MISQP – Mixed-Integer Sequential Quadratic Programming

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Solving Nonconvex MINLP Problems:

Mixed-Integer Sequential Quadratic Programming:

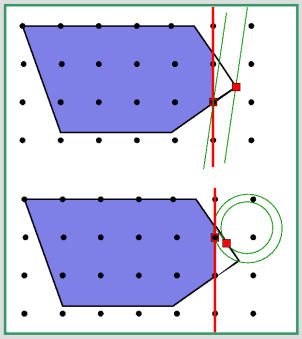
- Convex MIQP approximations
- Integer variables are not relaxed
- Gradient approximations at grid points
- Trust region stabilization
- Extremely efficient in terms of function evaluations

MISQP and Outer Approximation:

- Convergence for convex problems
- Good results for nonconvex problems
- Efficient in terms of function evaluations
- Improved robustness

Cut-and-Branch MIQP - Solver:

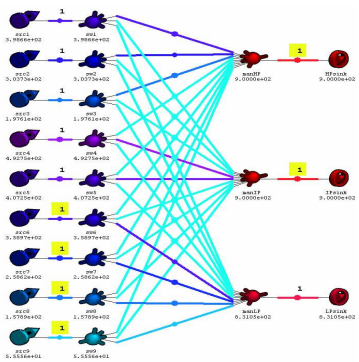
- Warmstarts
- Exploitation of dual information for improved branching
- General cutting planes for non-basic QP solutions:
  - Complemented mixed-integer rounding cuts
  - Disjunctive cutting planes



Practical Applications in Oil Industry:

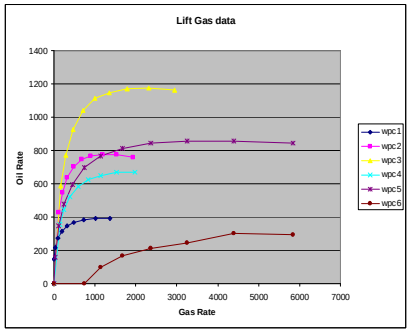
Well Relinking:

- Maximize oil flow in network
- 3^9 = 19,683 feasible combinations



Lift Gas Optimization:

- Lift gas increases oil production
- Optimal distribution of limited lift gas
- Non-instantaneous response



Performance:

24 Well Relinking problems (Shell):

Solver	Global Solutions	Mean Deviation	Function Evaluations
MISQP	36.4 %	1.2 %	838
MISQPOA	59.1 %	0.7 %	2,934
B&B	90.1 %	0.04 %	55,173
OA	4.5 %	18.2 %	872
NLP	-	-	1,321

99 academic test cases:

Solver	Global Solutions	Infeasible	Function Evaluations
MISQP	88	2	216
MISQPOA (LP)	95	0	1,584
B&B	95	0	16,221
OA	58	11	348
MISQPOA (QP)	98	0	1,350
NLP	-	-	206

Conclusion:

In terms of ***function evaluations*** solving a MINLP problem by MISQP is ***as expensive as*** solving the relaxed formulation by a SQP method.

Literature:

Exler O., Schittkowski K. (2007): *A trust region SQP Algorithm for mixed integer nonlinear programming*, Optimization Letters, Vol. 1, No. 3, p. 269 - 280

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