KU LEUVEN

Learning To Schedule Sport Tournaments from Tensor Data

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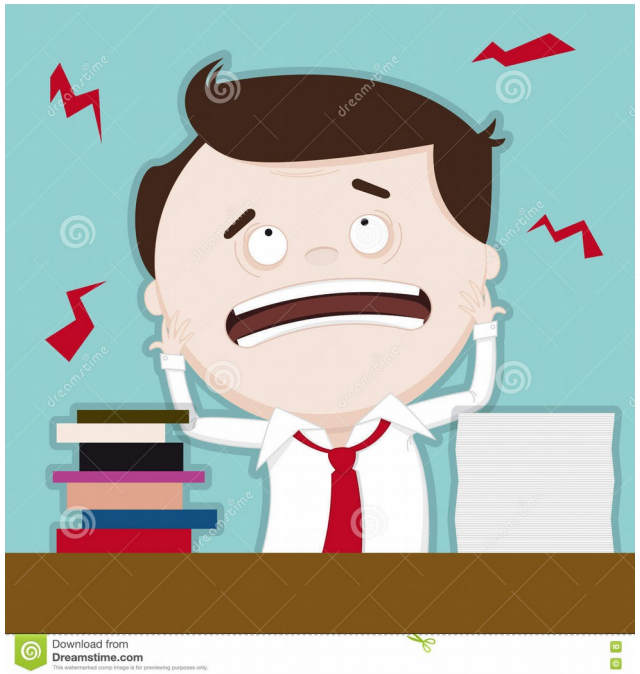
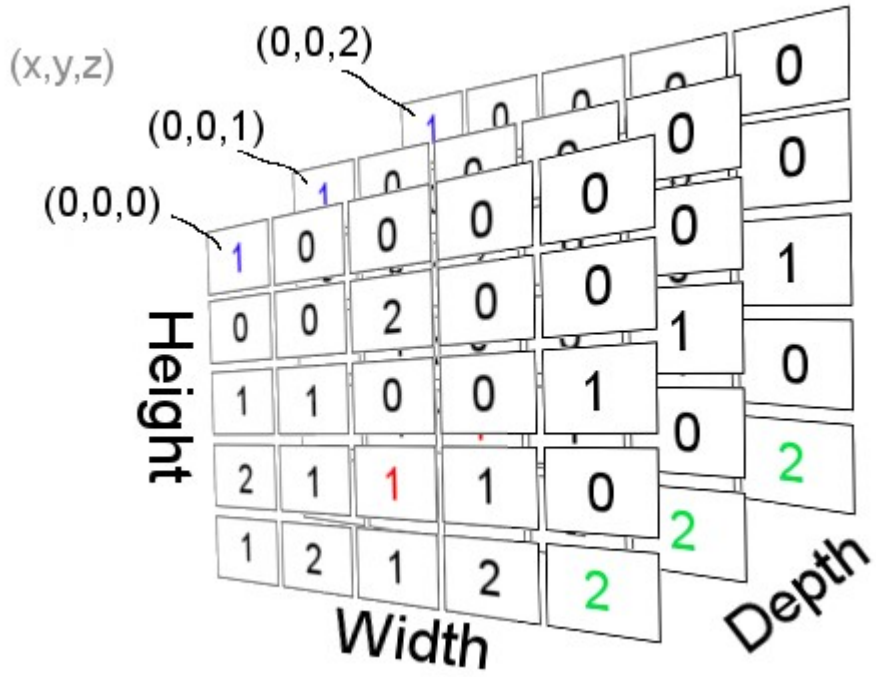
Context

- Many real world problems require constraints
- Sport scheduling is really complex and labboursome: MLB
    - 2 leagues
    - Each league consists of 3 divisions
    - 162 games per team per regular season
- Could this be automated to lower the amount of work?



Aim

- Use/adapt countOR algorithm with sport scheduling
    - Learning/acquiring constraints
    - Making sport scheduling easier



Approach: Literature study

- What are sport tournaments? Terminology?
- What are sport scheduling constraints? Commonly used?
- Mathematical context of constraints
- Other algorithms specifically used to generate schedules
- Constraint Learning solutions

Approach: Relevant literature

- Mohit Kumar, Stefano Teso, and Luc De Raedt. “Automating Personnel Rostering by Learning Constraints Using Tensors”. In: (2018)
- Krzysztof Apt. “Principles of Constraint Programming”. In: Principles of Constraint Programming (2003).
- Nicolas Beldiceanu and Helmut Simonis. “A Model Seeker : Extracting Global Constraint Models From Positive Examples”
- Rasmus V. Rasmussen and Michael A. Trick. “Round robin scheduling – a survey”. In: European Journal of Operational Research188.3 (2008)
- Kimmo Nurmi et al. “A framework for scheduling professional sports leagues”. In: AIP Conference Proceedings 1285.May 2014 (2010)
- Christian Bessiere. Constraint Propagation, Tech. rep. March. CNRS/University of Montpellier, 2002

Approach: CountOR

- Model schedules in tensors
- Applying tensor operations to achieve quantities of interest
  - Summing
  - Maximizing
- Applied in nurse rostering
- What can we learn from countOR as is?

	M0	M0	M0	M0	M0	M0	M1	M1	M1	M1	M1	M1	M2	M2	M2	M2	M2	M2
	T1	T2	T3	T4	T5	T6	T1	T2	T3	T4	T5	T6	T1	T2	T3	T4	T5	T6
T1	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
T2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
T3	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0
T4	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
T5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
T6	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0

Practical approach: Experimental pipeline

Generate a set of solutions for the Sport Scheduling Problem

↓

Learn an estimated model M from [1,10,25,50] solutions

↓

Generate many samples based on M

↓

Calculate Recall and precision based on the samples

Practical approach: CountOR(benchmark)

- Generate set of Solutions for the SSP

Index	Constraint	Importance
C01	Team t_j can not play home in round r_k	High
C02	Team t_j cannot play away in round r r_k	High
C03	Team t_j can not play at all in round r_k	High
C04	There should be at least m_1 and at most m_2 homegames for teams $t_1, t_2, \ldots$ on the same day d	medium
C05	No team can play against itself	Very high
C06	Team t wishes to play at least k_1 and at most k_2 homegames between round r_i and round r_j	medium
C07	Team t wishes to play at least k_1 and at most k_2 awaygames between round r_i and round r_j	medium

Practical approach: CountOR(benchmark)

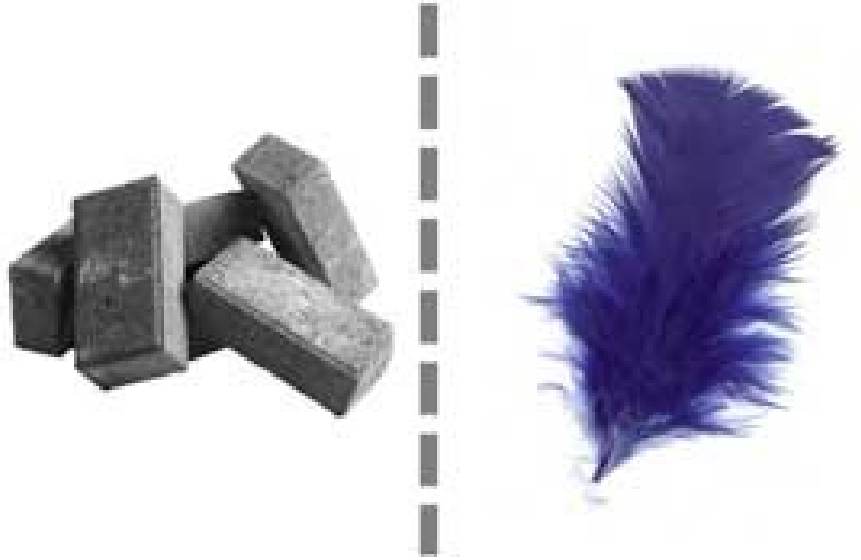
C24	Game h-team against a-team cannot be played before round r	high
C25	Game h-team against a-team cannot be played after round r	high
C26	The difference between the number of played home and away games for each team must not be larger than k in any stage of the tournament (a k-balanced schedule)	high
C27	The difference in the number of played games between the teams must not be larger than k in any stage of the tournament (in a relaxed schedule)	high
C28	Teams should not play more than k consecutive games against opponents in the same strength group	low (requires bk?)
C29	Teams should not play more than k consecutive games against opponents in the strength group s	low (requires bk?)
C30	At most m teams in strength group s should have a home game in round r	Low (requires bk?)
C31	There should be at most m games between the teams in strength group s between rounds r1 and r2	Low (requires bk?)

Approach: CountOR

M	S	Count(X,M,S)
Days	Home	# total Home games / team
Days	Away	#total Away games / team
Home	Days	#homegames played on a day
Away	Days	#awaygames on a day
Home	Away	# games played at the end of the tourney/team
Away	Home	# games played at the end of the tourney/team
Away	{Home,Days}	#away games per day per team
Home	{Away,Days}	#home games per day per team
Days	{Home,Away}	#times a particular fixture occurs
{Days,Away}	Home	#away games / team
{Days,Home}	Away	#Home games / team
{Home,Away}	Days	#Number of games played each day

Practical approach: CountSPORT

- Validation of models
    - Hard constraints
    - Soft constraints?



CountSPORT: Planning

- Extension of the countOR algorithm
- New aggregation functions
- Capture constraints
  - Priority based capture based on relevance
- Experimental pipeline remains the same