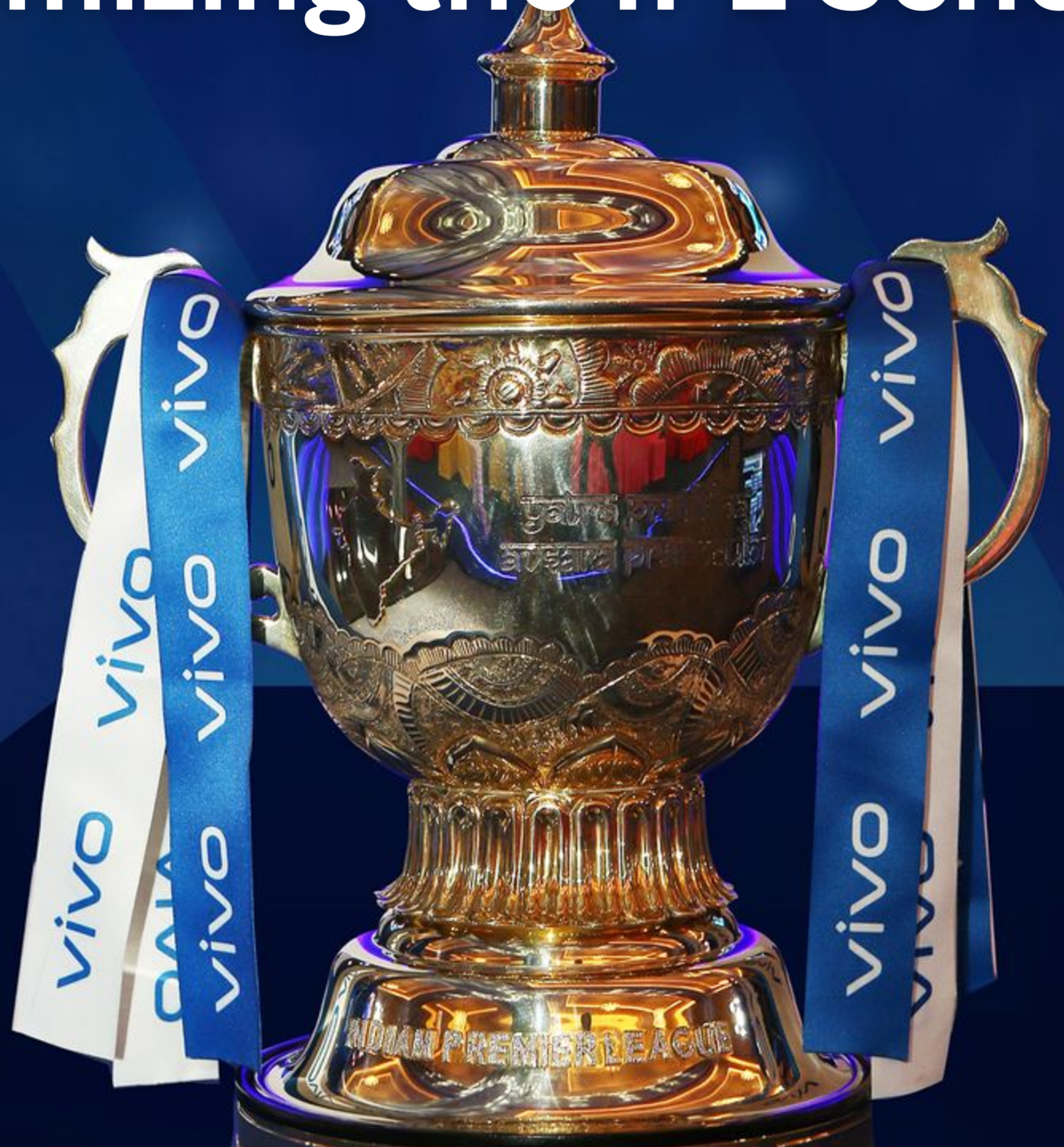
IPL IS BACK

May 24 to July 28

Optimizing the IPL Schedule



CHALLENGE

Travel and Accommodation Cost Optimization for the Indian Premier League (IPL) Cricket Tournament

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A Travelling Tournament Problem (TTP) Scheduling Approach

Let’s Formulate!!!!!

Formulating the Optimization Model

- The Indian Premier League (IPL): A Global T20 Cricket Powerhouse
- Scheduling Challenges: Teams, Venues, Broadcast Windows
- The Optimization Goal: Minimizing Travel & Accommodation Costs
- Our Approach: The Travelling Tournament Problem (TTP) Framework

Assumptions

- For a route from location A to location B, we always choose the airline who provides us the minimum fare.
- For any location we always choose the hotel which provides us with the minimum tariff.
- The cost of flights and hotels are constant for weekdays and then increase by a factor of ‘o’ during weekends
- For weekends, we can randomly assign any timing slot to the two matches being played on the same weekend day

Problem Formulation

Defining the Building Blocks

- **I: Teams (MI, CSK, KKR,etc) -> 8 Teams**
- **V: Venues (Wankhede Stadium, Eden Gardens, etc) -> 9 Venues**
- **D: Days of the Season (from May 24th - July 28th) -> Represented by natural numbers**
- **O: Broadcast Slots (Weekend, Weekday) -> 2 slots**
- **J: Airline Partners (e.g., Air India, Vistara, Indigo)**
- **H: Hotel Partner (e.g., Taj, Mariott, ITC)**
- **P: Playoff Matches (e.g., Semi-finals, Final)**
- **Parameters:**
- **c_vwijo: Travel Cost (Cost depends on origin, destination, team, airline, and broadcast slot)**
- **a_voh: Accommodation Cost (Cost depends on venue, hotel and broadcast slot)**

Decision Variables & Objective Function

Decision Variables:

- x_ijvd: Binary variable (1 if team i plays team j on day d at venue v, 0 otherwise)
- z_ijvdw: Binary variable (1 if team i travels directly from venue v to venue w for their next match after playing team j on day d, 0 otherwise)
- p_mndo: Binary variable (1 if playoff match m is played in timeslot o of day d in broadcast category n, 0 otherwise)

Objective Function

Minimize: Σ (Σ c_vwijo * x_ijvd * o) + Σ (Σ c_uwjio * z_ijvdw * o)
Travel Cost
i I, j I, v V, w V, d D, o O
i ≠ j, v ≠ w, u ≠ w

+ Σ (a_voh * (Σ x_ijvd + Σ y_ijvd) * o)
Accommodation Cost
i I, j I, v V, d D, o O, h H

+ Σ (a_vh * Σ p_mndo) //Accommodation (Playoff + Finals)
m P, v V, d D, n N, h H

Objective Function Breakdown:

Minimize: We want to find a schedule that minimizes the total cost for both travel and accommodation.

Travel Cost:

- **Σ (Σ c_vwijo * x_ijvd * o): This part calculates the outbound travel cost for all teams throughout the season.**
  - **Σ (summation): Loops through all possible combinations of teams (i), venues (v), days (d), and broadcast slots (o).**
  - **c_vwijo: Travel cost for team i from venue v to venue w using airline partner j for a match in slot o.**
  - **x_ijvd: Binary variable (1 if team i plays team j on day d at venue v, 0 otherwise).**
  - **o: Broadcast slot for the match (e.g., 1 - Weekend, 2 - Weekday).**

- **Σ (Σ c_uwjio * z_ijvdw * o): This part calculates the return travel cost for teams (if they travel directly back after an away match).**
  - **Similar logic to the outbound cost, but uses z_ijvdw which indicates if a team travels directly from venue v (played against j) to venue w for their next match (d).**

Accommodation Cost (Regular Season):

- Σ (a_{voh} * (Σ x_{ijvd} + Σ y_{ijvd}) * o): This part calculates the total accommodation cost for teams during the regular season, considering both home and away matches.
  - a_{voh}: Accommodation cost per day for a team at venue v during a match in slot o for hotel h.
  - Σ x_{ijvd}: Summation of x_{ijvd} for all teams (i) playing at venue v on day d. This captures the accommodation cost for away teams.
  - Σ y_{ijvd} (introduced earlier): Binary variable (1 if team i plays a return match against team j at their home venue (v) on day d, 0 otherwise). This captures additional accommodation for visiting teams during return matches.

Accommodation Cost (Playoffs):

- Σ (a_vh * Σ p_mndo): This part calculates the accommodation cost for playoff and final matches.
  - a_vh: Accommodation cost per day at venue v at hotel h. (Assumes same cost for all teams during playoffs).
  - Σ p_mndo: Summation of p_mndo for all playoff matches (m) played at venue v on day d in broadcast slot o.

Constraints

- **Match Constraint: Total 14 matches and 2 between each pair**

$$\sum_{j,d} x_{ijd} = 2^{*}(n-1) \quad \forall i \in I,\ n = |I|$$

- **One match per day (for weekdays):**

$$\sum_{i,j} x_{ijd} \leq 1 \quad \forall i \in I$$

Constraints

- No match within same team

$$x_{ii} = 0 \quad \forall i \in I$$

- Venue constraints: Limit options of venues for a pair to 3 {H,O,N}

Constraints

- **Rest days: Regular & Playoffs**

4) Rest days:

a) Regular season -

$$x_{ijd} + x_{ij(d+1)} + x_{ij(d+2)} \leq 1 \quad \forall\, i,j \in I,\ d \in D$$

b) Playoffs & Finals -

$$x_{ijd} + x_{ij(d+1)} \leq 1 \quad \forall\, i,j \in I,\ d \in D$$

Constraints

- **Broadcast slot constraint: Weekdays and weekends**

a) Weekdays -

$$\sum_{i,j} x_{ijo} \leq 4 \quad \forall\ o \in \text{weekdays}$$

b) Weekends -

$$\sum_{i,j} x_{ijo} \leq 6 \quad \forall\ o \in \text{weekends}$$

Constraints

- **Final Match Constraint**

$$\sum_{i,j} x_{i,j(d=28\text{ July})} = 1$$

Solution Approaches

- Mixed-Integer Linear Programming (MILP): Given the binary decision variables (x_ijvd, z_ijvdw, p_mndo), and linear constraints representing the scheduling rules, MILP is a powerful and widely used optimization technique for solving this problem. It allows us to incorporate both integer and continuous variables within the model.

- Solvers: Gurobi, CBC

- Metaheuristic: Due to the large computational complexity of the problem, we can go for this non exact algorithm. It will provide us with a near optimal solution. Eg: Genetic algorithm, Tabu search, Ant Colony Optimization

Thank You