Approximate Wasserstein Metric and its application to imaging problem

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The Monge-Kantorovich optimal mass transportation theory has many applications in various domains (economy, meteorology, cosmology and fluid mechanics), in particular in image processing and computer vision. In this theoretical framework, the "best" flow between probability measures is defined as the *optimal transport plan* given by the minimization of the *global transportation cost*.

Many applications in the literature rely on one of these two mathematical tools, such as the definition of robust similarity measures between shape and texture descriptors, the matching of bipartite graphs, or the definition of interpolation between histograms. From a numerical point of view, various algorithms have been proposed to solve the underlying optimization problem. However, they often yield a high time complexity, thus restricting their use to small-scale data.

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In this presentation, we introduce a new approach to compute the optimal transportation flow for high dimensional point clouds. To do so, we propose an approximation of the quadratic Wasserstein metric based on one-dimensional projections. Replacing the Wasserstein original metric by such *sliced approximation* allows us to use a fast gradient descent algorithm.

Example of point-clouds interpolation.

Several applications of this framework are considered :

- ▷ texture synthesis and mixing;
- ▷ bending invariant shape recognition;
- ▷ regularized color transfer of image sequence.

For more information:

- Geodesic Shape Retrieval via Optimal Mass Transport, J. Rabin, G. Peyré, and L. D. Cohen, ECCV'10. [Pdf file]
- Wasserstein Barycenter and its Application to Texture Mixing, J.Rabin, G. Peyré, J. Delon and Marc Bernot, SSVM 2011, [Preprint file]
- Wasserstein Regularization for imaging problems, J. Rabin and G. Peyré, ICIP'11. [Pdf file]