Problem Specification

1 Problem Statement

Scheduling tennis tournaments is contingent upon several crucial constraints (as outlined below). Our group aims to probe different optimization techniques to determine the most optimal schedule for each knockout stage of the tennis tournament, yielding maximum revenue. The rest of this paper will provide a brief overview of the problem we are trying to solve.

2 Input

The following are the input parameters:

- Number of players (INTEGER)
- Number of days (INTEGER)
- Number of courts (INTEGER)
- List of players (Each player has its ranking and popularity)
- List of courts (Each court has capacity and ticket price)

3 Objective

The main objective of the algorithm is to maximize the total revenue of the tournament (See Equation 2) with the given inputs and constraints.

$$R(c, p, t) = (p_1 + p_2) \cdot c \cdot t \tag{1}$$

where

$$\begin{aligned} R &= \text{Revenue generated for a match} \\ p_1 &= \text{Popularity of player 1 } (0 \leq p_1 \leq \tfrac{1}{2})^* \\ p_2 &= \text{Popularity of player 2 } (0 \leq p_2 \leq \tfrac{1}{2}) \\ c &= \text{Capacity of court} \\ t &= \text{Price of a ticket} \end{aligned}$$

* Popularity of a player means the percentage of crowd that they can attract. For e.g., a 0.4 popularity of a player means he/she attracts 40% of the crowd.

$$R_{\text{total}} = \sum_{i=1}^{m} R(c, p, t) \tag{2}$$

where

$$\begin{aligned} R_{\text{total}} &= \text{Total revenue for the tournament} \\ m &= \text{Number of matches} \end{aligned}$$

4 Output

The algorithm will firstly determine if a valid fixture is possible given the input listed above.
If it is possible, then the algorithm will proceed to maximize revenue possible with the given input and constraints.

- If the fixture is not possible
  - Return an exception
- If the fixture is possible
  - Return the schedule which yields the maximum revenue
  - Format : Key(Day Number), Value(List of stadiums and the corresponding fixtures in that stadium for that day)

5 Constraints

- Number of players should be a power of 2.
- Minimum number of players should be 2.
- Number of courts ≥ 1.
- A player should not be scheduled to play two consecutive days.
- There can be at most four matches played on a court in a given day.
- Given n(Number of players), d(Number of days in the tournament), c(Number of courts), we need to have,

$$d \geq 2 \cdot log_2(n) \tag{3}$$

and,

$$c \geq n/16 \tag{4}$$

For eqn(3), for a player to reach a final in a knockout tournament, he has to play at least $log_2(n)$ matches. After every knockout round, the number of players are halved. Thus,

$$n \rightarrow n/2 \rightarrow n/4 \rightarrow ....1 = log_2(n)$$

Since, a player can only play on alternate days, the minimum number of days required for a tournament is $2 \cdot log_2(n)$.
For eqn(4), from data collected till date, it is observed that an average tennis match lasts for 3 hours. Hence, on a court we can schedule 4 matches in a day, i.e. a total of 12 hours of play on average. Considering this information, for a valid schedule, i.e. half of the players ($N/2$) on a given day, which in turn would mean $N/4$ matches, we can define our constraint on the number of courts c as: $c \geq N/16$.

6 Assumptions

- Each match at a stadium will have a new crowd
- All tickets in a court are equally priced
- Popularity of a player cannot exceed 0.5, so that total of popularity of 2 players does not exceed 1 which essentially means full capacity.