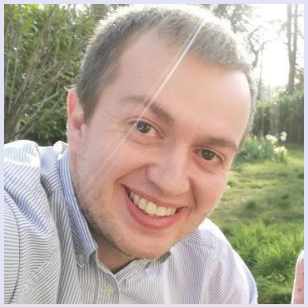
HNPE: Leveraging Global Parameters for Neural Posterior Estimation

P. Rodrigues, **T. Moreau**, G. Louppe, A. Gramfort



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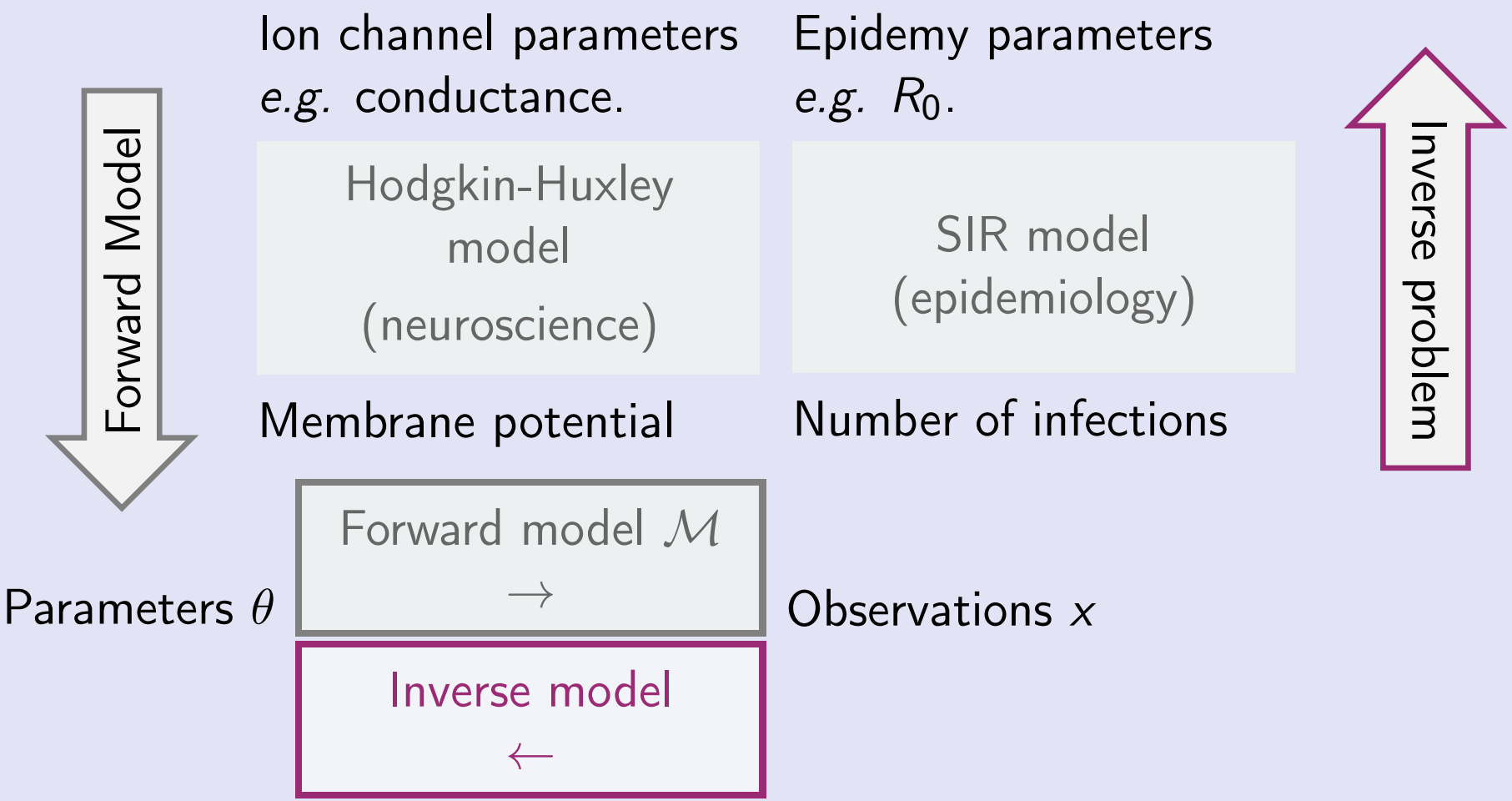
Inverse problems

Inferring parameters of a model from observations is a fundamental scientific challenge.



Inverse problems

Inferring parameters of a model from observations is a fundamental scientific challenge.

Ion channel parameters
e.g. conductance.

Hodgkin-Huxley model
(neuroscience)

Membrane potential

Epidemy parameters
e.g. R_0.

SIR model
(epidemiology)

Number of infections

Forward Model

Inverse problem

Parameters θ

Forward model $\mathcal{M}$
$\rightarrow$

Inverse model
$\leftarrow$

Observations x

Goal:
Learn $p(\theta|x)$

Key challenge: Non-injective models

Distance

Voice Amplitude

Close and quiet or far and loud?

Brain tissue

propagation

brain activity

Amplified weak or attenuated strong ?

Key challenge: Non-injective models

Distance

Voice Amplitude

Other speakers at same distance

Close and quiet or far and loud?

Brain tissue

propagation

brain activity

Other recordings from the same subject

Amplified weak or attenuated strong ?

$\Rightarrow$ Leverage observations with common *global* parameter.

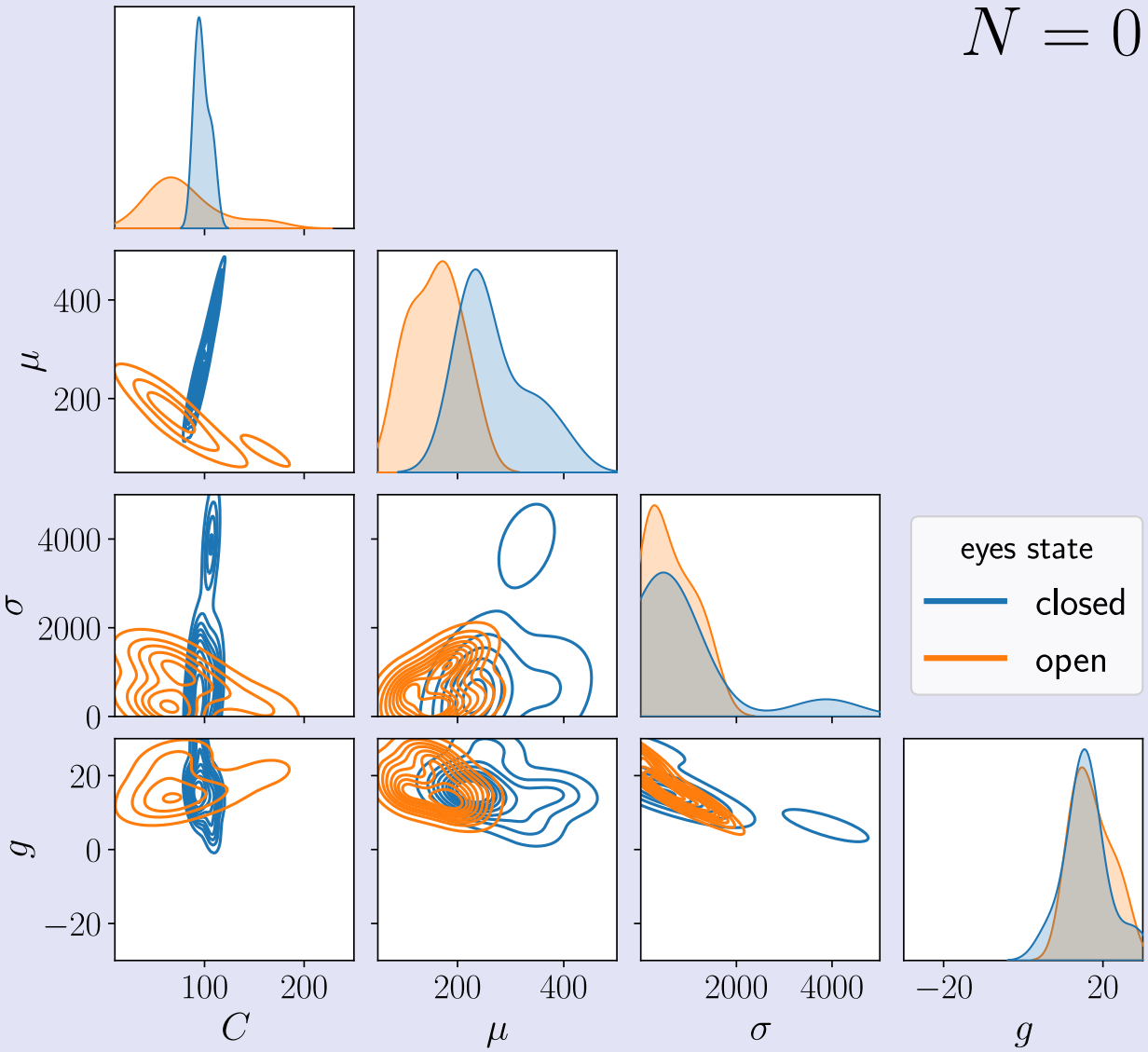
Our contributions

- Hierarchical model to account for extra observations $\mathcal{X} = \{x_1, \dots x_N\}$,
- Adapt normalizing flows to approximate the posterior,
  [Papamakarios et al. 2019]
- Use DeepSet architecture to account for invariance in $\mathcal{X}$,
  [Zaheer et al. 2017]
- Show its capability on a toy problem and a real neuroscience model.

Results: Jansen & Rit Neural Mass Model

$N = 0$

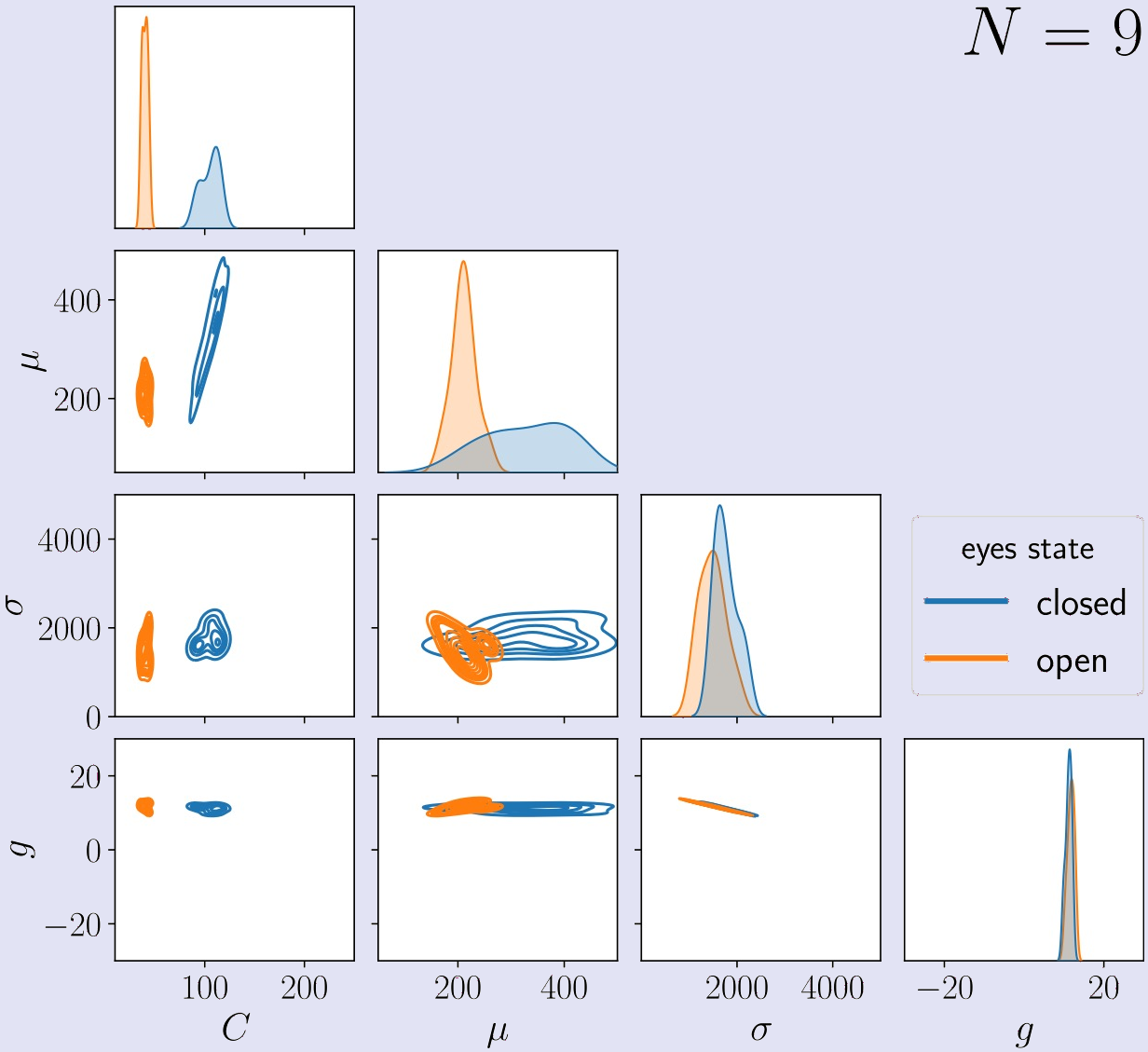
- Observations x are EEG signals.
- θ are physiological properties of the brain.



Results: Jansen & Rit Neural Mass Model

$N = 9$

- Observations x are EEG signals.
- θ are physiological properties of the brain.



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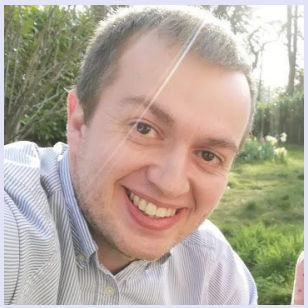


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