Optimization in Industry Assignment 1
Mathematical Formulation for Round Robin Match Scheduling

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Sets

- T: Set of teams, indexed by i, j, where $i, j \in T$.
- D: Set of days in the tournament, indexed by d.

Parameters

- $I_{i,j}$: Binary parameter, 1 if the match between team i and j is interesting, 0 otherwise
- W_d: Binary parameter, 1 if d is a weekend, 0 otherwise.
- $D_{i,j}$: Distance between home stadiums of teams i and j.
- SC_i: Capacity of home stadium of team .
- $E_{d,i}$: Binary parameter, 1 if there is a big event in the city of home stadium of team i on day d, 0 otherwise.
- Z_i: Zone of home stadium of team i.
- MinGap, MaxGap: Minimum and maximum gap between two consecutive matches for a team.
- $\mathrm{N}_{i,j,d}$: Binary variable if there is a night match between team i and j at home stadium of i in day d, 0 otherwise

Decision Variables

- $x_{i,j,d}$ $(i \neq j)$: Binary variable, 1 if match (day or night) is scheduled on day d at home stadium of i between team i amd j, 0 otherwise.

Objective Function

$$\text{Maximize: } \sum_{m\in M}\sum_{d\in D}\sum_{s\in S}\text{Interest}(m)\cdot x_{m,d,s}\cdot\text{Weekend}(d) - \lambda_1\sum_{i\in T}\sum_{d\in D}\sum_{s_1,s_2\in S}\text{Distance}(s_1,s_2)\cdot z_{i,d}\cdot z_{i,d+1},$$

where λ_1 is a weight balancing the importance of minimizing travel distances.

Constraints

1. **Each team plays all others twice (one home and one away):**

$$\sum_{d\in D}\sum_{j\in T, j\neq i} x_{i,j,d} = |T|-1, \forall i\in T$$
$$\sum_{d\in D}\sum_{i\in T, j\neq i} x_{i,j,d} = |T|-1, \forall j\in T$$

2. **Only one match in a single day/night slot:**

$$\sum_{i,j\in T, i\neq j} x_{i,j,d}(1-N_{i,j,d}) \leq 1, \forall d\in D$$
$$\sum_{i,j\in T, i\neq j} x_{i,j,d}N_{i,j,d} \leq 1, \forall d\in D$$

3. **Night Match is not possible if there is no match on that day**

$$N_{i,j,d} \leq x_{i,j,d}$$

4. **No overlapping of interesting matches:**

$$\sum_{i,j\in T, i\neq j} x_{i,j,d}I_{i,j}N_{i,j,d} \leq 1 \quad \forall d\in D$$
$$\sum_{i,j\in T, i\neq j} x_{i,j,d}I_{i,j}(1-N_{i,j,d}) \leq 1 \quad \forall d\in D$$

5. **Match gaps for teams:**

6. **Minimize consecutive away matches:**

7. **Home/away match balance:**

8. **Avoid matches on restricted days:**

$$x_{i,j,d} \leq 1 - E_{d,i} \quad \forall d\in D, \forall i,j\in T, i\neq j$$

9. **Match relocation day for incase of rain:**

$$x_{i,j,d} + x_{i,j,d+1} \leq 1 \quad \forall d\in D\setminus\{\text{end\_date}\}$$

10. **Stadium capacity for smaller matches:**

11. **Day and night match balance:**

$$\sum_{d \in D:\text{DayMatch}(d)} y_{i,d} \approx \sum_{d \in D:\text{NightMatch}(d)} y_{i,d} \quad \forall i \in T.$$

Assumptions

- All matches can be rescheduled to the next day if rain occurs.
- Interesting matches are known in advanced and depends on which two teams are playing only.
- Stadiums are uniformly distributed across zones.
- Travel distances between stadiums are known and constant.
- Each team has only one home stadium.
- MinGap and MaxGap values are set based on league regulations.
- Day and night matches do not overlap with each ohter for any day.
- $\forall d \in D, d+1,$ is the immediate next day
- end_date is the last date in D