

# Scheduling the yearly national football tournament in Brazil

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**Abstract** We describe the integer programming-based system developed for scheduling the yearly national football tournament in Brazil and we report on the practical experience after two years running the system.

**Keywords** Sports scheduling · Tournament scheduling · Round robin · Integer programming · Football · Soccer

## 1 Motivation

Professional football leagues are big businesses and a major economic activity in Brazil and around the world. Broadcast rights in some professional competitions amount to hundreds of millions of dollars. TV networks buy the rights to broadcast the games for huge amounts of money but, in return, they want the most attractive games to be scheduled at certain times. Revenues from public attendance and tournament attractiveness also strongly depend on the schedule of the games, which must satisfy a number of hard and soft constraints. Efficient schedules are therefore of major interest for teams, leagues, sponsors, fans, and the media. The reader is referred to Rasmussen and Trick (2008) and Kendall et al (2010) for recent surveys on the sports scheduling literature.

Nurmi et al (2010) have shown that, in spite of the relevance of good schedules of games, very few professional leagues adopted optimization models and software to date. This seems to be due not only to the hardness of the problem and to some fuzzy preference restrictions and criteria that can be hardly described, but also to the resistance of teams and leagues to the use of new tools that introduce modern techniques in sports management.

The yearly national football tournament organized by CBF (the Brazilian football confederation) is the most important sport event in the country. Its major sponsor is TV Globo,

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the largest media group and television network in Brazil. Games involving teams from São Paulo and Rio de Janeiro are of special interest for broadcasting through open TV channels, due to larger revenues from advertising.

Due to the importance of football in Brazil, fair and balanced fixtures for all teams are major issues for attractiveness and confidence in the outcome of the tournament. Furthermore, TV sponsors invest a lot of resources on broadcast rights and their support is conditioned to suitable fixtures that make it possible to broadcast the most important games by open TV channels. The fact that some large cities often host at least two and up to four traditional teams with a large number of fans imposes additional security constraints to avoid clashes of fans before or after the games.

## 2 Tournament structure and schedule requirements

The tournament lasts for almost eight months (from April to December) and is structured as a compact mirrored double round robin tournament played by 20 teams. Each team is based at its home city, where it has its assigned stadium for home games. Each team faces every other twice: once at home and the other away. The game between each pair of teams occurs once in the first half of the tournament and once in the second, with interchanged venues. Games in the second half occur exactly in the same order as in the first. Midweek rounds are played on Wednesdays and Thursdays, while weekend rounds are played on Saturdays and Sundays. We say that there is a home break (resp. an away break) whenever a team plays two consecutive home games (resp. away games).

Elite teams are those with larger numbers of fans, better records of previous participations in the tournament, and more valuable players. The most important games involve elite teams and should as much as possible be played during the weekends, when they can attract larger stadium attendances and TV audiences. League officials and media sponsors have two main goals:

1. Fair and balanced fixtures: the tournament should be equilibrated and all teams should face the same difficulties. In particular, the organizers seek a fixture in which all teams have the same and minimum number of home and away breaks.
2. Broadcast by open TV channels: the media sponsor aims to maximize revenues from advertising. A number of attractive games for broadcasting and involving some of the best teams should be scheduled in every round.

The fixture should satisfy more than 30 different types of constraints. Some of them are listed below:

- Each team playing at home (resp. away) in the first round plays away (resp. at home) in the last round.
- Each team perfectly alternates home games with away games in the first four and in the last two rounds.
- Teams are organized in pairs: teams in the same pair have complementary patterns of game playing.
- Games between teams based at the same home city are not to be played in midweek rounds, in the first two rounds, or in the last four rounds.
- No team can play more than two consecutive home games or more than two consecutive away games.
- Certain games cannot be played at some specific rounds, while others have to be played at specific rounds.

We developed a decomposition approach to tackle the problem. The initial phase is devoted to the generation of home-away patterns of game playing satisfying the hard constraints related exclusively to the patterns. Only home-away patterns with exactly the minimum number of breaks are constructed. This is followed by an enumeration scheme that assigns a different home-away pattern to each team obeying the corresponding constraints. The algorithm proceeds to the solution of an integer programming problem considering the selected assignments of home-away patterns and optimizing a weighted sum objective function that considers violations of the soft constraints.

### 3 Practical experience

The complete model and the software system have been developed and adjusted over the last three years. The staff of CBF participated actively in their validation. The optimization software runs on any standard processor in a few minutes of processing time.

This system was used for the first time in 2009 to build the fixtures of the first and second divisions of the national football tournament in Brazil. Several alternative fixtures have been provided to the decision makers, who selected their preferred choice. The 2009 tournament revealed itself as the most attractive in the last decade, with four teams (Flamengo, Internacional, São Paulo, and Palmeiras) still being candidates to the title when the last round started, with all games being simultaneously played.

The new system was used for the second time in 2010, with the fixture to be played being announced last February. Once again, the decision makers were happy with the proposed alternatives and with the choices they had. This was a particularly hard tournament to be scheduled. Since the tournament had to be interrupted in June and July during the 2010 World Cup, very few dates were available for game playing. In consequence, there will be more midweek rounds and fewer weekend rounds, making it harder to find good feasible fixtures.

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