Daniel Mimouni
IFP Energies nouvelles
Department of Applied Mathematics
1-4 Av. Bois Préau, 92852 Rueil-Malmaison. France
✉ *daniel.mimouni@ifpen.fr*

July 4, 2023

To
***Dr. Tamara G. Kolda**,*
MathSci.ai
Dublin, CA 94568, USA

Cover Letter

Dear Dr. Kolda,

Please find enclosed our manuscript entitled *Computing Wasserstein Barycenters via Operator Splitting: the Method of Averaged Marginals*, which we would like to submit as a research paper on computational methods for data science. This research paper presents a new algorithm for computing Wasserstein Barycenters (WB) named MAM (Methods of Averaged Marginals). The presented method adapts the celebrated Douglas-Rachford splitting method to the huge-scale linear optimization problem underlying WB computation on empirical measures. The presented method exhibits the following noticeable properties:

- It converges exactly to a WB, thanks to Douglas-Rachford properties,
- It is embarrassingly parallelizable and memory efficient,
- It can handle balanced and unbalanced WB problems in the same formalism.

This research paper contains a thorough description of the proposed methods, the proof of convergence for balanced and unbalanced settings, and some numerical comparisons with state-of-the-art methods, namely IBP [1] and B-ADMM [2]. In addition, source code and data are freely available at `https://ifpen-gitlab.appcollaboratif.fr/detocs/mam_wb`.

SIMODS has recently published several research papers on WB computation [3, 4]. Therefore the authors assume that this paper will interest this journal.

This research paper is original; no parts of this paper have been published before. No parts of this paper are under consideration for publication in another journal.

Best regards,

Daniel Mimouni

━━━━━━━━ co-authors

- Dr. Paul Malisani, IFP Energies nouvelles, Department of applied mathematics, paul.malisani@ifpen.fr
- Dr. Jiamin Zhu, IFP Energies nouvelles, Department of control and signal processing, jiamin.zhu@ifpen.fr
- Dr. Welington de Oliveira, Mines-Paris, Center of Applied Mathematics, welington.oliveira@minesparis.psl.eu

References

[1] Benamou, J. D., Carlier, G., Cuturi, M., Nenna, L., and Peyré, G. (2015) *Iterative Bregman projections for regularized transportation problems.* SIAM Journal on Scientific Computing, 2015, vol. 37, no 2, p. A1111-A1138.

[2] Ye, J., Wu, P., Wang, J. Z., and Li, J. (2017). *Fast discrete distribution clustering using Wasserstein barycenter with sparse support.* IEEE Transactions on Signal Processing, 65(9), 2317-2332.

[3] Altschuler, J. M., and Boix-Adsera, E. (2022). *Wasserstein barycenters are NP-hard to compute.* SIAM Journal on Mathematics of Data Science, 4(1), 179-203.

[4] Heinemann, F., Munk, A., and Zemel, Y. (2022). *Randomized Wasserstein barycenter computation: resampling with statistical guarantees.* SIAM Journal on Mathematics of Data Science, 4(1), 229-259.