Latest developments for mixed-integer nonlinear programming in Artelys Knitro

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1 Introduction

Artelys Knitro is a mathematical programming solver for nonlinear and mixed-integer nonlinear problems. As input, it accepts linear structures, quadratic structures and black-box functions, with if possible, their first and second-order derivatives. Knitro relies on derivative-based algorithms to find locally optimal solutions. Knitro finds the global optimum for convex problems. For non-convex problems, Knitro converges to a first order stationary point (e.g. local optimum) for continuous models and is a heuristic for mixed-integer problems.

2 Recent improvements for MINLP applications

For nonlinear continuous problems, Artelys Knitro includes two interior point algorithms, a sequential linear quadratic programming algorithm and a sequential quadratic programming (SQP) algorithm. For mixed-integer nonlinear problems, Artelys Knitro includes a nonlinear branch-and-bound algorithm, a Quesada-Grossman branch-and-bound algorithm and a mixed-integer sequential quadratic programming algorithm. Since Artelys Knitro 13.0, the nonlinear branch-and-bound has been fully rewritten. The new nonlinear branch-and-bound is parallel and deterministic. Cut generation and cut management have been greatly improved by adapting the ideas developed for mixed-integer linear programming. The portfolio of heuristics executed during the search has been extended. It also includes better branching strategies and a restart procedure. Finally, to improve the solutions for non-convex problems, two ways to use multi-start within the nonlinear branch-and- bound have been implemented.

In this talk, we will present the algorithms implemented in Artelys Knitro for mixed-integer nonlinear problems in Knitro 14.0, and detail the recent developments for the nonlinear branch-and-bound algorithms. Those features include specific presolve operations and cuts for nonlinear applications (Gleixner et al., 2023; Bonami, 2011) and a heuristic portfolio to provide effort effective search (Luteberget et al, 2023).

We will show the improvements on the classical datasets for mixed-integer nonlinear problems.

3 Conclusions et perspectives

Both nonlinear features and extension of linear features for nonlinear applications were implemented to efficiently solve nonlinear models. It opens several perspectives for future developments and extensions for nonlinear models that we will present during this talk.

Références

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