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Locally-informed proposals in Metropolis-Hastings algorithm with applications

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Abstract

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1 Introduction

The Markov Chain Monte Carlo methods (abbrv. MCMC) are a family of algorithms used for sampling from a given probability distribution. At first they do not seem useful for solving practical deterministic problems, but with some tweaks they can become a powerful tool. It happens especially when space of possible solutions is enormous and computing becomes infeasible for machines. These offer a shortcut for obtaining "close enough" answers.

At their core, MCMC methods generate a Markov Chain (abbrv. MC) with a defined distribution and sample using it. The convergence of the chain is assured by ergodic theorems. The most known of them is *Metropolis-Hastings* algorithm, which constructs a MC using another set of distributions, maybe simpler ones.

In this thesis we work on *locally-informed proposals*, which involve determining *local* distribution – which comes down to finding transition probabilities of the state. They are a bit more complex and computationally heavy, but offer better results with less iterations.

To test this method we will need a deterministic problem which quickly becomes infeasible for machines to compute – one of them is a well-known traveling salesman problem. The testing is carried out using its benchmark training set *tsplib95* and implementation is provided in *Python3*.

2 Markov Chains

3 Markov Chain Monte Carlo methods

4 Traveling salesman problem

5 Decoding encrypted text

6 Code description?

7 Conclusions

References

[1] O. Häggström et al. *Finite Markov chains and algorithmic applications*, volume 52. Cambridge University Press, 2002.

[2] C. Karpiński. On use of monte carlo markov chains to decode encrypted text and to solve travelling salesman problem. 2020.

[3] C. J. Maddison, D. Duvenaud, K. J. Swersky, M. Hashemi, and W. Grathwohl. Oops i took a gradient: Scalable sampling for discrete distributions. 2021.

A Source code