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42 ANALYTICS

Spatial Statistics to Evaluate Player Contribution in Ultimate

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Overview

Ultimate (Frisbee) analyses rely on summary statistics to assess player strengths and weaknesses. However, these statistics are limited in their ability to evaluate a player's contribution to winning points; that is, two players of different value may look identical statistically. To better determine player contribution, we develop a spatially-aware measure. We leverage sequential, location-based data to build scoring probability maps that aggregate possession outcomes with a function of location. From these maps we define an **Expected Contribution (EC)** measure that captures a player's ability to increase their team's spatially-defined probability of scoring, which can be separated into unique contribution scores from throwing, receiving, and defense. Our measure weighs both positive and negative actions—completions and blocks, as well as turnovers and yards yielded—based on the change of the location-based scoring probabilities. We validate our model on real data from high-level ultimate, showing that our measure both aligns with ultimate intuition while also identifying undervalued ``dark-horse'' players who contribute statistically to wins without garnering attention.

2013 College Champions: Pittsburgh and Oregon

Rules of Ultimate

Ultimate is a two-team, seven-on-seven game played with a disc on a football field with the goal of possessing the disc in the opponent's endzone, *i.e.*, a score. The player with the disc must remain stationary (maintain a pivot) and release the disc within 10 seconds. If the disc touches the ground while not in possession or the first person to touch the disc after its release is the thrower, the play results in a turnover and a member of the other team picks up the disc with the intent of scoring in the opposite endzone. Each score is worth 1 point, and the game typically ends when a team reaches 15.

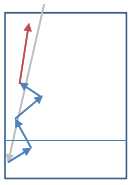
Expected Contribution (EC)

Point outcome $y \in \{0,1\}$: 1 if a possessor score, 0 if an opponent score.
Conditional probability distribution $p(y|x)$: x denotes planar location
Contribution: the scoring probability difference i.e. $p(y|x)$ from $p(y|x')$ based on the change of location, attributed positively to the thrower and receiver, and negatively to the defender.
{Total, Thrower, Receiver, Defender} **Expected Contributions (EC)**: contributions tabulated and averaged over points.
Model: Logistic regression, LOESS and kNN (k=100) for $p(y|x)$

Input and Data

Source: 2013 Club Season
Input: UltiApps. Game observers tap on an Android app to enter rosters, the locations of the disc, scores and turnovers. Below: a depiction of the USA possession in the 2012 USA-Australia game.
Data: 68 games, 1,579 points, 3,099 possessions, and 17,883 plays.

Thrower	Location	Receiver	Location	Complete
Schlag	-10, 0	Cahill	-2, 10	1
Cahill	-2,10	Watson	20,0	1
Watson	20,0	Kittredge	30,10	1
Kittredge	30,10	Watson	40,5	1
Watson	40,5	Simon	65,5	0



Discussion

Only disc location is tracked, not the wind vector, nor the location of other 13 players. It is also non-i.i.d. data of limited sample size.
Should we attribute the outcome of the play equally to thrower, receiver, and defender?
Temporal information largely ignored. Throwers progress through "reads" and select the best throw given the situation and stall count.
Future analyses: WARP, men's versus women's versus mixed, propensity scoring to mimic A/B testing.

Acknowledgments

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Risk and reward, or play it safe?

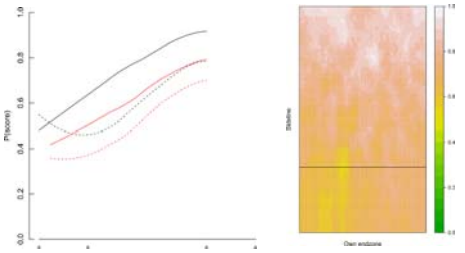
Player	Completions (%)	Goals (/p)	Assists (/p)	Blocks	Total EC	Throw/Catch/D EC
Rebholz	167 (97.8)	3 (0.03)	14 (0.12)	1	0.22	0.19/0.12/-0.09
Kittredge	112 (94.1)	20 (0.20)	11 (0.11)	7	0.14	-0.01/0.17/-0.02
Lance	45 (90.0)	1 (0.02)	10 (0.20)	5	0.14	0.08/0.02/0.04
Malecek	54 (96.4)	2 (0.03)	8 (0.10)	4	0.03	0.03/0.01/-0.01

The players shown epitomize the offensive thrower (Rebholz), the offensive receiver (Kittredge), and two defensive throwers (Lance and Malecek). Note EC prefers Lance over Malecek despite their completion percentages.

Field position matters.

LOESS (left) and kNN (right) scoring probability estimate as a function of field position. Solid/dotted: point/possession Black/red: home/away team

Endzone proximity matters. Sideline proximity might not.

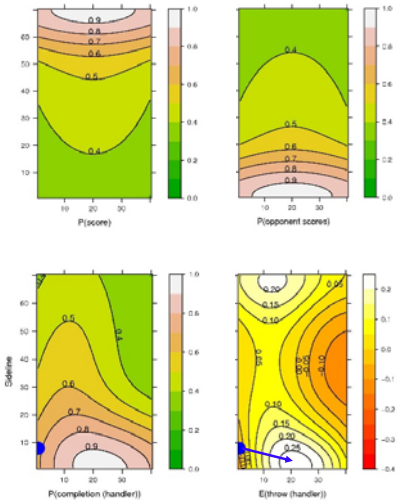


Tell me where to throw.

Probability of scoring for each team (top left and right), and probability of completion (bottom left), and expected value of throw (bottom right).

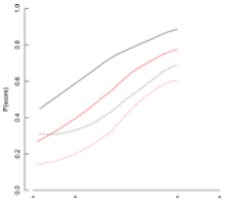
The expected value graph is determined by weighing the probability of scoring graphs by the probability of completion from the blue dot (middle right) at each location.

The best throw location in this example is backwards toward the middle of the field (called a reset or dump).



Shrink the women's field.

LOESS probability of scoring estimate as a function of field position.
Solid/dotted: point/possession
Black/red: home/away team



While the graph is different under different conditions and opponents, the graph hints strongly at the Hail Mary (or punting).

A 40-yard punt to the opponent's end-zone line changes the probability of scoring from 0.70 to 0.65, **requiring only a completion percentage of 4.8%** to make the throw worthwhile.

Choose the minimax strategy

Prevent defense (left) and **pressure defense** (right), expected value graphs. The minimax outcome occurs in the prevent defense graph, indicating that the defense should choose it, and the offense should counter with a short forward pass with expected value around 0.3.