AUTOMATIC CONTROL
COMMUNICATION SYSTEMS
LINKÖPINGS UNIVERSITET

A Preprocessing Algorithm for MIQP solvers with Applications to MPC

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Introduction

MIQP problem of interest:

$$\begin{cases} \min\limits_{x} & \frac{1}{2}x^T H x + f^T x \\ \text{subject to} & x \in \mathbb{R}^{n_c} \times \{0,1\}^{n_b} \end{cases}$$

Background:

- **Exponential** worst case complexity in number of variables.
- Try to reduce the average complexity by using computationally cheap **preprocessing**.

Preprocessing

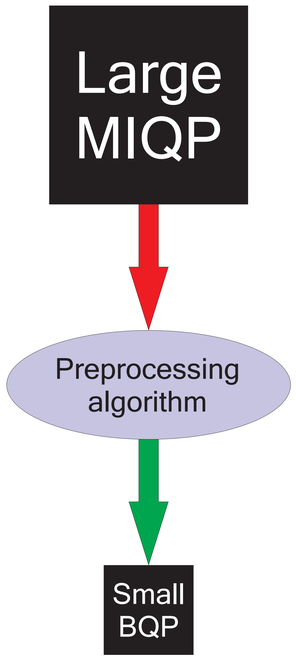
Try to reduce the number of variables sent to the actual optimization routine in an efficient way.

What can be gained?

Preprocessing is performed in polynomial time, instead of exponential time.

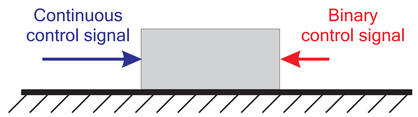
When is it possible?

When the Hessian is **"diagonal dominant"**.



Examples

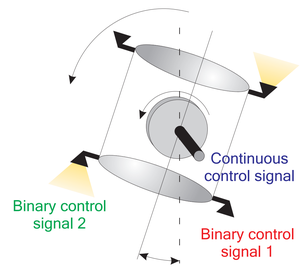
Mass position control



Solver	Solution time [s]
No preprocessing	15.861
Preprocessing	0.0868

All 50 binary variables were determined by the preprocessing algorithm.

Satellite attitude control



Solver	Solution time [s]
No preprocessing	11.449
Preprocessing	0.0414

All 40 binary variables were determined by the preprocessing algorithm.

Conclusions

In the examples above, the results are very good:

Example	Binary variables reduction	Computational time reduction
Mass	100 %	180 times
Satellite	100 %	275 times

Caveat: Not always possible to solve all variables using preprocessing.