Centre for
Data Analytics

Insight

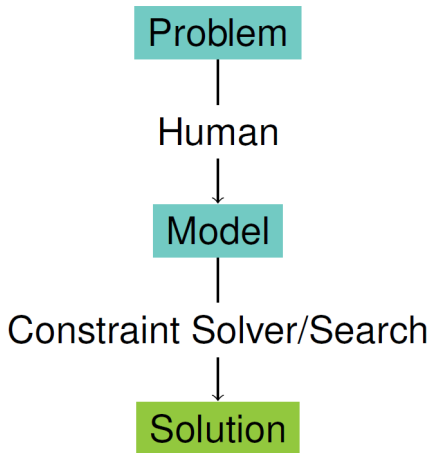# Considering Feedback Loops in Constraint Programming Methodology

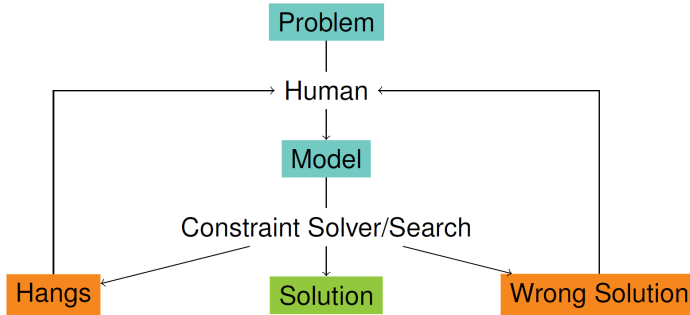Helmut Simonis

ModRef 18, August 27, 2018

Based on work with…

- Current and past staff at Insight
- ICON project partners
- TASC team in Nantes
- Constraint team in Uppsala

The Conventional Story

Problem

Human

Model

Constraint Solver/Search

Solution

A Slightly More Accurate Picture

Key Points

- This is not a realistic model
- Definitely not for industrial work
- Nobody knows what the problem is
- The problem keeps changing
- The process is a set of nested feedback loops, all influencing each other

Focus on Benchmarking Hides This Issue

- Work on clearly defined problem
- Solutions may already exist for comparison
- Quality is easily defined
  - Better objective value
  - Faster than previous approaches
- Only run-time counts
- Should be:
  - Overall development time until first usable solution
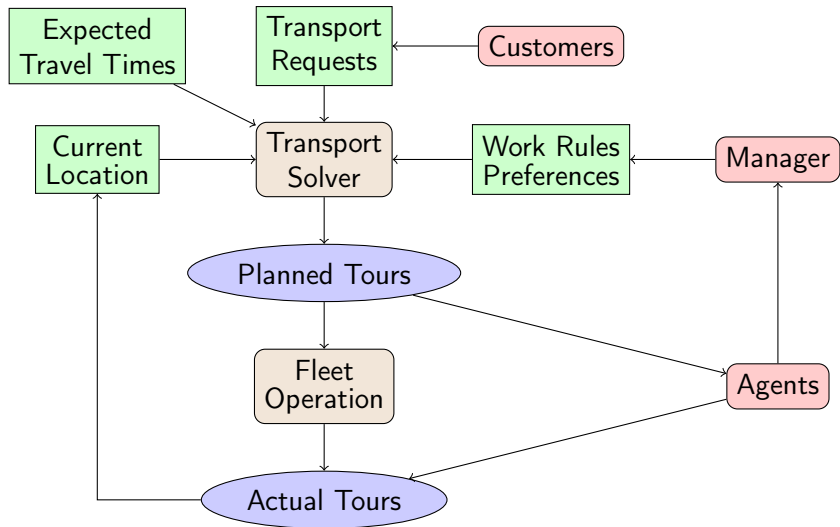 - Including design, revision, training

Some Real-World Examples

- Based on recent projects at Insight
- Not in production use

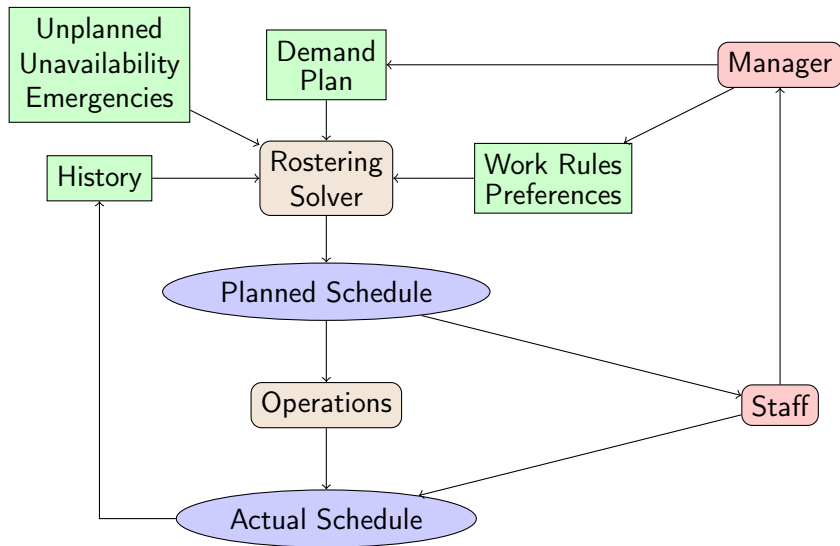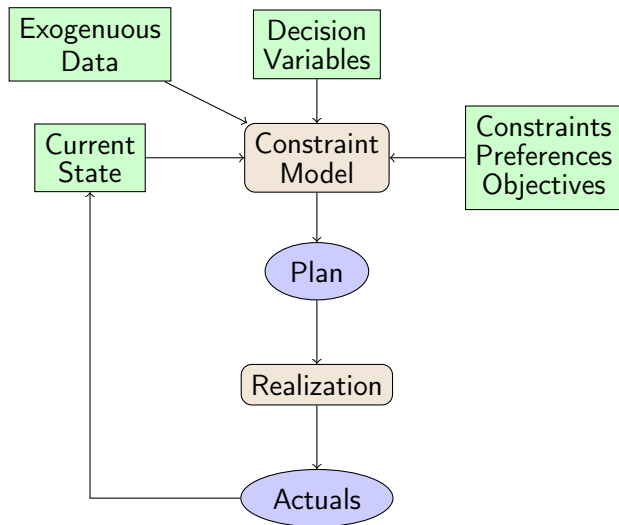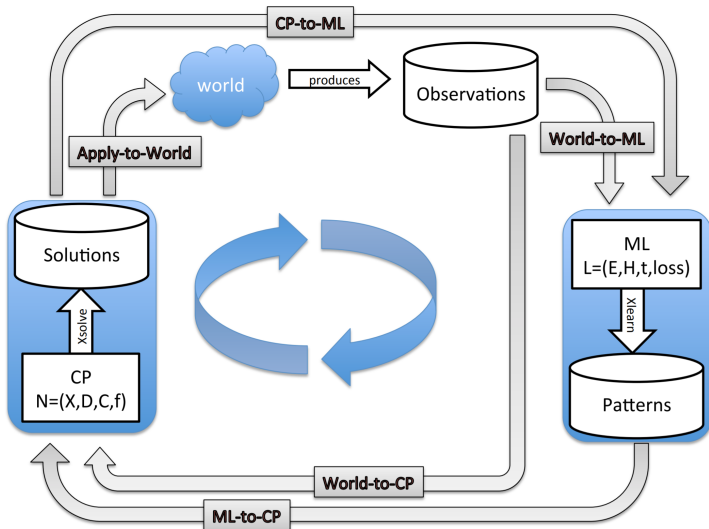# Example: Datacenter Management
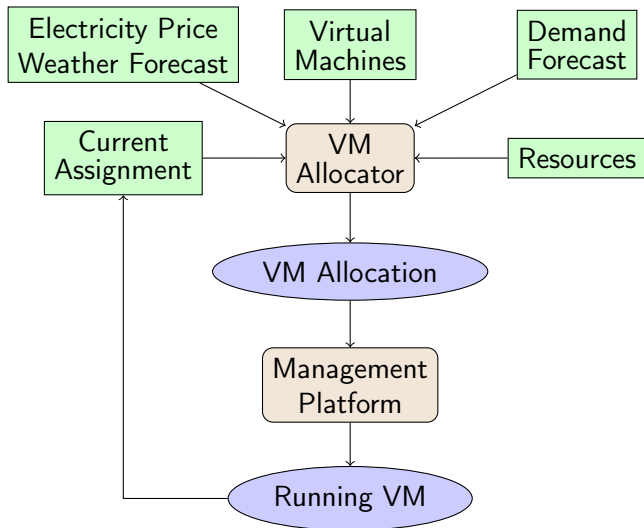
Example: Transport

Example: Personnel Rostering

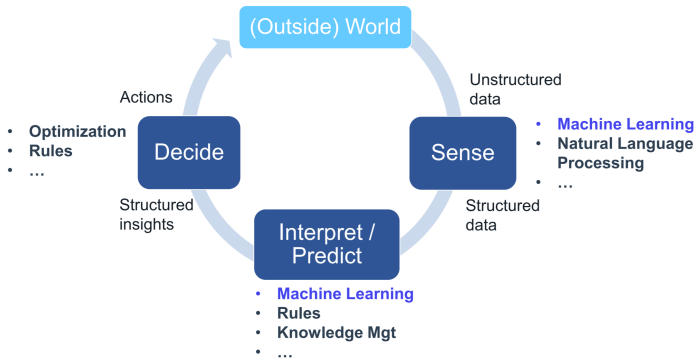# The General Scheme

The ICON Loop

A Blueprint for Interaction

- Developed in the European ICON project
- Partners KU Leuven, Montpellier, Pisa, UCC
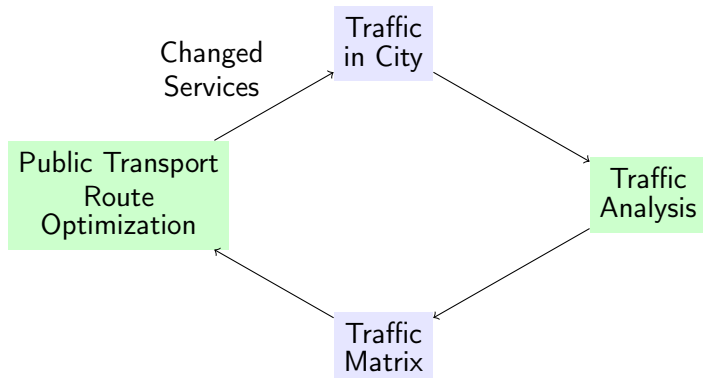- Ways of combining Machine Learning with CP

DecisionCamp 2017, Eric Mazeran, IBM
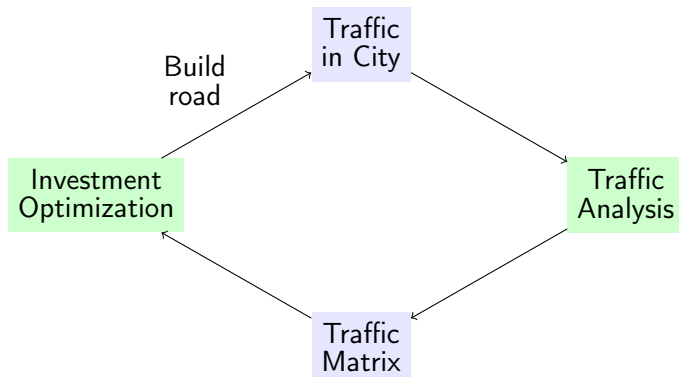
Machine Learning fuels Decision Making

Copyright © 2017 by International Business Machines Corporation (IBM).

Example: Intra-City Transport

Changed Services

Traffic in City

Traffic Analysis

Public Transport Route Optimization

Traffic Matrix

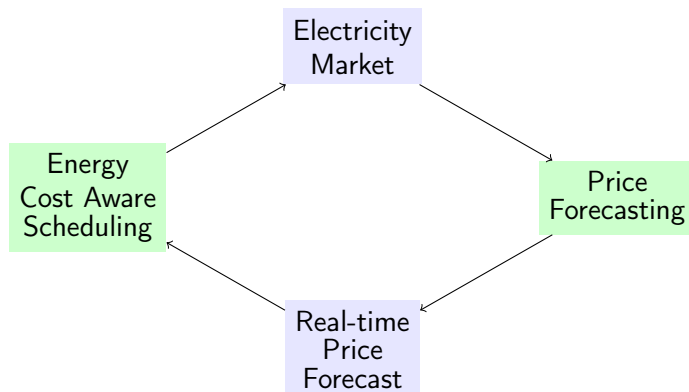- Optimization only as good as data feeding into it

Feedback May Lead to More Traffic

- The "world" reacts to changes
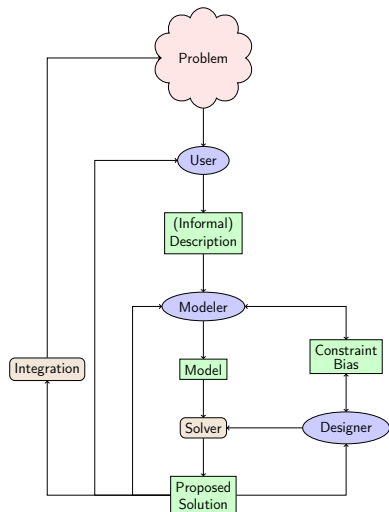- That may be difficult to predict

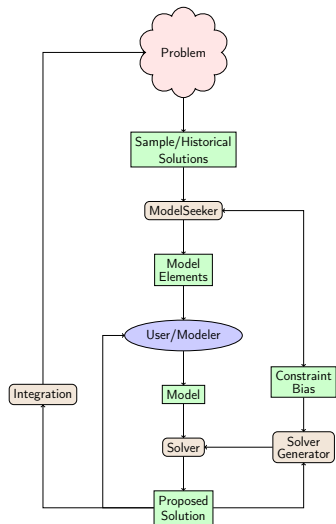# Reacting to Real-time Electricity Prices

- Good way to optimize cost individually
- May lead to oscillation if everybody does it

Feedback Loops in Modelling

The Future: Automated Modelling

ModelSeeker

- Learn elements of constraint models from positive examples
- Highly stuctured problems
  - Essentially matrix models
  - Conjunctions of global constraints
  - Based on global constraint catalog
- System suggests sets of constraints
- Relies on user to select meaningful subset

SolverGenerator

- Generate constraints for families of constraints automatically
- Currently being developed for time-series
- No limit on number of different constraints needed to model problem
- Also generate implied constraints for conjunction of basic constraints

Conclusions

- Very little work on methodology
- CHIC-II project
- Not the linear model often presented
- Feedback loops are everywhere
- Impact little understood