

TODO

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# 1 Critical analysis

## 1.1 Introduction

**TODO**Titsias and Ruiz [2] introduce Unbiased Implicit Variational Inference (UIVI) as a variational inference method that allows for a flexible variational family and that addresses the issues of the methods that it is built on. In this analysis, we summarize the work of Titsias and Ruiz [2] in the context of the literature and critically examine the strengths and limitations of UIVI. This analysis is organized as follows: Section 1.2 introduces the problem context and previous work; Section 1.3 describes how UIVI works and how it addresses the limitations of previous methods, and discusses its own limitations.

## 1.2 Context and previous work

Variational inference (VI) [1] is a Bayesian inference method that formulates the problem of finding the posterior distribution  $p(\mathbf{z}|\mathbf{x})$  of latent variables  $\mathbf{z}$  given data  $\mathbf{x}$  as an optimization problem. VI posits a variational family  $\mathcal{Q} = \{q_\theta\}$  of distributions indexed by variational parameters  $\theta$  and aims to approximate the posterior distribution by some simpler variational distribution  $q_\theta(\mathbf{z}) \in \mathcal{Q}$ . In standard VI, the selected distribution  $q_\theta$  is the one that minimizes its Kullback-Leibler (KL) divergence with  $p(\mathbf{z}|\mathbf{x})$  or equivalently, the one that maximizes the evidence lower bound (ELBO) denoted as

$$\mathcal{L}(\theta) = \mathbb{E}_{q_\theta(\mathbf{z})} [\log p(\mathbf{x}, \mathbf{z}) - \log q_\theta(\mathbf{z})] .$$

To maximize the ELBO, standard VI places strong restrictions on the choice of the model and the variational family in order to allow the use of a coordinate ascent algorithm. These restrictions include (1) a mean-field assumption where the latent variables are marginally independent and the variational distribution factorizes as  $q_\theta(\mathbf{z}) = \prod_{i=1}^d q_{\theta_i}(\mathbf{z}_i)$  and (2) the model has conjugate conditionals where  $p(\mathbf{z}_i)$  and  $p(\mathbf{z}_i|\mathbf{x}, \mathbf{z}_{-i})$  are from the same distribution family.

BBVI

**TODO**black box vi and hierarchical methods + limitations

## 1.3 Current work

**TODO**how UIVI works, main advantages, other contributions of paper (empirical vs sivi), limitations

## 2 Project report

TODOtitle

Abstract

TODO

### 2.1 Introduction

## References

- [1] Michael I. Jordan, Zoubin Ghahramani, and et al. An introduction to variational methods for graphical models. In *Machine Learning*, pages 183–233. MIT Press, 1999.
- [2] Michalis K Titsias and Francisco Ruiz. Unbiased implicit variational inference. In *The 22nd International Conference on Artificial Intelligence and Statistics*, pages 167–176. PMLR, 2019.