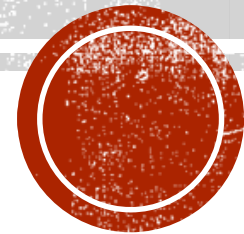


CSPs TUTORIAL VOL. 1

MODELING CSPs EXAMPLES



MODELING CSPs EXAMPLES

- Coworkers Café Schedule
- Sudoku Puzzle
- Major League Baseball Schedule



COWORKERS CAFÉ SCHEDULE

1. Jim, Jane and John are coworkers at Costa Coffee, Lewes, UK.
2. They have 2 swifts, Morning, Afternoon and they have Days Off also.
3. Café operates with only one employee in each swift every day.
4. Every employee must have at least 2 consecutive Days Off.
5. If an employee works in Afternoon, he mustn't work the next day Morning.
Rest Rule!
6. Jim prefers to work Saturday Morning and have Day Off on Wednesday.
7. Jane prefers to work Wednesday Morning and have Day Off on Friday.
8. Jon prefers to work Thursday Afternoon and have Day Off on Tuesday.



COWORKERS CAFÉ SCHEDULE

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8. Jon prefers to work Thursday Afternoon and have Day Off on Tuesday.

$3^{21} = 10.5$ billions possible solutions!



COWORKERS CAFÉ SCHEDULE

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Jim	X1	X2	X3	X4	X5	X6	X7
Jane	X8	X9	X10	X11	X12	X13	X14
John	X15	X16	X17	X18	X19	X20	X21

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Jim				DO			M
Jane				M		DO	
Jon			DO		A		



COWORKERS CAFÉ SCHEDULE

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Jim	X1	X2	X3	X4	X5	X6	X7
Jane	X8	X9	X10	X11	X12	X13	X14
John	X15	X16	X17	X18	X19	X20	X21

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Jim	A	A	A	DO	DO	M	M
Jane	M	M	M	M	M	DO	DO
John	DO	DO	DO	A	A	A	A

Step by step, we found deterministically the One and Only solution.



COWORKERS CAFÉ SCHEDULE

- Variables = $\{X_1, X_2, \dots, X_{20}\}$
- Domains = $\{M, A, DO\}$
- Constraints
 - (6) $C_1: S_1 = \{X_7\}$, $T_1 = \{M\}$ $C_2: S_2 = \{X_4\}$, $T_2 = \{DO\}$
 - (7) $C_3: S_3 = \{X_{11}\}$, $T_3 = \{M\}$ $C_4: S_4 = \{X_{13}\}$, $T_4 = \{DO\}$
 - (8) $C_5: S_5 = \{X_{17}\}$, $T_5 = \{M\}$ $C_6: S_6 = \{X_{17}\}$, $T_6 = \{DO\}$



COWORKERS CAFÉ SCHEDULE

- (5) $C7: S7 = \{X1, X2\}$, $T7 = \{(M,A), (M,M), (A,A), (M,DO), (DO,M), (A,DO), (DO,A), (DO,DO)\}$
- (5) $C8: S8 = \{X2, X3\}$, $T8 = T7$

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- (3) $C25: S25 = \{X1, X8, X15\}$, $T25 = \{(A,M,DO), (M,A,DO), \dots\}$

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COWORKERS CAFÉ SCHEDULE

- (4) C32: S32 = {X1,X2,X3,X4,X5,X6,X7},
T32 = {(M,M,M,M,M,DO,DO),}
- (4) C33: S33 = {X8,X9,X10,X11,X12,X13,X14},
T33 = {(M,M,M,M,M,DO,DO),}
- (4) C34: S34 = {X15,X16,X17,X18,X19,X20,X21},
T34 = {(M,M,M,M,M,DO,DO),}



SUDOKU PUZZLE

5	3			7				
6			1	9	5			
	9	8					6	
8				6				3
4			8		3			1
7				2				6
	6					2	8	
			4	1	9			5
				8			7	9



SUDOKU PUZZLE

5	3	4	6	7	8	9	1	2
6	7	2	1	9	5	3	4	8
1	9	8	3	4	2	5	6	7
8	5	9	7	6	1	4	2	3
4	2	6	8	5	3	7	9	1
7	1	3	9	2	4	8	5	6
9	6	1	5	3	7	2	8	4
2	8	7	4	1	9	6	3	5
3	4	5	2	8	6	1	7	9



SUDOKU PUZZLE AS CSP

- Variables = $\{X_{11}, X_{12}, \dots, X_{99}\}$
- Domains: $\{1, \dots, 9\}$
- Constraints:
 - row constraint: $X_{11} \neq X_{12}, \dots, X_{11} \neq X_{19}, \dots$
 - column constraint: $X_{11} \neq X_{21}, \dots, X_{11} \neq X_{91}, \dots$
 - block constraint: $X_{11} \neq X_{12}, \dots, X_{11} \neq X_{33}, \dots$



MONSTER SAMURAI SUDOKU

5				1		6	8				6	2			
			5 7			3 7 5		1			6	2		3 6	
9			3 2									9	1	5	
	5	6				3	8					3	1		
7 9	3			4		2	4 5				5 2	6 9	8		
6	4 2						7 9	3			9	8			4
	7		9	4		6 8				9	7	3	8		
		4			1 5			5 7			6				7
3						8 2		4 5						3 5	6
			3	4 1	6			7				4 2			
				9				3				8			
									9				1		
9			7		4		9 8			3	7				
6 8		4	9	3		5		2		4 2	5	6			
	2			8				4 5	8				1	5	
		7				5			2 6		4 8		2	7	
	8	6	1			7							3 6	2	
3	4 1 9					2	6	9					5	1 9	
			1		7 6 9					1				8	1
			7					6			9		7 6 9		
6		2 9		1				4							7 8
				5 3 1					3						
			4					4	6		5				
			9	2 7	6				7		4				
7 1			5		4				7			5 2			8
			3 8				5	9		1			2	7	
2		1		7					5 9		6	9		6	
3		8 2		6						1			9		9
9	5		3					2 7 8			9				4
	7				1			7 4						5	
	4 2 1 6		8					4	7 3				4	1	3 7
	9				3					4			7		6 5
					4										2 3 4 9 1
	6			4				8 5							



MAJOR LEAGUE BASEBALL SCHEDULE OR RUBIK'S CUBE ?

- MLB consist of 2 leagues, each has 3 divisions (East, Central, West) of 5 Clubs.
- MLB Clubs play 162 games, 81 home, 81 on the road. Games are organized in home series and away series.
- Games will not be scheduled over a period of less than 178 days or more than 183 days.
- No Club shall be scheduled to play more than 20 consecutive dates without an open day.
- Each Club will play no more than 20 Interleague games. Each Club will play no fewer than 17 games against each its division foes.
- An open day shall be scheduled for or following travel from cities in the Pacific time zone to cities in the Eastern time zone. 7 exceptions maximum.
- MLB teams make special requests e.g. Blue Jays must be in Toronto on Canada Day (July 1), Yankees must be in New York on Patriot Day (9/11), Dodgers must be in LA on Jackie Robinson Day, every Club wants to be home on Independence Day (July 4), no Club wants to play home on Mother's Day or Labor Day (!!!), what about concerts ?
- In markets with two clubs, one club home while the other club is on the road.



MAJOR LEAGUE BASEBALL SCHEDULE

The screenshot shows the Toronto Blue Jays website header with the team logo and name. The navigation menu includes links for NEWS, VIDEO, SCORES, STATS, SCHEDULE, ROSTER, JAYS CARE, FANS, ROGERS CENTRE, BASEBALL ACADEMY, TICKETS, MOBILE, SHOP, MLB.TV, FANTASY, and TEAMS. A search bar is located on the right side of the header.

CALENDAR

July 2015

Select Team

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	



MAJOR LEAGUE BASEBALL SCHEDULE



TORONTO BLUE JAYS™

BLUEJAYS.COM

NEWS VIDEO SCORES STATS **SCHEDULE** ROSTER JAYS CARE FANS ROGERS CENTRE BASEBALL ACADEMY
TICKETS
MOBILE SHOP MLB.TV FANTASY TEAMS

CALENDAR

◀ July 2015 
▶

Select Team ▼

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
			1 vs Red Sox 1:07 pm	2 vs Red Sox 7:07 pm		
5 @ Tigers 1:08 pm	6 @ White Sox TBD	7 @ White Sox TBD	8 @ White Sox TBD	9 @ White Sox TBD	10 @ Royals TBD	11 @ Royals TBD
12 @ Royals TBD	13	14 NL vs AL	15	16	17 vs Rays 7:07 pm	18 vs Rays 1:07 pm
19 vs Rays 1:07 pm	20	21 @ Athletics 10:05 pm	22 @ Athletics 10:05 pm	23 @ Athletics 3:35 pm	24 @ Mariners 10:10 pm	25 @ Mariners 4:10 pm
26 @ Mariners 4:10 pm	27	28 vs Phillies 7:07 pm	29 vs Phillies 7:07 pm	30 vs Royals 7:07 pm	31 vs Royals 7:07 pm	



MAJOR LEAGUE BASEBALL SCHEDULE

