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2 edits | Thu, Nov 5, 2020 at 10:40 AM BDT

dimkadimon
4478 posts

Here I want to give some background about the problem. First a little story that is not directly relevant to the problem.

As a Liverpool supporter I was bitterly disappointed when they finished second in the 2018-2019 English Premier League, despite playing an almost perfect season (just one loss). This made me wonder what would happen if the points were awarded differently, namely 1 for a draw and 2 for a win. To my delight this would have given Liverpool the win over Manchester City. Of course if that system was used then arguably Manchester City would have played differently and perhaps still get the win. This system was widely used prior to 1981 and could have given different results:
https://www.skysports.com/football/news/11661/10233723/footballs-parallel-universe-what-if-the-two-point-win-had-remained

I then wondered if it is possible to predict the outcomes of the games if you only know the final goals scored and points collected. Combining this idea with variable point systems from above gave birth to this problem. I realised that there are many possible results that give the same final points, so this "reconstruction" would not be unique*. In order to make the reconstruction easier I introduced team attacking and defending strength, which can be predicted from the data. Even with this change the testing team was worried that there is too much randomness. The final breakthrough came from JacoCronje who suggested the introduction of the "X" parameter. Essentially the game results become more predictable as X increases, which is something that we wanted.

*Note there are some interesting exceptions to this. For example, for 4 teams there can be 25 possible tournaments that arrive at a unique points table (with standard scoring). This led me to a nice integer sequence: https://oeis.org/A330637. This makes me wonder if there were any cases that could be reconstructed uniquely without any ambiguity?