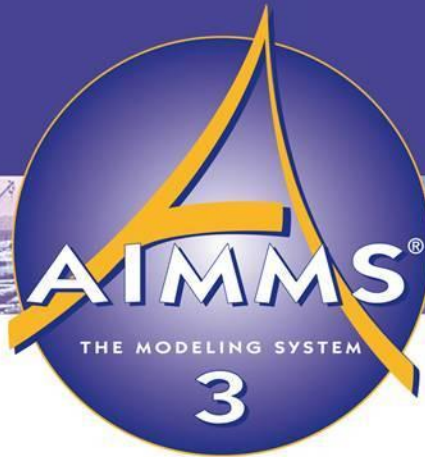


The AIMMS Interface to Constraint Programming



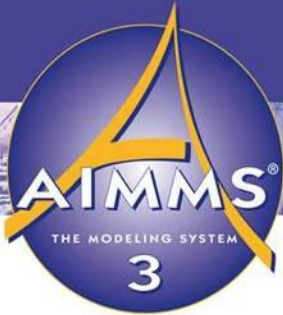
Willem-Jan van Hoeve ¹⁾,
Marcel Hunting ²⁾,
Chris Kuip ²⁾

CPAIOR 2011, Berlin

- 1) Carnegie Mellon University
- 2) Paragon Decision Technology

cp@aimms.com

Literature reference



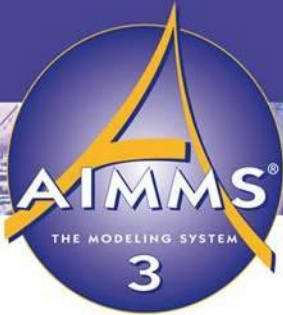
Extending an Algebraic Modeling Language to Support Constraint Programming

By Robert Fourer and David M. Gay

INFORMS JOURNAL ON COMPUTING

Vol. 14, No. 4, Fall 2002, pp. 322-344

CP for AIMMS Users ... AIMMS for CP Users

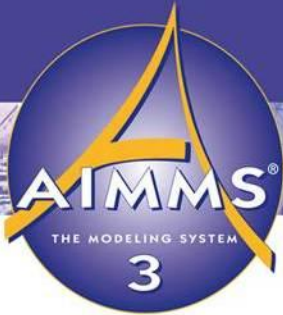


- Algebraic notation
- Development environment
- GUI solution presentation
- Mature solvers
- Combine with LP, NLP, ...
- Deployment facilities

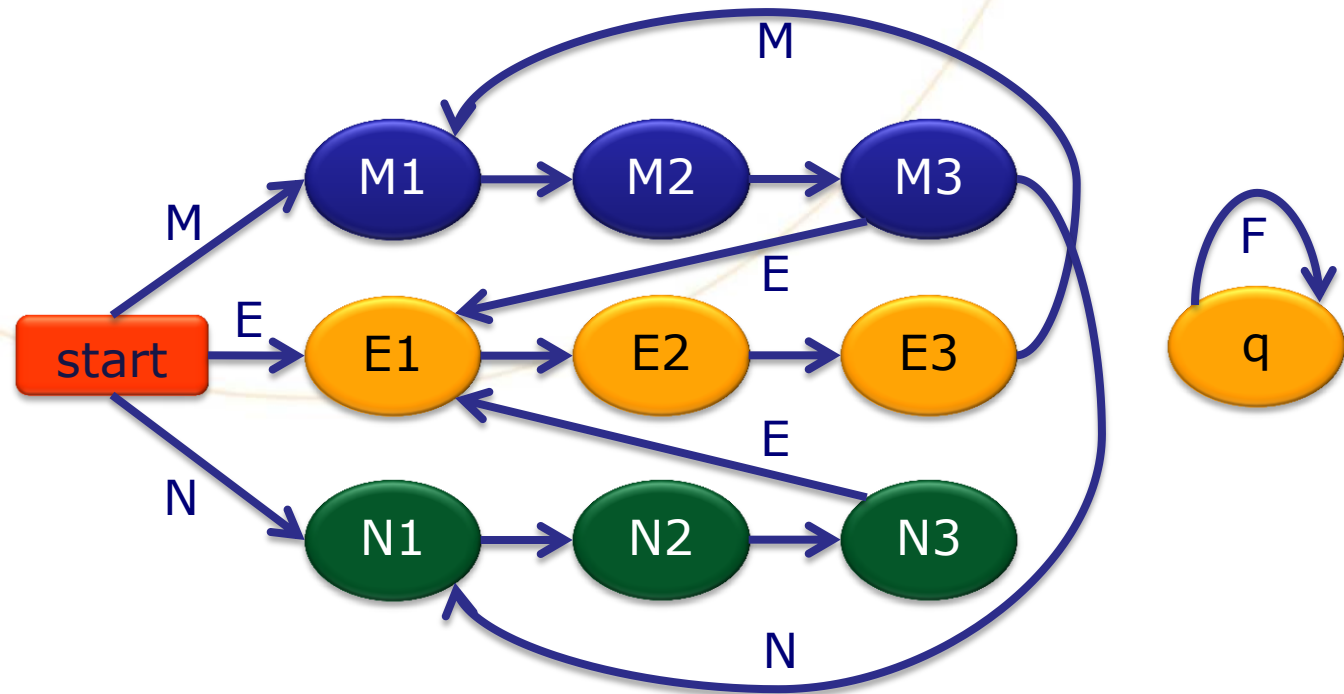


Rostering for Shift Scheduling

a real-life example

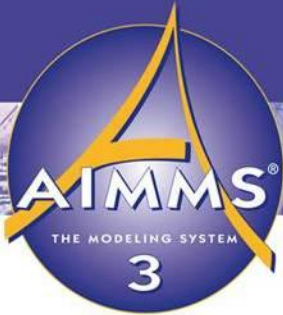


- Roster employees on shifts: Morning, Evening, Night.
- Most of the work in the morning, least at night.
- Each employee does a sequence of the same shifts
- Free days in between shifts are allowed.



Shifts = {
F, ! Free
M, ! Morning
E, ! Evening
N} ! Night

Element variables



```
SET Shift = { F, M, E, N }
```

```
SET States = { Start, M1, ... }
```

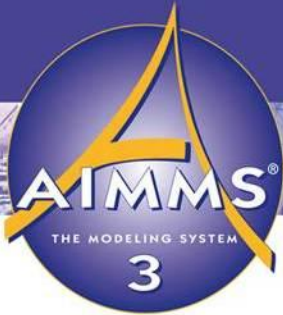
ELEMENT VARIABLE:

```
identifier      : Shift  
index domain    : (e, d)  
range           : Shifts ;
```

ELEMENT VARIABLE:

```
identifier      : State  
index domain    : (e, d)  
range           : States ;
```

Table constraints to implement DFA



```
TransitionRelation subset of (States, Shifts, States) =  
    {(start, 'F', start), (start, 'M', 'M1'), ... };
```

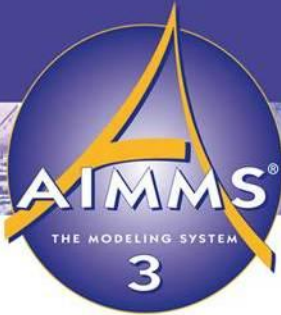
CONSTRAINT:

```
identifier      : DFA_Start  
index domain   : e  
definition     : ( 'start', shift(e,d1), state(e,d1) )  
                in TransitionRelation
```

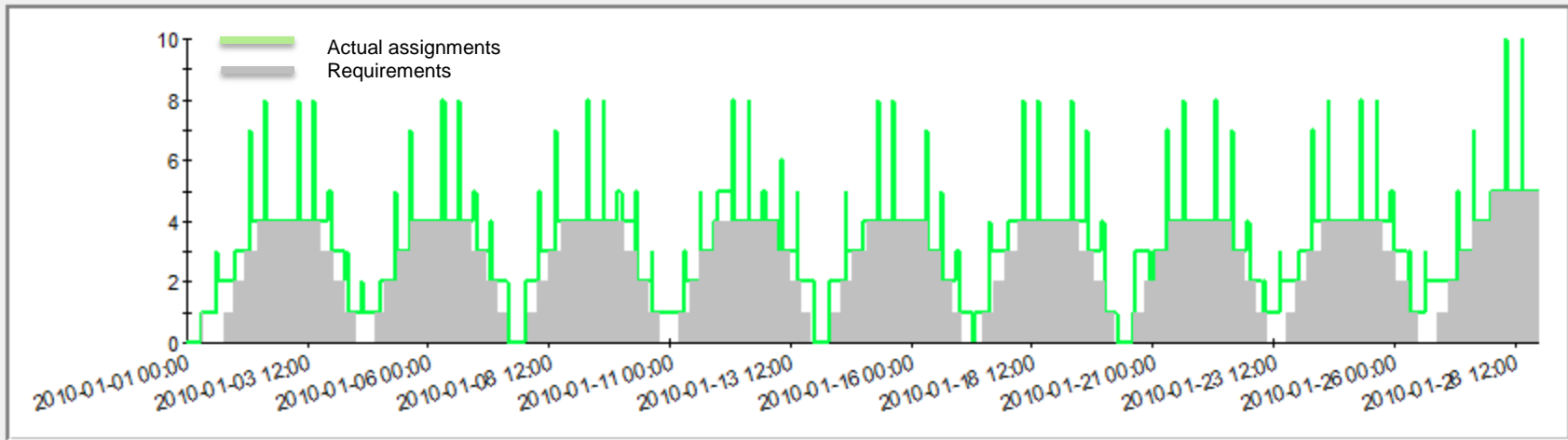
CONSTRAINT:

```
identifier      : DFA_Step  
index domain   : (e,d) | d<>d1  
definition     : ( state(e,d-1), shift(e,d), state(e,d) )  
                in TransitionRelation
```

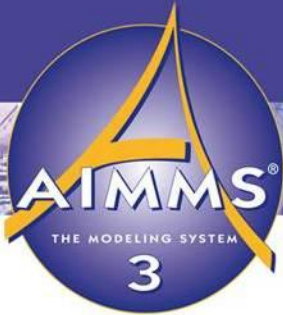
Solution



iDay	2010-01-01	2010-01-02	2010-01-03	2010-01-04	2010-01-05	2010-01-06	2010-01-07	2010-01-08	2010-01-09	2010-01-10	2010-01-11	2010-01-12
Employee												
W1	Free	Evening	Free	Free	Evening	Evening	Free	Evening	Evening	Free	Morning	Morning
W2	Free	Evening	Evening	Evening	Free	Evening	Free	Evening	Free	Morning	Free	Morning
W3	Free	Night	Free	Free	Free	Free	Free	Night	Night	Free	Night	Free
W4	Evening	Free	Free	Free	Free	Evening	Free	Free	Free	Free	Free	Free
W5	Free	Free	Evening	Free	Evening	Free	Free	Evening	Evening	Evening	Free	Morning
W6	Free	Morning	Free	Free	Free	Free	Morning	Morning	Morning	Free	Free	Free
W7	Free	Evening	Evening	Free	Evening	Free	Free	Free	Free	Free	Evening	Free
W8	Free	Night	Free	Free	Free	Night	Free	Night	Night	Night	Night	Night
W9												

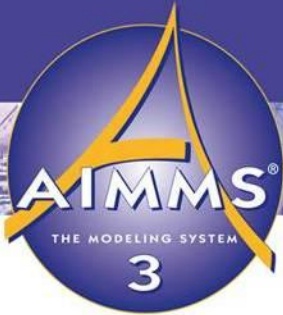


Approach comparison

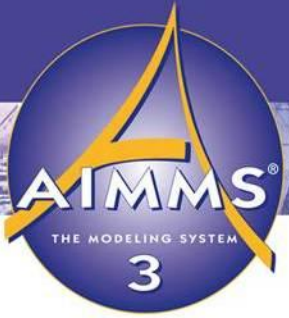


- **MIP:**
 - Problem did solve, and...
 - Very difficult to implement some sequencing constraints
 - Long running times / high memory usage
 - Does provide a lower bound on the objective
- **CP formulation with counting shifts, registering last shift:**
 - Model does provide (good) results in reasonable times
 - Constraints are complicated
- **CP formulation with states:**
 - Model provides near optimal results in matter of minutes
 - Clean/Clear formulation of possible combinations

Our interests



- Participation in existing beta-program cp@aimms.com
 - Collect expert feedback, also on scheduling objects
 - Jointly develop examples & best practices
- Insights in CP problem behavior
 - Visualization of the solution process
 - Infeasibility analysis
- Constraint Programming advanced concepts
 - Search specification
 - User defined global constraints
- Local search / SAT



Thank you