Software Supporting Interior Point Approaches in Energy Optimization

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Talk Overview

1. Few words about interior point methods (IPMs)
2. IPMs and Energy Industry
3. Modeling issues
4. On some general advises
5. Conlusions

Few considerations on Interior point Methods

Interior-Point Methods

IPMs are among the most important tools in the toolbox of any optimization practictioner.

A very established techology used on a daily basis.

Huge number of papers about theory and practice.

IPM in short

There will be an IPM for your continuous optimization problem:

- Conic Optimization(LP, QCQP, SOCP, SDP), convex NLP, non-convex NLP
- primal, dual, primal-dual
- feasible, unfeasible
- long-step, short-step
- commercial, academic and open-source
- ...

IPMs might be seen as **a framework** from which select the building blocks that suites your problem the most.

IPMS: Pros

- Customizable to meet problem structure,
- Typically robust,
- Consistent in performance,
- It can be built on top of tuned linear algebra,
- A proven technology.

IPMs: Cons

May not be easy to chose the type of IPMs

Not easy to implement at industrial level

Lack of general and effective warm start

IPM for the Energy Industry

IPM for Energy Industry

Portfolio management

Similarly to the financial industry

- often casted as large continuous SOCP
- risk models have structured matrices
- flexibility particularly appreciated!

IPM for Energy Industry

Optimal Power Flow

Many recent papers and software

- QCQPs, SOCPs and SDPs
- fairly hard distances for general purpose solvers,
- may suffer from ill conditioning.

IPM for Energy Industry

Solar panel alignment and tracking

Solved regularly in mnay solar plants all over the world.

IPM for Energy Industry

Hydro valley managment

Sometimes casted as LP or QP

Similarities with other water resources managment problems.

IPM for Energy Industry

Additional/auxiliary problems:

- polynomial optimization (pooling prolem?)
- nearest correlation matrices repair (SDP)
- non-trivial polynomial fitting

Modeling

The importance of the modeling phase

Too often practitioners have too much faith in algorithms and do not carefully consider how the model formulation affect the solver performance.

Never stop advise on potential pitfalls!

The importance of the modeling phase

Be aware of the dual

Switching from primal to dual formulation could give even an order of magnitude of improvements!

Even for primal-dual IPMs, though counter-intuitive, it is always worth investigate the dual formulation (conic formulation can help).

The importance of the modeling phase

Do not over estimate the presolver!

- bad scaling
- (almost) linear dependencies
- uselessly large bounds

can easily lead to failures or poor performances.

They should be avoided from the very beginning at modeling stage.

Benchmark

One of the outcome of the project should be build a collection of high quality benchmarks in widely used formats. Examples:

`http://gaslib.zib.de/`

`http://vrp-rep.org/`

But also put on the table good practices for benchmarking.

Few general advises

General advice

Given the extreme variety of problems and actors, a general advice is mostly impossible.

The only requirement that is always important is **robustness**.

Robustness is key

Robustness: a true story

Last month a customer from a financial institution:

> *Guys, in our stress tests we record* **one instance over 2 million** *in which the solver gives an optimal solution but the return code is meaningless. Shall we be worried? Could you investigate asap??*

What about the wiki??

- IPMs are a proven technology, and therefore appealing to industrial setting.
- Wiki should point out existing implementations and linear algebra and potential pitfall.
- Good modeling is fundamental even for a correct choice of the deployed software: a section we pointers and good advise would be of great help.

What about the wiki??

- Providing good benchmark will be great!
- a list of software tends to get old soon, especially when it comes to adademic projects! It takes an effort to keep it uptodate unless a collaborative approach is taken, see

  `https://github.com/mikecroucher/awesome-MATLAB`

Thank you!

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