INITIAL PLAN

Sport Scheduling Problems with Entertainment Maximization

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One Semester Individual Project (CM3203) – 40 Credits

Project Description

Sport scheduling is the problem of determining when teams should play every other team in a tournament. Inherently, this is a difficult problem that gets ever more complex when the number of teams and games to be played increases. In addition to this, in real life scenarios there will be many more constraints to consider when calculating the schedule, such as not allowing teams to play at certain times and to give teams rest periods.

The Travelling Tournament Problem (TTP) is a specific sport scheduling problem where a set of teams must play a double round robin tournament where each team must have a home and away fixture against all the other teams. Often being constrained with a specific home and away pattern with the goal to find the minimum distance required for the teams to travel. While it has not been formally proven, it is believed that TTP is NP-Hard and appears to be computationally harder than the Travelling Salesman Problem[1]. Finding an optimum solution to the TTP is important to sports teams as they will want to travel as little possible, as too much travelling can have a negative effect on the performance of the team. However, whilst it is important to find a schedule that minimizes the distance travelled during a tournament, it is vital to find a schedule that is also entertaining.

In the UK alone, the business of sport is a multibillion-pound industry, which was worth approximately £20bn in 2015[2]. A significant proportion is generated from the sponsorship and media rights purchased by broadcasters, which now surpasses the revenue generated by ticket sales[3]. The English Premier League broadcasting rights for 2019-2020 reached more than £4.55bn, with some of the rights being purchased by an online streaming company for the first time[4]. This shows the great importance in getting the sports schedule right as broadcasters will only be willing to pay large sums of money if the schedule suits their requirements and the matches are likely attract a sizeable TV audience. Without the sale of media rights, international sports teams would lack a core element of their funding which may have a knock-on effect on their successes.

Therefore, a balance between creating a schedule that fulfills the needs of the sports teams but maximizes the entertainment factor for the broadcasters must be met.

During this project I plan to implement a solution that will solve sport scheduling problems under various kinds of constraints; with a focus on maximizing the entertainment factor of a schedule. Whilst the entertainment 'factor' itself can be quite subjective, I will focus on attempting to leave the identity of the overall champion unknown for as long as possible. This provides an incentive for the audience to watch all the matches in a tournament and maximizes viewing figures.

Ethics

All data that will be used during this project is publicly available online and does not contain any personal data. Therefore, my project does not require ethical approval.

Aims and Objectives

Primary Aims

Aim

To model sport scheduling problems with a basic set of constraints that will maximize entertainment value using Integer Linear Programming (ILP).

Objectives

- Represent real world constraints as ILP constraints
- Determine how to maximize the entertainment value of the schedule and formulate the objective function of the ILP
- Run the ILP on a small round robin style tournament compare the output to the expected results

Aim

Extend the ILP to the travelling tournament problem, to account for home and away patterns and the distances travelled by teams.

Objectives

- Extend the current ILP by adding in constraints to allow for a double round robin tournament
- Then formulate constraints that require the schedule to have a specific home and away pattern
- Expand on the current objective function to also minimize the distance travelled by teams

Aim

Develop an application with a Graphical User Interface for the project.

Objectives

- Build a C# .NET Application that uses the Gurobi libraries to solve the ILPs
- The Application will allow the use to input the constraints of a scheduling problem through a user-friendly interface

Aim
Analyze the effectiveness of using the Integer Linear Programming to create exciting sport schedules

Objectives
- Run real world scheduling problems with the knowledge of the outcome of the tournament to find the most entertaining schedule and compare this to the actual schedule
- Produce a schedule based on constraints of an actual sports tournament and with the knowledge of the outcome of the tournament. Then compare this to the actual schedule of the sports tournament.
- Run real world scheduling problems based on betting odds or previous results of the tournament and discuss the resulting tournament schedule.

Secondary Aim

Aim
Explore extensions to this project that may improve the entertainment of sports schedule.

Objectives
- A potential idea to investigate further could be proportional representation whereby there are not enough TV slots to cover all matches across a tournament, so each team is given a minimum proportion yet still allowing for the more popular teams to have a higher percentage.
- Additionally, I could consider dynamically scheduling (creating the schedule as the tournament progresses and adapting it to enhance entertainment should it need it).

Work plan

Week	Dates	Tasks	Milestones
1	28/01 – 03/02	- Research the importance of the project and other similar studies in sport scheduling - Meet with my supervisor to discuss the project in further detail and draft some aims and objectives - Write up the Initial plan	
2	04/02 – 10/02	Familiarize myself with Gurobi	Initial Plan Submitted on 04/02

		• Formulate the sport scheduling ILP's constraints and objective function for a basic sport scheduling problem • Gain a more in depth understanding of the TTP.	
3	11/02 – 17/02	• Continue to investigate the TTP • Extend my current sport scheduling ILP to the TTP • Gather datasets to test the ILP against	
4	18/02 – 24/02	• Layout the structure of the final report and start the sections for the introduction, approach and background • Review work on the ILP and discuss with my supervisor specific application requirement during out meeting on 19/02	Starting the Final Report
5	25/02 – 03/03	• Refresh my knowledge of creating a C# .NET Application • Start to build the desktop application to implement the ILP • Focus on the implementation of the ILP and the use of Gurobi's libraries	Starting the Sport Scheduling Application
6	04/03 – 10/03	• Consider how to interpret user input and formulate the appropriate constraints and objective function	
7	11/03 – 17/03	• No new task planned to allow for any task that over run as there will be	Application will take user input and formulate the Integer

		a high work load during the previous couple of weeks from another module	Linear Program to be solved by Gurobi
8	18/03 – 24/03	• Create the results displaying for ILP to user • Review core functionality of the application and discuss with my supervisor potential extensions that can be implemented to the project with the time remaining on 19/03	
9	25/03 – 31/03	• Start to implement any further application extensions	Core functionality of the application completed and producing sport schedules
10	01/04 – 07/04	• Continue work on application extensions • Start work on the Implementation section of the Final Report	
11	08/04 – 14/04	• Run tests on the application and fix any outstanding bugs • Evaluate the effectiveness of the solution	
12	15/04 – 21/04	• Extra week to accommodate plan over-running • Finish work on the Implementation section of the Final report	Sport Scheduling Application completed
13	22/04 – 28/04	• Work on the Results and Evaluation and the Future Work sections of the Final Report	
14	29/04 – 05/05	• Work on the conclusion of the Final Report • Give my supervisor a draft of the Final Report to allow time for	

		feedback and make the required changes	
15	06/05 – 12/05	• Review and make any final edits to the Final Report	Final Report and Source Code Submitted on 10/05

References

[1] K. Easton, G. Nemhauser, and M. Trick, "Solving the Traveling Tournament Problem: A Combined Integer Programming and Constraint Programming Approach," p. 10.

[2] A. Cave, "The potential of sport: a £20 billion industry," *The Telegraph*, 13-Apr-2016.

[3] "Sport and broadcasting rights: adding value." [Online]. Available: https://www.wipo.int/wipo_magazine/en/2013/02/article_0005.html. [Accessed: 31-Jan-2019].

[4] SOTB, "Amazon & BT scoop remaining live Premier League rights," *Sport On The Box*, 07-Jun-2018.

School of Computer Science and Informatics

Coursework Submission Cover Sheet

Please use Adobe Reader to complete this form. Other applications may cause incompatibility issues.

Student Number	C1507016
Module Code	CM3203
Submission Date	04/02/2019
Hours spent on this exercise	5

Special Provision　　　　　　☐

(Please place an x in the box above if you have provided appropriate evidence of need to the Disability & Dyslexia Service and have requested this adjustment).

Group Submission

For group submissions, *each member of the group must submit a copy of the coversheet.* Please include the student number of the group member tasked with submitting the assignment.

Student number of submitting group member

By submitting this cover sheet you are confirming that the submission has been checked, and that the submitted files are final and complete.

Declaration

By submitting this cover sheet you are accepting the terms of the following declaration.

I hereby declare that the attached submission (or my contribution to it in the case of group submissions) is all my own work, that it has not previously been submitted for assessment and that I have not knowingly allowed it to be copied by another student. I understand that deceiving or attempting to deceive examiners by passing off the work of another writer, as one's own is plagiarism. I also understand that plagiarising another's work or knowingly allowing another student to plagiarise from my work is against the University regulations and that doing so will result in loss of marks and possible disciplinary proceedings.