First Project Peer Review

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Project Title: Energy-guided Entropic Neural Optimal Transport

The authors solve the problem of modelling the Optimal Transport (OT) plans. This problem is important for such practical cases as unpaired image to image translation, as it provides the desired transform from source to target distribution. The proposed approach solves known limitations of existing approaches, thus, may be highly relevant both for the OT community and practitioners.

The main idea of the proposed approach is to model Entropy-regularized Optimal Transport (EOT) using the recent developments from the Energy-Based Models (EBM). Primal EOT problem can be seen as a particular case of weak OT problem with the specific choice of cost function C_{EOT}. The notion $f^{C_{EOT}}$ is the C-transform with this specific cost function C_{EOT}. Using this $f^{C_{EOT}}$ in dual weak functional for primal WOT problem, one obtains the expression referred to as weak dual objective which constitutes solution to the EOT problem due to strong duality. The authors show that the weak dual objective permits unique minimizer in the form close to the energy function. This allows to reformulate $f^{C_{EOT}}$ as the closed form expression rather than minimization problem and this reformulation is further used in the weak dual objective. In practice, optimization of weak dual objective is performed with stochastic gradient ascent. The authors show that the gradient of this objective w.r.t. parameters of neural network, parametrizing the continuous function of target domain, resembles the gradient for EBM. Thus, methods suitable for gradient computation for EBM (e.g. using Unadjusted Langevin Algorithm, ULA) can be applied to optimize weak dual objective. This brings connection between EOT and EBM.

In the section with related works, the authors provide overview of methods both from EBM and OT fields, highlighting existing connections and revealing the characteristic features and benefits of the proposed method. In my opinion, the section is presented in very informative and concise way with an emphasis to the most appropriate works. In particular, in the introduction, the authors provided high-level overview of the approaches recovering the OT plans compared in terms of cost function limitations, bias and unbiasedness, fake solutions, etc. This helps a lot to gain insight into the problem complexity and how far the problem has been solved.

Overall, I find the approach is well justified and presented, and the text quality is very good. The only concern I have is the requirement on space limitations that is sometimes imposed on the paper's size. If applicable, probably, the background on OT can be compressed to the most essential parts while the rest may be put into the appendix as well as proofs.

The experiment protocol is reasonable and well described, the presented results look very promising. Regarding the experiment on Colored MNIST, it would be interesting to see the performance of other approaches and quantitative comparison, if applicable.

Although the code is missing, README.md contains the overall description of the repository and the proposed approach and well organised.