Normalizing Flows and the Bayesian Evidence

Likelihood   Prior

Bayesian Evidence : $Z = \dfrac{L(\theta)\Pi(\theta)}{p(\theta)}$
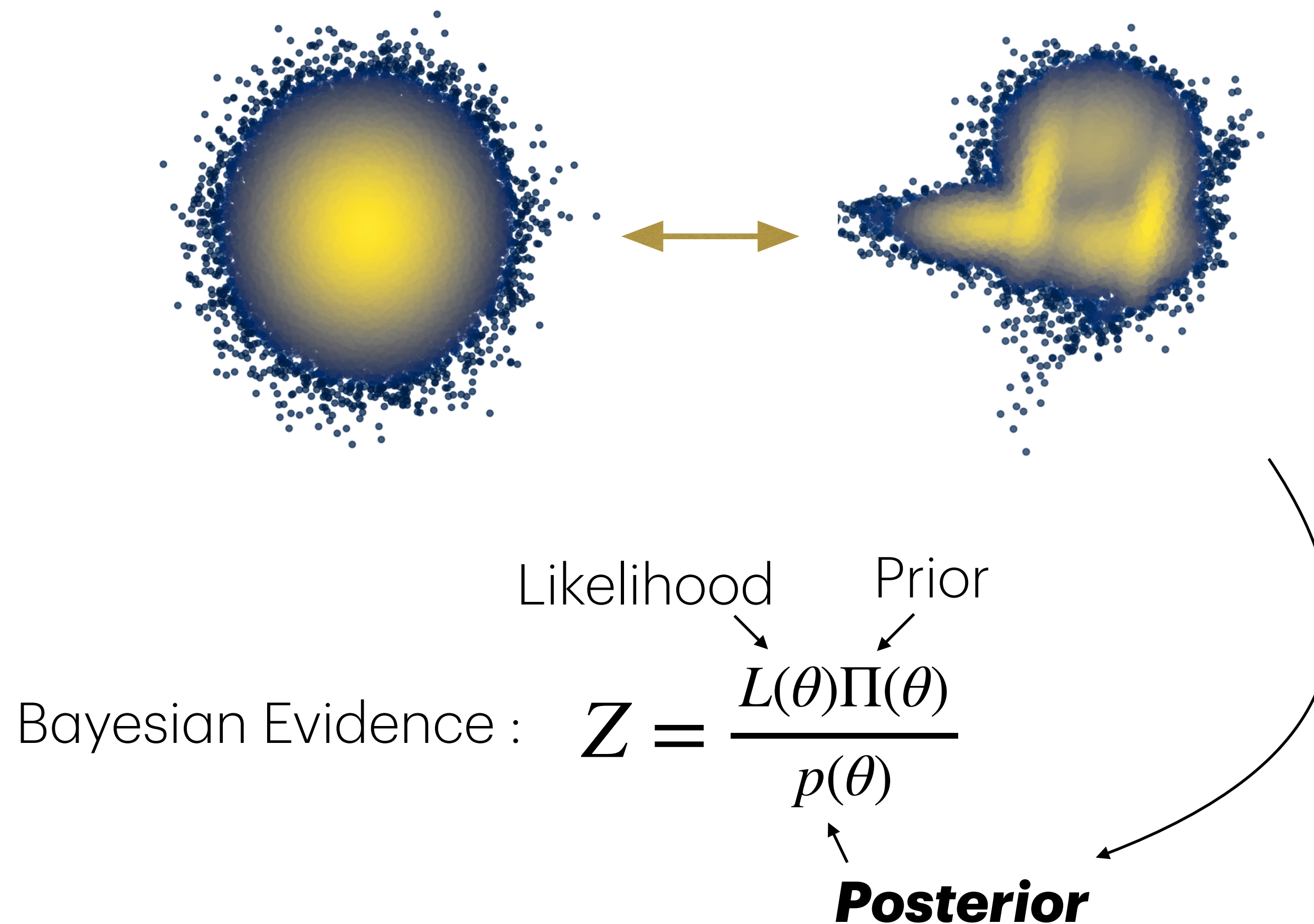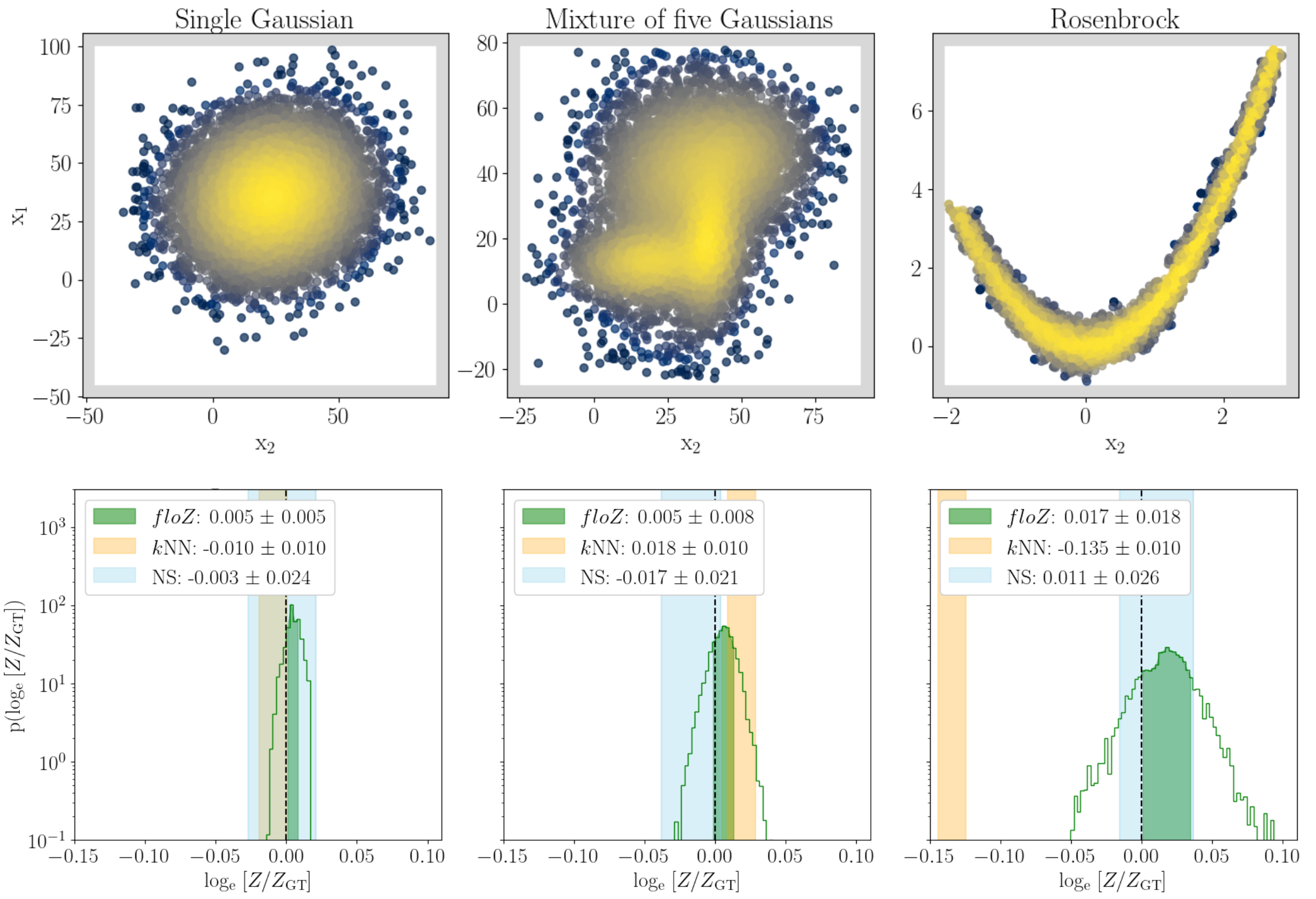
Posterior

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$FloZ$

Posterior distributions in increasing complexity

Single Gaussian — Mixture of five Gaussians — Rosenbrock

floZ perform <u>comparable</u> and often *better* than **nested sampling**.

floZ: 0.005 ± 0.005
kNN: -0.010 ± 0.010
NS: -0.003 ± 0.024

floZ: 0.005 ± 0.008
kNN: 0.018 ± 0.010
NS: -0.017 ± 0.021

floZ: 0.017 ± 0.018
kNN: -0.135 ± 0.010
NS: 0.011 ± 0.026

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$Flo\mathcal{Z}$

Why does it work well?

Transfer learning over different losses that:

1) Includes the standard cross-entropy loss of flow training $\mathscr{L}_1$.

2) Minimizes the <u>error</u> in the evidence estimation $\mathscr{L}_2$.

3) <u>Robust</u> to low sample statistics $\mathscr{L}_{3a}, \mathscr{L}_{3b}$:
   - Trained over $\mathcal{O}(\mathrm{N}_{\mathrm{samples}}^2)$ data points.

Loss scheduling

Applications?

Evidence of higher modes in gravitational waves? (Ongoing analysis)

Evidence of stochastic gravitational wave background from Pulsar Timing Arrays observations?

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