EPFL

## Low-rank optimal transport

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## ▶ Setting

The goal of this project is to apply a low-rank approximation of a matrix to accelerate solving optimal transport problems.

## ▶ Tasks

1. We want to approximately solve problems of the form (4.2) in [2]. Explain Proposition 4.3 and the relation to the Sinkhorn algorithm in your own words.
2. The Sinkhorn algorithm is essentially a matrix scaling algorithm that repeatedly evaluates marginals of a given matrix. Explain how a low-rank approximation of this matrix might help to accelerate the computation.
3. State and proof theorem 5 in [1] in your own words. You may use any Lemmas in the appendix of [1] and any results cited in [1] directly without proofing them further.
4. Optimal transport can be used to transfer color between images. Implement the color transfer by solving the optimal transport problem using the Sinkhorn algorithm. (I will give you the precise formulas for this step if you use this project in the end).
5. Study how much the Sinkhorn algorithm can be accelerated by using a low-rank approximation. Study the error introduced by using the low-rank Sinkhorn algorithm.

## ▶ References

[1] Altschuler, J., Bach, F., Rudi, A., Niles-Weed, J. Massively scalable Sinkhorn distances via the Nyström method. arXiv preprint arXiv:1812.05189 (2019). `https://arxiv.org/abs/1812.05189`

[2] Peyré, G., Cuturi, M. Computational Optimal Transport. arXiv preprint arXiv:1803.00567 (2020). `https://arxiv.org/abs/1803.00567`