TRAINING GROUND GURU

Pitch to the Pros 2025

Corner Threat Index | CTI

Quantifying Risk and Reward in the Box

Tiago Monteiro | 03 December 2025

The Corner Dilemma
‘Threat’ or Trick?

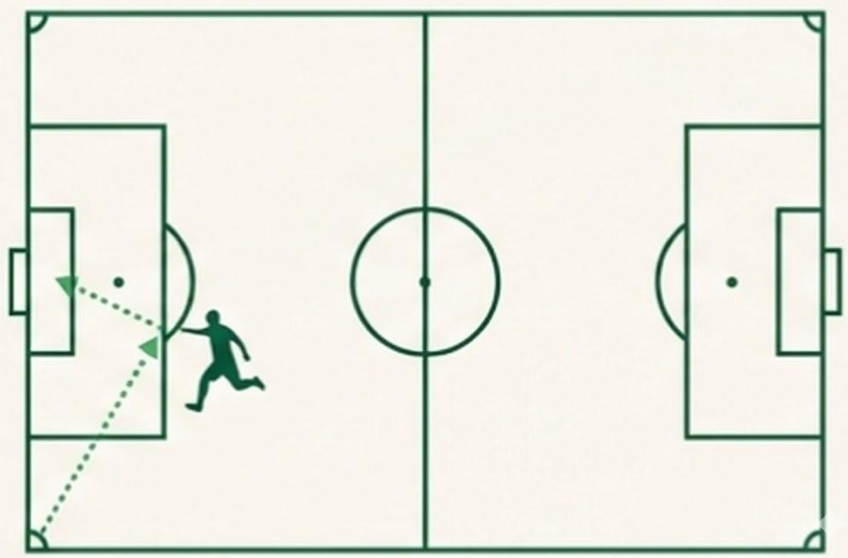
377
Matches Analyzed

2,243
Corners analyzed by season
2024/2025 Premier League

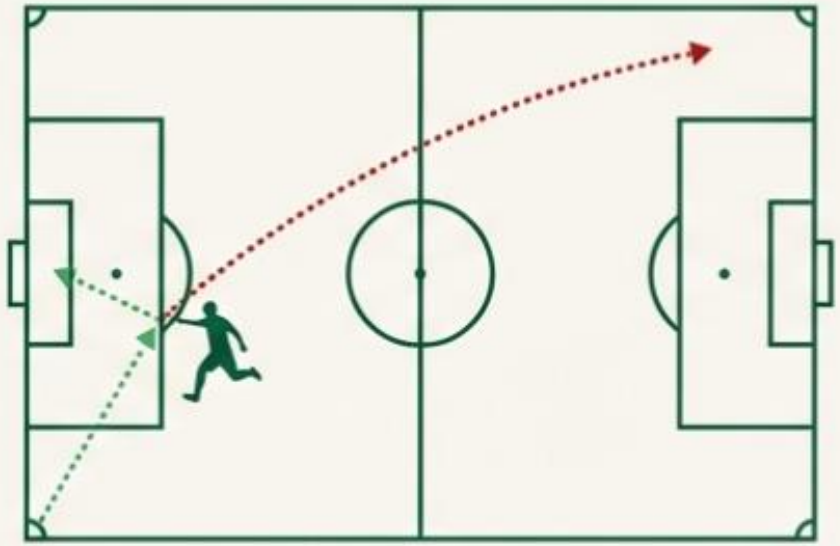
5.95
Average number of corners per game

Set-pieces, and corner kicks in particular, are a frequent and strategically important source of goal-scoring opportunities in elite football. Teams typically win several corners per match, yet only a small fraction of these situations are actually converted into goals, highlighting a pronounced gap between opportunity volume and scoring efficiency. The current metrics don’t distinguish a dangerous corner from a simple delivery to the opponent team.

Success
(Shot or Goal)



?



Unsuccessful
(Interception or Block)

Current metrics, such as goals or shots, are too sparse. They fail to capture the tactical danger and the risk of counter-attacks.

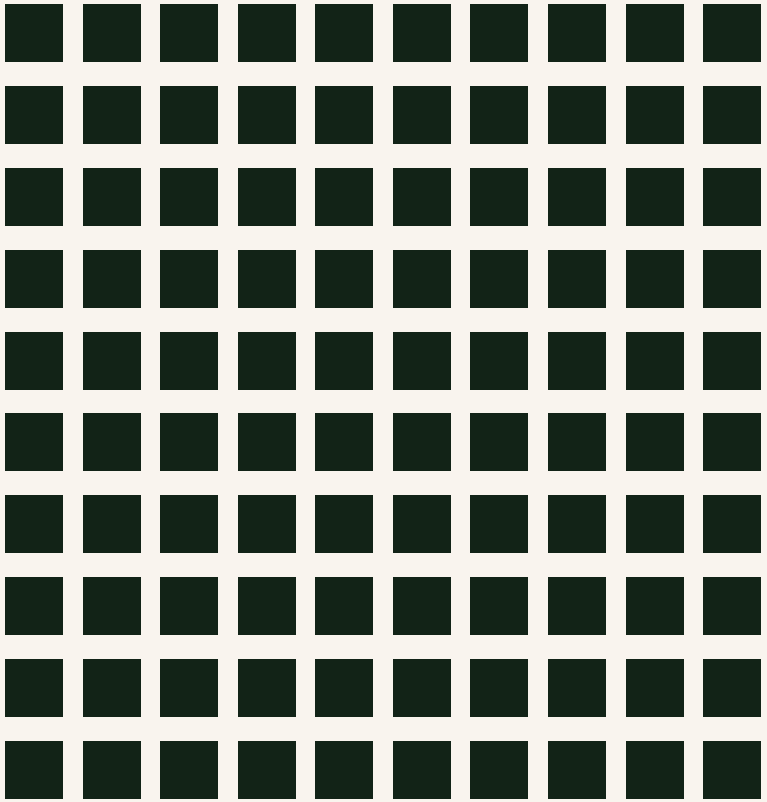

Can we **quantify corner threat** with a comprehensive index that captures spatial dynamics, tactical intent, and defensive vulnerability?

Initial obstacle

The problem of 'Zero'

The first logical approach was to use **xG** (Expected Goals) to measure the danger created by a corner. The result was a complete failure.

In more than **95%** of corners, no shot occurs in the following **10 seconds**. Consequently, the xG value is zero. The machine learning model simply learned to predict zero.



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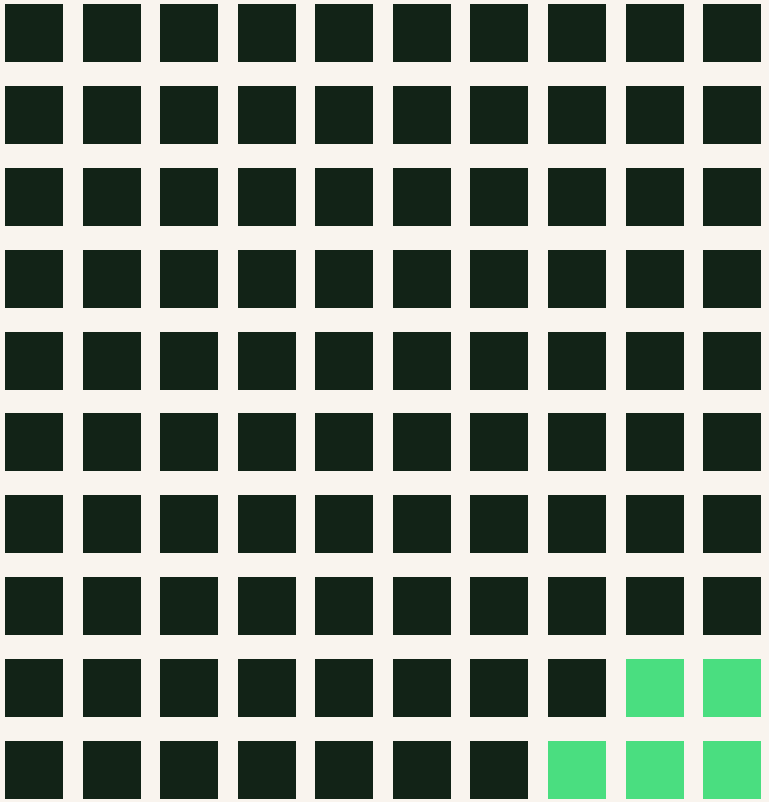
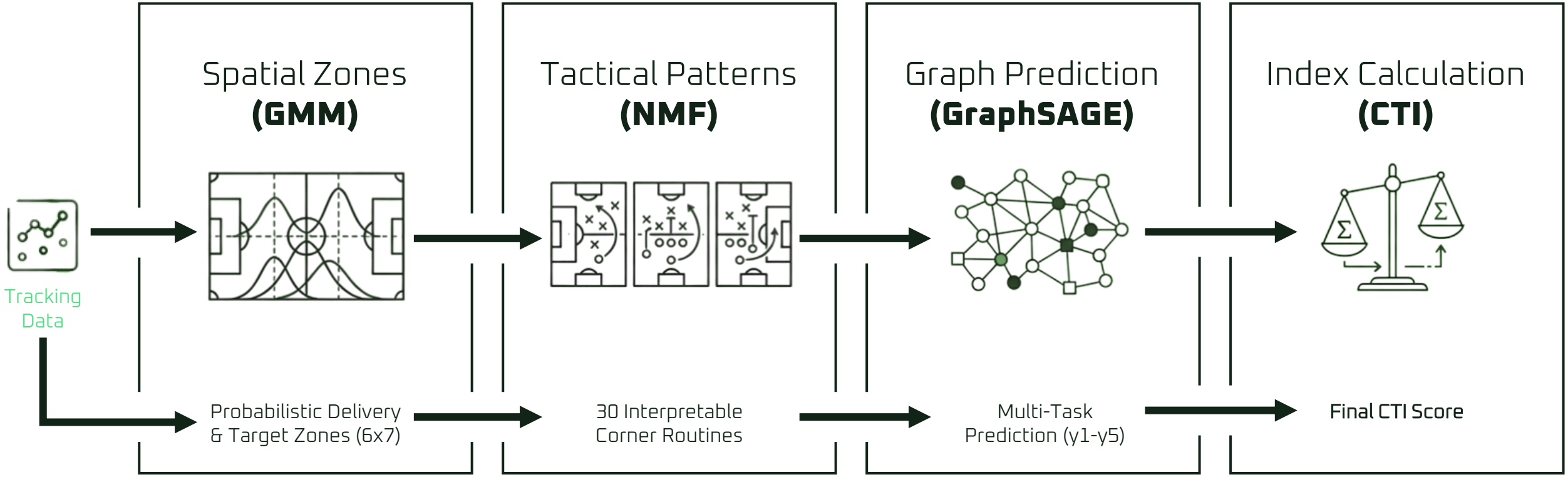
The proportion of corners that directly result in a goal, is very low, **around 2% in most elite leagues** (Shaw & Gopaladesikan)



A four-pillar Architecture

CTI Engine

The CTI pipeline integrates spatial modeling, pattern discovery, and graph-based prediction.



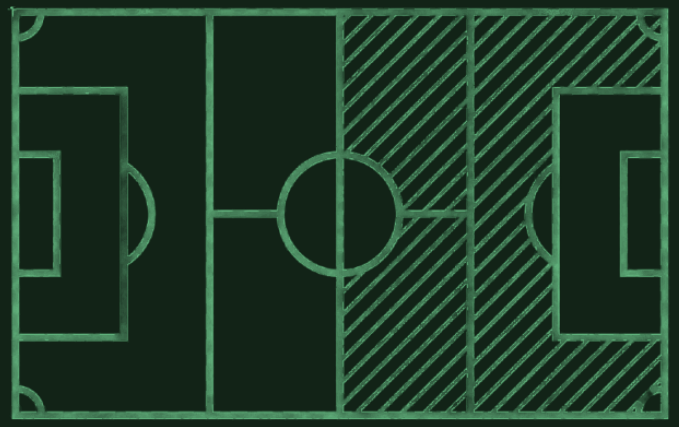
GMM: Understands *where* the ball goes.

NMF: Discovers *how* teams attack.

GraphSAGE: Predicts *what* will happen.

CTI: Synthesizes the final score.

A holistic Approach
Introducing the CTI



Territorial Gain
The value of advancing the ball into dangerous areas, even if no shot is taken.

CTI

Offensive Value
The immediate attacking success generated by the corner. Did it create quality chance?

Counter-Attack Risk
The danger posed by the defending team if they regain possession. How likely is a counter and how threatening is it?

CTI = [Offensive Value] – [Counter-Attack Risk] + [Territorial Gain]

A holistic Approach

The concept is implemented with five key labels.

Inference Safeguard
A final check rescales the predicted counter-danger (y4) if it's abnormally low, ensuring the risk term remains meaningful in team rankings.

$$\text{CTI} = [\text{Offensive Value}] - [\text{Counter-Attack Risk}] + [\text{Territorial Gain}]$$

$$\text{CTI} = y1 \cdot y2 - \lambda \cdot y3 \cdot y4 + \gamma \cdot y5$$

Offensive Value
The probability of a shot multiplied by the quality of the delivery.

Counter-Attack Risk
The probability of a counter-attack multiplied by its maximum threat.

Territorial Gain
The net change in expected threat from ball progression.

Default weights are $\lambda = 0.5$ and $\gamma = 1.0$. We will deconstruct each label ('y1' through 'y5') in the following slides

Asking questions to obtain answers
Introducing the CTI

y1 Shot
Did the Corner result in a shot?

y2 Corner Danger
Historically, how dangerous is the ball delivery zone?

CTI

y3 Counter Attack
What is the danger of this counterattack?

y4 Counter Attack Danger
Did we suffer a counterattack?

y5 Pitch Control
We have gained or lost valuable territory?

Offensive Value

y1: Did the corner lead to an immediate shot?

A binary indicator answering the question: Did the attacking team take any shot within 10 seconds of the corner?

How It's Made

- **Window:** Scans frames [frame_start, frame_start + 10*fps] for the attacking team.
- **Trigger:** The label is 1 if any event within the window has a shot flag.
- **Event Cues Checked:**
  event_type|event_subtype|end_type =="shot",
  lead_to_shot== True, or is_shot == True.
- **Outcome:** A simple 1 (shot) or 0 (no shot).

At a Glance

Team: Attacking
Time Window: [t0, t0 + 10s]
Data Source: Events

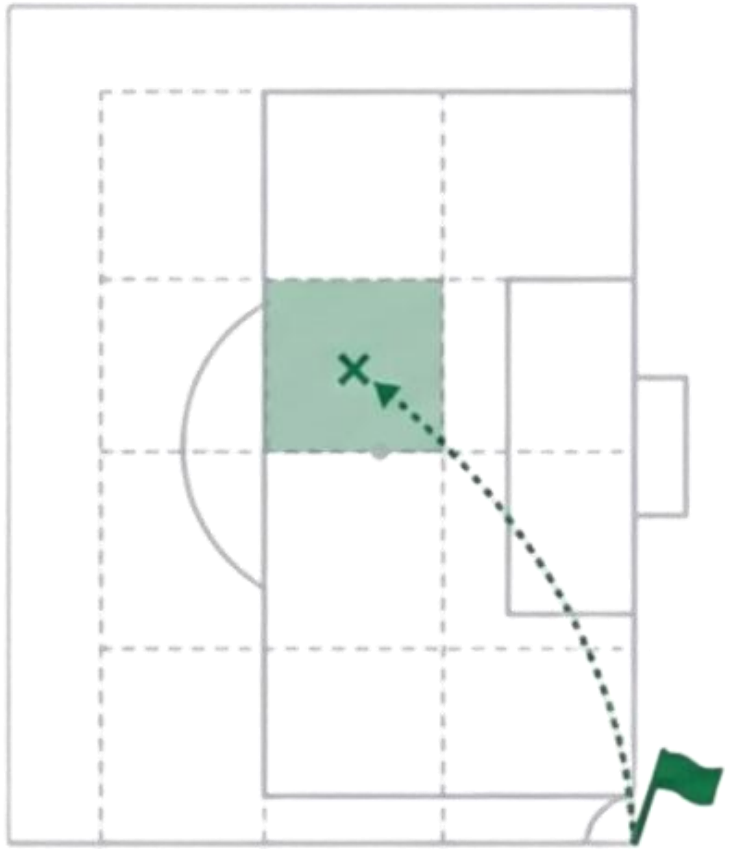
Offensive Value

y2: How dangerous was the corner delivery itself?

The expect threat (**xThreat**) generated by the first touch of the corner, based on a historical model of the delivery location.

At a Glance

Team: Attacking
Time Window: [t0, t0 + 3s]
Data Source: Events



How It's Made

1. Identify the first touch by the attacking team within 3 seconds.
2. Map the (x, y) coordinates of that touch to a 4x3 grid.
3. Assign a pre-computed xthreat_corner value to that zone.
4. Formula: xthreat_corner = 0.7 * p_shot(zone) + 1.0 * p_goal(zone).
5. A fallback value of 0.05 is used for unseen zones.

Counter-Attack Risk Value

y3: Did the defending team launch a counter-attack?

A binary label that triggers if three specific conditions are met, indicating a genuine counter-attack has occurred. This label requires both event and tracking data.

At a Glance

Team: Defending
Time Window: [t0, t0 + 7s]
Data Source: Events + Tracking

How It's Made

Condition 1

Is there any event from the defending team in the first 7 seconds?

If **YES**

Condition 2

Does the attacking team fail to regain possession within 3 seconds of the defending event?

If **YES**

Condition 3

Does the ball (from tracking data) cross midfield OR advance >= 15 meters in the defending team's direction of attack?

If **YES**

y3=1

Returns '0' if tracking data for the ball ('is_ball == True') is missing

Counter-Attack Risk

y4: If a counter happens, how threatening is it?

The maximum xThreat value generated by the defending team in the subsequent ‘counter-attack’ phase.

How It’s Made

- The model looks at a later, distinct time window: 10 to 25 seconds after the corner.
- It scans all events for the defending (team_id != attacking) team.
- y4 is assigned the maximum value found in the xthreat event column during this window.
- If no events with xthreat occur, or the column is missing, the value is 0.

At a Glance

Team: Defending
Time Window: [t0 + 10s, t0 + 25s]
Data Source: Events + Tracking

Key Insight
Note the distinct time window. y3 detects the start of a counter (0-7s) while y4 measures its peak threat later on (10-25s).

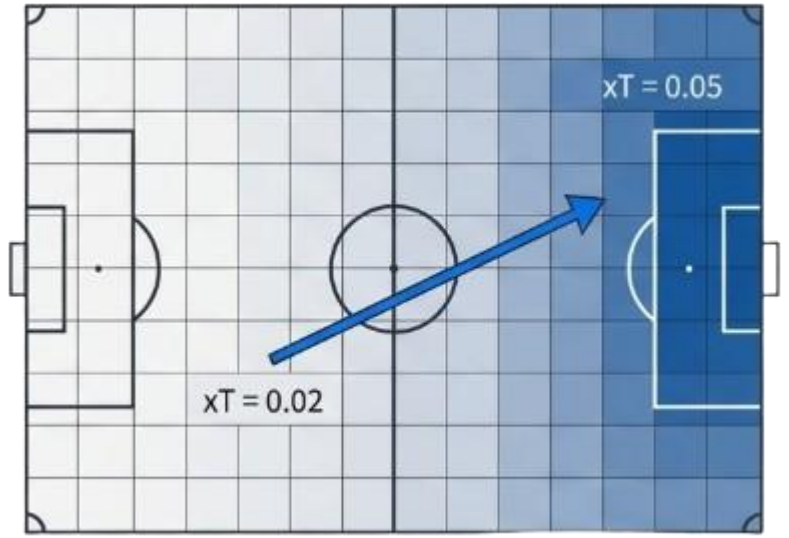
Territorial Gain

y5: Did the corner improve the team's field position?

The aggregated change in expected threat (

At a Glance

Team: Attacking
Time Window: [t0, t0 + 10s]
Data Source: Events + xT Grid



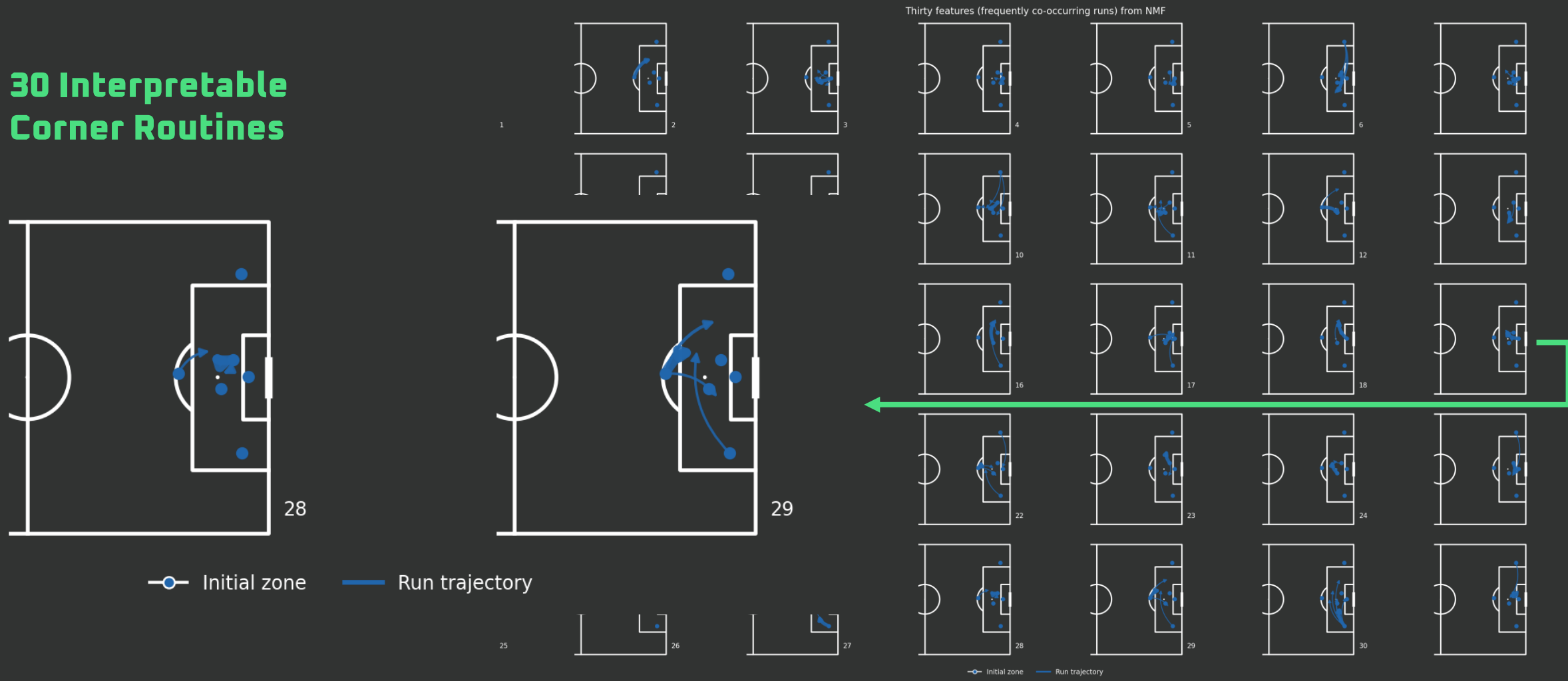
How It's Made

- Within the first 10 seconds, track the ball's location from the attacking team's events (x_end, y_end).
- Map these successive locations to a 12x8 half-pitch xT grid.
- Calculate the change in xT value between locations.
- y5 is the total vectorized delta:
  xT(final_location) − xT(start_location).

NMF

The NMF component allows us to identify which corner routines teams prefer and to characterize their associated risk–reward profiles.

30 Interpretable Corner Routines



The League's Tactical Landscape

Top Corner Feature per Team

Key Observations

Notice the clusters
Multiple teams rely on the same core concepts (e.g., the popular Central Cluster of Feature 3)

Spot the specialists
Arsenal and Newcastle share a near-post focus (Feature 12)

Identify the innovators
Manchester City (Feature 11) and Crystal Palace (Feature 23) have developed unique, signature plays.

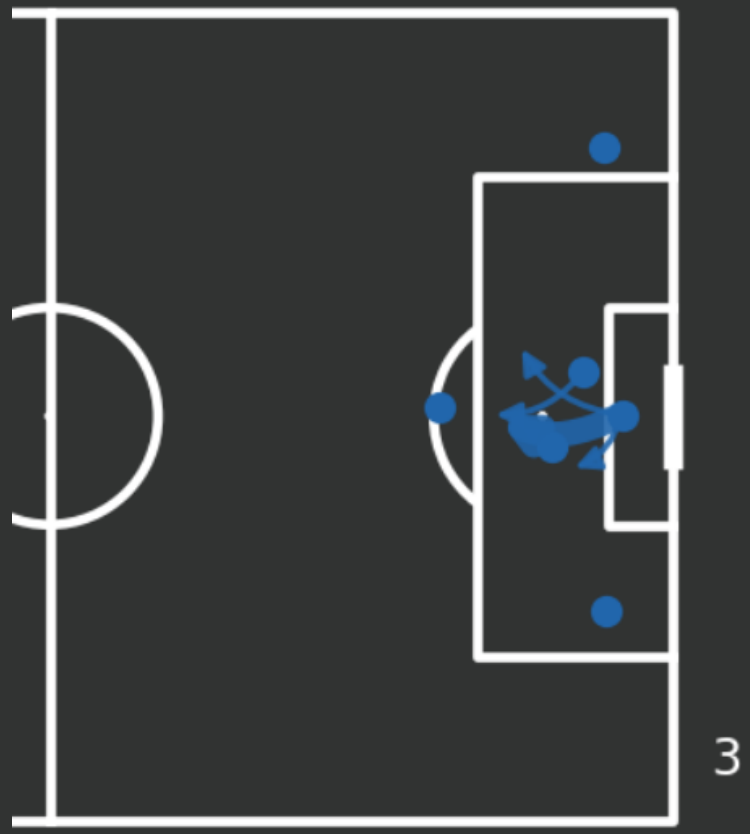
Tactical Analysis

The same play, wildly different results: Execution is everything

Routine:
Feature 3 (Central Cluster)

Avg. Threat (xT): **0.179**

Best-in-class execution of the most common routine in the league.



Routine:
Feature 3 (Central Cluster)

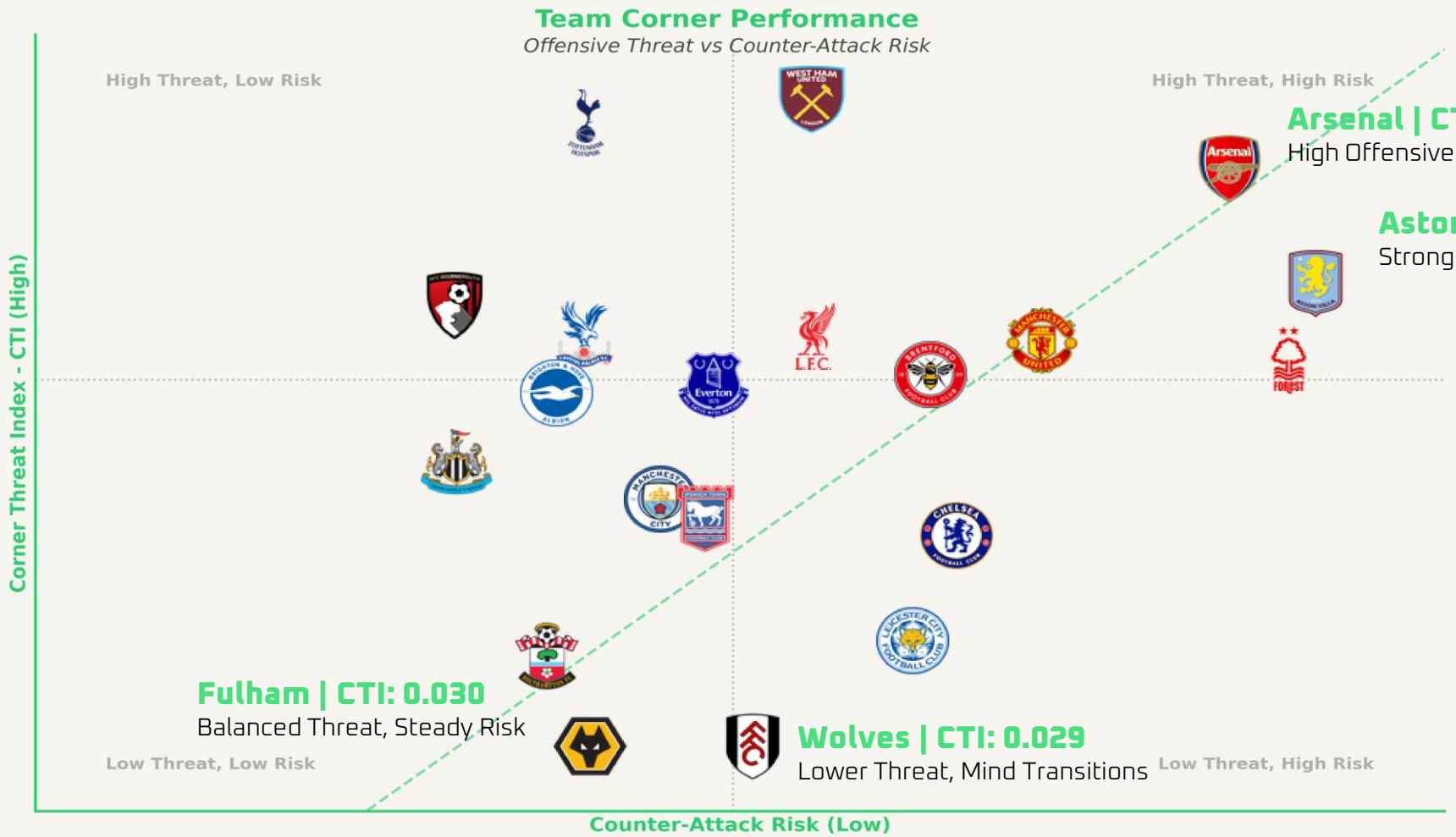
Avg. Threat (xT): **0.048**

Highest commitment to Feature 3 in the league (weight 0.122) but the lowest threat generation.

Manchester United generates **3.7x more threat** than Leicester City using the same tactical routine. It's not just what you do, it's how you do it.

Offensive Threat vs Counter-Attack Risk

Positioning teams by corner efficiency and transition safety



Arsenal | CTI: 0.077
High Offensive Threat, Controlled Risk

Aston Villa | CTI: 0.068
Strong Threat, Moderate Risk

Fulham | CTI: 0.030
Balanced Threat, Steady Risk

Wolves | CTI: 0.029
Lower Threat, Mind Transitions

Objective

This plot maps each team's corner output: higher is more attacking threat, further left is lower counter risk. Allows to see which teams combine strong routines with solid rest defense.

Arsenal sits high-left: strong threat with controlled risk. Aston Villa is higher but riskier, expect more danger if we leave space. Prioritize aggressive delivery vs Fulham for example.

Arsenal Corner Brief | Threat vs Risk

Stay high-threat, tailor rest defense: standard vs Fulham, reinforced vs Aston Villa

Our Profile

Arsenal

High offensive threat with controlled counter risk. CTI puts us in the top tier on threat, and the counter-attack risk is low, our rest defense is solid. Keep that balance: maintain aggressive delivery and shot creation, but don't loosen the cover on second balls.

CTI 0.077 | P(shot) 0.532

Maintain our aggressive delivery and shot creation (high y1/y2 is our edge).

VS

Opponent

Fulham

Balanced threat, steady risk. They don't spike threat or risk, they're more "middle of the pack." We can press their routines without overcommitting, win the first duel, but be ready for recycling because they're not reckless. Emphasize second-ball structure but allow an extra runner into the box. Their counter risk is moderate, so the rest defense can be standard rather than ultra-conservative.

CTI 0.030 | P(shot) 0.441 | Counter risk 0.002

Push an extra runner into prime zones; standard rest-defense shape should suffice.

Opponent

Aston Villa

Strong threat, moderate risk. They create more than Fulham and can hurt us if we leave space. Against Villa, keep our high-threat routines but reduce loading on the weak side to keep at least two anchors behind the ball. Stress box matchups on their key zones and be disciplined on the exit lanes; they'll punish loose transitions more than Fulham.

CTI 0.068 | P(shot) 0.446 | Counter risk 0.006

Stick to strong delivery but hold an extra safety (6 or FB) to keep counter risk low, be tighter on second-ball exits.
Bottom line: we're already high-threat/low-risk, stay on-plan.

Limitations and Avenues for Future Work

Dataset Limitations

- **Single Season & League.:** Analysis is on the 2024/25 Premier League only; tactical patterns may not generalize.
- **Data Size.:** With 2,243 corners, learning rare routines is challenging.

Methodological Limitations

- **Stationary Assumptions:** Historical zone danger (y_2) assumes team tactics are stable over the season.
- **No Ablation Studies:** The precise contribution of each architectural component was not isolated.

Future Directions

- **Opponent-Specific CTI.:** Model how a team's CTI changes based on the defensive setup they face.
- **Player-Level Features.:** Incorporate player attributes like height and aerial ability.
- **Ball Trajectory Modeling.:** Add delivery characteristics like speed, curve, and spin.

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Thank you!