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Large scale optimization for AI

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Mathematical challenges

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- Design fast and simple algorithms for AI
- Provide theoretical guarantees and progress towards certification
- Mathematical models for neural networks and AI
- Towards new non convex theories

Deep Learning and Mathematics

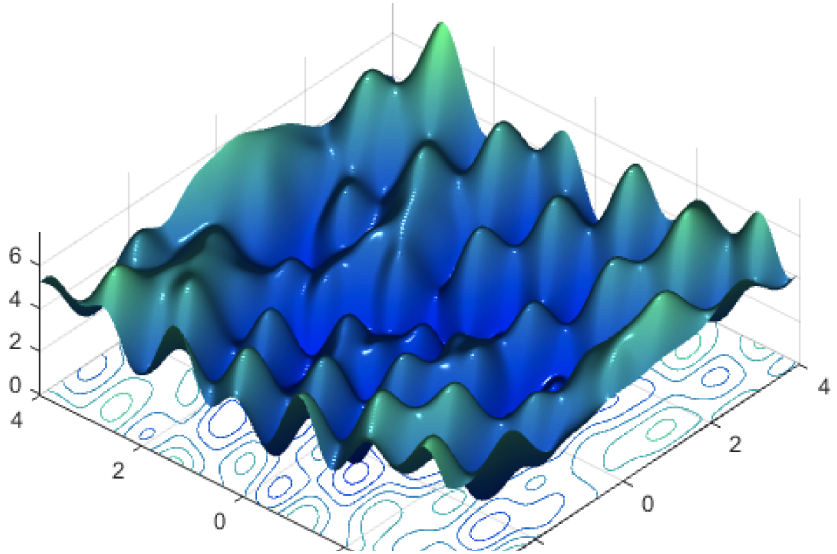

Figure: Find the lowest point in 2D can be delicate... In Deep Learning one can have millions of dimensions.

- Geometry and learning rates
- Geometry of large landscapes
- Non-convex theories for optimization
- Infinite dimensional models
- Symmetries and algorithms
- Stability of minimizers

From theory to coding

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- Mathematical models for training softwares
- Learning and activation functions: models for a slower but deeper learning?
- Construction of stable architectures
- Matching architectures to structured data

The extended team and collaborators

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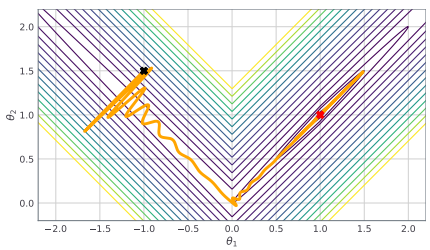
- S. Sabach, The Technion
- L. Vanderberghe, UCLA
- M. Teboulle, Tel Aviv University
- P. Weiss, ITAV
- ...

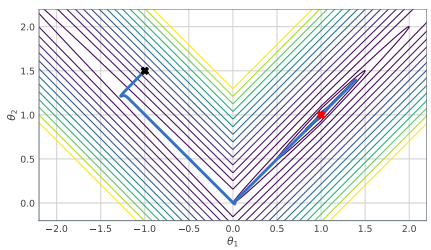
First algorithm: INDIAN "*An Inertial Newton Algorithm for Deep Learning*"

INDIAN algorithm with Castera, Bolte, Févotte and Pauwels

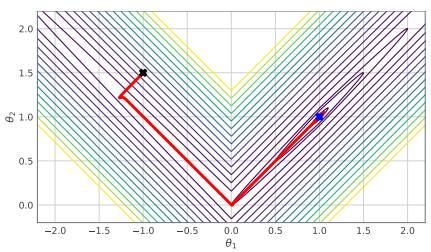
- Reach the best current performances,
- State of the art generalization properties,
- Avoid parasite oscillations.



(a) $\alpha = 0.5,\ \beta = 0.01$



(b) $\alpha = 0.5,\ \beta = 0.1$



(c) $\alpha = 1.3,\ \beta = 0.1$