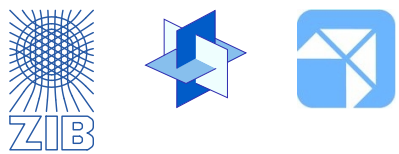
SCIP at Work

Examples and Case Studies

Ambros M. Gleixner

Zuse Institute Berlin · MATHEON · Berlin Mathematical School



5th Porto Meeting on Mathematics for Industry, April 10–11, 2014, Porto

Outline

SCIP at Work

Industry Projects

Application-driven Research Cycle

Hands on: cutting circles from area-minimizing rectangles

Outline

SCIP at Work

Industry Projects

Application-driven Research Cycle

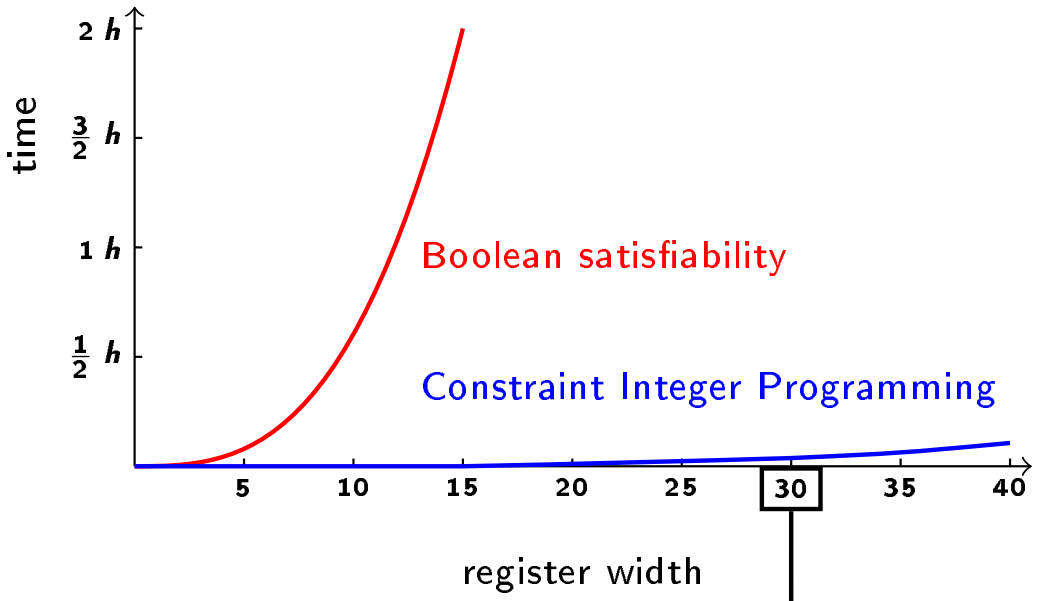
Hands on: cutting circles from area-minimizing rectangles

Chip Design Verification

Goal: (computer-)proof, that a design is free of errors

Method: property checking using CIPs

Result:



constraints	422	152026
variables	3714	50756

Infineon technologies

OneSpin SOLUTIONS

Duration: 2003-2008

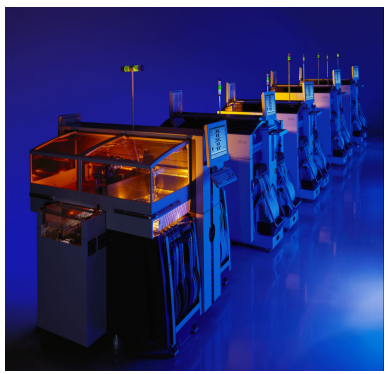
Siemens Cooperation

Longstanding cooperation with Department
Modeling, Simulation, Optimization

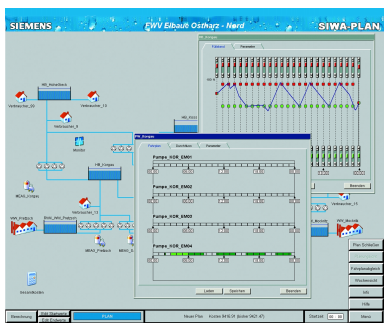
SIEMENS

- first licensee (1996) of SoPlex
- steady use of SCIP/SoPlex in various optimization modules

placement robots in
circuit board production

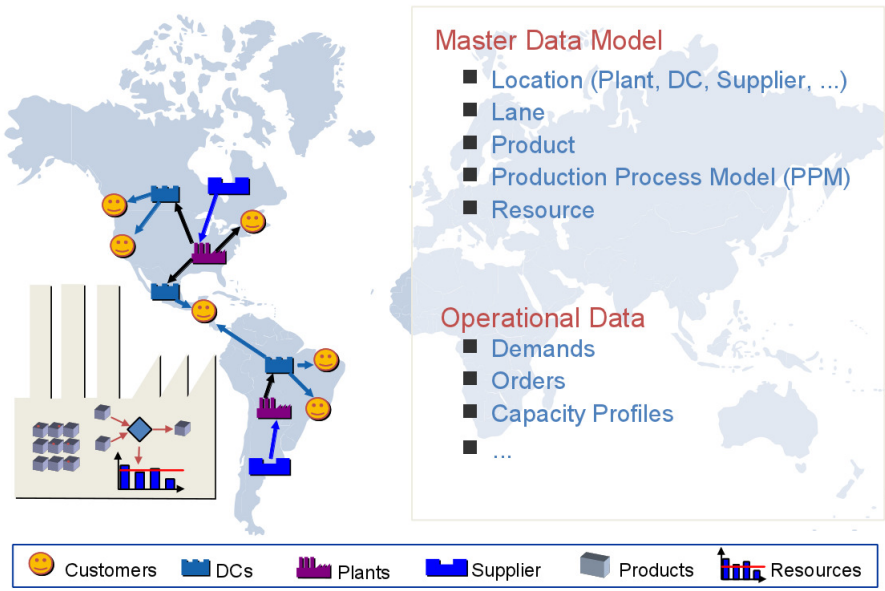


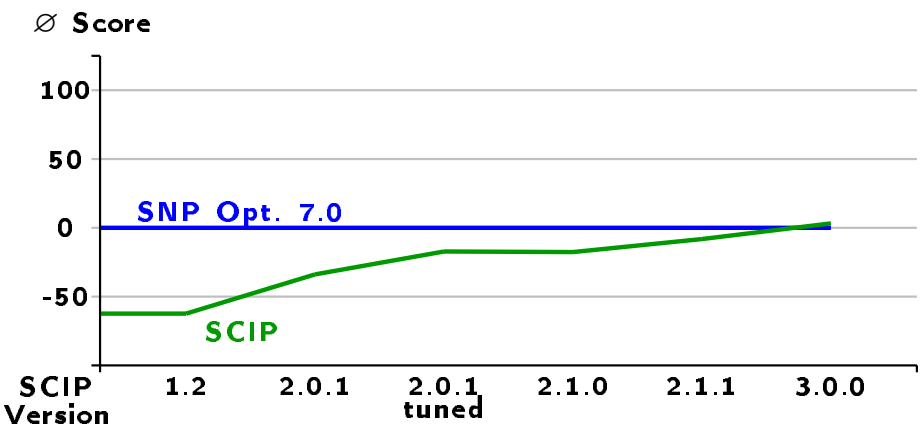
optimal operation of
water networks



Supply Chain Management

Huge, numerically challenging problems





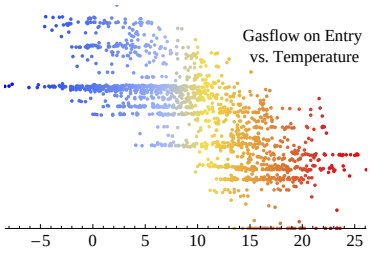
Topics:

- LP solver
- presolving
- numerical stability
- multi-level objective

Industry partner:

Optimization of Gas Transport

Stochastic Mixed-Integer Nonlinear Constraint Program



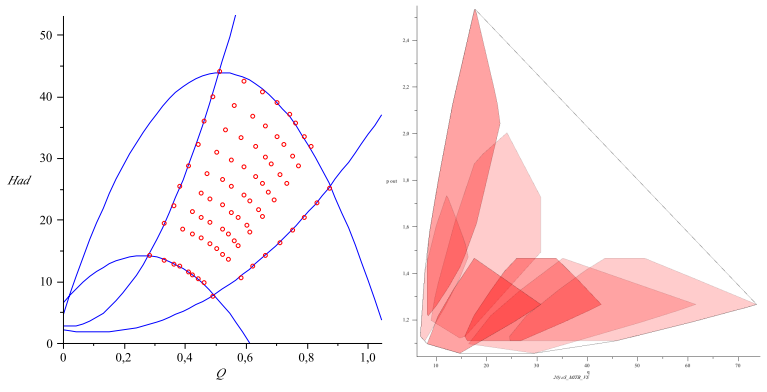
over a **large** network.

Goal:

- develop algorithms to solve such problems to “global optimality”!

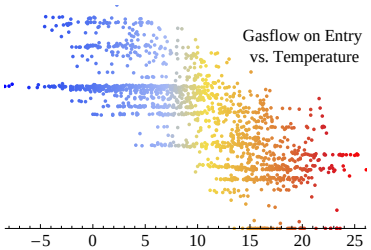
Industry partner:

Open Grid Europe
The Gas Wheel



Optimization of Gas Transport

Stochastic Mixed-Integer Nonlinear Constraint Program



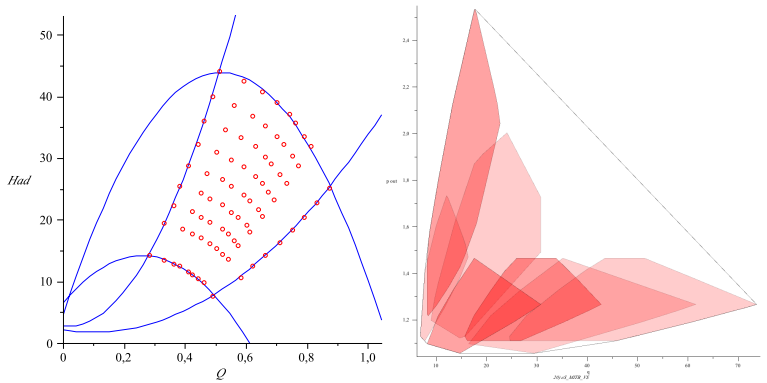
over a **large** network.

Goal:

- develop algorithms to solve such problems to “global optimality”!
- rather: attempt to integrate as many aspects as possible

Industry partner:

Open Grid Europe
The Gas Wheel



Outline

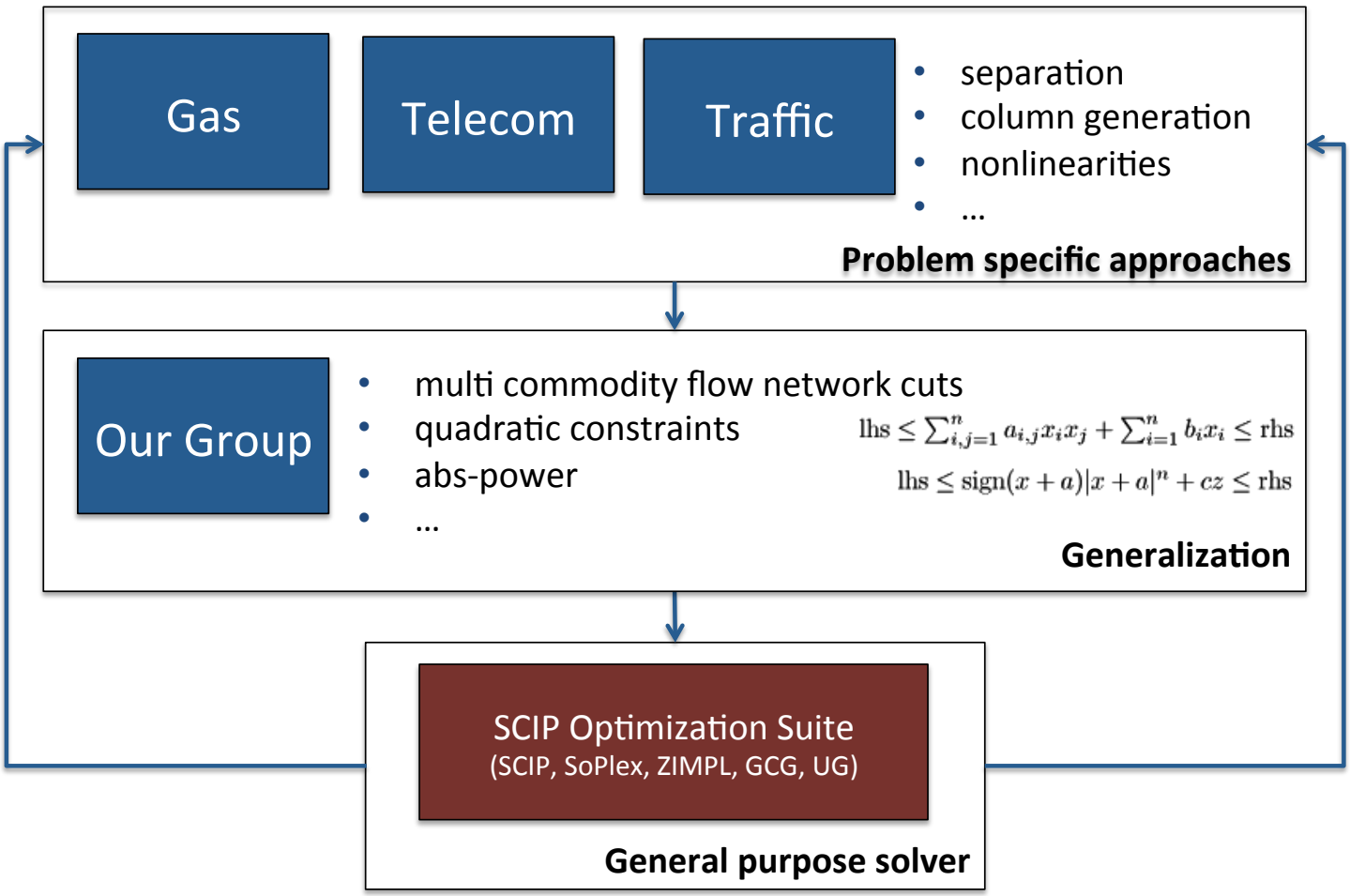
SCIP at Work

Industry Projects

Application-driven Research Cycle

Hands on: cutting circles from area-minimizing rectangles

Application-driven Research at ZIB



Outline

SCIP at Work

Industry Projects

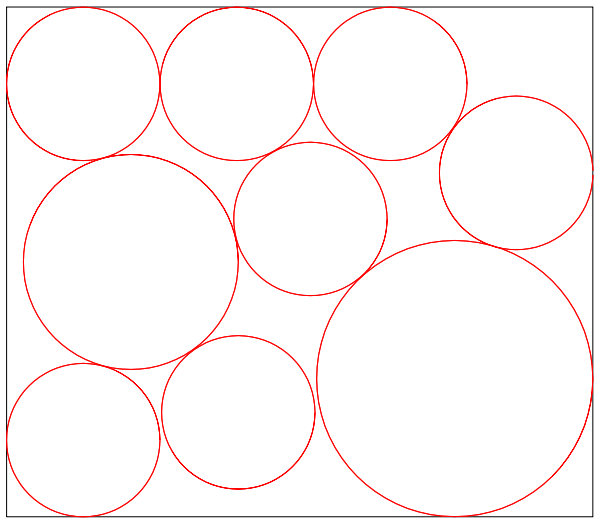
Application-driven Research Cycle

Hands on: cutting circles from area-minimizing rectangles

Cutting circles from area-minimizing rectangles

Task

Given n circles of radii $r_1, \ldots, r_n > 0$, find a rectangle of width w and height h such that all circles fit into the rectangle without overlap and the area hw is minimized.



Download

- `http://www.zib.de/gleixner/download/exercise-circlecut.pdf`
- SCIP binary from `http://scip.zib.de`

An NLP Model

$$\min \quad h \cdot w$$

$$h, w \in \mathbb{R}_{\geq 0}$$

An NLP Model

$$\min \quad h \cdot w$$

$$\begin{aligned} r_i &\leq x_i \leq w - r_i && \text{for all } i \\ r_i &\leq y_i \leq h - r_i && \text{for all } i \end{aligned}$$

$$x, y \in \mathbb{R}^n_{\geq 0}$$
$$h, w \in \mathbb{R}_{\geq 0}$$

An NLP Model

$$
\begin{aligned}
\min \quad & h \cdot w \\
s.t. \quad & \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2} \geq r_i + r_j && \text{for all } i, j : i < j \\
& r_i \leq x_i \leq w - r_i && \text{for all } i \\
& r_i \leq y_i \leq h - r_i && \text{for all } i \\
& x, y \in \mathbb{R}^n_{\geq 0} \\
& h, w \in \mathbb{R}_{\geq 0}
\end{aligned}
$$

An NLP Model

$$
\begin{aligned}
\min \quad & h \cdot w \\
s.t. \quad & \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2} \geq r_i + r_j && \text{for all } i, j : i < j \\
& r_i \leq x_i \leq w - r_i && \text{for all } i \\
& r_i \leq y_i \leq h - r_i && \text{for all } i \\
& h \leq w \\
& x, y \in \mathbb{R}^n_{\geq 0} \\
& h, w \in \mathbb{R}_{\geq 0}
\end{aligned}
$$

An NLP Model

$$
\begin{aligned}
\min \quad & h \cdot w \\
s.t. \quad & \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2} \geq r_i + r_j && \text{for all } i, j : i < j \\
& r_i \leq x_i \leq w - r_i && \text{for all } i \\
& r_i \leq y_i \leq h - r_i && \text{for all } i \\
& h \leq w \\
& x_1 \leq w/2 \\
& x, y \in \mathbb{R}^n_{\geq 0} \\
& h, w \in \mathbb{R}_{\geq 0}
\end{aligned}
$$

An NLP Model

$$
\begin{aligned}
\min \quad & h \cdot w \\
s.t. \quad & \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2} \geq r_i + r_j && \text{for all } i, j : i < j \\
& r_i \leq x_i \leq w - r_i && \text{for all } i \\
& r_i \leq y_i \leq h - r_i && \text{for all } i \\
& h \leq w \\
& x_1 \leq w/2 \\
& y_1 \leq h/2 \\
& x, y \in \mathbb{R}^n_{\geq 0} \\
& h, w \in \mathbb{R}_{\geq 0}
\end{aligned}
$$

To be continued?

Thank you very much for your attention!

Muito obrigado!

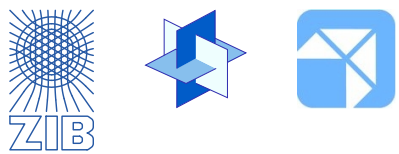
More slides and exercises at `http://scip.zib.de/` and `http://co-at-work.zib.de/`.

SCIP at Work

Examples and Case Studies

Ambros M. Gleixner

Zuse Institute Berlin · MATHEON · Berlin Mathematical School



5th Porto Meeting on Mathematics for Industry, April 10–11, 2014, Porto