Scheduling a Major College Basketball Conference - Revisited

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Overview

- The Problem of Scheduling the 1998 ACC Basketball Season
- Approaches to Round Robin Scheduling Problems
- Constraint Programming for Sport Scheduling
- Friar Tuck, a Tournament Scheduling Tool

The Problem

Finding a suitable schedule for the 1998 Atlantic Coast Conference in basketball, an American college organization.

[Nemhauser, Trick, Opns. Res. 46(1), 1998]

- **General Setup**
- **Constraints**
- **Optimization Criteria**

General Setup: Double Round Robin

- Each team plays each other team twice.
- Meetings of every two teams is at different venue.
- 9 teams
- Temporally dense schedule
- Matches alternate between weekend and mid week.

Constraints

- **No team ends with two away games.**

- **No team may have more than two away matches in a row.**
- **No team may have more than two home matches in a row.**
- **No team may have more than three away matches or byes in a row.**
- **No team may have more than four home matches or byes in a row.**
- **No team may have more than two away matches on weekends in a row. . .**

- **Of the weekends, each team plays four at home, four away and one bye.**

- **Each team must have home matches or byes at least on two of the first five weekends.**

- **In the last match, each team plays against its traditional rival.**

Optimization Criteria

- **Avoid two away games for a team in rounds 1 and 2.**
- **The number of occurrences of four subsequent home matches or byes should be small…**
- **February matches are classified according to their attractiveness using a specified matrix. February dates should have good overall quality with respect to this measure.**

Official 1997/98 Schedule

teams		rounds																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Clem 1	+5	+6	−9		+3	−2	+8	−5	−6	+7	−4	+9		−3	+2	−8	−7	+4
	Duke 2	+8	−5	+7	−3	−9	+1		−8	+5	+4	−6	−7	+3	+9	−1		−4	+6
	FSU 3	+6	−7	−5	+2	−1	−4	+9	−6	+7		−8	+5	−2	+1	+4	−9		+8
	GT 4	+7		−6	+9	−8	+3	+5	−7		−2	+1	+6	−9	+8	−3	−5	+2	−1
	UMD 5	−1	+2	+3	−7	+6	−9	−4	+1	−2	+8		−3	+7	−6	+9	+4	−8	
	UNC 6	−3	−1	+4	+8	−5		−7	+3	+1	−9	+2	−4	−8	+5		+7	+9	−2
	NCSt 7	−4	+3	−2	+5		−8	+6	+4	−3	−1	+9	+2	−5		+8	−6	+1	−9
	UVA 8	−2	+9		−6	+4	+7	−1	+2	−9	−5	+3		+6	−4	−7	+1	+5	−3
	Wake 9		−8	+1	−4	+2	+5	−3		+8	+6	−7	−1	+4	−2	−5	+3	−6	+7

Overview

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- **Approaches to Round Robin Scheduling Problems**
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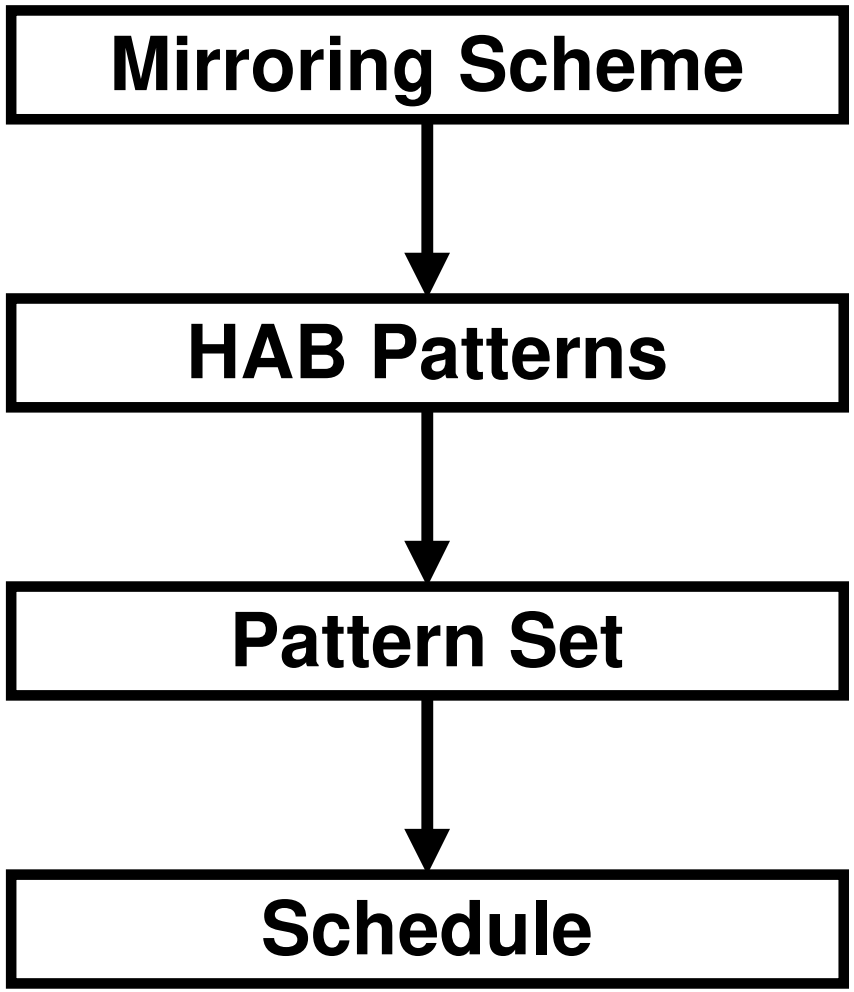
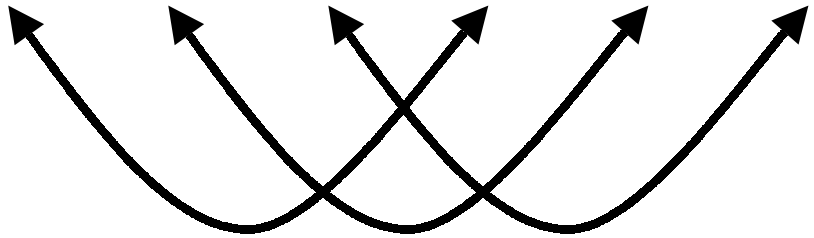
Phases towards a Schedule



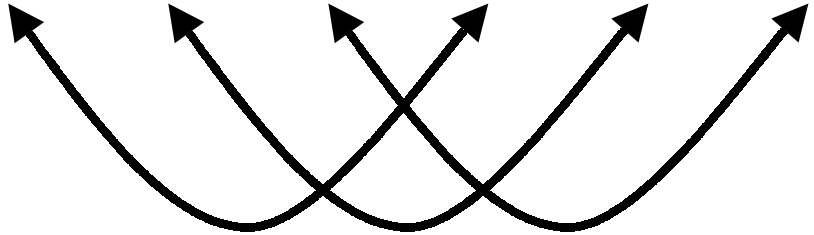
Date-wise Mirroring Scheme

Dates	1	2	3	4	5	6
Dynamo Sparta Vitesse						



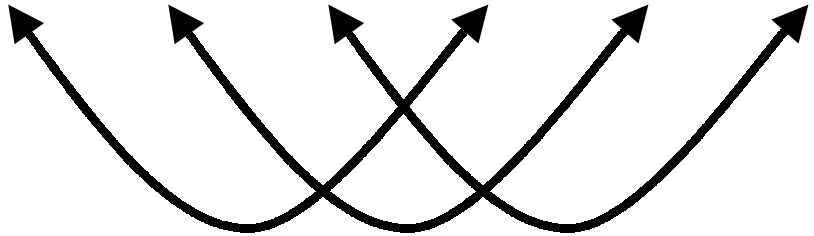
Home-Away-Bye Pattern

Dates	1	2	3	4	5	6
Pattern	H	A	B	A	H	B



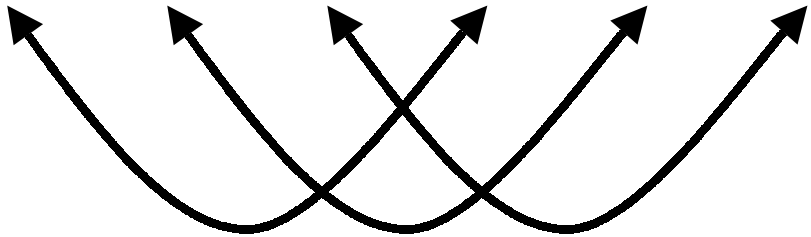
Pattern Set

Dates	1	2	3	4	5	6
Pattern 1	H	A	B	A	H	B
Pattern 2	B	H	A	B	A	H
Pattern 3	A	B	H	H	B	A



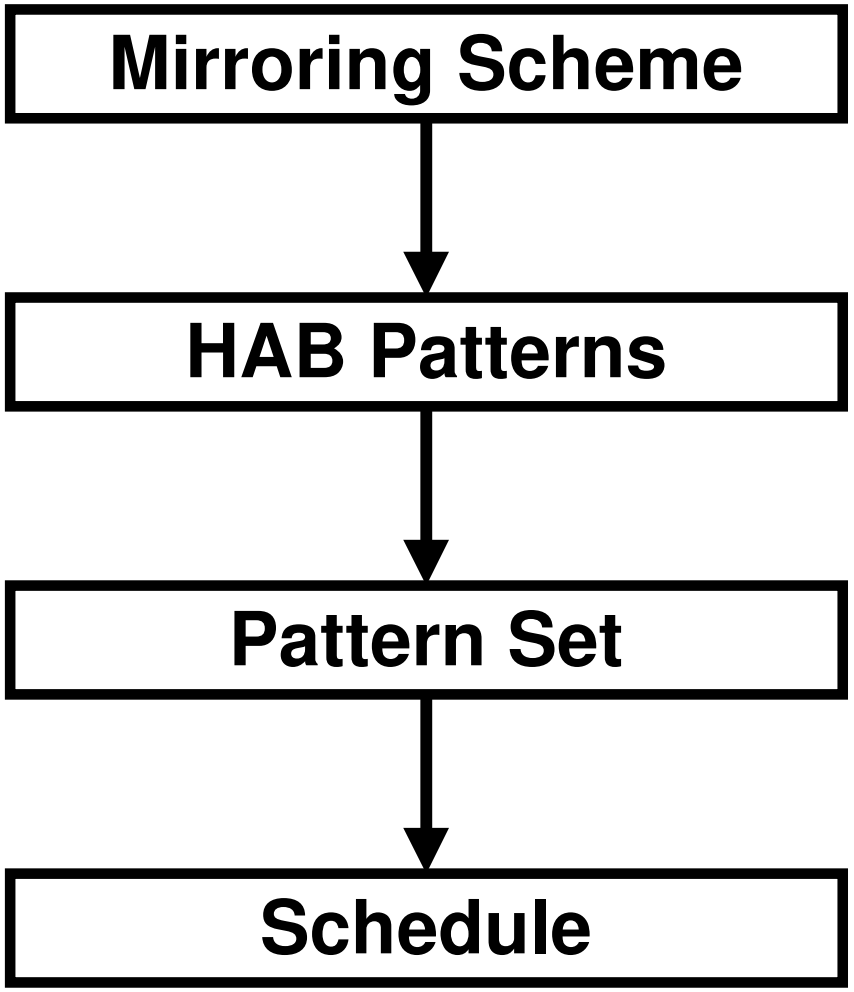
Schedule

Dates	1	2	3	4	5	6
Dynamo	V^{H}	S^{A}	B	V^{A}	S^{H}	B
Sparta	B	D^{H}	V^{A}	B	D^{A}	V^{H}
Vitesse	D^{A}	B	S^{H}	D^{H}	B	S^{A}



Approaches

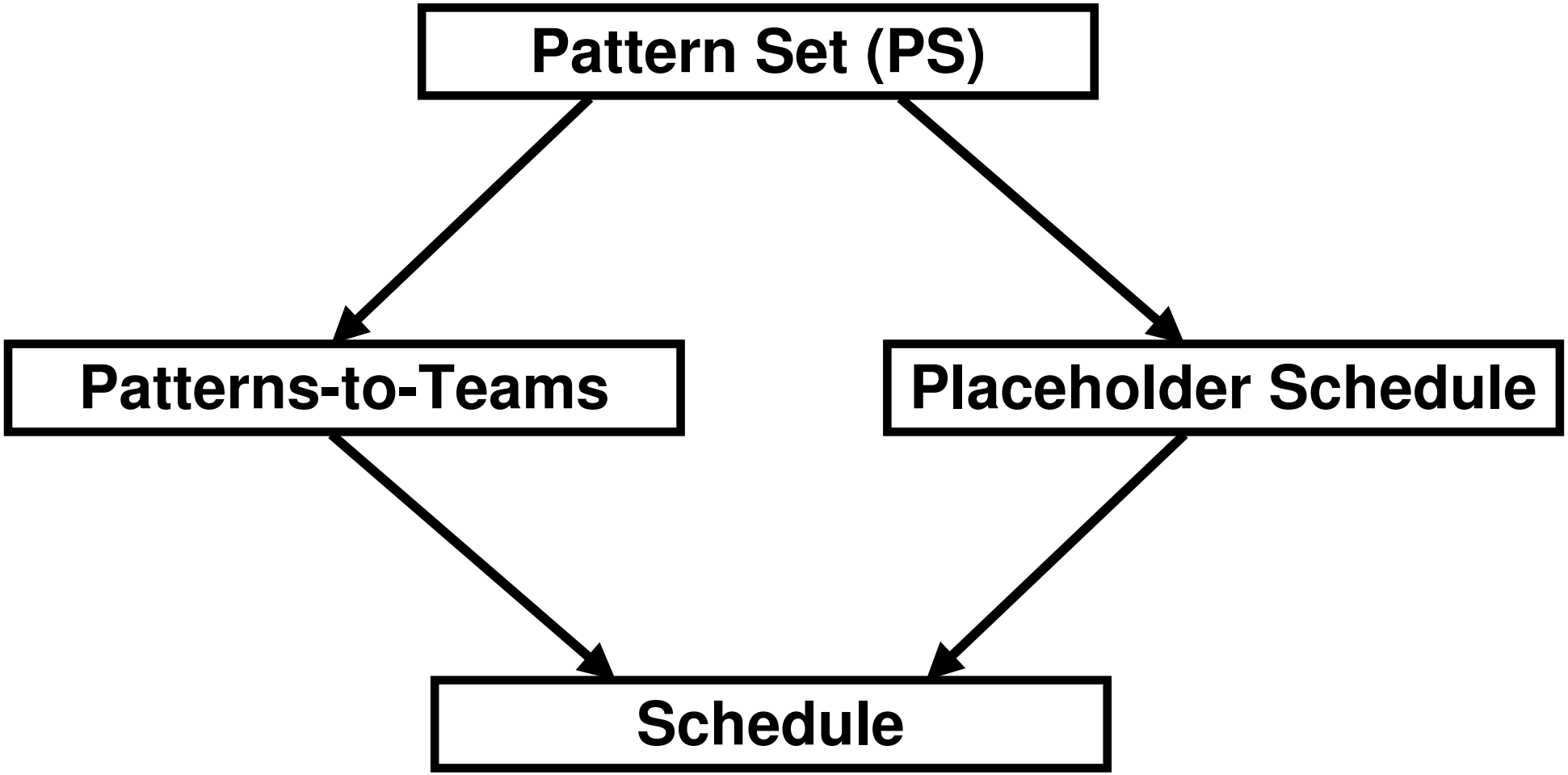
Nemhauser/ Trick		this work
Fix manually	Mirroring Scheme	fix manually
exhaustive enumeration	HAB Patterns	constraint programming
integer programming	Pattern Set	constraint programming
IP and enum.	Schedule	constraint programming



Approaches to Schedule Generation

Cain 1977

Schreuder 1992



Search for Pattern Sets

Cain 1977

Dates	1	2	3	4	5	6
Pattern 1	H	A	B	A	H	B
Pattern 2	B	H	A	B	A	H
Pattern 3	A	B	H	H	B	A

Schreuder 1992

Dates	1	2	3	4	5	6
Dynamo	H	A	B	A	H	B
Sparta	B	H	A	B	A	H
Vitesse	A	B	H	H	B	A

Dates	1	2	3	4	5	6
Team 1	3H	2A	B	3A	2H	B
Team 2	B	1H	3A	B	1A	3H
Team 3	1A	B	2H	1H	B	2A

Dates	1	2	3	4	5	6
Dynamo	VH	SA	B	VA	SH	B
Sparta	B	DH	VA	B	DA	VH
Vitesse	DA	B	VH	DH	B	VA

Overview

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- **Constraint Programming for Sport Scheduling**
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Constraint Propagation for Pattern Sets

Dates	1	2	3	4	5	6
Pattern 1	H					
Pattern 2				B		
Pattern 3						A

constraint propagation

Dates	1	2	3	4	5	6
Pattern 1	H	A	B	A	H	B
Pattern 2	B	H	A	B	A	H
Pattern 3	A	B	H	H	B	A

Constraint Propagation for Schedules

Dates	1	2	3	4	5	6
Dynamo	H	A	B	A	H	B
Sparta	B	H	A	B	A	H
Vitesse	A	B	H	H	B	A

constraint propagation

Dates	1	2	3	4	5	6
Dynamo	V^H	S^A	B	V^A	S^H	B
Sparta	B	D^H	V^A	B	D^A	V^H
Vitesse	D^A	B	S^H	D^H	B	S^A

Search for Pattern Sets

Dates	1	2	3	4	5	6
Pattern 1	H	AB	AB	A	BH	BH
Pattern 2	AB	H	AB	BH	A	BH
Pattern 3	AB	AB	H	BH	BH	A

distribute

P2 D1 = B

P2 D1 = A

Dates	1	2	3	4	5	6
Pattern 1	H	AB	AB	A	BH	BH
Pattern 2	B	H	AB	BH	A	BH
Pattern 3	AB	AB	H	BH	BH	A

Dates	1	2	3	4	5	6
Pattern 1	H	AB	AB	A	BH	BH
Pattern 2	A	H	AB	BH	A	BH
Pattern 3	AB	AB	H	BH	BH	A

propagate

propagate

Dates	1	2	3	4	5	6
Pattern 1	H	A	B	A	H	B
Pattern 2	B	H	A	B	A	H
Pattern 3	A	B	H	H	B	A

Dates	1	2	3	4	5	6
Pattern 1	H	B	A	A	B	H
Pattern 2	A	H	B	H	A	B
Pattern 3	B	A	H	B	H	A

Computational Results

Nemhauser/ Trick		this work
Fix manually	Mirroring Scheme	fix manually
not available	HAB Patterns	0.25 s
under 1 minute	Pattern Set	8.6 s
about 24 hours	Schedule	223 s

Improved vs Official Schedule

teams		rounds																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Clem 1	+5	+6	−9		+3	−2	+8	−5	−6	+7	−4	+9		−3	+2	−8	−7	+4
	Duke 2	+8	−5	+7	−3	−9	+1		−8	+5	+4	−6	−7	+3	+9	−1		−4	+6
	FSU 3	+6	−7	−5	+2	−1	−4	+9	−6	+7		−8	+5	−2	+1	+4	−9		+8
	GT 4	+7		−6	+9	−8	+3	+5	−7		−2	+1	+6	−9	+8	−3	−5	+2	−1
	UMD 5	−1	+2	+3	−7	+6	−9	−4	+1	−2	+8		−3	+7	−6	+9	+4	−8	
	UNC 6	−3	−1	+4	+8	−5		−7	+3	+1	−9	+2	−4	−8	+5		+7	+9	−2
	NCSt 7	−4	+3	−2	+5		−8	+6	+4	−3	−1	+9	+2	−5		+8	−6	+1	−9
	UVA 8	−2	+9		−6	+4	+7	−1	+2	−9	−5	+3		+6	−4	−7	+1	+5	−3
	Wake 9		−8	+1	−4	+2	+5	−3		+8	+6	−7	−1	+4	−2	−5	+3	−6	+7

teams		rounds																	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Clem 1	+7	−6	−8	+3	−2		+5	−7	+6	−9	−4	+8	−3	+2		−5	+9	+4
	Duke 2	+5	−7	−3	+9	+1	−8		−5	+7	+4	−6	+3	−9	−1	+8		−4	+6
	FSU 3	+6	−5	+2	−1		+9	−4	−6	+5	+7	−8	−2	+1		−9	+4	−7	+8
	GT 4	+8		−6	+5	−9	+7	+3	−8		−2	+1	+6	−5	+9	−7	−3	+2	−1
	UMD 5	−2	+3	+9	−4	+7	−6	−1	+2	−3	+8		−9	+4	−7	+6	+1	−8	
	UNC 6	−3	+1	+4	−7	+8	+5	−9	+3	−1		+2	−4	+7	−8	−5	+9		−2
	NCSt 7	−1	+2		+6	−5	−4	+8	+1	−2	−3	+9		−6	+5	+4	−8	+3	−9
	UVA 8	−4	−9	+1		−6	+2	−7	+4	+9	−5	+3	−1		+6	−2	+7	+5	−3
	Wake 9		+8	−5	−2	+4	−3	+6		−8	+1	−7	+5	+2	−4	+3	−6	−1	+7

Overview

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- **Friar Tuck, a Tournament Scheduling Tool**

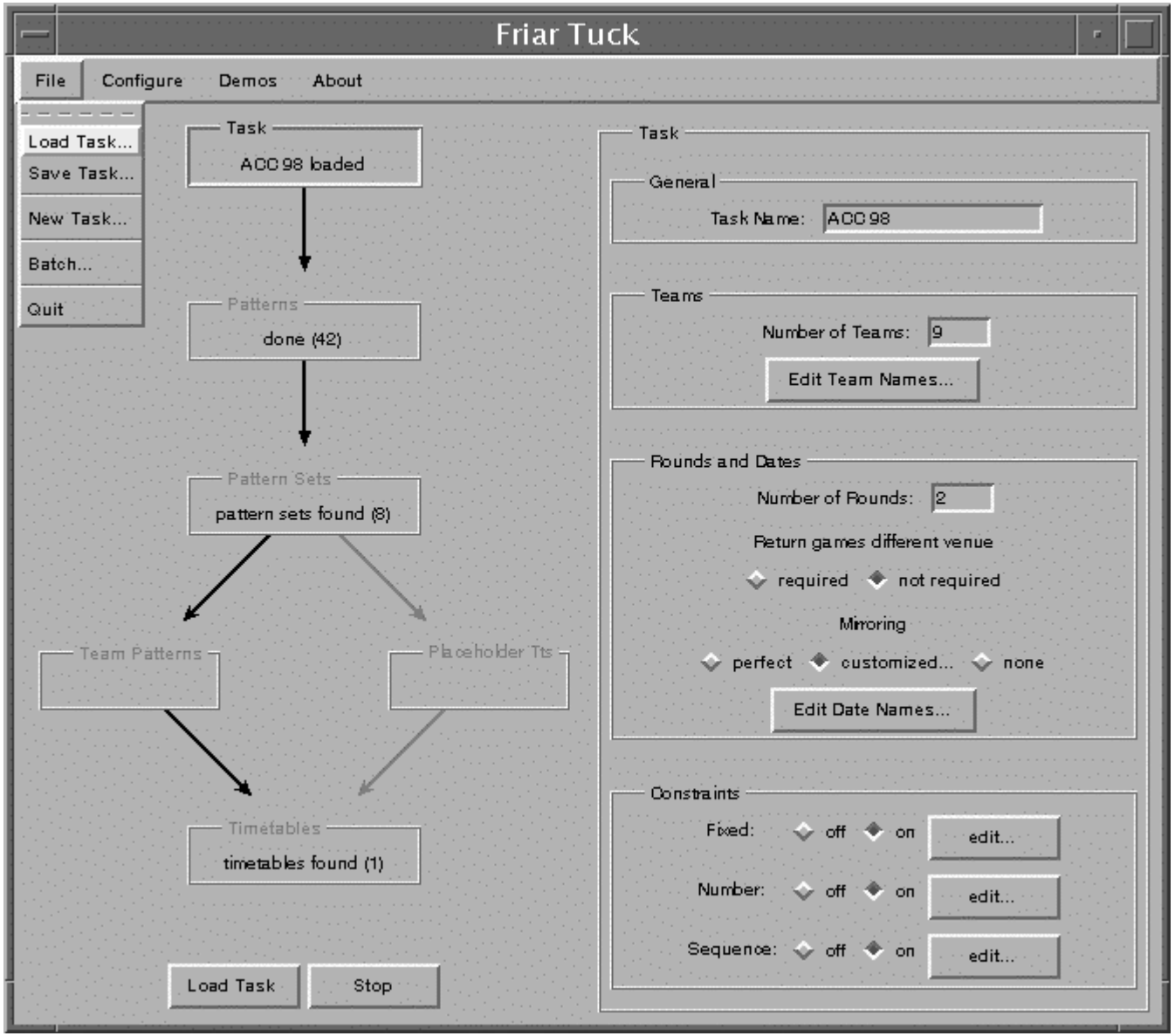
Friar Tuck, a Tournament Scheduling Tool

- Single, double, multiple round robin scheduling
- Fixing matches and home/away/bye patterns possible
- constraints on sequences of home/away/bye patterns
- experimentation platform for pattern, pattern set and schedule generation
- batch mode for computational experiments

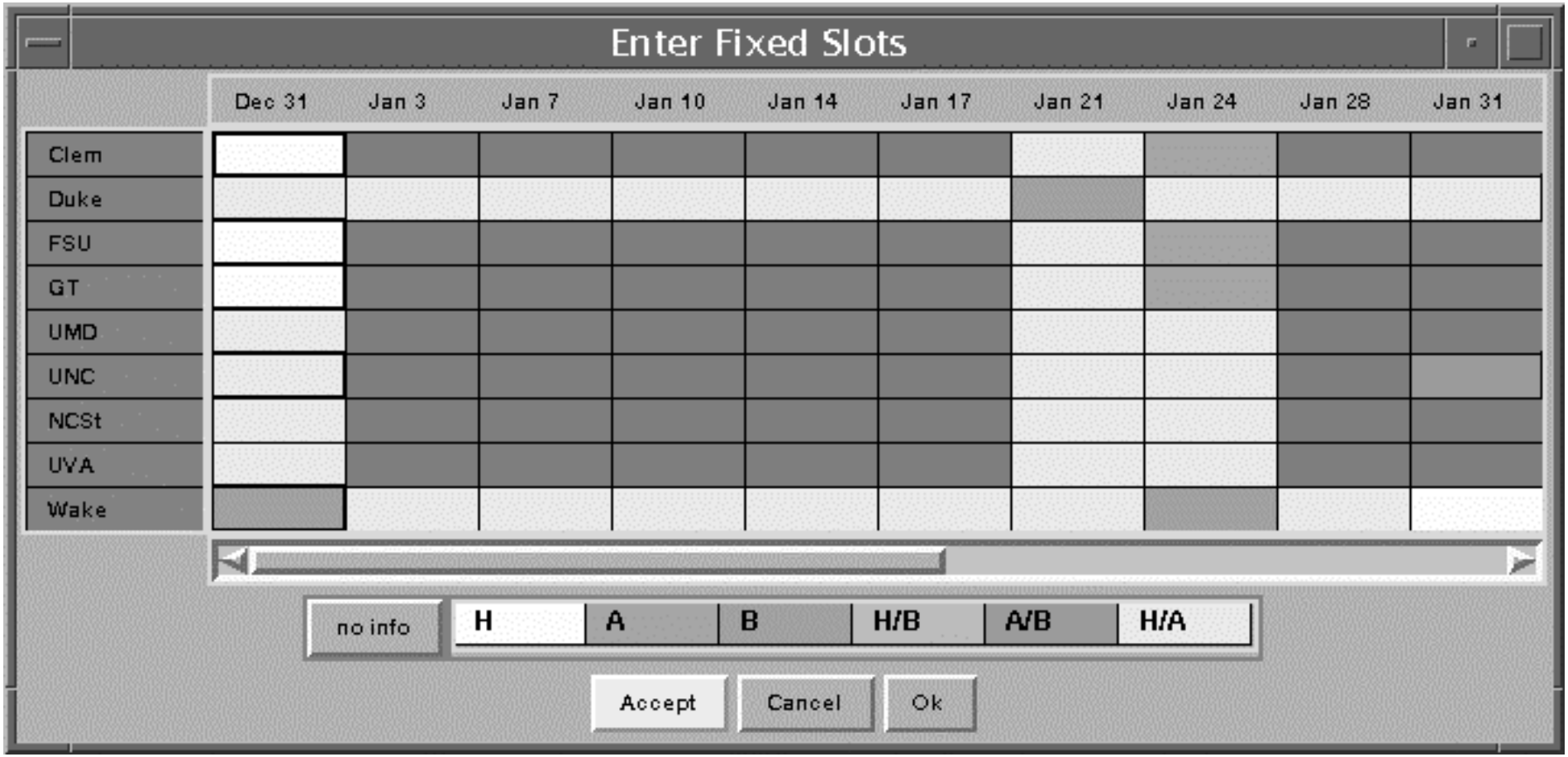
Public domain software, download from

http://www.comp.nus.edu.sg/~henz/projects/FriarTuck

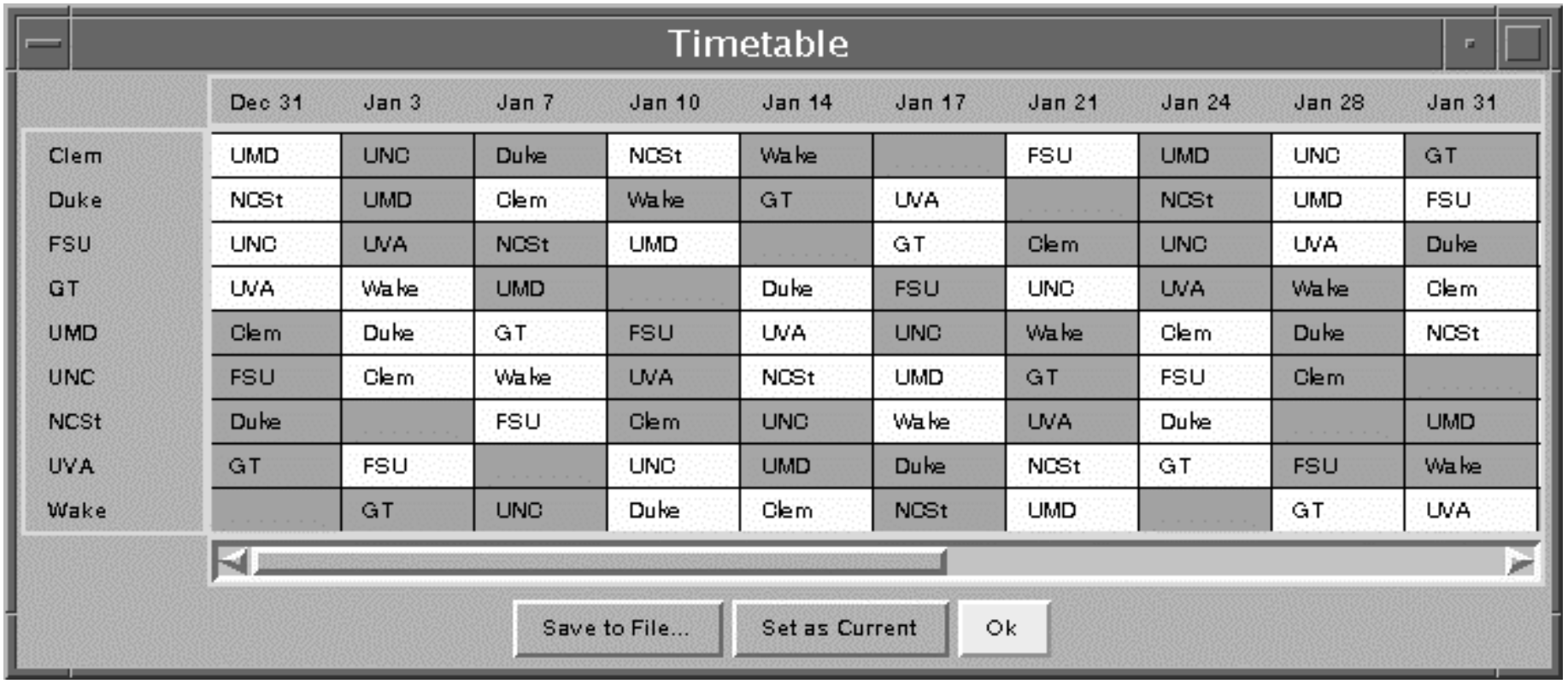
Toplevel Interface



Entering Fixed Constraints



Generated Schedule



Summary

- Constraint programming viable for a class of round robin scheduling problems
- All phases can be solved with constraint programming.
- Friar Tuck: a constraint-based tournament scheduler
- Experience with other tournaments needed.