Universität Basel

Moving on from the Index: The next iteration to evaluate PowerPlay Danger

WHKYHAC 2023

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Agenda.

1	Introduction
2	Expected Threat
3	Voronoi Diagrams
4	Results
5	Discussion & Outlook

Introduction

Big Data Cup 2022 project: Power Play Danger Index

- advancement of the PowerPlay Structure Index (Cane, 2017)
- Structure Index: Measuring distance from average shot location
- Danger Index: Weighting structure Index by expected goals
- Danger Index lacks simplicity and applicability

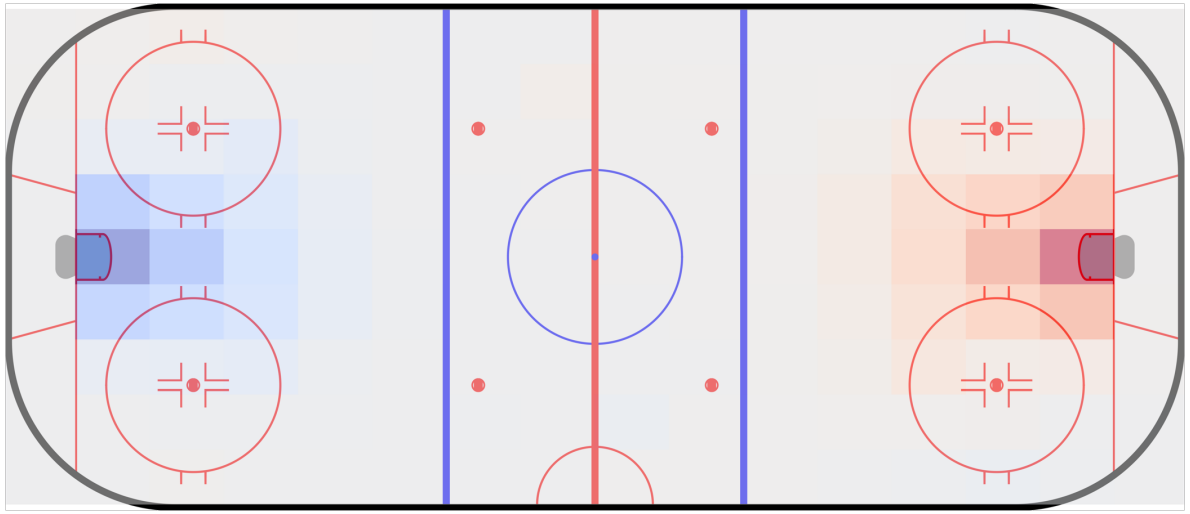
	player_name	powerplay_shots	player_structure_index	player_xg_index	player_danger_index
0	Michelle Karvinen	5	25.057538	0.458524	0.207949
1	Petra Nieminen	4	11.870287	0.087543	-0.031160
2	Elisa Holopainen	8	5.536409	0.022472	-0.032892
3	Megan Keller	3	8.152026	0.001273	-0.080247
4	Alina Muller	3	7.983230	-0.002158	-0.081990
5	Nina Pirogova	3	8.449289	-0.002375	-0.086868
6	Phoebe Staenz	4	18.535490	0.086245	-0.099110
7	Minnamari Tuominen	11	11.420921	-0.008016	-0.122225
8	Anna Shokhina	6	13.013396	0.004158	-0.125975
9	Jenni Hiirikoski	6	16.487716	0.021960	-0.142918
10	Angelina Goncharenko	4	15.291697	0.002551	-0.150366
11	Nelli Laitinen	5	12.887208	-0.021772	-0.150644
12	Alex Carpenter	7	14.083180	-0.035821	-0.176653
13	Lara Stalder	8	20.802099	-0.012026	-0.220047
14	Cayla Barnes	7	20.129781	-0.027182	-0.228480
15	Hilary Knight	3	22.522477	-0.019212	-0.244436

Leaderboard sorted by the player danger index of shots at the 2022 Winter Olympics Women's hockey tournament

Introduction

LINHAC 2023 student competition project: Where did they get out? Evaluating zone exits using expected threat in hockey

- Expected threat (xT) implementation to evaluate passes and carries
- concept of exit lanes to look at impact of zone exits in different locations



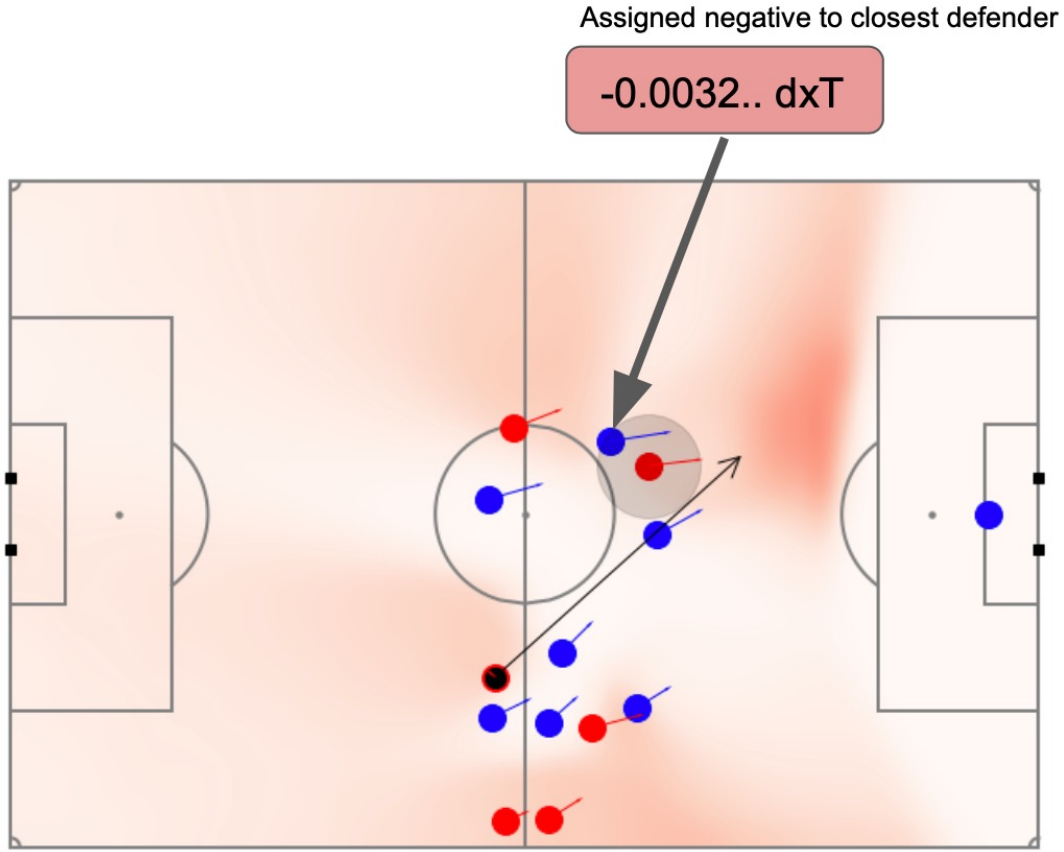
Visualization of the Net xT values in Swedish Men's Hockey League.

blue negative values, red positive values

Introduction

OSUSAC 2023 poster: Who keeps track of their marking assignments? Evaluating the performance of defenders in soccer by measuring their mistakes.

- Evaluating defenders in Soccer using the concept of pitch control and expected threat
- if player marked by defender receives a pass successfully xT value weighted by pitch control value assigned to defender



Example of dxT failed marking

Introduction

- **Next iteration of power play danger**: Combining parts from all these project
- Focusing on different aspect than **Danger Index**: passes instead of shots
- **Expected Threat (xT)** as simpler evaluation metric
- **Voronoi Diagrams** to evaluate controlled space (simplification of pitch control)

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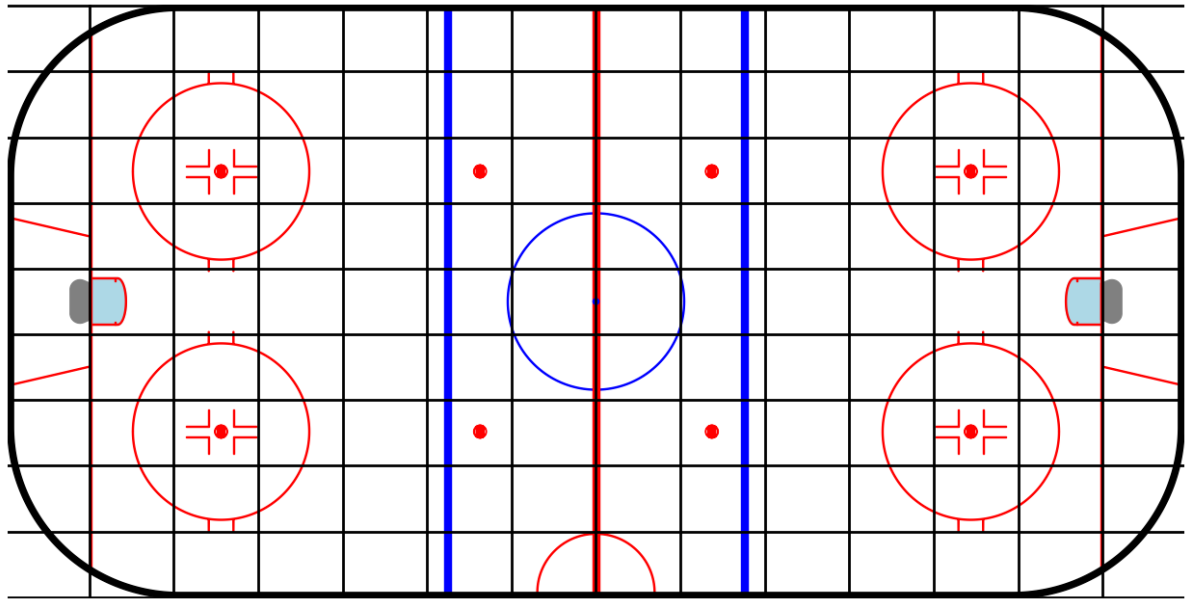
Expected Threat (xT)

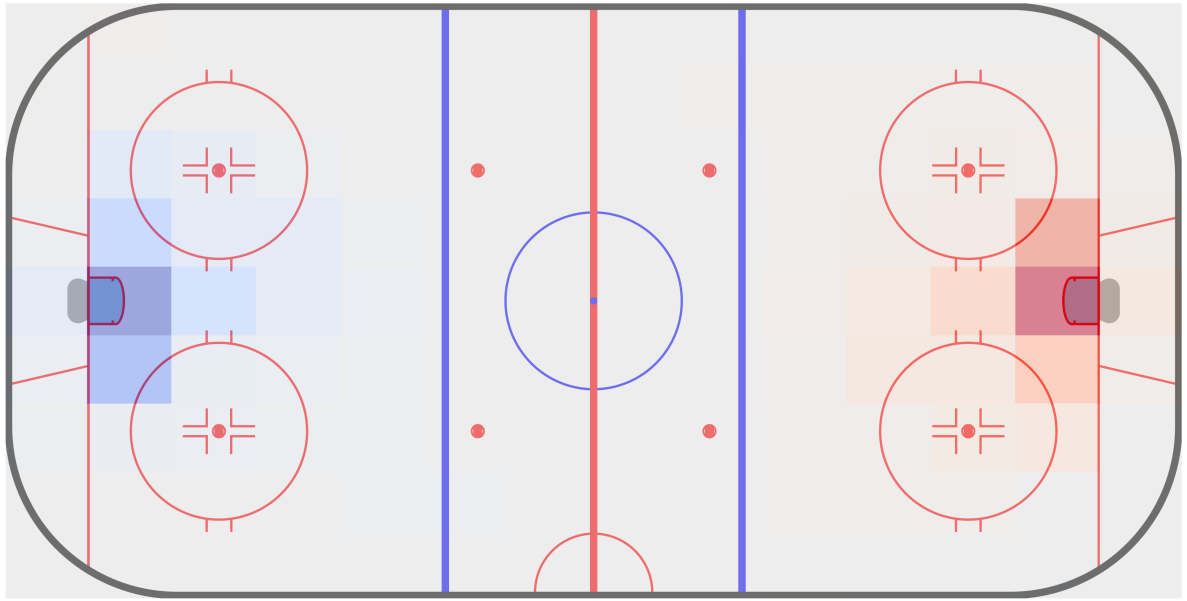
- Concept developed for soccer with Markov Chains by Sarah Rudd
- Further developed in the most widely used form by Karun Singh
- Every section of the field value of scoring in a given amount of moves
- Difference between sections used to evaluate actions
- Translation into ice-hockey: divide the ice surface into a 14 x 9 matrix on IIHF surface (16 x 9 on NHL surface)



Visualization of division of the ice surface into a 14x9 matrix

Expected Threat (xT)

- Difference to Linhac project: only ”plays” (passes) considered, no move actions
- Trained with the 2021 Big Data Cup dataset
- Use Markov chains to calculate transition matrices after 8 moves → xT for offense
- Defensive xT: flipped values xT offense
- Net xT: offensive xT + defensive xT
- In the project: only used offensive xT



Visualization of the Net xT values in Womens Hockey.

blue negative values, red positive values

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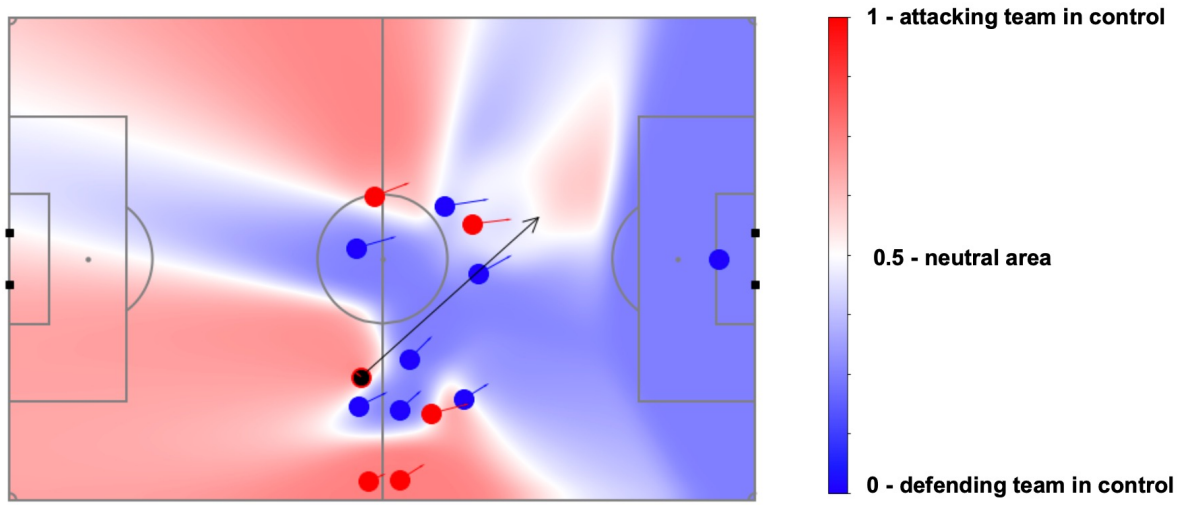
Pitch Control

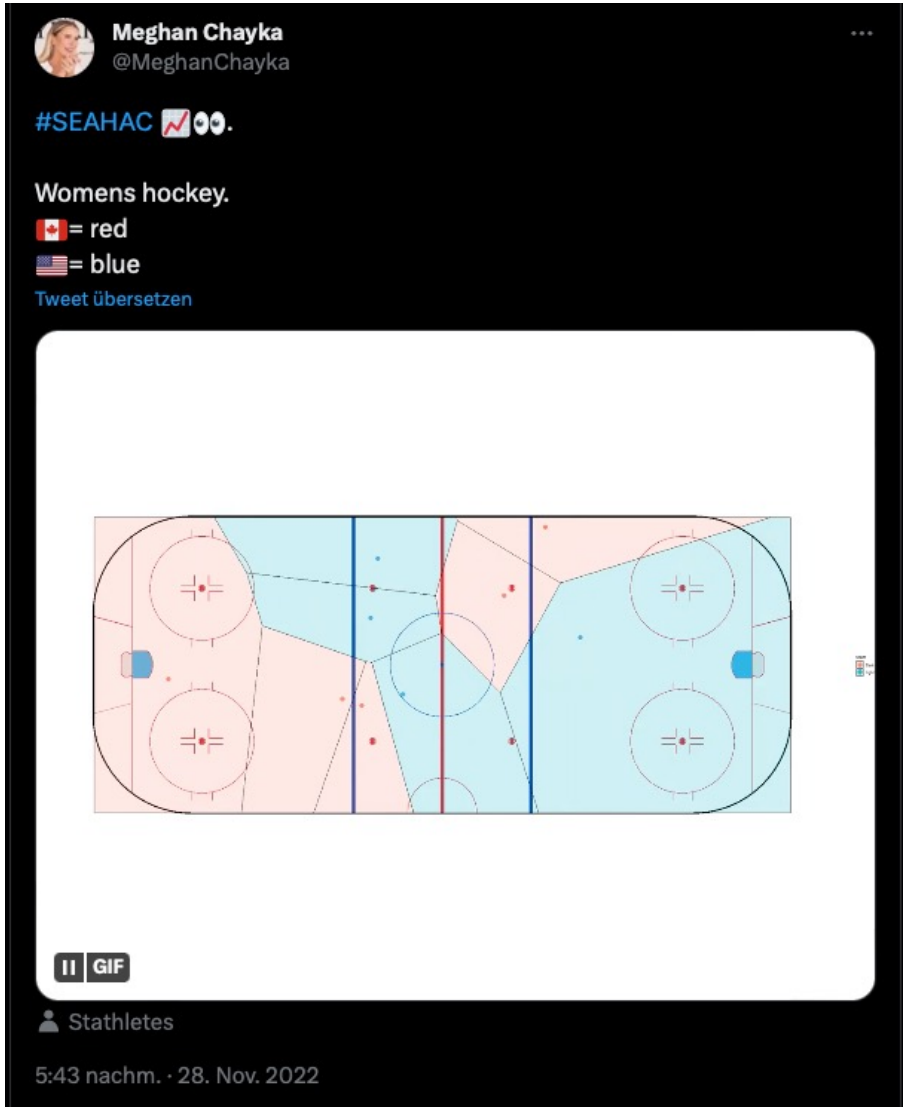
- identifies what regions of the pitch are in control of each team
- First mentions by Will Spearman, Javier Fernàndez and Luke Bornn (2018)
- Application to hockey difficult, adjustments necessary (e.g., accounting for boards)



Example of a pitch control application in soccer

Voronoi Diagrams

- " a **Voronoi diagram** is a partition of a plane into regions close to each of a given set of objects." – Wikipedia
- Popular to visualize the spaces player occupy on the ice
- Using area of Voronoi regions as simplified pitch control value



Screenshot of a tweet by Meghan Chayka showing a gif of a Voronoi diagram

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Expected Threat

- Results from the 2022 Olympics significantly different to the danger index → different ways to create danger
- Michelle Karvinen on top of both leaderboards → outstanding performance on the powerplay

	xT		
	mean	sum	count
player_name			
Michelle Karvinen	0.008175	0.073577	9
Dominique Ruegg	0.003997	0.043971	11
Abby Roque	0.003247	0.038958	12
Evelina Raselli	0.002568	0.028251	11
Amanda Kessel	0.001835	0.029354	16
Savannah Harmon	0.001252	0.017522	14
Nelli Laitinen	0.001065	0.029831	28
Nina Pirogova	0.000909	0.007271	8
Anna Shokhina	0.000718	0.007176	10
Minnamari Tuominen	0.000484	0.012591	26

Leaderboard: Expected Threat on the Powerplay (min. 8 passes)

xT weighted by Voronoi area

- Pass with a high xT value
  → pass increases odds to score

  → puck received in favorable position

- Voronoi region with a big area
  → pass receiver occupies the space

- Difficulties with unbounded Voronoi spaces

→ Too much data leakage to properly evaluate

Pass xT value:

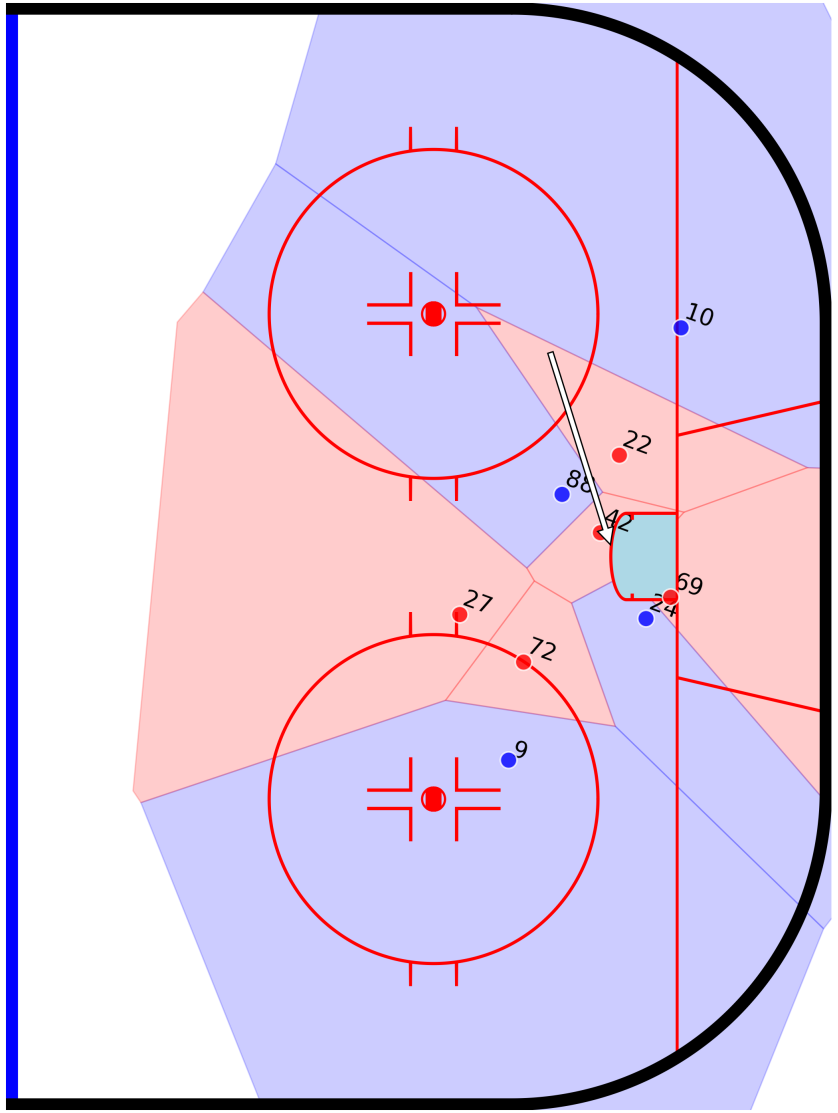
0.00432

Voronoi area player #42:

82.752

Voronoi weighted xT value:

0.3572



Voronoi diagram of a pass with high xT value

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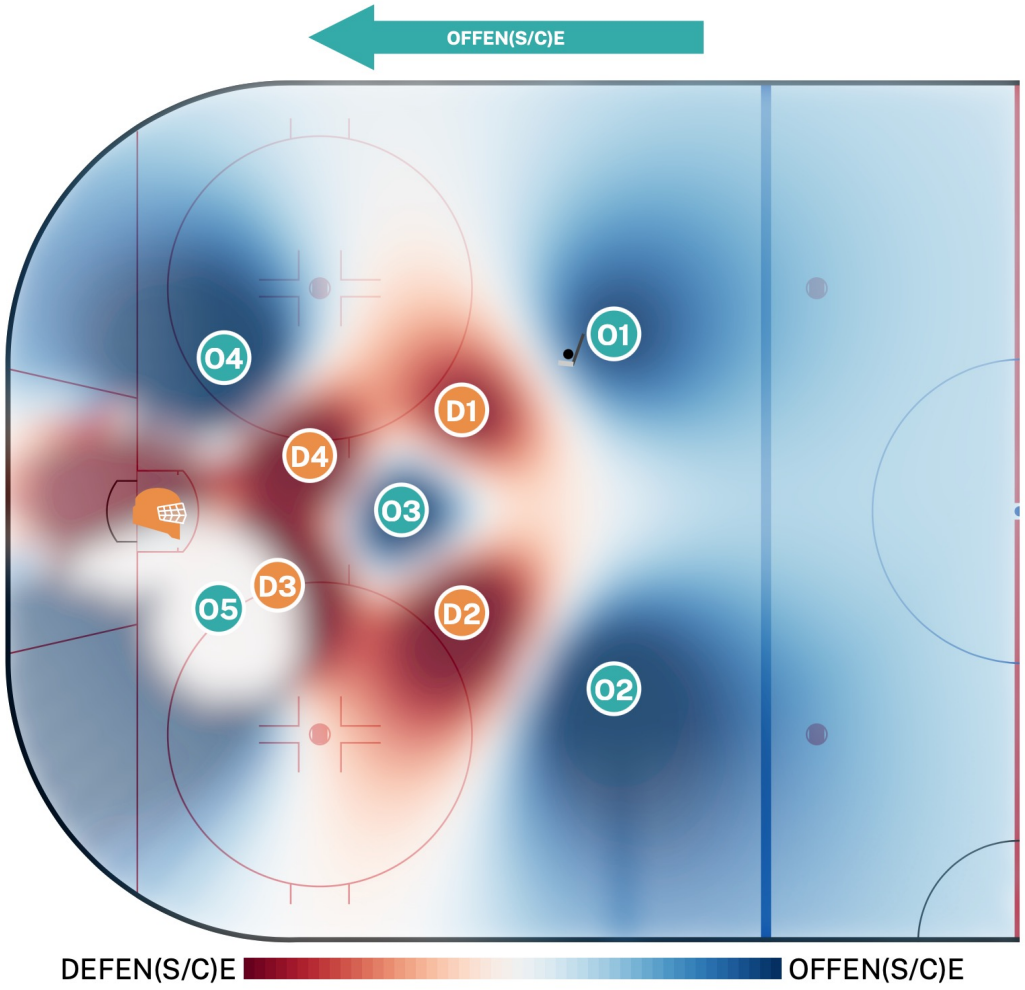
Conclusion

- Combination of Expected Threat and Voronoi diagrams nice to visualize dangerous situations
- Project needs some more work to overcome the limitations for practical application
- With the right data is availability: Expected Threat is a useful concept in hockey

Other applications

- Sources: Interesting projects using Expected Threat in the viz launchpad competition later
- WePlay and underlying passing analysis model uses pitch control



Screenshot of the WePlay app: https://weplay.netlify.app

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Thank You
for your attention!

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Thanks to Alyssa, Carlie and Mike
for letting me present once more!