

How to measure the non-convexity?

Friday, 8 March 2024 12:05 (15 minutes)

In this talk, we are partially motivated by the problem of non-convex optimization in Machine Learning and by applications of Morse theory in Data Science. We aim to introduce Poincaré-Reeb graphs. Encoding both quantitative geometrical aspects of the shape and qualitative topological properties, these graphs are meant to measure the non-convexity of a real algebraic plane curve. Our main goal is to give a characterization of all topological types of Poincaré-Reeb graphs. Using the polar curve and the discriminant curve, we unveil the properties of these graphs, emphasizing the asymptotic behavior of level curves near a strict local minimum of a real bivariate polynomial function. In the local setting, the Poincaré-Reeb graphs are stabilizing trees that encode the asymptotic shape of the levels near the strict local minimum. Inspired by the works of Arnold and Ghys, we first rephrase our problem in terms of univariate Morse polynomials. We present an effective algorithm that constructs a large family of real bivariate polynomial functions near a strict local minimum realizing all separable Poincaré-Reeb trees.

Presenting author

Miruna-Stefana Sorea

Primary author: SOREA, Miruna-Stefana (Lucian Blaga University of Sibiu, Romania)

Presenter: SOREA, Miruna-Stefana (Lucian Blaga University of Sibiu, Romania)

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