Prescient Perspectives on Football Tactics: A Case with Liverpool FC, Corners and AI

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Abstract. Prescient (*not prescientific*) ideas are those that challenge the assumptions that predominate a given field and that typify beforehand the future of that domain. In this short communication, we question how much we are willing to believe that predictive Artificial Intelligence is already able to suggest good prescient ideas on football, for example by hinting the tactical adjustments needed to shoot corner kicks that finally end in goals. We have conducted statistical Chi-squared tests that show that the Liverpool Football Club, in the Premier League seasons 2021/22, 2022/23 and 2023/24, has reached a higher potential for goals from corners with respect to the previous seasons 2016/17, 2017/18 and 2018/19, only in the attacking phase of play (scored goals), but not in the defensive one (conceded goals). This despite a multi-year collaboration between Liverpool FC and authors of [1] on AI, reportedly begun during the season 2020/21. Moreover, no statistically significant difference was found, with another series of Chi-squared tests, between the goals scored/conceded from corner kicks by Liverpool FC and those scored/conceded, in the seasons 2021-24, by Arsenal FC and Manchester City FC. Our study suggests preliminary evidence against the belief that AI is ready to prompt prescient ideas in a dynamic domain, characterized by many multi-agent interactions, like football. Limitations to these results come from the uncertainty on the real nature of the collaboration between Liverpool FC and AI on corner kicks, as discussed at length in the paper.

Keywords: Football data analysis Artificial intelligence, Prescient ideas.

1 Introduction

Prescient (which does not means *prescientific*) ideas are those that foreshadow the future of a given domain while challenging the most common beliefs predominating that field. Another distinguishing characteristic of prescient ideas is that they should firmly depart from prevailing attitudes at the time of inception but become commonplace in the future. In our times, predictive Artificial Intelligence (AI) is emerging as a promising source of such far-sighted ideas which manifest in the form of field-specific radical innovations, with a potential to foretell fundamental changes of an entire domain. Liverpool Football Club (FC) has taken a historic step along this path by beginning a multi-year collaboration with the authors of [1], experimenting with a data-driven procedure that employs predictive AI to provide its coaches with tactical adjustments used to respond to rival teams. TacticAI is the name of this procedure developed

to help coaches to adjust the tactic that makes a particular outcome happen (goals scored/avoided) starting from a corner kick. Essentially, TacticAI uses both predictive and generative AI to predict, among all the possible alternatives of players setup, the one with the highest likelihood of scoring (or preventing) a goal during a corner routine.

The intent of this short communication is to question how much we are willing to believe that this type of AI may become central to the football domain's logics of actions, with its imaginative ideas that should by themselves guarantee a success [2]. Unfortunately, our study suggests that the randomness of the gameplay, in a football match, makes still hard to predict the final outcome, even in *semi-controlled* situations, like those following a corner kick. In fact, our results show that Liverpool FC has reached a statistically significant higher potential for scored goals from corners in the Premier League seasons 2021/22, 2022/23 and 2023/24, if compared with the previous seasons 2016/17, 2017/18 and 2018/19. Yet, the quantity of conceded goals did not significantly decrease, as the null hypothesis of zero-difference was not rejected based on the relative Chi-squared tests if the defensive phase of play following corners is examined. All this despite a three-year collaboration of Liverpool FC with the authors of [1], focused on corner kicks, begun with training TacticAI on data from 7176 corner kicks in the 2020/21 season. Not only that, but no statistically significant difference was found, with another series of Chi-squared tests, between the goals scored/conceded from corner kicks by Liverpool FC and those scored/conceded, in the same seasons (2021-24), by two other clubs, among those considered in the group of the *big six* of the Premiership, namely: Arsenal FC and Manchester City FC. Of notice is the fact that, following a preliminary version of this paper, we have been reached out by some authors of [1] who confirmed the aforementioned scientific collaboration with Liverpool FC, but stated that TacticAI was never deployed in a "real game" [3]. Actually, there is plenty of articles in the news media, sharing information on this collaboration and explaining, for example, that in blind tests "football experts from Liverpool FC favored the AI-generated tactics, 90 per cent of the time", against human designed tactics [4]. In this situation of uncertainty, we do not want to start a debate with authors of [1] on whether a football tactical training session, with data produced by an AI system, should be considered as a part of the "real game" or not. Nonetheless, the fact remains that the performances of interest (i.e., Liverpool FC's goals from corner kicks) have not statistically significantly changed so far, not even after the scientific collaboration described in [1], whatever the nature of that collaboration. In the end, our study provides preliminary evidence against the belief that AI is already ready to suggest prescient ideas in a dynamic domain, characterized by many random multi-agent interactions, like football. Data show that predicting the outcomes of corner kicks remains a complex task, still challenging AI, maybe due to the lack of abundant data. (For example, an estimation suggests that, on average, less than ten corners are shoot per each match in the Premier League [5]). Obviously, limitations to these results come from the uncertainty on the nature of the scientific collaboration discussed above. We believe that, in this particular case, these limitations touch more upon the specificity of the investigated topics rather than addressing the potential weaknesses of our study. Writing about them should help towards an in-depth understanding of this controversial issue. The remainder of the paper is structured as follows. Respectively, in Sections 2, 3 and 4, we provide

details on the data, the methods we have used, and then we provide the results we have obtained. Finally, Section 5 concludes this paper.

2 Data

In this Section, we provide details on the data used for our study. The timeframe for this study was comprised of two triplets of Premier League seasons of Liverpool FC. Specifically, the three seasons, 2021/22, 2022/23 and 2023/24 were taken into account and then compared with other three previous seasons, namely: 2016/17, 2017/18 and 2018/19. These two different triplets of seasons have been chosen, based on the consideration that the three seasons 2016-19 were played by Liverpool FC prior to the beginning of the collaboration on corner kicks with the authors of [1] (whatever the real nature of this collaboration).

The latest three seasons 2021-24, instead, were played while the abovementioned scientific collaboration was already going on. It is worth reminding that in all these six seasons the head football manager of Liverpool FC was: Jürgen Norbert Klopp, regarded as one of the best football managers in the world. All data concerning these six seasons were collected from an online football data repository termed *sofascore.com*, available online at: https://www.sofascore.com, keyword: Liverpool FC [6].

A comprehensive summary of the data scraped from the above repository is provided in the following Table 1 and 2. In Table 1, all the awarded/defended corner kicks, the goals scored/conceded, respectively in the attacking and in the defensive phases of the play, are reported for all the Premier seasons 2021/22, /2022/23 and 2023/24.

These three seasons totaled: 39 goals scored from 804 awarded corners, and 12 goals conceded following 387 defended corners. In Table II, similar data are provided for Liverpool FC regarding the seasons 2016/17, 2017/18 and 2018/19. These three seasons totaled: 23 goals scored from 731 awarded corners and 18 goals conceded following 379 defended corners.

Table 1. Liverpool Performances (2021-24).

Liverpool FC	Attacking Phase	Defensive Phase
Corners (**2021/22**)	279	112
Goals scored/conceded (**2021/22**)	15	4
Corners (**2022/23**)	241	128
Goals scored/conceded (**2022/23**)	12	1
Corners (**2023/24**)	284	147
Goals scored/conceded (**2022/23**)	12	7
Total (**21-24**): corners	**804**	**387**
Total (**21-24**): goals scored/conceded	**39**	**12**

Table 2. Liverpool Performances (2016-19).

Liverpool FC	Attacking Phase	Defensive Phase
Corners (**2016/17**)	250	132
Goals scored/conceded (**2016/17**)	4	7
Corners (**2017/18**)	231	122
Goals scored/conceded (**2017/18**)	7	5
Corners (**2018/19**)	250	125
Goals scored/conceded (**2018/19**)	12	6
Total (**16-19**): corners	**731**	**379**
Total (**16-19**): goals scored/conceded	**23**	**18**

Moreover, since a record number of goals were scored from corner kicks in the latest seasons of the Premier League, continuing a steady rise in the influence of goals scored from corners [7], we decided to analyze two other clubs, in the group of the *big six* of the Premiership: Arsenal FC and Manchester City FC.

Our intent was to compare their data with those of Liverpool, to measure the presence of differences during the seasons 2021/22, 2022/23 and 2023/24. Similar to Table 1 and 2, Tables 3 and 4 report data on corners awarded/defended, and goals scored/conceded for those two clubs.

Table 3. Arsenal Performances (2021-24).

Arsenal FC	Attacking Phase	Defensive Phase
Corners (**2021/22**)	208	175
Goals scored/conceded (**2021/22**)	13	3
Corners (**2022/23**)	223	113
Goals scored/conceded (**2022/23**)	15	6
Corners (**2022/23**)	265	141
Goals scored/conceded (**2022/23**)	14	6
Total (**21-24**): corners	**696**	**429**
Total (**21-24**): goals scored/conceded	**42**	**15**

Table 4. Manchester City Performances (2021-24).

Manchester City FC	Attacking Phase	Defensive Phase
Corners (**2021/22**)	316	106
Goals scored/conceded (**2021/22**)	14	2
Corners (**2022/23**)	238	93
Goals scored/conceded (**2022/23**)	10	5
Corners (**2022/23**)	286	129
Goals scored/conceded (**2022/23**)	11	3
Total (**21-24**): corners	**840**	**328**
Total (**21-24**): goals scored/conceded	**35**	**10**

All these data were again scraped from the football data repository, termed *sofascore.com*, keywords: Arsenal FC and Manchester City FC [6]. The last information to share on these data is about the method we used to count goals form corners (both scored and conceded). This kind of information is not available as a statistic. We had to reconstruct all the situations that, starting from corners (awarded or defended), ended in goals (scored or conceded), on a per match basis. This operation consisted in starting from each given goal (scored or conceded) and then backtrack the action that leaded to that goal, to understand if it started from a specific corner routine.

3 Methods

In this Section, we provide details on the methods used for this research. The intent of this study was to compare the goals scored/conceded from corners routines in the seasons 2021-24, after the start of the collaboration of Liverpool FC on AI and corner kicks, as described in [1], against the seasons 2016-19 (prior to the beginning of that collaboration). Moreover, the objective was also to compare the performances of Liverpool FC from 2021 to 2024, in terms of scored/conceded goals in situations of play following corners, with the analogous performances of other two major Premiership clubs: Arsenal FC and Manchester City FC. To this aim, we decided to resort to a typical hypothesis testing procedure, based on the use of the Chi-squared tests. The Chi-squared distribution is a special case of a Gamma distribution, being one of the most widely used for testing the goodness of fit of an observed distribution against a theoretical one. A practical method to develop a Chi-squared test amounts to checking if observed frequencies in some categories match the correspondent expected frequencies [8].

We carried out two different series of this kind of test. In the first one, we chose as expected frequencies those of goals scores/conceded following corner routines by Liverpool FC, in the period 2016-19, while the observed frequencies were those of goals scored/conceded by the same club in the period 2021-24. The null hypothesis to test was that of no increase in scored goals (and no decrease in conceded goals) passing from the seasons prior to the collaboration on AI and corner kicks to the seasons when that collaboration was on course. For the sake of conciseness, we have identified those two null hypotheses in the following Table 5.

The second set of Chi-squared tests was comprised of two different types of that test. In the former one, we chose as expected frequencies those of goals scored/conceded following corner routines by Arsenal FC, in the period 2021-24, while the observed frequencies remained those of scored/conceded goals by Liverpool FC in the period when its collaboration on AI and corners was going on (2021-24). In the latter one, the Manchester City FC took the place of Arsenal FC, with all the rest unchanged. Consequently, we defined four null hypotheses of no increase in scored goals (and no decrease in conceded goals) passing from Arsenal/Manchester City to Liverpool, in the same seasons 2021-24. Again, for the sake of conciseness, the four null hypotheses were specified as described in Table 6. All the six hypotheses were tested with: i) a 5% significance value (α), ii) a right tailed test, and iii) a degree of freedom equal to 1.

Table 5. Null Hypotheses - Liverpool (16-19) vs (21-24).

Null Hypotheses: 1-2	Liverpool (16-19) vs (21-24)
$\mathbf{H0_1}$	*no-increase in scored-goals*
$\mathbf{H0_2}$	*no-decrease in conceded-goals*

Table 6. Null Hypotheses – Arsenal/Manchester vs Liverpool (21-24).

Null Hypotheses: 3-6	Arsen./Manch. vs Liverpool (21-24)
$\mathbf{H0_3}$	*Arsenal-Liverpool: no-increase in scored-goals*
$\mathbf{H0_4}$	*Arsenal-Liverpool: no-decrease in conceded-goals*
$\mathbf{H0_5}$	*Manchester-Liverpool: no-increase in scored-goals*
$\mathbf{H0_6}$	*Manchester-Liverpool: no-decrease in conceded-goals*

We conclude by reminding the formula that computes the Chi-square values starting from the above data which is as follows:

$$Chi\text{-}square = \Sigma\,(observed\text{-}expected)^2/expected. \quad (1)$$

4 Results

To compute the Chi-square values, we now need to take the data from Tables 1, 2, 3 and 4 and normalize them, based on the consideration that the number of corners awarded/defended may vary, depending on the combination club/season. The results of this normalization activity are reported in Tables from 7 to 12, where the values of the expected/observed frequencies are shown for all the Chi-square procedures testing the null hypotheses from $H0_1$ to $H0_6$.

Table 7. Liverpool (16-19) vs Liverpool (21-24) - Attacking.

$H0_1$	Expected	Observed
Corners awarded w/o goals	708	695.542
Corners awarded w/ goals	23	35.458

Table 8. Liverpool (16-19) vs Liverpool (21-24) - Defending.

$H0_2$	Expected	Observed
Corners defended w/o goals	361	367.248
Corners defended w/ goals	18	11.752

Table 9. Arsenal (21-24) vs Liverpool (21-24) - Attacking.

$H0_3$	Expected	Observed
Corners awarded w/o goals	654	662.592
Corners awarded w/ goals	42	33.408

Table 10. Arsenal (21-24) vs Liverpool (21-24) - Defending.

$H0_4$	Expected	Observed
Corners defended w/o goals	414	415.698
Corners defended w/ goals	15	13.302

Table 11. Manchester (21-24) vs Liverpool (21-24) - Attacking.

$H0_5$	Expected	Observed
Corners awarded w/o goals	805	799.254
Corners awarded w/ goals	35	40.746

Table 12. Manchester (21-24) vs Liverpool (21-24) - Defending.

$H0_6$	Expected	Observed
Corners awarded w/o goals	318	317.830
Corners awarded w/ goals	10	10.170

The final results (Chi-square and *p*-values) are shown in Table 13 for all the six null hypotheses above.

Table 13. Chi-Square test results.

Null Hypothesis	Chi-square	*p*-value
H0$_1$	6.97	$p < 0.01$
H0$_2$	2.28	$0.1 < p < 0.9$
H0$_3$	1.87	$0.1 < p < 0.9$
H0$_4$	0.267	$0.1 < p < 0.9$
H0$_5$	0.745	$0.1 < p < 0.9$
H0$_6$	0.03	$0.95 < p < 0.975$

It is shown that only the first null hypothesis above is rejected (*p*-value < 0.05), leading to accept the alternative that there is a (statistically significant) evidence that, during 2021-24, Liverpool FC has scored a quantity of goals, stemming from corners, larger than during 2016-19. All the other null hypotheses cannot be rejected, with *p*-values > 0.05. Data show that predicting outcomes of corner kicks remains a complex task, still challenging AI [9, 10, 11,12, 13, 14, 15, 16].

5 Conclusions

Liverpool FC has reached a higher potential for scored goals from corners (2021-24), following a collaboration with [1] on AI. Yet, the quantity of conceded goals after corners during a defensive phase did not significantly decrease. Moreover, no statistically significant difference was found between the performances of Liverpool and those of Arsenal /Manchester City. Limitations to these results come from the uncertainty on the real nature of the collaboration of Liverpool with [1].

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