

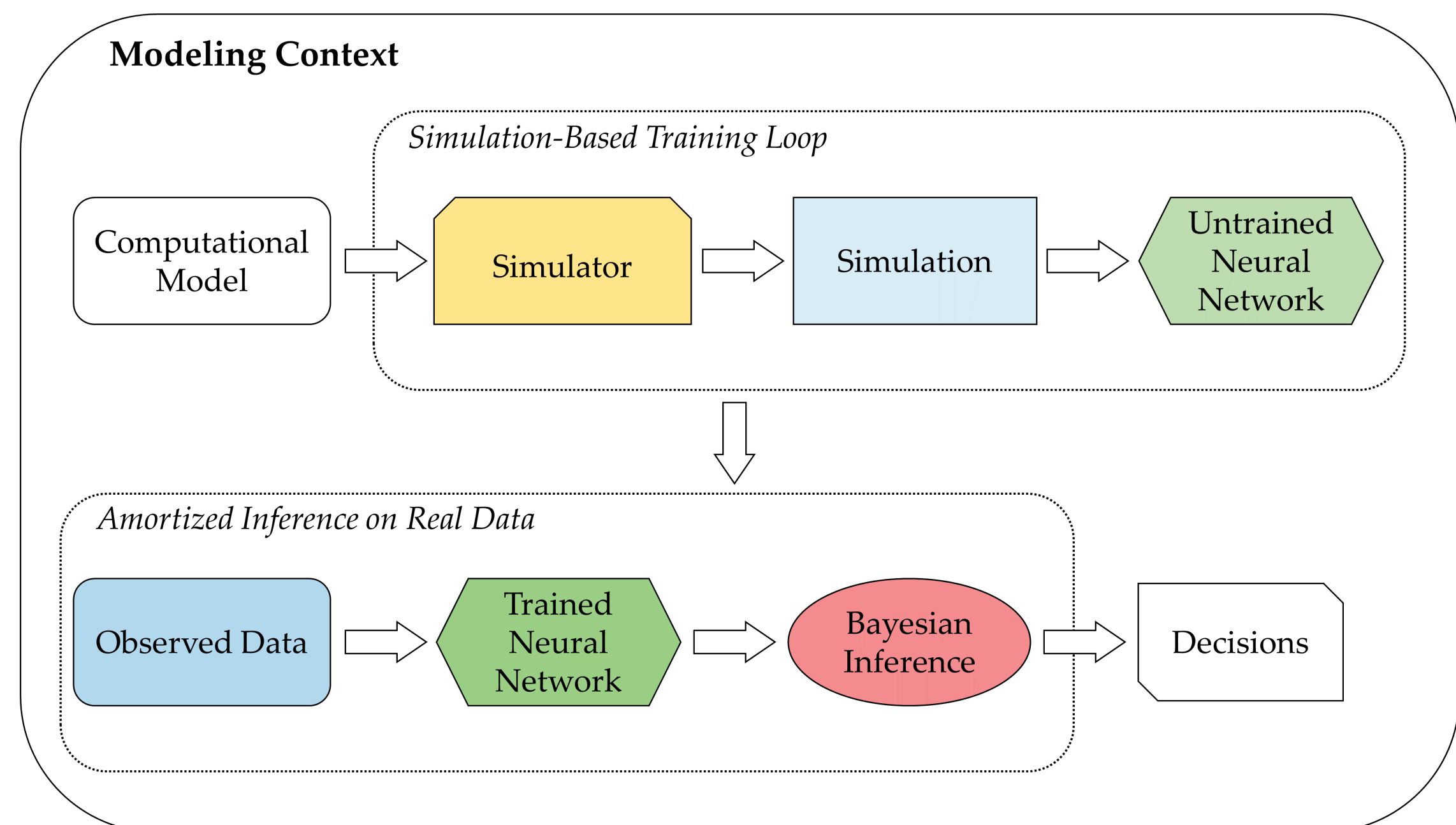
Detecting Model Misspecification in Amortized Bayesian Inference

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Amortized Bayesian Inference



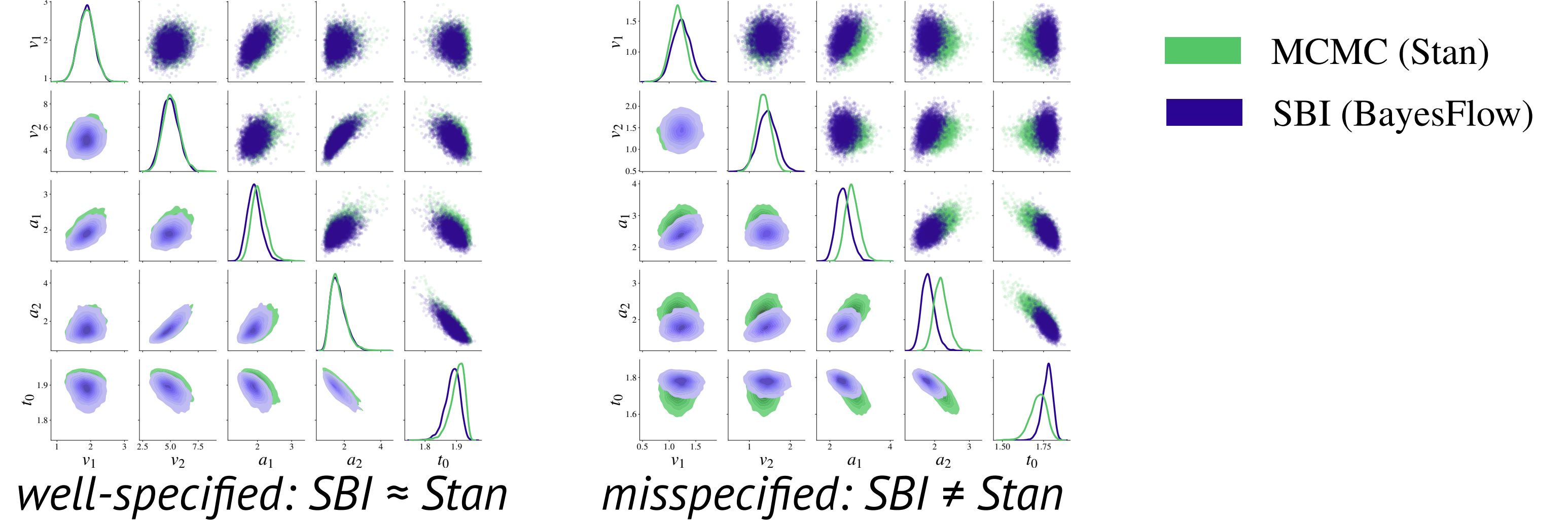
Simulation Paradigm

Generative model $\mathcal{G} = (g(\theta, \xi), p(\xi|\theta), p(\theta))$

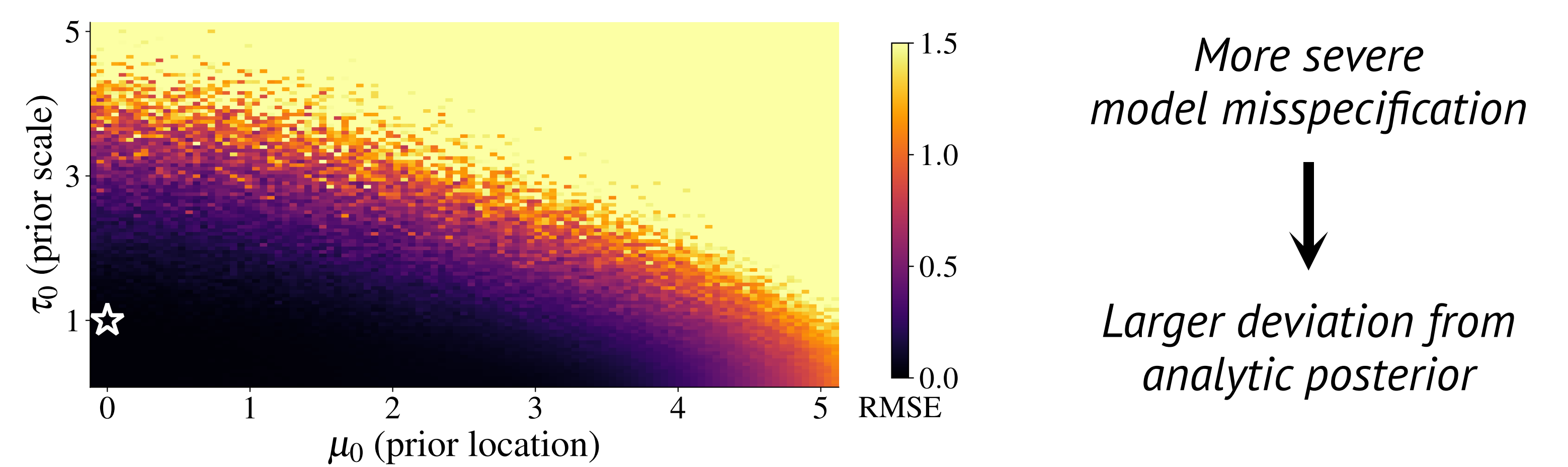
$x = g(\theta, \xi)$ (simulator)
 $\xi \sim p(\xi|\theta)$ (contamination)
 $\theta \sim p(\theta)$ (prior)

Model Misspecification → Posterior Errors

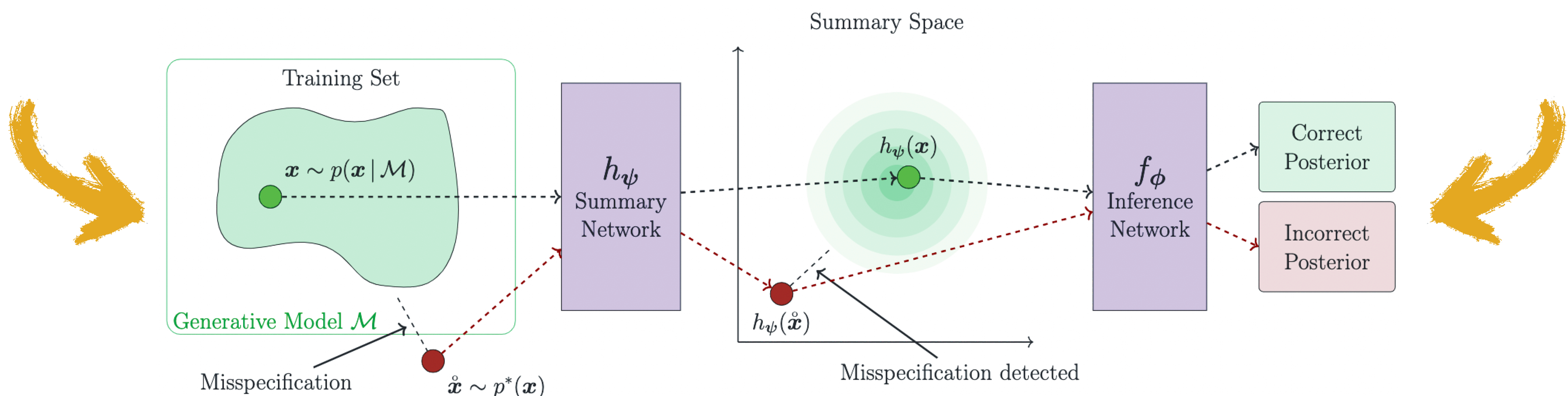
(1) Cognitive modeling: Drift Diffusion Model



(2) Conjugate Model: 2D Gaussian Means



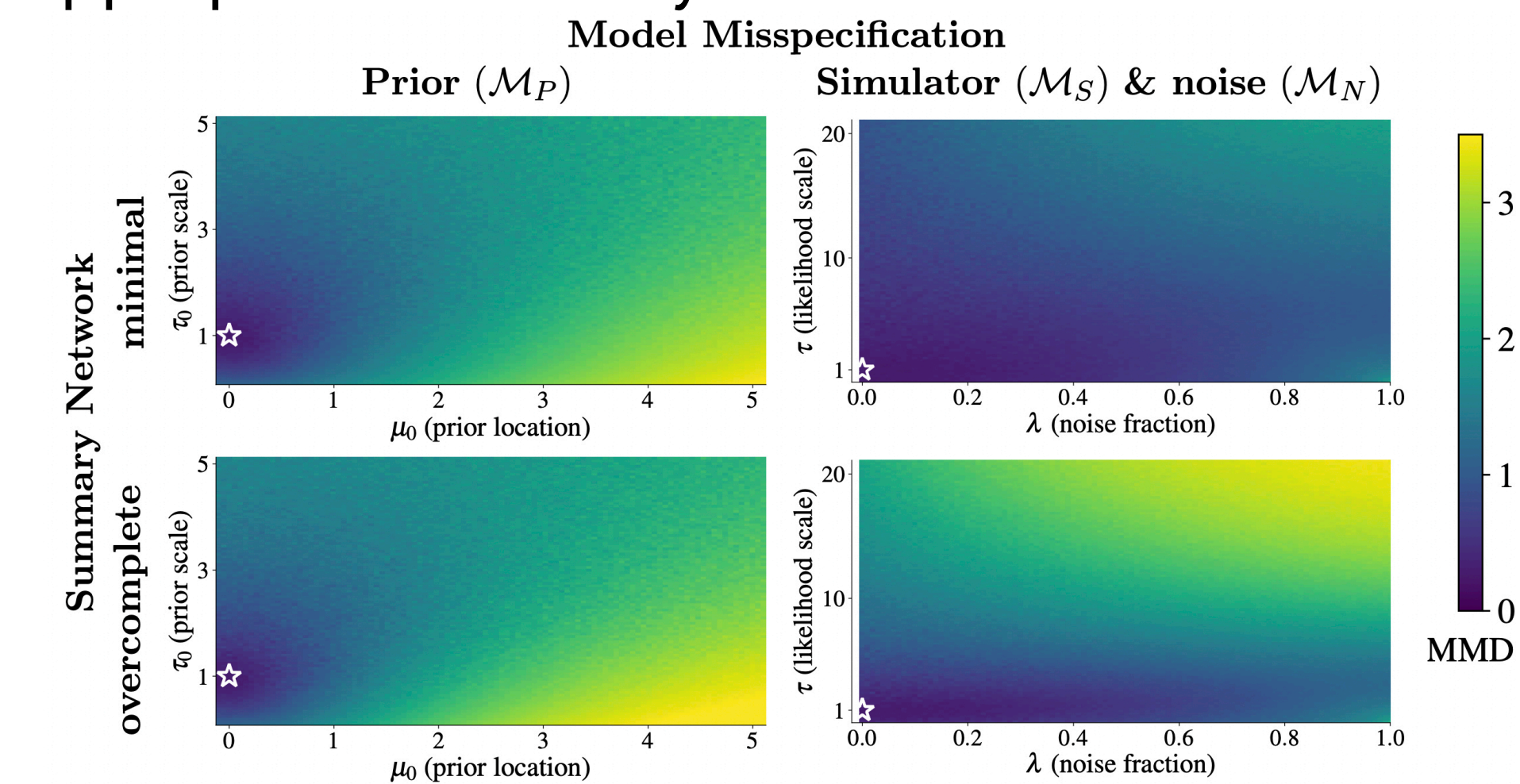
Our Framework to Detect Model Misspecification



Experiments

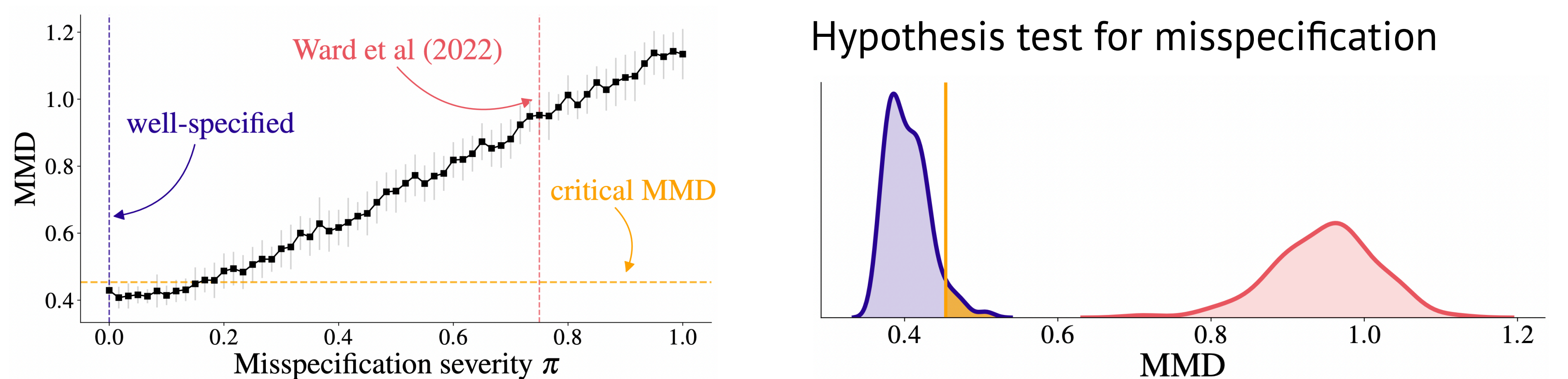
Toy 2D Gaussian

Model misspecification can be detected with appropriate summary networks



Cancer Cell Model

More severe misspecification → higher MMD (louder alarm)



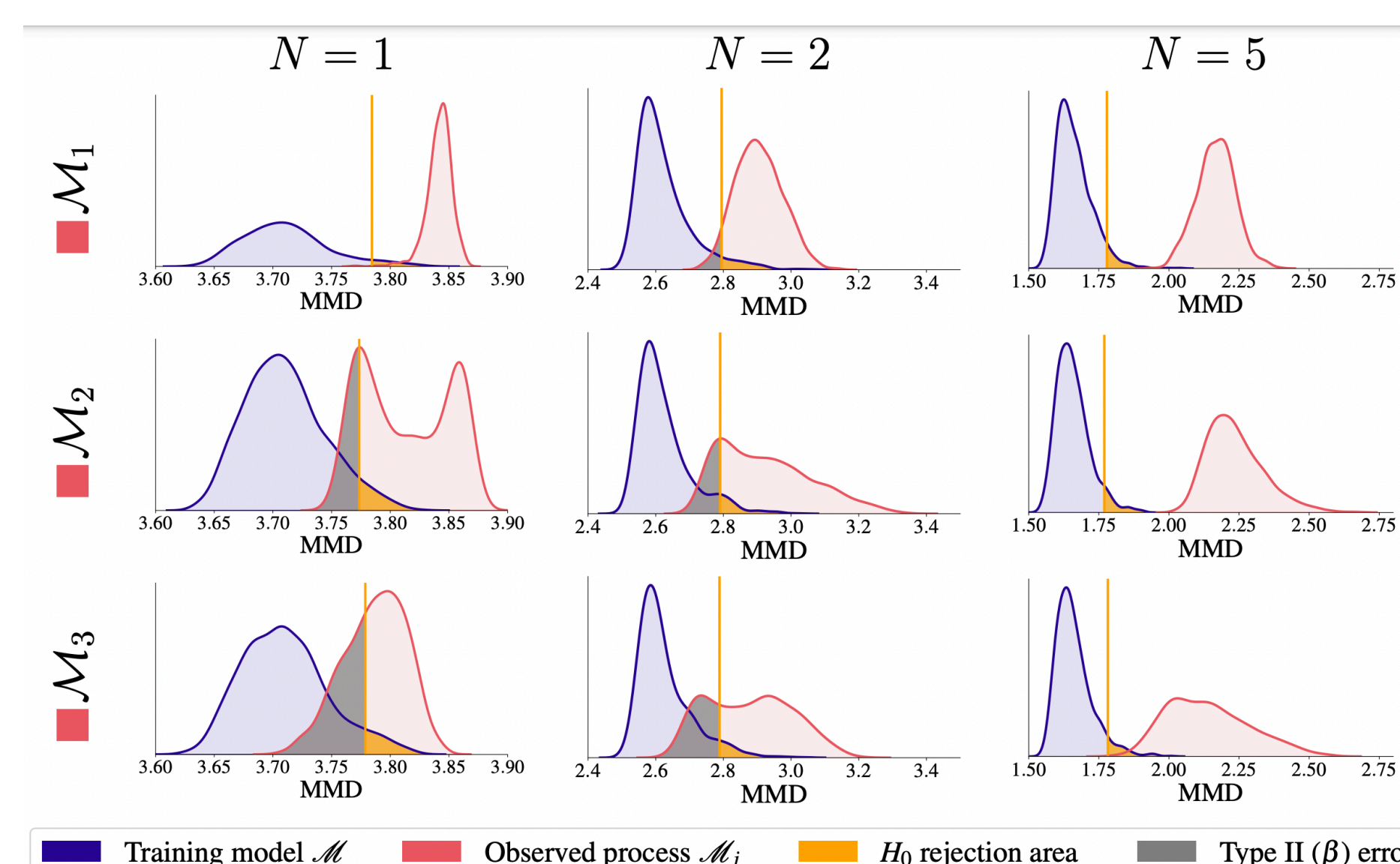
Drift Diffusion Model

Principal components (PCA) in the learned summary space align with true parameters

| | PC1 | PC2 | PC3 | PC4 | PC5 | PC6 | PC7 | PC8 | PC9 | PC10 |
|--------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|
| v_1 | -0.03 | -0.29 | -0.48 | -0.58 | -0.23 | -0.06 | 0.05 | 0.03 | 0.07 | 0.02 |
| v_2 | -0.00 | -0.71 | -0.06 | 0.44 | -0.14 | -0.04 | 0.09 | 0.00 | 0.08 | 0.04 |
| a_1 | 0.10 | -0.05 | 0.68 | -0.21 | -0.48 | 0.15 | 0.15 | -0.10 | 0.02 | 0.13 |
| a_2 | 0.04 | 0.49 | -0.39 | 0.33 | -0.50 | 0.06 | 0.19 | 0.01 | 0.04 | 0.02 |
| t_0 | 0.99 | -0.01 | -0.07 | -0.00 | 0.06 | -0.03 | -0.02 | 0.02 | -0.02 | 0.00 |
| ΣR^2 | 0.31 | 0.47 | 0.60 | 0.73 | 0.85 | 0.95 | 0.99 | 1.00 | 1.00 | 1.00 |

COVID-19 Time Series

Power ≈ 1 for as few as $N = 5$ data sets



Hypothesis test result:
"The model is well-specified for the observed data from Germany."

