

Navigating the Rink: Analyzing Zone Entry Sequences and Expected Threat in Ice Hockey

Priyansh Gupta¹, Vignesh Aswathanarayana¹, and Ragini Gunda¹

Linköping University liu.se

Abstract. This research paper analyses the dynamics of offensive zone entry in ice hockey, employing an adapted expected threat (xT) metric. Evaluating pass and carry sequences, investigating the influence of lane choices on offensive potential and defensive vulnerability. The findings offer insights for optimizing entry strategies and enhancing team performance.

Keywords: Zone entry · Markov’s chain analysis · Expected threat(xT).

1 Introduction

Ice hockey, renowned for its intense pace and complex strategies, revolves around critical moments that finishes in scoring goals. The outcome of a match depends on many factors, ranging from skills of individual players to cohesive strategies deployed by the team. Among these factors, we look closely at offensive zone entries-the strategies that enable a team to advance the puck beyond the blue line and into the opposition’s defensive zone. Despite the acknowledged significance of zone entries, our objective is to explore deep into this aspect of the game

Our research takes inspiration from the studies of Nick Czuzoj & Shulman [1], who have previously explored related themes, with a particular focus on the implications of offensive zone entries in relation to player handedness. While we draw upon their findings, our study seeks to identify patterns and tendencies that can inform more offensive strategies, thereby enhancing a team’s ability to capitalize on scoring opportunities.

2 Background

Our analysis of offensive zone entry was conducted utilizing the event data sourced from one hundred and fifty-six games played during 2023 season in the Swedish Hockey League (SHL). To facilitate a detailed spatial analysis of gameplay, the hockey rink is segmented into lanes; effectively forming nine longitudinal lanes, as shown in Fig 1. The central lane is designated as “Middle”, while the remaining eight lanes are symmetrically distributed as “Left”, “Left Middle”, “Right Middle”, “Right”; with two lanes allocated to each category respectively. The division allows for detailed examination of player movements and puck trajectories across the rink.

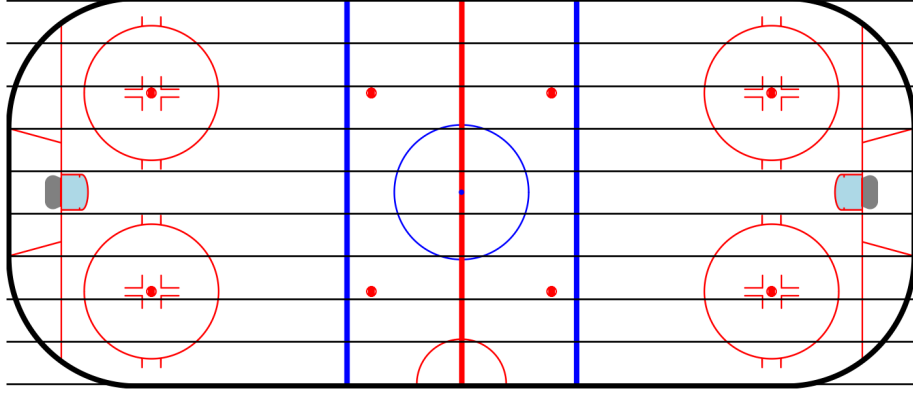


Fig. 1. Ice Hockey rink grid division

It is recognised that events such as the pass, carry, and dump-in facilitate players to enter the offensive zone. Our study focuses on passes and carries, which we categorize as controlled zone entries. This distinction aids in our understanding of how teams strategically move the puck over the blue line and into the opposition’s territory, with an emphasis on the precision and intentionality behind these movements.

3 Algorithms

In this paper, we have two key methodologies to aid our analysis of zone entries, which are Markov’s chain and entry sequence analysis.

3.1 Markov’s Chain Analysis:

Markov chain analysis is a powerful probabilistic model, extensively used in sports analytics, adapted here from its original application in soccer metrics. This approach involves modelling the transitions between different events in the game, such as player positions and puck movements. By quantifying the probabilities of transitioning between different events, we can compute the xT for various scenarios on the ice. This allows us to assess the likelihood of scoring opportunities leading to specific offensive plays.

Expected Threat: The concept of xT, originating from Sarah Rudd’s work in soccer[4], was further developed by Karun Singh [5], and adapted in context of ice hockey by Tim Keller[2]. Expected threat in ice hockey combines offensive threat (xT_{Off}) and defensive threat (xT_{Def}). This involves quantifying risk for each event, including shot attempts and preceding movements. Offensive threat is computed using probability distributions from binned statistics based on spatial coordinates, while defensive threat is assessed by mirroring offensive threat

values and negating them. The overall xT for each event is derived by summing offensive and defensive threats, which is demonstrated in Fig 2.

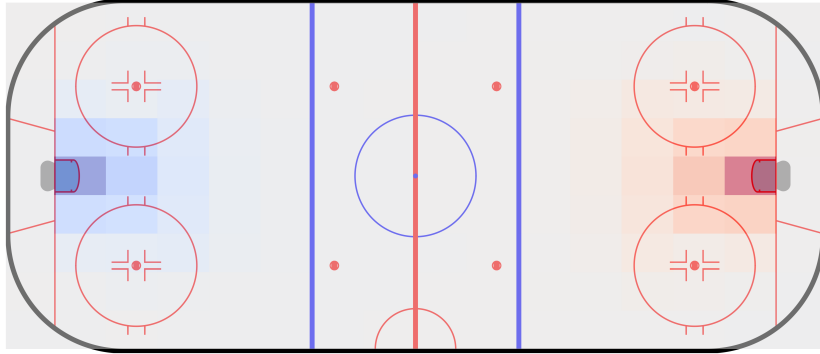


Fig. 2. Expected threat matrix on an Ice Hockey rink, blue colour represents the negative values (high defensive threat) while red colour represents the positive values (high offensive threat).

3.2 Entry Sequence Analysis:

In addition to Markov chain analysis, a custom method is employed to analyse entry sequences leading to controlled zone entries. This method tracks puck possession and events leading up to a successful entry. Key movements, puck movements, and event chains are identified to discover various entry strategies through the use of event tracking techniques.

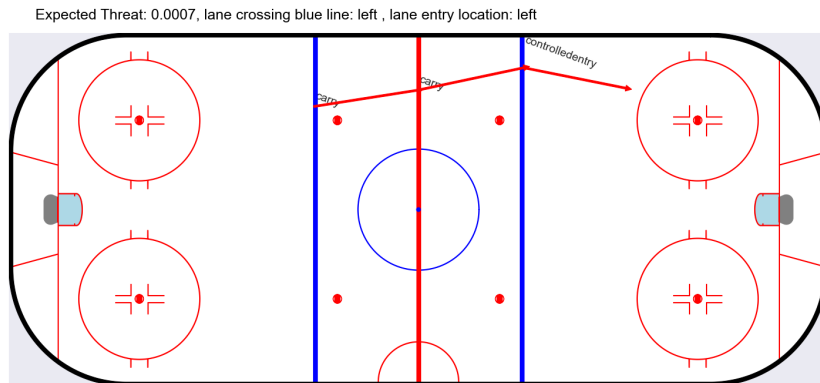


Fig. 3. An example sequence for the controlled entry into offensive zone

The methodology involves data preprocessing to isolate entry sequences. Through classification based on game events, entry attempts are categorized into passes, carries, and successful controlled entries. Spatial coordinates are used to analyse entry lanes and identify spatial distribution patterns. The impact of different strategies is assessed by associating the entry attempts with xT. One such example sequence is displayed in Fig 3.

4 Results

Entry sequence analysis is employed to determine the last few sequences before a successful zone entry. Typically, an offensive zone entry is finalized by the last action, but previous events such as passes and carries are also integral to the sequence leading up to a successful zone entry in the opposition defensive zone. Therefore, we have considered the last three events which leads up to a successful zone entry.

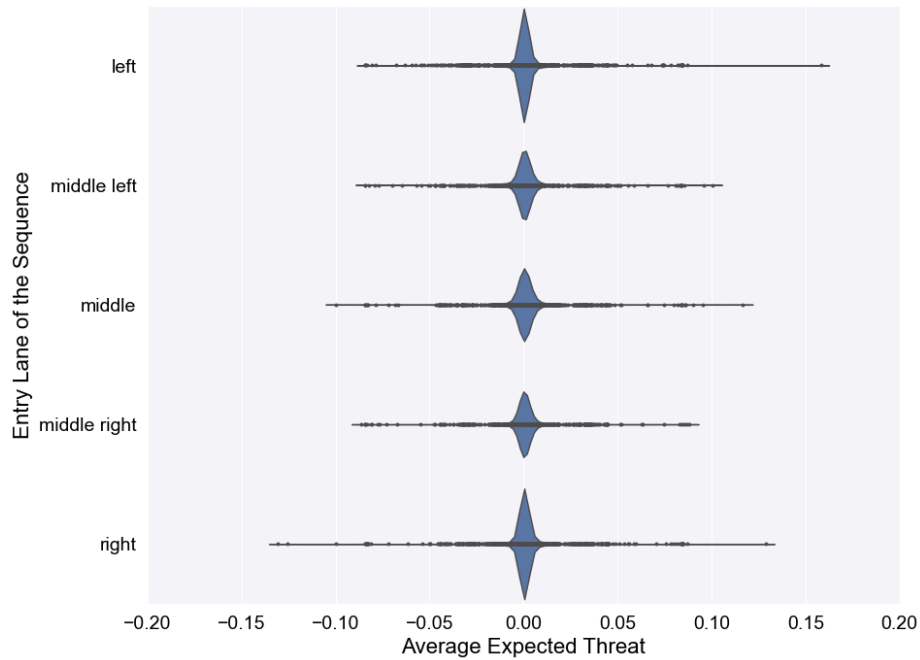


Fig. 4. Violin plot displaying the average expected threat for entry sequence group according to different lanes in the Ice hockey rink.

As the entry sequences are mixed, we didn't separate them based on different events like dump-in, pass, or carry. From Fig 4, we found that the left and right

lanes exhibit high peak values. However, the middle lane also shows comparably high average xT within a sequence. Surprisingly, the right lane also exhibits the lowest value within a sequence, unlike the left lane. Overall, the plot provides evidence that the right and left lanes have the greatest number of sequences for offensive zone entry, thus indicating potential for the most extreme values.

Furthermore, we found an interesting trend when comparing the xT values for different lanes for two most occurring events: passes and carries while entering the offensive zone. Specifically, when entering the zone while passing the puck, the middle, middle left, and middle right lanes have the highest xT as represented in Table 1. Whereas, entering the zone while carrying the puck, the right, and left lanes have the highest xT . However, xT values in the case of carrying are negative, indicating that the defensive team poses a threat to the attacking team, thus increasing the chances of losing possession while carrying the puck in the offensive zone.

Table 1. Expected threat values for pass and carry along in accordance with the different lanes in descending order

Lanes	xT for pass	Lanes	xT for carry
Middle	0.002503	Right	-0.000411
Middle left	0.001492	Left	-0.000466
Middle right	0.001092	Middle left	-0.001649
Right	0.000332	Middle right	-0.002539
Left	0.000048	Middle	-0.009637

5 Summary

Our paper presents a thorough analysis of offensive zone entry in ice hockey using Markov chain and entry sequence analysis. Results reveal distinct characteristics of different entry lanes play a crucial role in shaping offensive strategies in the game. The left and right lanes are notable for their high offensive potential, offering wider angles that facilitate lateral movement and provide numerous passing options. The middle lane also emerges significant, providing a direct path to the net. Furthermore, considering xT values associated with different entry events, passing into the offensive zone through the middle left, middle, and middle right lanes consistently yield the highest xT values, indicating promising scoring opportunities. On the other hand, carrying the puck into the offensive zone through the left and right lanes risk losing possession. This suggests that precise puck movement in key areas of the offensive zone significantly increase the likelihood of creating scoring opportunities.

6 Future Works

Further investigation on sequence of events that leads to successful goal opportunities, risk of penalty can be done in future. We could gain a deeper understanding on key moments that leads to scoring opportunities with this transition. This would involve both offensive actions and defensive responses. The work of Anton Olivestam[3] on determining the sequence which lead to shots with high expected goal value, gives more insight about shots on goal.

Acknowledgments. We would like to thank David Sumpter and Aleksander Andrzejewski [6] for their work in the soccer for expected threat and possession chain to make it available publicly, which we modified in context of Ice Hockey. That part of code belongs to their copyrights, which is clearly marked in our published notebook as well. We do not take any credit for that part of code.

Link to GitHub Code: <https://github.com/priyansh16/Linhac-2024>

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