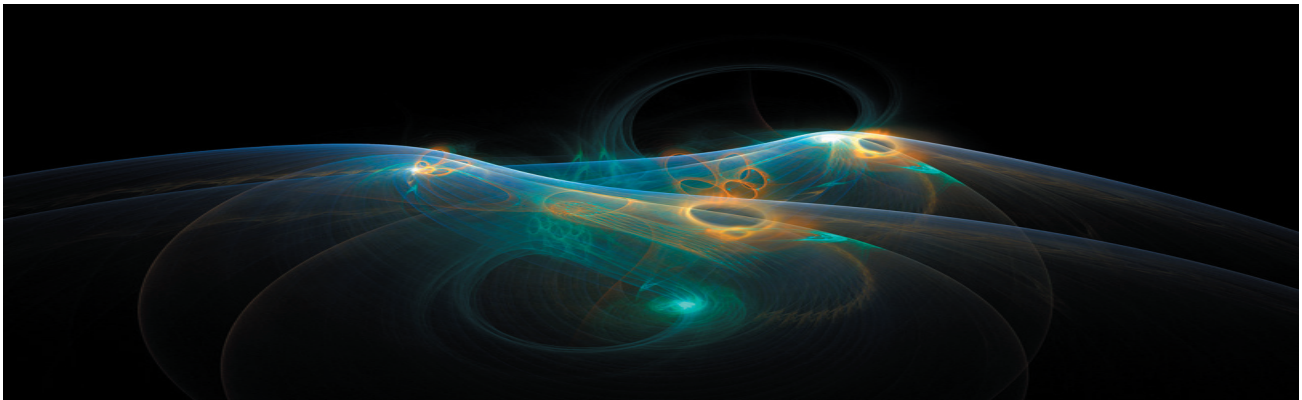


The **TOMLAB /CGO** toolbox efficiently solves global non-convex (integer) problems where the function  $f(x)$  is very costly to compute.

The toolbox consists of three general solvers:

- rbfSolve - using a Radial Basis Interpolation (RBF) algorithm.
- ego - using the Efficient Global Optimization (EGO) algorithm.
- arbfMIP - new Adaptive Radial Basis Interpolation (ARBF) algorithm.



Response surface methods were discussed in a paper by Donald R. Jones:

*A Taxonomy of Global optimization Methods Based on Response Surfaces* **Journal of Global Optimization** **21 (4)**, 345:383, 2001.

Jones draws the conclusion that methods based on EGO and RBF algorithms are the most promising. The TOMLAB /CGO toolbox is based on these promising methods, and has been continuously further developed along with the state-of-the-art research in the field.

One previous example that motivated the research was industrial design of trains, where one  $f(x)$  value took 30 minutes to compute. The function value was the result of a simulation of 30 second train ride. This problem is discussed in the paper:

Mattias Björkman, Kenneth Holmström: *Global Optimization of Costly Nonconvex Functions Using Radial Basis Functions*, **Optimization and Engineering** **1**, 373-397, 2000.

The train design included costly nonlinear constraints. They were assigned a weight and added to the objective function. This approach showed to be very successful. The choice of weights were not crucial.

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## Main Features

- rbfSolve, EGO and arbfMIP have shown good results in practice on industrial and financial problems.
- All solvers are completely integrated in the TOMLAB Optimization Environment, and easy to combine with other solvers in TOMLAB.
- It is easy to use warm starts, and combine the EGO and (A)RBF solvers. The EGO solver sometimes have problem with ill-conditioning of the inverse of the correlation matrix when the number of sampled points grows. rbfSolve have showed to work without problems on up to 1000 points.



- The initial set of points is important. The TOMLAB /CGO solvers have several ways to generate initial points. The user may also specify any number of initial points to include.
- The TOMLAB /CGO solvers have several algorithmic options that may be tuned for the particular class of user problem.
- It is recommended to combine this toolbox with TOMLAB /NPSOL or TOMLAB /SOL, using NPSOL as fast and robust local solver on the response surface.
- Read more about the [rbfSolve](#) solver.
- Read more about the [ego](#) solver.
- Read more about the [arbfMIP](#) solver.

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