Evaluation of soccer team defense based on ball recovery and being attacked

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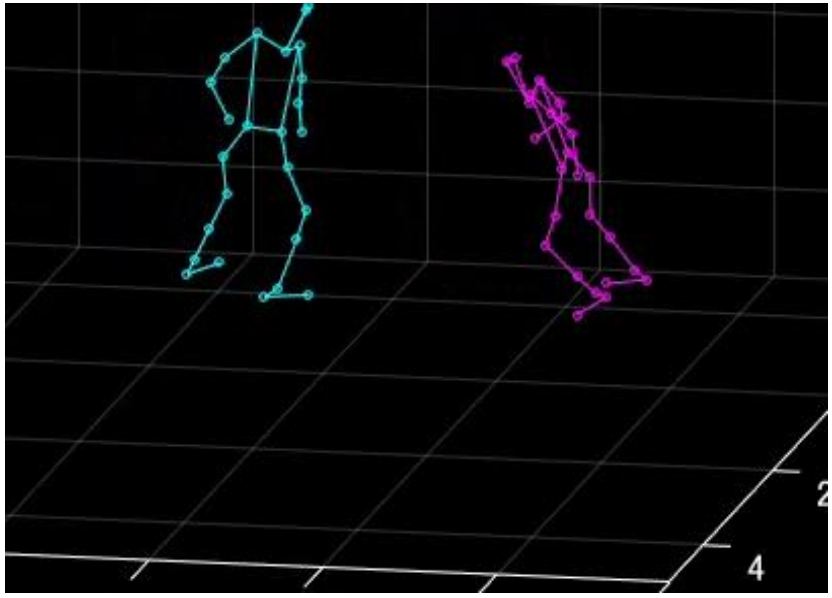
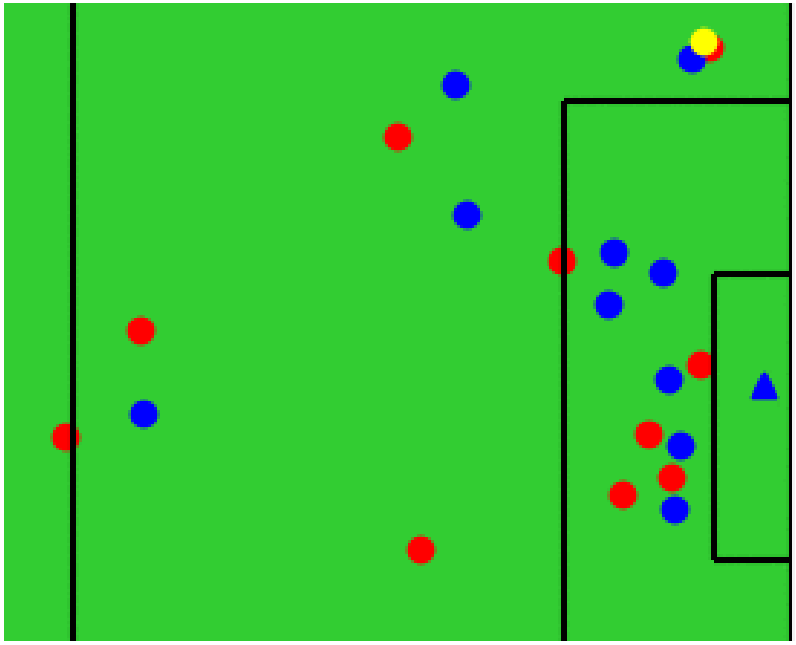
Team sports

- During a match, all players interact in complex ways for scoring goals or preventing being scored (called conceding)
- In particular, tactics are considered difficult to evaluate because of the limited amount of available statistics, such as goals scored in the case of attacks





Three main approaches to evaluation for soccer games

① based on scoring prediction [e.g., Lucey+14; Decroos19]

② to evaluate plays which lead to shots

- offense : passes [Power+17], effective attacks [Ueda+14], etc.
- defense : pass interceptions [Piersma 20], pressing [Robberechts 19], etc.

③ spatial positioning of players

- Voronoi diagram [Taki+00], movements creating space [Fernandez+18], etc.

Problems:

- Score prediction (①) may be often unreliable because it is rare throughout a game, and the process leading up to the goals is sometimes ignored
- Most of ②③ have difficulties in relating the evaluation to overall performance
- Most of ①② have used only the data around the ball, it would be difficult to evaluate players at greater distances from the ball and the team as a whole

We propose a evaluation method of team defense to solve those

Proposed: VDEP（Valuating **Defense** by Estimating Probabilities）

A evaluation using prediction with data of all players and a ball

Our approach：

Modify the VAEP (Valuating **Actions** by Estimating Probabilities) method [Decroos + 19] so that it can be applied to ball recovery (interception) and being effectively attacked to evaluate the process of team defense

Advantage:

1. Based on predictions of events that occur more frequently
2. use the location information of players away from the ball
3. defensive evaluation of the team in relation to the team performance

Evaluation of our method：

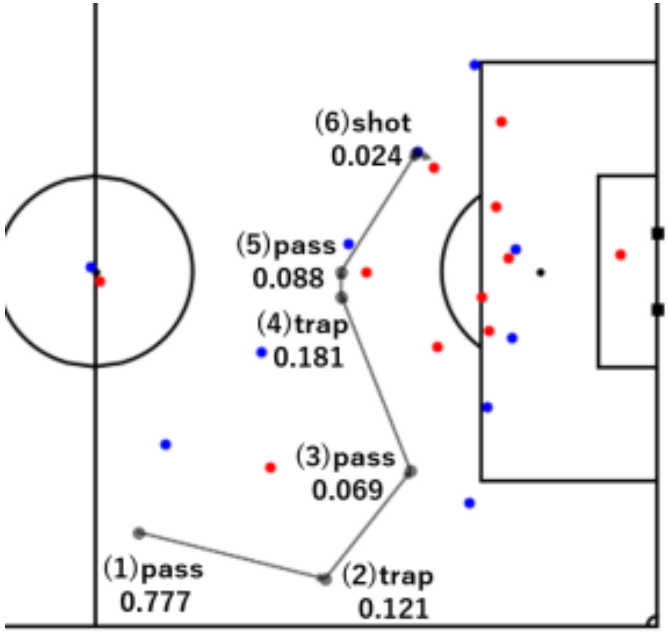
- Relationship with actual match goals
- Relationship with team performance throughout the season
- Specific examples of analysis for a match and a season

Dataset

45 soccer games of the Japanese professional (J-) league in 2019

- event data (19 labels of actions)
- tracking data (i.e., xy coordinates of all players and the ball)

- Basic statistics
  - 106 goals
  - 1,174 shots
  - 3,701 effective attacks （※1）
  - 9,408 ball recoveries （※2）
- Evaluation
  - used a five-fold cross-validation procedure (training with 36 games and testing with 9 games) and finally evaluated all games



※1 effective attack: an event that finally ends in a shot or penetrates the penalty area
※2 ball recovery: a change in the attacking team before or after the play due to some factors other than an effective attack

Formulation: VDEP（Valuating Defense by Estimating Probabilities）

Value of defense based on ball recovery and being attacked

$$V_{VDEP}(S_i) = P_{recoveries}(S_i) - C * P_{attacked}(S_i)$$

（Highly evaluated if $P_{recoveries}$ increases or $P_{attacked}$ decreases）

S_i: a state at *i*-th and (*i-1*)-th events and their xy coordinates for all

C: is a parameter that adjusts the $P_{recoveries}$ and $P_{attacked}$ (frequency here)

$P_{recoveries}$, $P_{attacked}$: estimated by learning-based classifiers (XGBoost)

- Input: 19 events, their xy coordinates for all players and the ball, time, the displacement of movement, the distance and angle with ball and goal
- Output : probability of ball recovery or being attacked within k (= 5) events
- Inspired by VAEP[Decroos+19]

Evaluation indices

Evaluation value per game for team *p* is as follows:

$$R_{VDEP}(p) = \frac{1}{M} \sum_{S_i \in \boldsymbol{S}_M^p} V_{VDEP}(S_i)$$

M: number of events in a match

$\boldsymbol{S}_M^p$: set of states *S* up to the *M*-th event

Similarly, the mean of $P_{recoveries}$ and $P_{attacked}$ are defined as $R_{recoveries}(p)$ and $R_{attacked}(p)$, respectively

Also, $S_{VAEP}(p)$, $S_{scores}(p)$ and $S_{concedes}(p)$ are computed as the sum of VAEP-related values based on [Decroos+19]

(since we here evaluate a team, sum and mean have the same meaning)

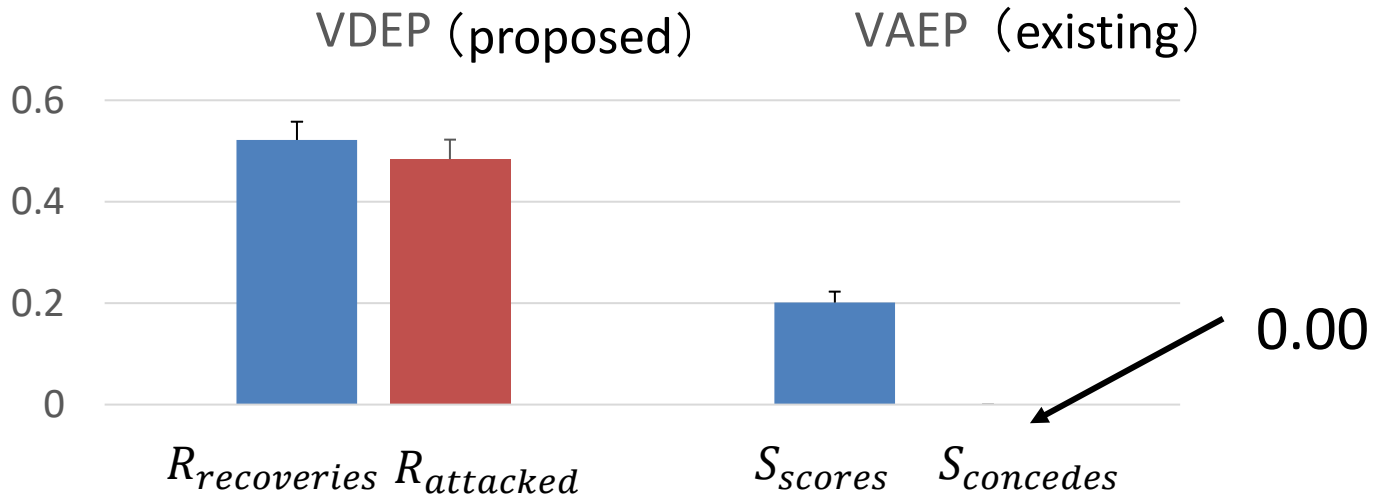
Validation of Classifiers

	Positive	Negative	
True	True Pos	True Neg	Recall
False	False Pos	False Neg	

Precision

Evaluate true positives using F1 score

F1 score = (2 × Precision × Recall) / (Precision + Recall)



- VDEP : 35,286 ball recoveries, 13,353 attacks / 97,335 events in total (k = 5)
- VAEP : 753 scores, 227 concedes / 97,335 events in total (k = 10)

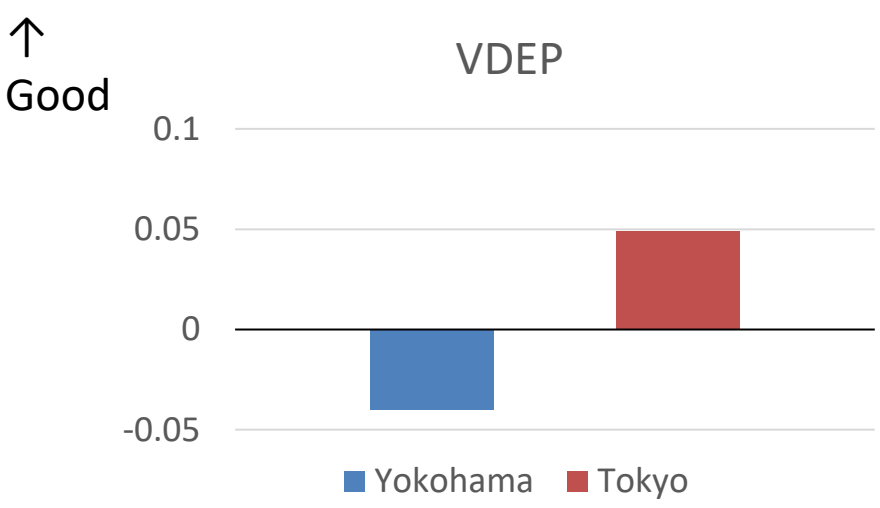
Results suggest that VDEP can be evaluated based on accurate predictions

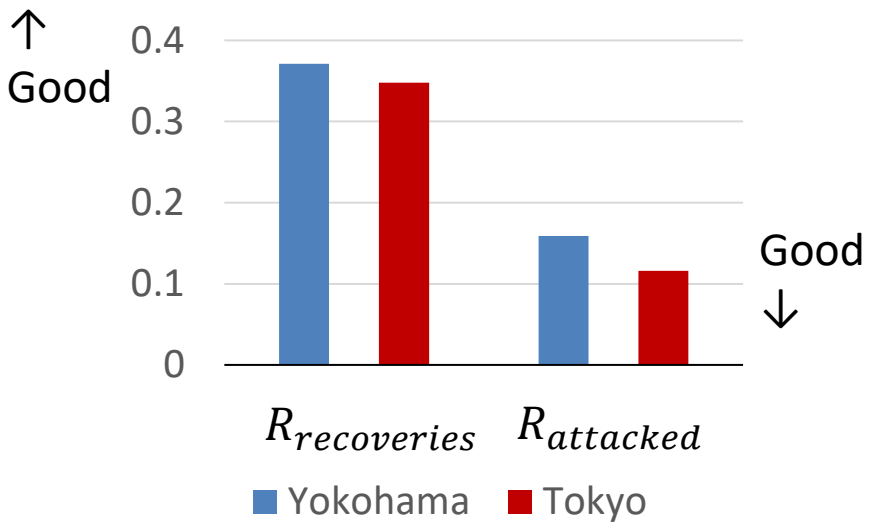
Example of VDEP analysis ① a game

Yokohama F. Marinos vs. FC Tokyo

3-0, but qualitatively similar performance

- numbers of shots were the same in both teams





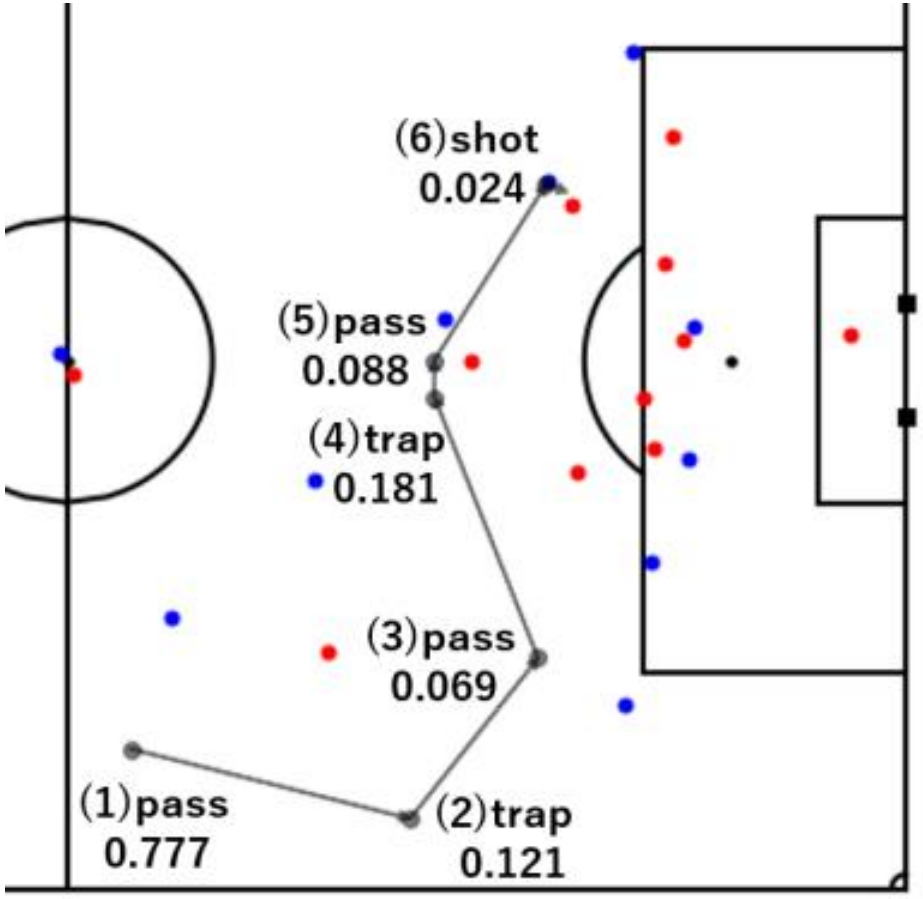
- ✓ VDEP and $R_{attacked}$ in Tokyo were better than that in Yokohama
- ✓ As in this game, there are cases where the evaluation results do not match the game outcome, e.g., when shot was better even if defense was good

Example of VDEP analysis ② a play

1st goal in the same game (Yokohama vs. Tokyo)

VDEP can be interpreted as good defense when positive and bad when negative

Event	player	action	VDEP
1	Matsubara	Pass	0.777
2	Erik	Trap	0.121
3	Erik	Pass	0.069
4	Wada	Trap	0.181
5	Wada	Pass	0.088
6	Theerathon	Shot	0.024



The defense was not so bad that the goal was conceded (evaluation is possible regardless of the outcome)

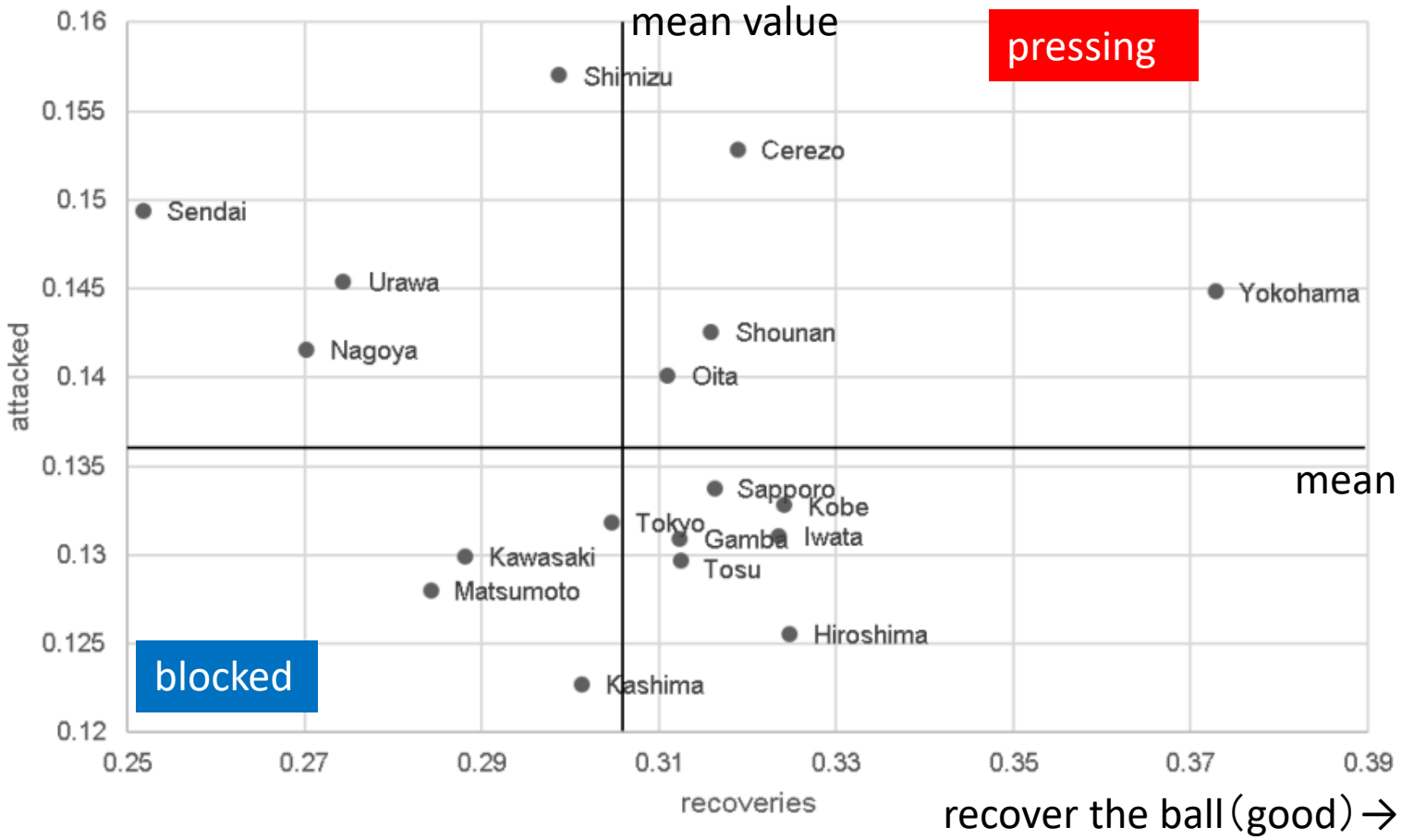
Verification of VDEP (correlation with team performances)

	with the game outcome		with the season outcome	
	VDEP	VAEP [1]	VDEP	VAEP [1]
Winning points	0.464	**0.830**	**0.397**	0.177
Scores	0.392	**0.953**	0.342	**0.497**
Concedes	**-0.245**	-0.040	**-0.291**	-0.098
	Indirectly predicted	Directly predicted		

[1] Decroos+ 19

- VAEP[1] more reflects (or predicts) goals in the actual game
- VDEP could be a well-balanced indicator to evaluate both attacks and defense, also throughout the season

Example of VDEP analysis ③ relation with season performance



Not being attacked (good) ↓

mean value

recover the ball (good) →

- Yokohama (highest score): higher $R_{recoveries}$ and $R_{attacked}$
- Hiroshima (lowest concedes): higher $R_{recoveries}$ but lower $R_{attacked}$

Conclusion

Kosuke Toda, Masakiyo Teranishi, Keisuke Kushiro & Keisuke Fujii, arXiv preprint arXiv:2103.09627, 2021

- We proposed VDEP to quantitatively evaluate the defense of the team
- VDEP based on the prediction of ball recovery and being attacked shows high reliability because these occurs more frequently than the existing score prediction method
- VDEP could be a well-balanced indicator to evaluate both attacks and defense also in the long term rather than winning or losing due to accidental factors

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