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Global convergence in non-convex minimization: new dynamics and classical numerics

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If a function $f : \mathbb{R}^d \to \mathbb{R}$ is convex and smooth, then its global minimum can be reached by following the gradient flow associated with $-\nabla f$. This approach, however, breaks down in the non-convex setting, where multiple local minima may arise, or when the gradient is not directly accessible. This raises the question of whether one can design a dynamical system whose trajectories converge, from arbitrary initial conditions, to the set of global minimizers.

The aim of this talk is twofold. First, I will introduce such a (deterministic) dynamics and show its convergence to the set of global minimizers. This constitutes the main new contribution. Second, I will show that this approach can be implemented using previously established numerical methods, thereby ensuring compatibility with existing computational techniques and providing a natural bridge to numerical practice.

The underlying idea originates in a joint work with Martino Bardi from University of Padova (see [1]), and is rooted in weak KAM theory and Hamilton-Jacobi equations. It was subsequently developed in collaboration with Yuyang Huang and Dante Kalise from Imperial College London (see [2]), and further refined in [3], where quantitative results were obtained.

References

[1] M. Bardi and H. Kouhkouh: An Eikonal equation with vanishing Lagrangian arising in global optimization. Applied Mathematics & Optimization, 3 (2023), 49.

[2] Y. Huang, D. Kalise, and H. Kouhkouh: Non-convex global optimization as an optimal stabilization problem: Dynamical Properties. Preprint, arXiv:2511.10815 (2025).

[3] Y. Huang, D. Kalise, and H. Kouhkouh: Non-convex global optimization as an optimal stabilization problem: Convergence Rates. Preprint, arXiv:2511.11122 (2025).