



# Optimal European Soccer Matches Scheduling

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## Problem Statement

The goal is to optimize 5 top European soccer leagues schedule to maximize rest time. The best model has the best trade-off between performance and computation time.

We consider a single league:  
N=20 teams, W = N - 1 = 19 weeks (first half of the season)



**“We are going to kill the players!” –  
Ex-PSG/Chelsea Head Coach Tuchel**



**“We play so much, too much ...” –  
Tottenham/ex-Juve Head Coach Conte**



- Injuries doubled over the last 20 years.
- Optimizing schedule is beneficial for players, supporters, sponsors and TV broadcasters.

## Data

- 2022 schedules of European soccer leagues used as baseline.
- No other external data but required domain expertise and knowledge of soccer schedule rules.

## How to solve the problem?

Mixed-integer optimization problem & multiple heuristics to make the solution scalable

## General formulation

$$\min_x \sum_{i,j,k,w,d,d'} C_{7w+d,7(w+1)+d'} x_{ijwd} x_{ik(w+1)d'}$$

Variables:

$$x_{ijwd} = \begin{cases} 1, & \text{if } i \text{ plays } j \text{ on day } d \text{ of week } w \\ 0, & \text{otherwise} \end{cases}$$

Parameters:

$$C_{w'} = \begin{cases} \frac{1}{v-t}, & \text{if } t' > t \\ 0, & \text{otherwise} \end{cases}$$

Sequence	$\frac{1}{v-t}$	$t' - t$
(1, 3, 5)	$\frac{1}{2} + \frac{1}{2} = 1$	$2 + 2 = 4$
(1, 2, 5)	$\frac{1}{1} + \frac{1}{3} = 1.33$	$1 + 3 = 4$

Constraints:

- One opponent per week
- N-1 games per team
- Teams play each other once
- No games on Tuesday, Wednesday & Thursday

## Different approaches

### Optimal approach

Solve the optimization problem

### Split teams in groups

Solve the problem for 4 groups of 5 teams

### Greedy approaches

Optimize P weeks at a time and freeze the results

### Greedy approaches & random restart

Re-optimize randomly subsets of weeks k times

## Results and impact

Models	Objective function	Time (s)
Baseline (Real life)	55.76	/
Freeze entire period optimized (5.3)	56.95	3,084
Freeze first week of period optimized (5.4)	51.68	9,881
(5.3) + Random restart	56.20	5,373
(5.4) + Random restart	51.68	11,932
Optimal model (time limit)	51.46	21,600

- Best heuristic approach: *Freeze first week of period optimized*
  - 7.3% improvement over the baseline
  - 54.25 % faster with 0.3% gap to optimality

WEEK 1								WEEK 2							
Row	Tuesday Float64	Wednesd Float64	Thursda Float64	Friday Float64	Saturday Float64	Sunday Float64	Monday Float64	Row	Tuesday Float64	Wednesda Float64	Thursda Float64	Friday Float64	Saturday Float64	Sunday Float64	Monday Float64
1	0.0	0.0	0.0	0.0	0.0	0.0	6.0	1	0.0	0.0	0.0	0.0	7.0	0.0	0.0
2	0.0	0.0	0.0	0.0	12.0	0.0	0.0	2	0.0	0.0	0.0	0.0	0.0	0.0	4.0
3	0.0	0.0	0.0	0.0	0.0	0.0	18.0	3	0.0	0.0	0.0	0.0	9.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	17.0	4	0.0	0.0	0.0	0.0	0.0	0.0	2.0
5	0.0	0.0	0.0	0.0	0.0	0.0	15.0	5	0.0	0.0	0.0	0.0	0.0	0.0	18.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6	0.0	0.0	0.0	0.0	0.0	11.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7	0.0	0.0	0.0	0.0	1.0	0.0	0.0
8	0.0	0.0	0.0	0.0	19.0	0.0	0.0	8	0.0	0.0	0.0	0.0	12.0	0.0	0.0
9	0.0	0.0	0.0	0.0	0.0	13.0	0.0	9	0.0	0.0	0.0	0.0	3.0	0.0	0.0
10	0.0	0.0	0.0	0.0	14.0	0.0	0.0	10	0.0	0.0	0.0	0.0	15.0	0.0	0.0
11	0.0	0.0	0.0	0.0	0.0	20.0	0.0	11	0.0	0.0	0.0	0.0	0.0	6.0	0.0
12	0.0	0.0	0.0	0.0	2.0	0.0	0.0	12	0.0	0.0	0.0	0.0	8.0	0.0	0.0
13	0.0	0.0	0.0	0.0	0.0	9.0	0.0	13	0.0	0.0	0.0	0.0	16.0	0.0	0.0
14	0.0	0.0	0.0	0.0	10.0	0.0	0.0	14	0.0	0.0	0.0	0.0	0.0	0.0	17.0
15	0.0	0.0	0.0	0.0	0.0	0.0	5.0	15	0.0	0.0	0.0	0.0	10.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16	0.0	0.0	0.0	0.0	13.0	0.0	0.0
17	0.0	0.0	0.0	0.0	0.0	0.0	4.0	17	0.0	0.0	0.0	0.0	0.0	0.0	14.0
18	0.0	0.0	0.0	0.0	0.0	0.0	3.0	18	0.0	0.0	0.0	0.0	0.0	0.0	5.0
19	0.0	0.0	0.0	0.0	8.0	0.0	0.0	19	0.0	0.0	0.0	0.0	0.0	0.0	20.0
20	0.0	0.0	0.0	0.0	0.0	11.0	0.0	20	0.0	0.0	0.0	0.0	0.0	0.0	19.0

## Improvements

- Consider adding international competitions and international breaks



- Consider the environmental impact of traveling
- Formulate problem at **player level** instead of team level