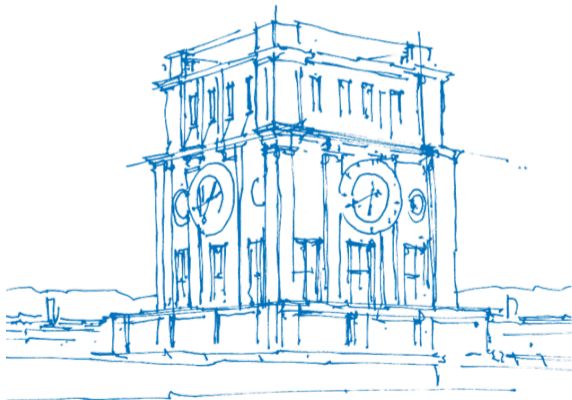


# Automatic Posterior Transformation for Likelihood-free Inference

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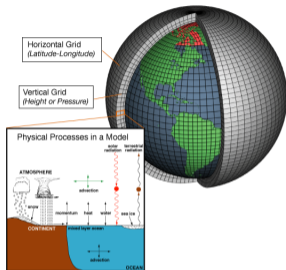
Technical University of Munich  
Computational Neuroengineering  
Department of Electrical and Computer Engineering



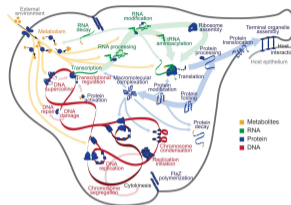
*TUM Uhrenturm*

# For many important simulators, the likelihood is unavailable

## Climate

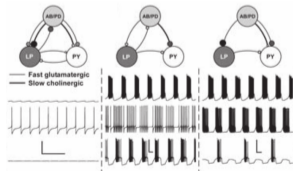


## Cell biology



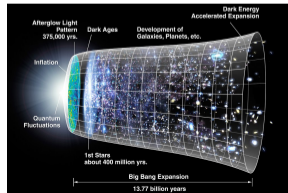
*Mycoplasma Genitalium*, Karr et al., 2016

## Neuroscience



*Homarus Americanus*, Prinz et al., 2004

## Cosmology



# Bayesian Inference without Likelihood Evaluation

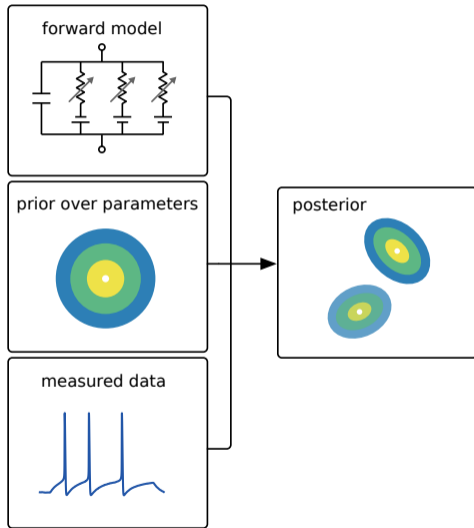
Given a simulator, a prior on its parameters, and observed data, we aim to infer the **posterior distribution** on parameters.

We **cannot evaluate** the likelihood

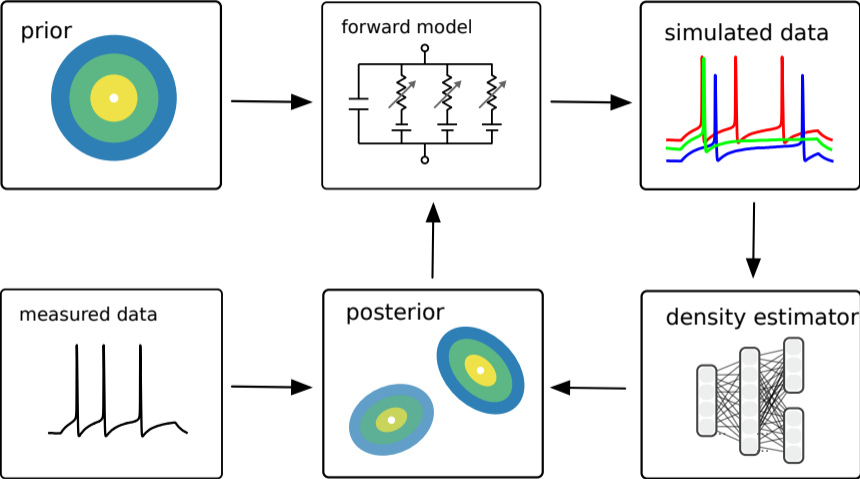
$$p(\text{data}|\text{parameters}) = ???$$

But we **can sample** data given parameters

$$\text{simulation} \sim p(\text{data}|\text{parameters})$$



# Sequential Neural Posterior Estimation (SNPE)



# Automatic Posterior Transformation vs. previous methods

True posterior



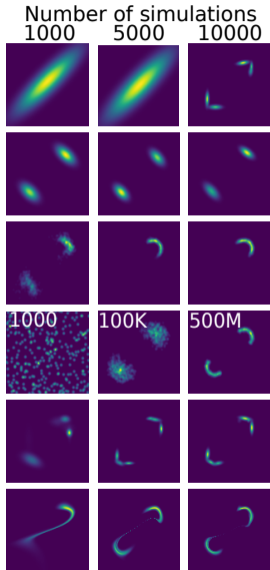
**SNPE-A** Papamakarios & Murray, 2016  
Restricts choice of proposal and density estimator, can't reuse data

**SNPE-B** Lueckmann et al., 2017  
Importance weights limit performance

**SNL** Papamakarios et al., 2017  
Estimates likelihood instead of posterior, requires MCMC after training

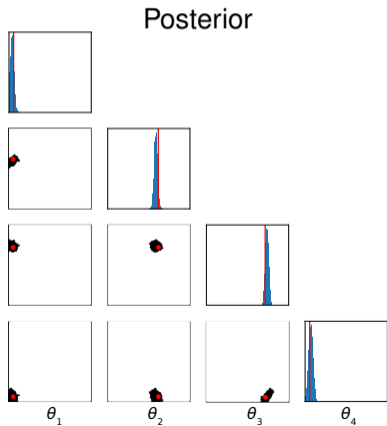
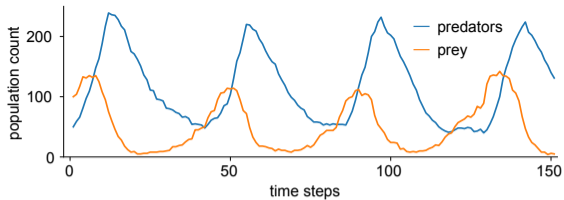
**Classical ABC**  
Requires many more simulations

**Automatic Posterior Transformation**  
Posterior estimation with flows or MDNs  
Simulation parameters can be freely chosen  
Feature learning (no summary stats)  
Scales to high dimensional data (10000+)

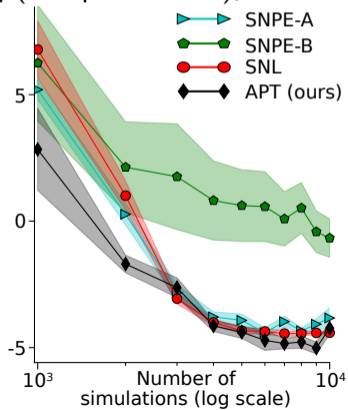


# Lotka-Volterra model

Lotka, 1920



$-\log p(\text{true parameters})$ , lower is better



# Rock-Paper-Scissors model

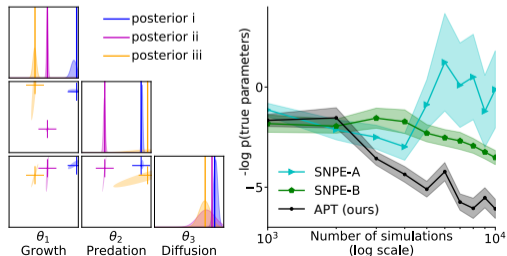
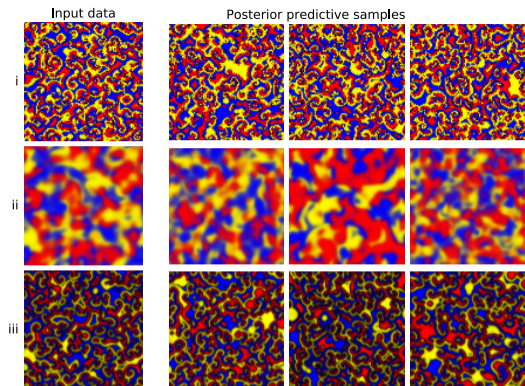
Reichenbach et al., 2008

Simulator is defined by a stochastic PDE.

Data is 10000 dimensional.

CNN-based feature learning.

APT infers tight posteriors around the ground-truth parameters.



# Thanks!

More details at **poster 238, tonight at 6:30pm in the Pacific Ballroom.**

Technical  
University  
of Munich



Marcel Nonnenmacher



Jakob Macke

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