Geometric Shape Optimization for Dirichlet Energy With Physics Informed and Symplectic Neural Networks

Amaury Bélières Frendo[1]

[1] Université de Strasbourg - IRMA
belieres@unistra.fr

In this work, we are interested in optimizing the boundary of a given domain under a volume constraint, with respect to the solution of a partial differential equation. We focus on the numerical aspect of this question, and we propose to apply recent approaches based on neural networks. For simplicity, the problem under consideration is the minimization of the Dirichlet energy for the Poisson equation in R2. We first quickly recall results on the mathematical analysis of this problem. We select physics-informed neural networks to approximate the solution of the Poisson equation in a given shape. To represent the shape with a neural network, we parametrize a volume-preserving transformation from an initial shape to an optimal one. Both processes are combined in a single optimization algorithm, which only relies on minimizing one physical loss function, the Dirichlet energy. We conclude with the presentation of the open source code and its numerical validation.

Joint work with: Emmanuel Franck, Victor Michel Dansac, Yannick Privat