Functional Lifting 2.0:
Efficient Convexifications for Imaging and Vision

Almost all solutions of computer vision and image processing problems rely on high dimensional optimization problems. Examples are the training of neural networks in machine learning techniques, or variational methods, in which the solution is determined as the argument that minimizes a suitable cost function.

Unfortunately, most practically relevant problems inherently lead to non-convex cost functions, for which the computation of global minimizers is extremely challenging. The goal of this project is to develop global optimization methods that rely on a convexification of non-convex energies by the means of a technique called ***functional lifting***.

As illustrated in Figure 1, the basic idea is to artificially increase the dimensionality of the problem, which – intuitively speaking – offers more space to find a faithful convex approximation. While the illustration on the right provides some intuition of the idea of lifting a one-dimensional problem to a two-dimensional problem, we are interested in developing efficient global solvers for large-scale optimization problems with millions of unknowns.

I Project Management and Execution

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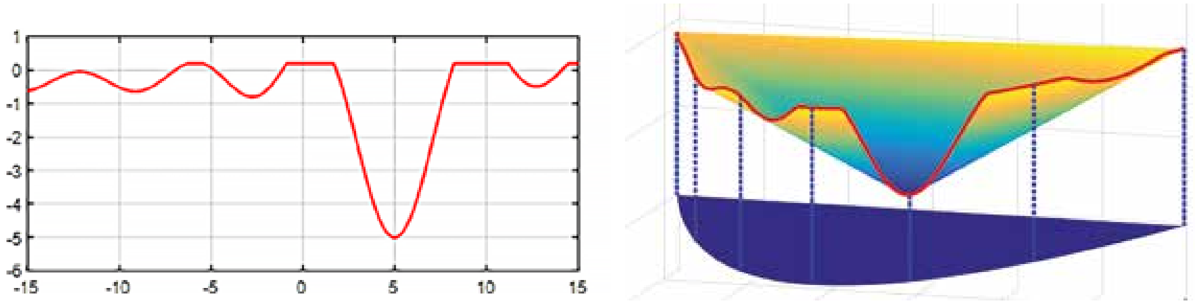
Figure 1: Illustrating the idea of functional lifting: The goal of the project is to find systematic ways to rephrase difficult nonconvex optimization problems such as in a) as easier optimization problems in a higher dimensional space as shown in b).



a) Example of a nonconvex function to optimize. Several local minima make the result of local descent methods depend on the starting point. In particular, they are unlikely to find the global minimum.

b) The same energy as in a) is drawn along a parabola in 2d (red line). Its convex hull (colored suface) represents a new cost function in a higher dimensional space in which any optimization method is guaranteed to find the global optimum independent of the starting point.