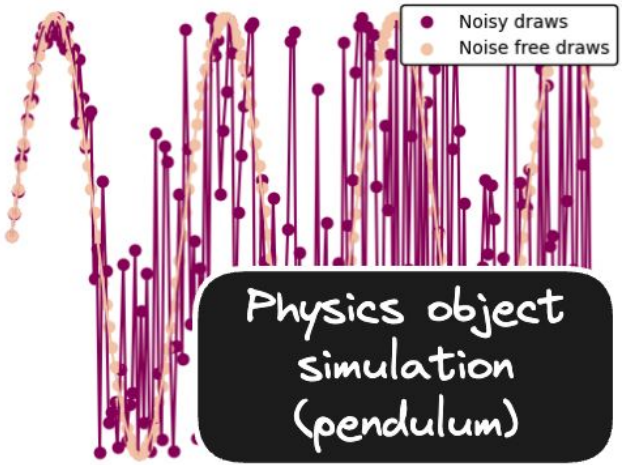


- ^Uncertainty is clearly really important in astrophysics^
- Can we trust the confidence of these models?
- How do these different models perform under different uncertainty conditions? Different types of uncertainty?

We require fine control over uncertainty properties → we use Deepskies' **DeepBench** software

https://github.com/deepskies/DeepBench





Testing the fidelity of posterior inference methods for astrophysics

- Comparing posterior inference methods (Bayesian inference, simulation-based inference, and deep ensembles)
- Developing software tools to assess uncertainty prediction from these methods