Probabilistic Inference with Stochastic Discrete Clenshaw-Curtis Quadrature

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Abstract. The partition function is fundamental for probabilistic graphical models—it is required for inference, parameter estimation, and model selection. Evaluating this function corresponds to discrete integration, namely a weighted sum over an exponentially large set. This task quickly becomes intractable as the dimensionality of the problem increases. We propose an approximation scheme that, for any discrete graphical model whose parameter vector has bounded norm, estimates the partition function with arbitrarily small error. Our algorithm relies on a near minimax optimal polynomial approximation to the potential function and a Clenshaw-Curtis style quadrature. Furthermore, we show that this algorithm can be randomized to split the computation into a high-complexity part and a low-complexity part, where the latter may be carried out on small computational devices. Experiments confirm that the new randomized algorithm is highly accurate if the parameter norm is small, and is otherwise comparable to methods with unbounded error.

Keywords: graphical model · quadrature · approximation

Summary. An entirely new method for approximate probabilistic inference in exponential family models is presented and discussed. Important preconditions on the models' sufficient statistics, namely χ-integrability, and the dependence of the approximation error on the parameter norm are explained. This work was originally presented at the International Conference on Machine Learning 2016 [1]. In addition to the results present at ICML, we will discuss how this technique could be applied to perform marginal inference and parameter estimation.

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References

1. Piatkowski, N., Morik, K.: Stochastic discrete Clenshaw-Curtis quadrature. In: Proceedings of the 33rd International Conference on Machine Learning. JMLR: W&CP, vol. 48. JMLR.org (2016)