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Product Jacobi-Theta Boltzmann machines with score matching

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We introduce a restricted version of the Riemann-Theta Boltzmann machine, a generalization of the Boltzmann machine with continuous visible and discrete integer valued hidden states. Though the normalizing higher dimensional Riemann-Theta function does not factorize, the restricted version can be trained efficiently with the method of score matching, which is based on the Fisher divergence. At hand of several common two dimensional datasets, we show that the quality of the fits obtained are comparable to state-of-the-art density estimation techniques such as normalizing flows or kernel density estimation. We also discuss how some of these methods can converge to an overfitted solution and we try to quantify this overfitting behavior.
Furthermore, we show that our model is less likely to converge to such non ideal solutions.
We also prove that the recursive calculation of the one dimensional Riemann-Theta function can be extended to the calculation of the first and second order gradients.
We also hint at the possibility of using the density estimated by this model
to perform multi-dimensional integration using Monte Carlo methods with a particular focus on High Energy Physics applications.

Significance

The major updates on the Riemann-Theta Boltzmann machine are the possibility to train efficiently
systems with more than 2 hidden layer thanks to the method of score matching. We also present a novel way to
quantify the overfitting through the surface fractal dimension.

References

https://inspirehep.net/literature/1644620
https://inspirehep.net/literature/1694236
https://inspirehep.net/literature/1737266

Experiment context, if any

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