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Excellent planning system for professional sports league scheduling

General facts:

Round-robin for professional sports league implies that each participant (team or individual) plays against each other competitor for the same number of games. It is considered as a fair and balanced system as all the various playing abilities will be compared with each other over a certain period of time and permits thereof an equitable final ranking.

Sports leagues often apply a combination of the round-robin mode along with a ***knockout(k.o.)*** respectively ***best-off*** scheme. Or there are additional round-robin sub-groups within the entire league, thus mainly due to travelling cost efficiency and/or support of more exciting games and regional derbys.

And the winner is:

At the end of the season it might happen that one or more teams face a tie score situation (i.e. same amount of points, equal goal differences and scored goals). If so, it is necessary to look closer at the ranking and the particular games between the two (or more) equally-placed teams (considering number of points, goal difference, scored goals in these games) and/or to have after the regular season, an additional tournament with a k.o./best-off modus in order to set the final ranking.

The so-called Swiss system is an alternative (tournament) play mode to the well-known round-robin and the k.o./best-off system. It states that after the first round, the leader has to play against the runner-up, whom he had not played as yet, the next against the best of the rest, and so on). There are a numerous other modes for tournaments, which basically are a combination of the above mentioned modes.



Difficulty and complexity:

It is useful to show an example at this point: How many season schedules are theoretically possible to generate, if we assume that: A certain league consists of 10 teams and each team plays (only!) 2 times against each other (meaning that there are 2 round-robins and, in total, 18 rounds) and no other restrictions (so-called **constraints**) to be considered whatsoever? The answer is mind-blowing: Over 10^{101} plans are possible!

In reality of course, many restrictions have to be considered (professional national sports league schedule normally have between **1'000 and 20'000 constraints.**) This surely limits the amount of possible optimal plans, however it significantly complicates creating a workable schedule. Each sport (league) might work with a different **play mode**, respectively different national and/or regional modes for the same sport are common. In addition to that, the final season schedule has to consider all the **hard** (musts) and **soft** (musts, if theoretical possible) **constraints** (-see above).

Hard constraints/restrictions are: The actual play mode such as: Amounts of round-robins during the season, the number of teams, (same) amount of home- (h) and away games (a), double-rounds and their terms of (h) and (a) matches, the gap and the frequency of games between the same teams (sequence and reflection of the 1st, 2nd etc. round-robin). In addition to the play mode, other hard constraints to be complied with, such as: Gap and frequency of the successive matches, allocation of stadiums, consideration of competitive events, contractual obligations f.e. with TV stations or operators of stadium, basic conditions (musts) for a as fair and balanced schedule as possible (f.e.: Must not exceed xy... of the optimal)

There to are the **soft constraints**, such as: Desires of the clubs, perfect balanced and fair scheduling, minimal costs and/or optimal cost-benefit calculation. As a result of the above, only a few plans (or only one in an extreme case) of the incredible many (usually xxi-billions) possible schedules imply an optimal and practicable solution. To establish the optimal plan in a reasonable time and at reasonable costs requires complex mathematical models and can be solved effectively by using complex (mathematical) modeling systems, such as LPL, and powerful solvers only.

Our approach:

The entire logic of the problem with the hard and soft constraints has to be re-written as a mathematical formula in the modeling system LPL. Naturally, this is not easy and demands for the relevant mathematical knowledge as mentioned earlier and in reality, the models for professional sports league contain between 1'000 and 20'000 constraints!

With LPL however the mathematical model involves approx. 10 lines only!

This means that smaller changes, but also even bigger amendments, such as the change of the play mode, can be done extremely quickly and with greater efficiency and flexibility.

Once the model is established, it will be 'sent' to a high-performance solver, where the model will be computed. Once an optimal solution is found, this will be returned to the LPL system and the (pre-determined) documents will be automatically generated. Apart of the schedule itself, a number of different documents and information can be generated and issued (gaps/frequencies of consecutive matches for each team, segmentation of playing days, etc.).

Our procedure:

Naturally to begin with, all the customized constraints (***mode*** and the other ***hard and soft restrictions***) have to be recorded and thereafter compiled in a mathematical model. This is, of course, far from trivial and requires an appropriate competence. Thereafter, our customer/the league representative ***has two options:***

The first option:

For each season or round-robin, Virtual Optima provides a complete customized ***schedule***, (it can contain additional reports, if requested) and to be presented to the customer in a requested form (.pdf/.xls etc.). The main ***advantage*** of this option for the customer is that he only has to provide Virtual Optima with the changed restrictions (changed from last year) and gets a complete plan for the season. Therefore, the (annual) efforts and expense are consistent.

The second option:

A customized tournament ***software*** on license fee is made by Virtual Optima. Thereafter the person in charge is able to comfortably issue and/or amend the season schedule at any time he wants to, and all by himself. The play mode and the constant constraints (hard and soft) are included in the programm. With an input mask, all the inconsistent restrictions can be entered (allocation of stadium, consideration of competitive events, blocked dates f.e. for games of the national team etc.). Afterwards, by point-on-click, the entire plan and other requested information will be issued. Normally and if needed, the software can be integrated within a bigger (internal) system.

The biggest ***advantage*** with the second option clearly is that any modification can be ***done independently***, and the amendments can be done ***quickly*** and in a ***most flexible*** method. A ***possible disadvantage*** might be, that in addition to the one-time charge for the software and the annual licence fee, an additional non-recurring fee for a commercial solver might arise. This depends on the complexity of the schedule, however the existing free-solvers are already fairly powerful and most of the plans can be easily and quickly generated by them. Anyway the purchase of a commercial solver would be paid off after 2-3 years after implementation.