A Multiobjective Approach for UK Football Scheduling

Graham Kendall[†]

Lyndon While[*]

Barry McCollum[&]

Frederico Cruz[$]

[†]*School of Computer Science, University of Nottingham, UK*

gxk@cs.nott.ac.uk

[*]*School of Computer Science & Software Engineering, The University of Western Australia, Australia*

lyndon@csse.uwa.edu.au

[&]*School of Computer Science, Queen's University Belfast, UK*

b.mccollum@qub.ac.uk

[$]*Departamento de Estatística, Universidade Federal de Minas Gerais, Brazil*

fcruz@ufmg.br

Abstract: Previous work by one of the authors minimised the distance travelled by UK football clubs over the Christmas/New Year period. In doing so various constraints have to be respected. One of these relates to *clashes* which measures how many *paired* teams play at home on the same day. The schedules that are actually used allow a certain number of clashes and our previous work utilised these values for our investigations. In this work we explore if travel distances increase if we reduce the number of clashes below those that were used in practise. This initial study considers one season and future work will carry out experiments across other seasons and extend the analysis that we carry out here.

Keywords: Sports Scheduling, Multiobjective

Introduction

In (Kendall, 20008) a problem was introduced that aims to minimise the travel distances for English football fixtures. This real world problem is faced by the English football authorities every year. Kendall (2008) considers fixtures played over the Christmas and New Year period, as these are also the first fixtures to be scheduled by The Football Association (which has responsibility for creating the fixture lists that are actually used). These fixtures are scheduled first so that the distance travelled by the teams (and supporters) can be minimised. These fixtures are then fixed, and the rest of the season is scheduled around them.

Although the four divisions under consideration each run their own distinct double round robin tournament, the divisions cannot be scheduled in isolation from one another, as there are constraints that operate across the divisions (see below). The problem we are solving can be described as follows:

We are required to produce two fixture lists, one for Boxing Day and the other for New Years Day. Each fixture list has to ensure that every team plays. As there are 92 teams, we are required to produce 46 fixtures for each day. The objective in producing these two sets of fixtures is to minimise the total distance travelled over the two days. In addition, there are a number of constraints that have to be respected.

1) If a team plays at their home venue on Boxing Day, it must play an away fixture on New Years Day. Similarly, a team playing at home on New Years Day must play away on Boxing Day.
2) The same teams cannot play each other on both Boxing Day and New Years Day. For example, Liverpool cannot play Chelsea on Boxing Day, followed by Chelsea playing Liverpool on New Years Day.
3) There is a limit on the number of London based clubs that can play at home on any one day. Similarly, there are limits on the number of London Premiership clubs that can play at home on the same day and also the number of Greater Manchester clubs that can play at home on the same day. These limits are shown in (Kendall, 2008).
4) Paired teams cannot play each other. The pairing system dictates that specific teams (perhaps more than two) cannot play at home on the same day. Examples of pairs include Manchester United/Manchester City, Liverpool/Everton/Tranmere and Chelsea/Fulham. In (Kendall, 2008), we did not allow paired teams to play each other (i.e. we treated it as a hard constraint), although there are examples where the football authorities relax this constraint (for example, in the 2005-2006 season Chelsea and Fulham played each other on Boxing Day). Note that by relaxing this constraint the problem of minimising distances is slightly easier as paired teams (by the nature of the pairing system) are often close to one another.
5) The number of paired teams playing at home cannot exceed given limits. When paired teams are playing at home, we refer to this as a clash. In each set of fixtures we only allow a certain number of clashes. These are shown in table 1. It can be seen that the values vary from season to season.

Table 1: Limits for the number of clashes allowed for each day

Season	*Boxing Day*	*New Years Day*
2007-2008	13	10
2005-2006	12	14
2004-2005	10	10
2003-2004	8	14
2002-2003	10	8

The values in Table 1 were derived from analysing the fixtures that were actually used. In (Kendall, 2008) we were able to achieve superior solutions to the published fixtures with respect to minimising the distance travelled. In doing so, the fixtures we generated had the same, or less, clashes than those shown in Table 1. However, we recognise that the police authorities have the final say as to whether a given fixture can be played on the planned day/time. Factors they will consider include the volatility of the fixture and what resources are required to police all the fixtures in a given geographical area. Given these observations we believe that the police authorities can be helped by reducing the number of clashes. However, this is likely to increase the distances travelled, as clashes (by their nature) usually allow teams that are closer to each other to play one another.

Therefore, our hypothesis is that by reducing the number of clashes the travel distances will increase. However, we would like to investigate if the travel distances rise so much that the solutions would not be acceptable.

Experimental Setup

We use a similar experimental setup as in (Kendall, 2008). The difference is that initial solutions are found by CPLEX which finds an optimal solution to a relaxed problem (in (Kendall, 2008) a depth first search was used). We also use simulated annealing, rather than a simple local search.

We carry out a series of experiments, each time reducing the number of allowable clashes. We continue this until we cannot find feasible solutions any longer. This methodology, in effect, provides us with a pareto front.

Initial Results

Table 2 shows the results from one season (2003-2004). We report the results from three runs, in order to demonstrate the we receive similar results over a number of runs. Each run restricts the number of clashes on Boxing Day and New Years Day and attempts to minimise the distance. The maximum clash values we use are those that are actually used by the football league (in the case of the 2003-2204 season this is 8 and 14 clashes for Boxing Day and New Years Day respectively (below we use the notation *n-m* to represent the number of allowed clashes for the two days)). We reduce the number of clashes until we no longer find any feasible solutions. For example, in Table 2 we found no feasible solutions for clashes 6-8, and therefore report no result.

Table 2: 2003-2004 Season. Results when minimising clashes and distances

BD-NYD	*Run#1*	*Run#2*	*Run#3*
8-14	5510	5478	5632
8-12	5610	5606	5841
8-10	6005	5982	5812
8-8	6277	6409	5855
6-14	6328	5667	5910
6-12	5602	5710	5722
6-10	6295	6167	7247
4-14	5718	5919	5929
4-12	6794	7057	7444
2-14	7369	6519	6757

Our initial results supports the hypothesis that if we limit the number of clashes, then the travel distance increases, but the increase might not be so great that the resultant reduction in policing costs could justify the extra travel. Looking at Table 2, we can see a general increase in the distances as the number of clashes is lowered. This is easier to see in Figure 1, where we plot the data from Table 2, using the total number of clashes and plotting this against the distance. This shows that the distance increases as the clashes are reduced. However, there might be an acceptable trade off. As an example, when we have 22 clashes (this is when we have 8-14), the minimum distance we have achieved is 5478. The best result we achieved when we have 18 clashes (i.e. 6-12) is 5602. We are yet to talk to the football authorities but they might consider that an increase in distance of 124 miles (5602-5478) is worth the price to reduce the number of clashes by four.

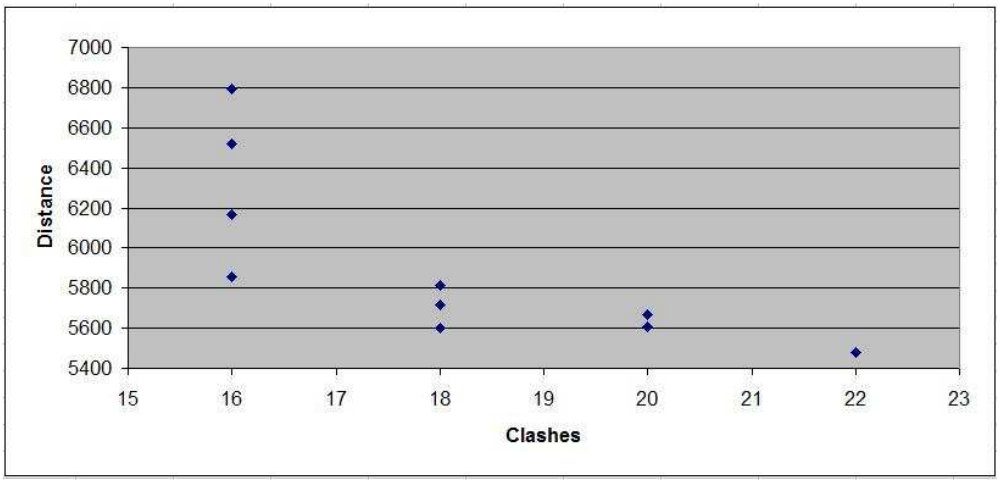

Figure 1: Plotting distances against clashes

Future Work

The present study has just considered one season (2003-2004). Our future work will look at other seasons to establish if the results for 2003-2004 are representative of other seasons. We would also like to investigate using a multi-objective algorithm, rather than running a set of algorithms which are minimising a single objective, while we manually adjust the other objective. We would also like to discuss these approaches with the stake holders (e.g. the police authorities) in order to validate the assumptions that we are making.

References

Kendall, G. (2008) Scheduling english football fixtures over holiday periods. Journal of the Operational Research Society **59**(6), 743-755