A method to assess the influence of individual player performance distribution on match outcome in team sports

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PROJECT ORIGINS

- Can star players be relied upon by teams to win matches, or is a spread of contributors preferable in order to achieve success?

- How can our answers to this question be used to inform player scouting, selection, development and contracting in elite team sports?

- Can we quantify player contributions to the team in a way whereby they are able to be compared longitudinally
    - Between matches and seasons; within player and team

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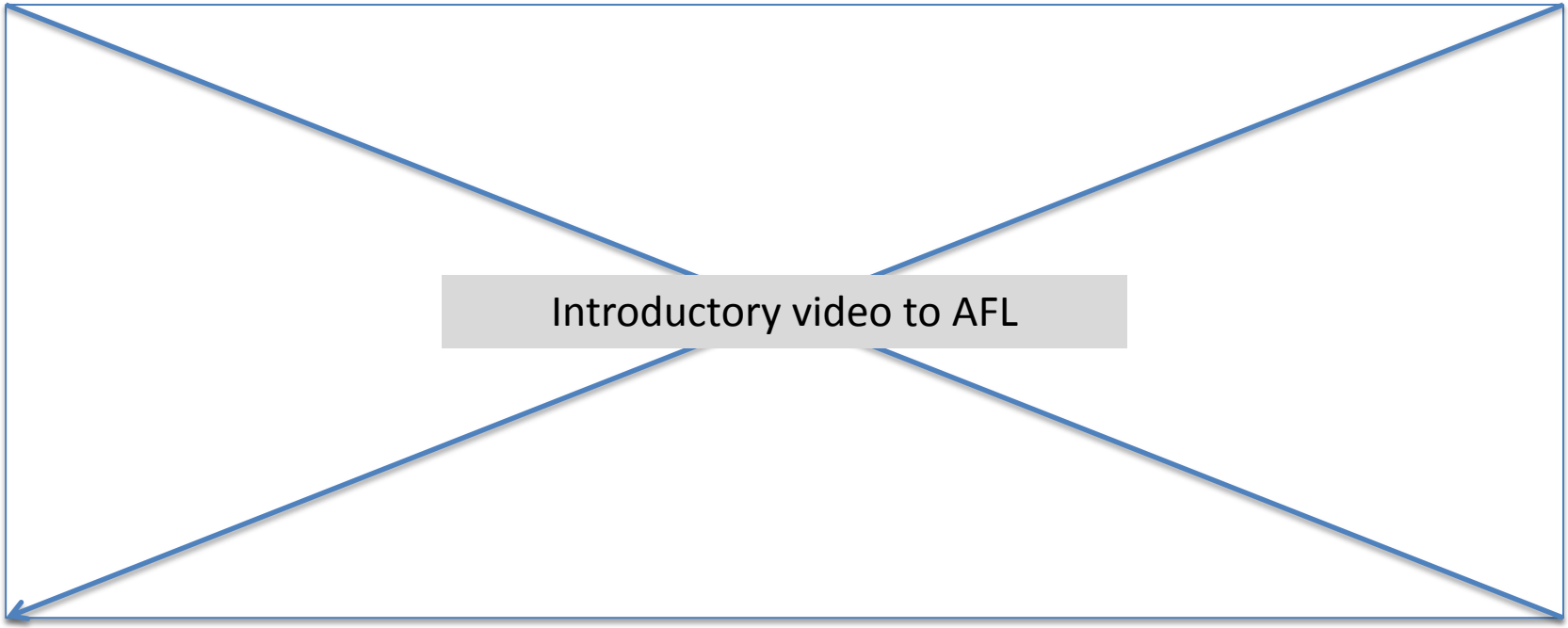
AUSTRALIAN RULES FOOTBALL



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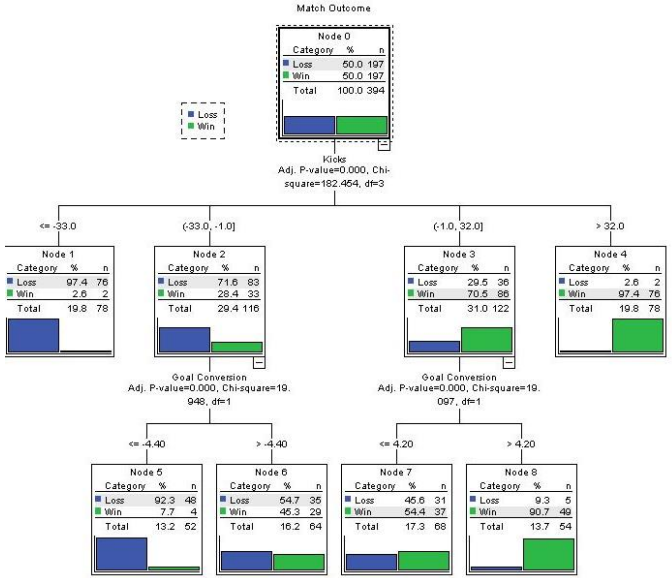
Performance Indicator	Definition
Kick	Disposing of the football with any part of the leg below the knee.
Mark	Catching or taking control of the football after it has been kicked by another player a distance of at least 15 metres without touching the ground or being touched by another player.
Handball	Disposing of the football by hitting it with the clenched fist of one hand, while holding it with the other.
Disposals	Total count of kicks and handballs.
Goals	The maximum possible score (6 points) achieved by kicking the ball between the two goal-posts without touching a post or any player
Behind	A score worth one point, achieved by the ball crossing between a goal post and a behind post, or by the ball hitting a goal post, or by the ball being touched prior to passing between the goalposts
Tackle	Taking hold of an opposition player in possession of the ball, in order to impede his progress or to force quick disposal of the ball
Inside 50	The act of running or passing the ball into the 50 m arc at the opposition's defensive end of the field.
Rebound 50	The act of running or passing the ball outside of the 50 m arc at the opposition’s offensive end of the field.
Clearance	Clearing of the ball out of a stoppage (congested) situation to the advantage of one’s team
Contested possession	A possession achieved as a result of winning a contest.
Uncontested possession	A possession achieved without having to engage in a contest.
Mark inside 50	The act of a player from the attacking team marking the ball inside the 50 m arc at their offensive end of the field

BACKGROUND: Performance indicators

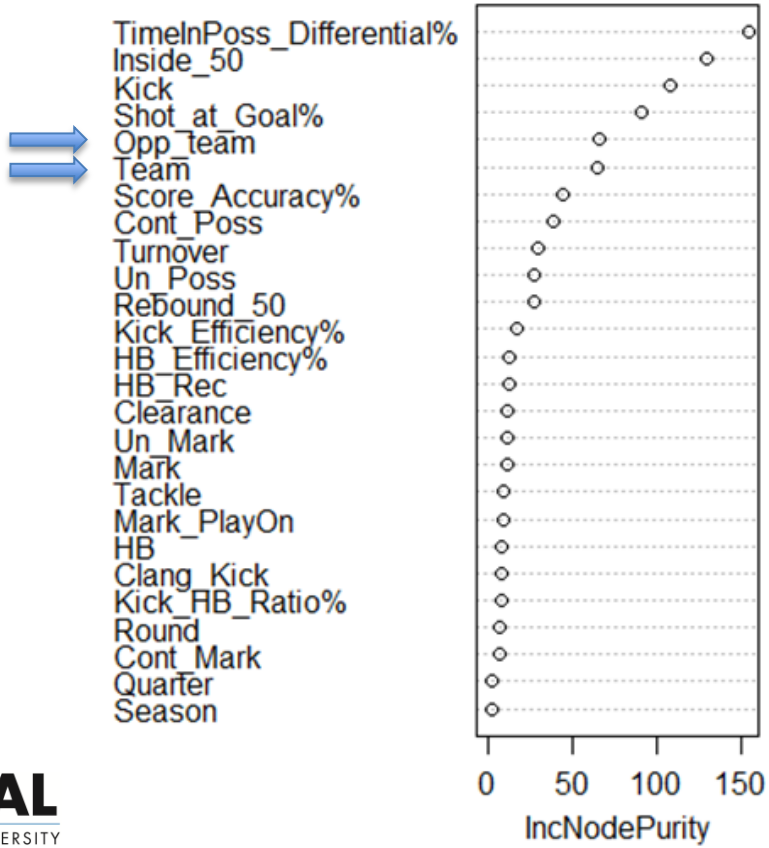
Table IV. Confusion matrix for classification of match outcome from the CHAID models for games played during the 2013 and 2014 AFL regular seasons.

Model set	Sample	Observed	Predicted Loss	Win	Per cent correct
Full	2013	Loss	178	19	90.4
	(training)	Win	21	176	89.3
		Overall			89.8
Full	2014	Loss	157	40	79.7
	(testing)	Win	42	155	78.7
		Overall			79.2
Reduced	2013	Loss	159	38	80.7
	(training)	Win	35	162	82.2
		Overall			81.5
Reduced	2014	Loss	153	44	77.7
	(testing)	Win	39	158	80.2
		Overall			78.9



Robertson, S. J., Back., N., & Bartlett (2015).Explaining match outcome in elite Australian Rules football using performance indicators. Journal of Sports Sciences

BACKGROUND: Importance of team?



Accuracy = 85.67%

- Win accuracy = 88.96%
- Loss accuracy = 82.30%

Considered additional influence of:

- Team
- Margin
- Quarter
- ↑ PI's

Potential for use in-game?

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Directions…

Question	Method
What?	‘Traditional’ PA
Where?	Spatio-temporal
When?	Spatio-temporal
How?	Coaching
Why?	Coaching
Who?	**?**

PROJECT AIMS

• To propose a method of describing the distribution of player performances in team sports

• To determine whether these distributions can be modelled to explain match outcome, using Australian Rules football as an example

• To provide an applied example of how the results can be used in player coaching, development and scouting

- Roster structure

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METHODOLOGY: Data collection

- 2014 AFL season data (198 games)
- Player and Team values for 13 x performance indicators obtained
- All 22 players contributions converted to a percentage of team total
  - Allows for direct comparison to be made across matches
  - Allows for team distributions to be obtained

Performance Indicator	Total observations
Kicks	81,364
Handballs	62,393
Marks	34,895
Disposals	143,757
Goals	4,962
Behinds	3,522
Tackles	26,353
Rebound 50's	14,640
Inside 50's	19,886
Clearances	15,077
Contested poss.	54,401
Uncontested poss.	88,215
Marks inside 50	3,771

(Stewart et al., 2007; Robertson, Back & Bartlett, 2015; Tangalos, Robertson, Spittle & Gastin, 2015;

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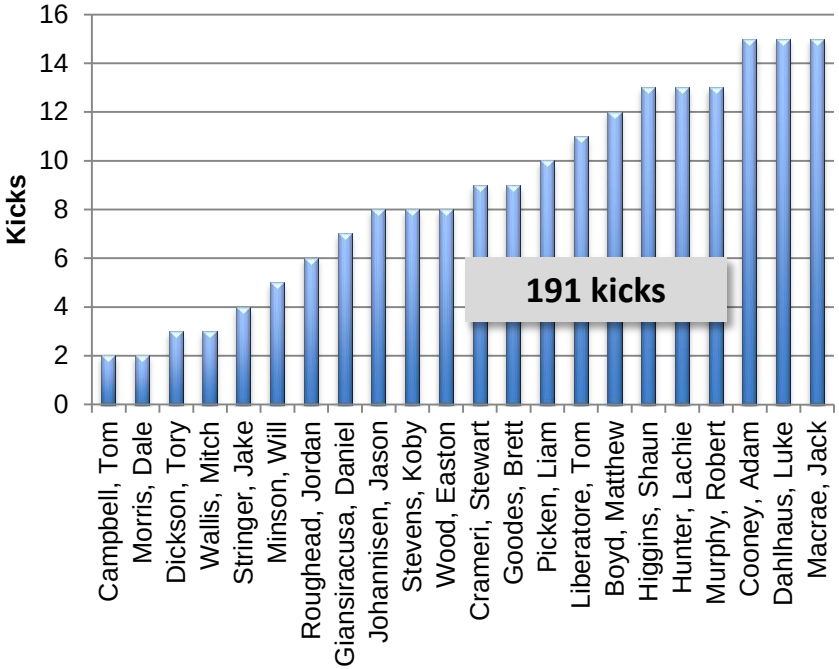
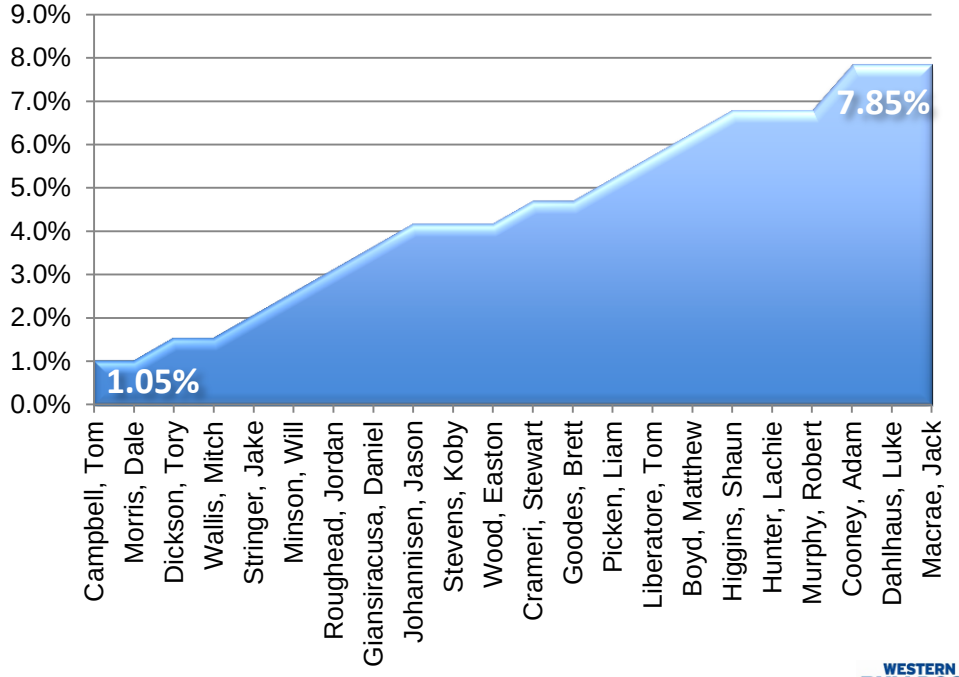
METHODOLOGY: Feature extraction





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METHODOLOGY: Feature extraction

Identifiers	
Team	*N* = 18
Player	*N* = 22

Match result	
Outcome	Win/Loss
Margin	± Points

Performance indicators
Kicks
Handballs
Marks
Disposals
Goals
Behinds
Tackles
Rebound 50's
Inside 50's
Clearances
Contested poss.
Uncontested poss.
Marks inside 50

Team features
Maximum
Minimum
Standard deviation
Mean
P5
P10
P25
P50
P75
P90
P95

Match feature set	
PI's	13
Features	11
Team	2
Total	**286**

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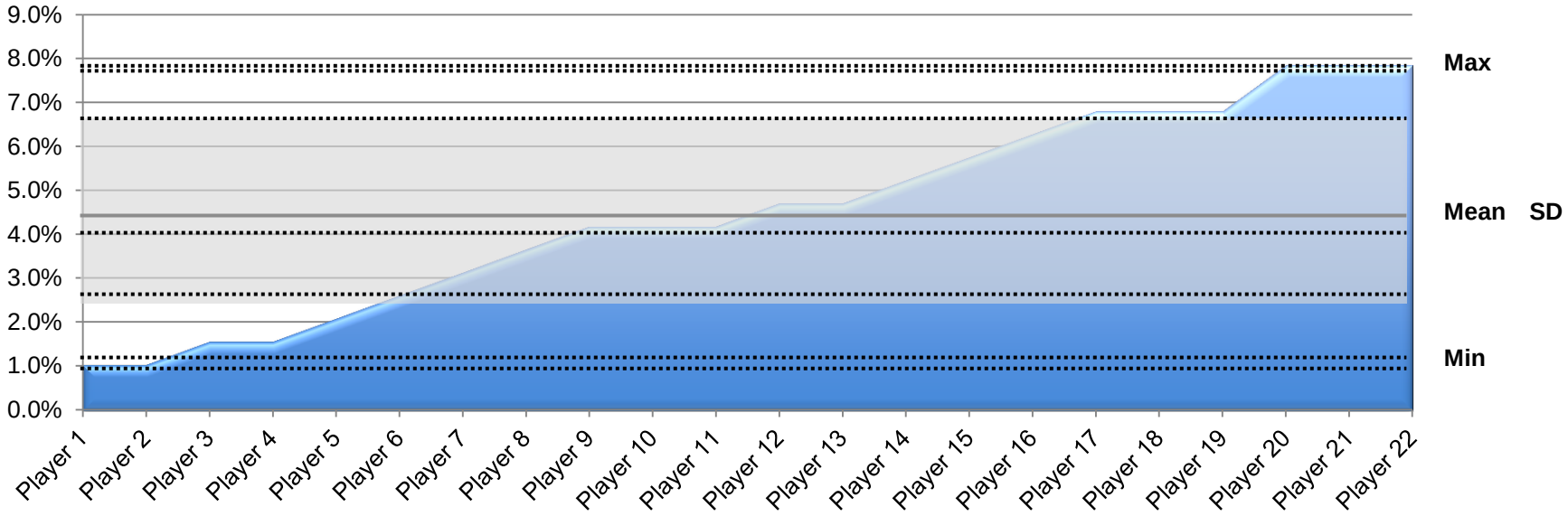
METHODOLOGY: Feature extraction



- Process repeated for remaining 12 performance indicators
- Match outcome [i.e., ‘Win’, +8 points]

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STATISTICAL ANALYSIS

- Model to explain match outcome (Win/Loss) as a function of the feature set for the performance indicators
- Generalized estimating equations [GEE] (Geepack in *R*)
    - Adjusting for the dependence of the 18 teams.
    - Exchangeable correlation structure
- Median match outcome classification accuracy obtained
    - 10-fold cross-validation using random 33% of data
- Decision tree (‘J48’ in R-Weka)

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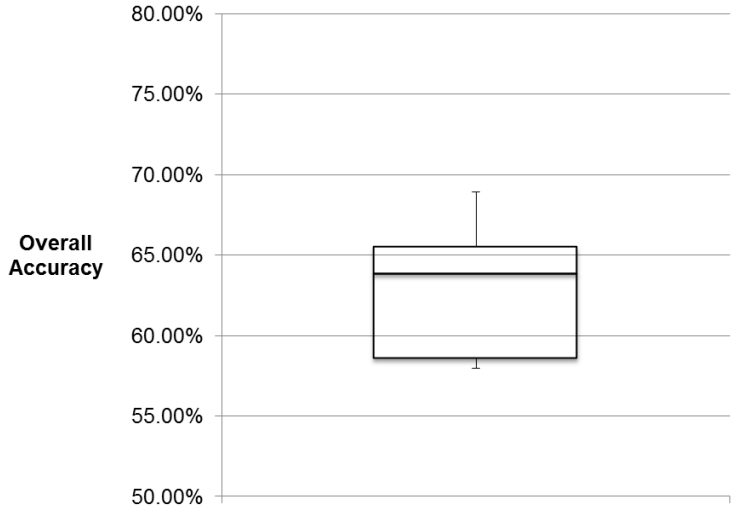
RESULTS: GEE models

- 8 features meaningfully contribute to explaining outcome in 2014 AFL season

Feature	β	S.E	χ^2	*P*
Intercept	0.25	1.71	0.02	*0.88*
Disposal.P25	101.51	35.47	8.19	*<0.001*
Disposals.P50	77.85	33.90	5.27	*0.02*
Marks.P25	38.89	17.95	4.69	*0.03*
Goals.P75	-21.70	3.82	32.27	*<0.001*
Goals.P95	-7.53	2.18	11.91	*<0.001*
Goals.P90	-9.91	3.08	10.36	*<0.001*
Behinds.P90	-6.33	2.00	10.04	*<0.001*
Inside50's.P95	-10.61	4.17	6.47	*0.01*



- Not only magnitude of differences that are important!
- Potential to combine with pre-existing models?

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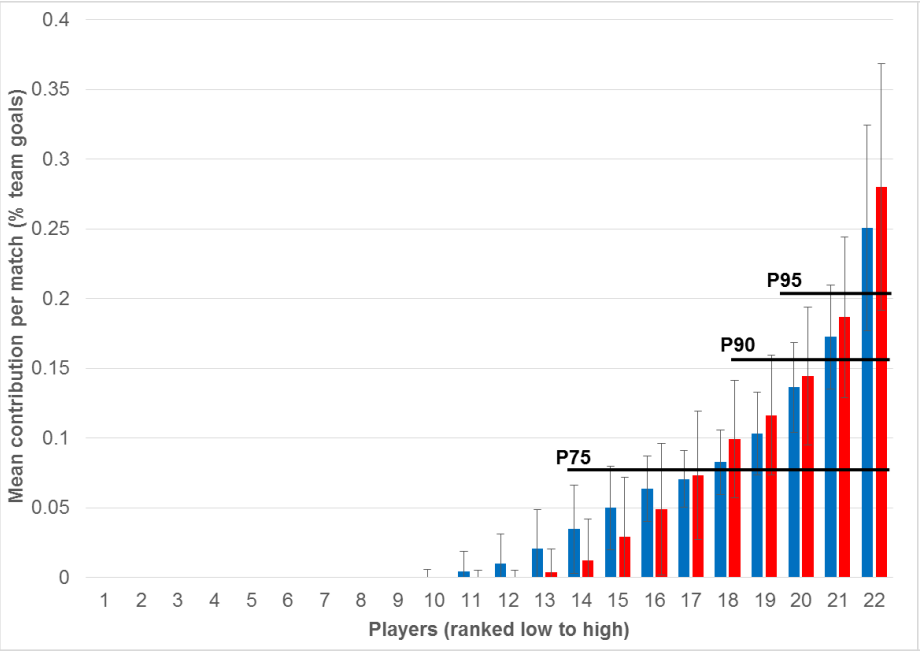
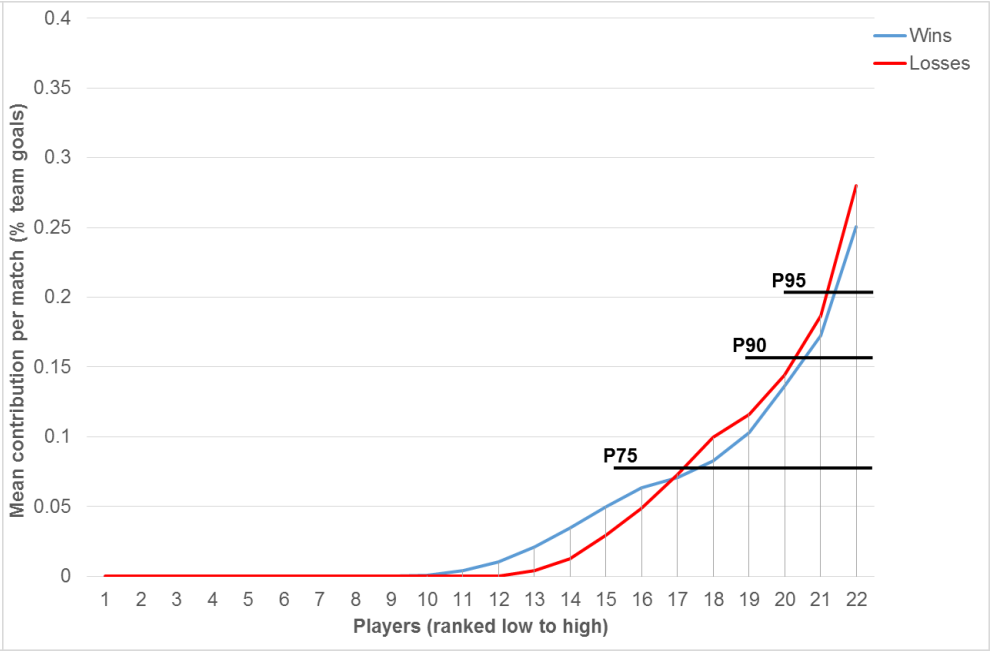
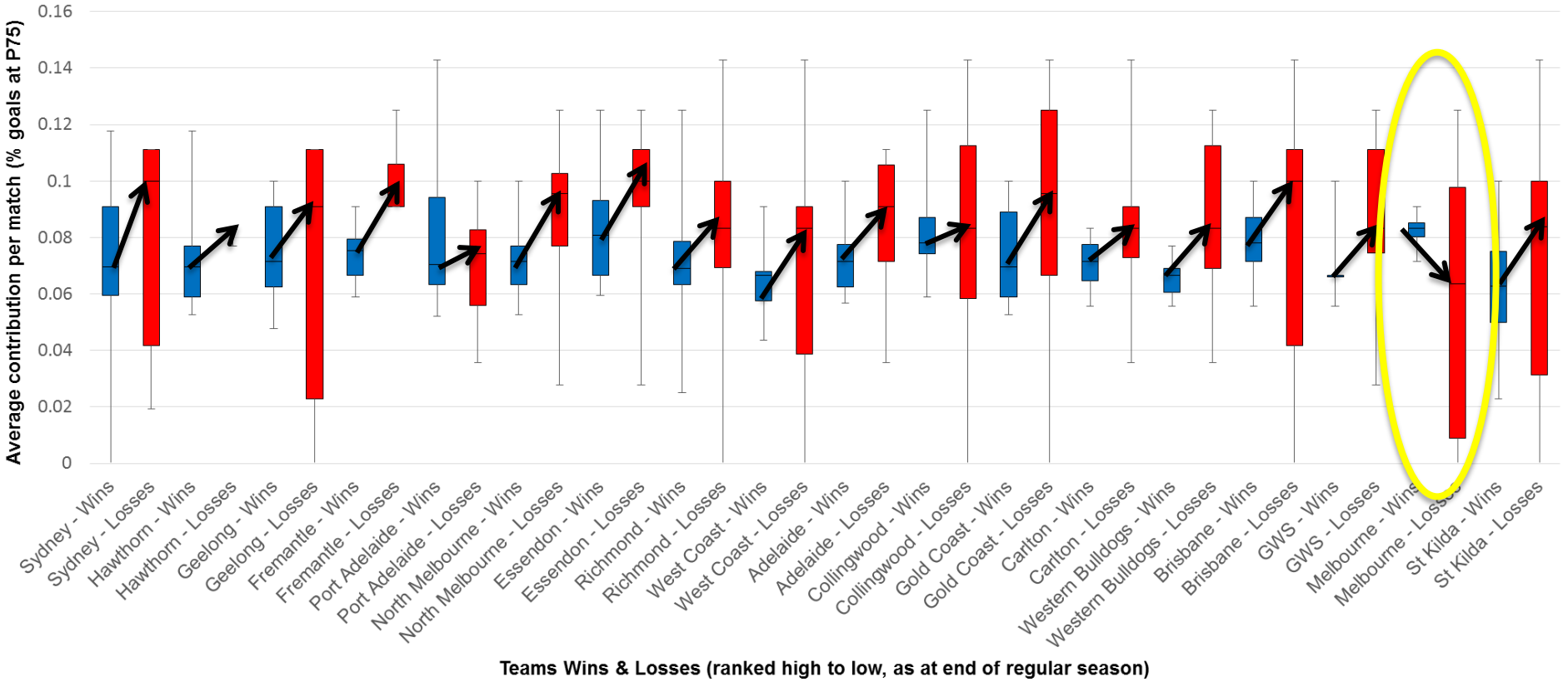
RESULTS: Goals

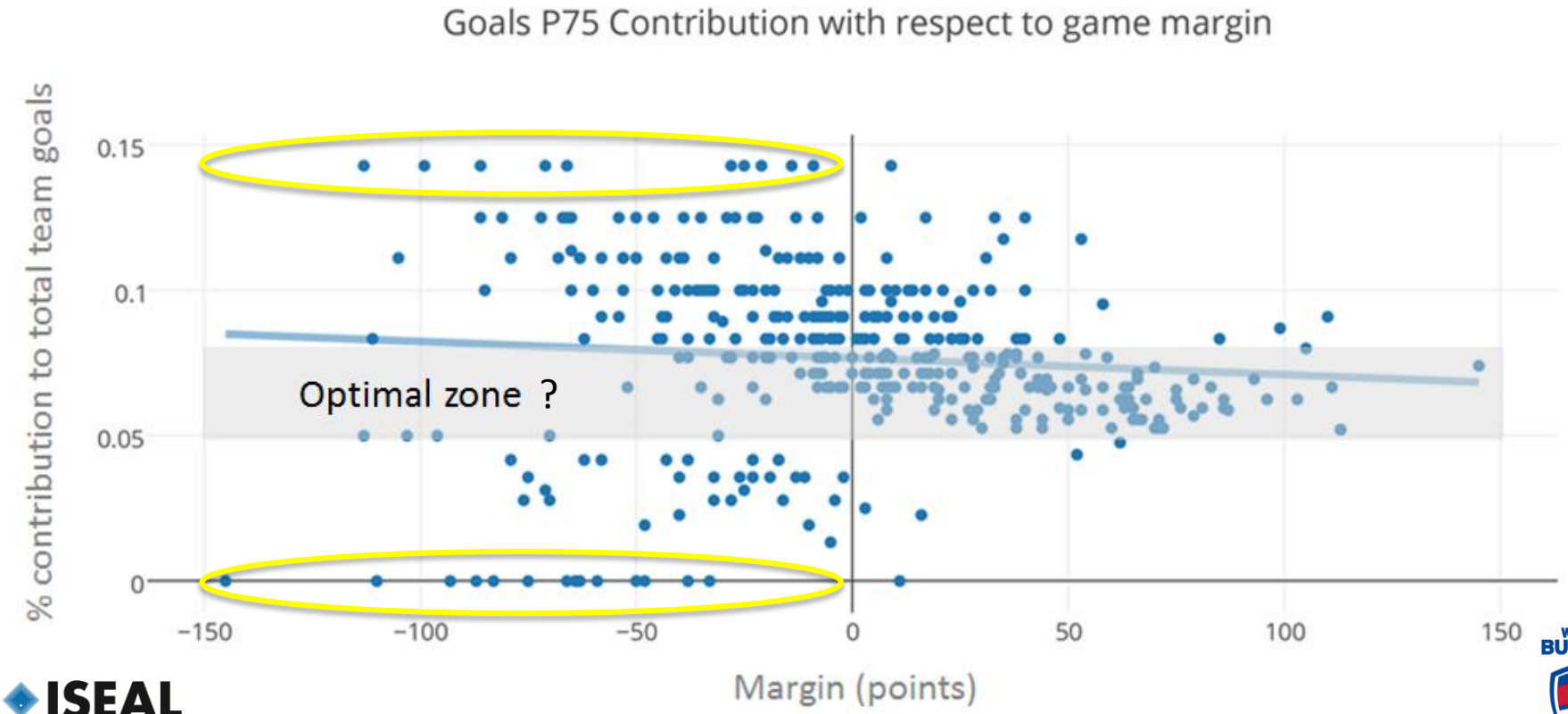




RESULTS: Goals P.75 by AFL team



What about margin?



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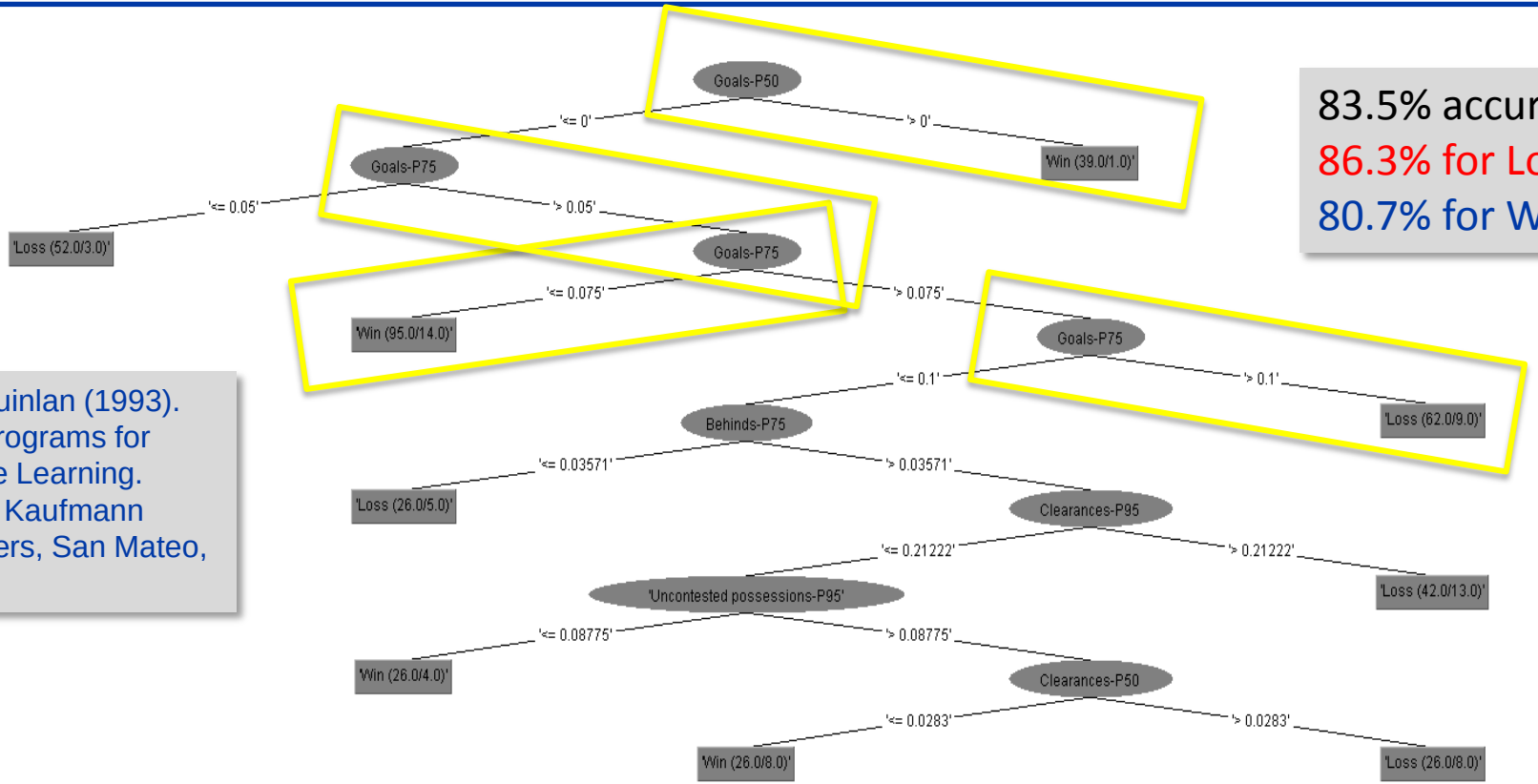
RESULTS: J48 decision tree



83.5% accuracy
86.3% for Loss
80.7% for Win

Ross Quinlan (1993). C4.5: Programs for Machine Learning. Morgan Kaufmann Publishers, San Mateo, CA.

APPLICATIONS: Positional line contributions

Defenders

DEFENDERS	Games Played	Kicks	Marks	Handballs	Disposals	Goals	Behinds	Tackles	Rebound 50s	Inside 50s	Clearances	Contested Possessions	Uncontested Possessions	Marks Inside 50
Austin, Mark	11	2.7%	4.1%	2.3%	2.5%	0.0%	0.0%	1.9%	3.7%	1.2%	1.0%	2.5%	2.5%	0.0%
Darley, Sam	5	4.1%	3.4%	3.5%	3.8%	1.1%	0.0%	3.4%	12.0%	0.8%	1.1%	2.5%	4.5%	0.0%
Goodes, Brett	2	4.0%	4.0%	1.5%	2.8%	0.0%	0.0%	2.2%	4.4%	1.2%	1.2%	1.2%	3.2%	0.0%
Higgins, Shaun	20	5.6%	4.9%	5.7%	5.6%	4.0%	2.5%	4.4%	9.0%	5.2%	1.7%	3.5%	6.7%	1.3%
Howard, Christian	2	2.1%	0.7%	1.8%	1.9%	0.0%	0.0%	3.2%	0.0%	4.3%	2.1%	1.3%	2.3%	0.0%
Johannisen, Jason	11	5.2%	5.1%	3.7%	4.5%	1.7%	5.5%	3.9%	6.6%	4.5%	1.4%	3.2%	5.3%	1.3%
Morris, Dale	20	3.1%	5.7%	3.2%	3.2%	0.0%	0.0%	3.4%	5.9%	1.1%	0.8%	3.0%	3.3%	0.0%
Murphy, Robert	22	7.0%	5.5%	4.3%	5.7%	1.5%	2.2%	2.5%	12.7%	5.0%	1.1%	3.5%	6.4%	1.9%
Picken, Liam	22	5.1%	5.2%	4.9%	5.0%	0.9%	3.0%	5.8%	8.4%	3.9%	2.3%	4.0%	5.5%	1.7%
Roberts, Fletcher	5	2.0%	2.9%	2.0%	2.0%	0.0%	1.8%	2.7%	0.0%	1.4%	0.9%	2.2%	1.6%	2.5%
Roughead, Jordan	15	3.2%	6.3%	3.0%	3.1%	0.0%	0.6%	3.1%	8.5%	1.3%	1.2%	2.7%	3.5%	0.0%
Talia, Michael	3	3.2%	4.5%	3.3%	3.3%	0.0%	0.0%	0.5%	4.8%	1.3%	0.9%	3.8%	3.0%	0.0%
Wood, Easton	18	3.8%	4.8%	4.6%	4.2%	0.4%	1.7%	3.5%	6.0%	4.7%	1.7%	4.1%	4.3%	0.0%
Young, Tom	4	2.7%	3.7%	3.6%	3.1%	1.5%	0.0%	1.7%	6.5%	1.9%	1.0%	2.9%	3.5%	0.0%
Defenders Average	**11.4**	**4.4%**	**5.0%**	**4.0%**	**4.2%**	**1.1%**	**1.7%**	**3.5%**	**7.6%**	**3.3%**	**1.4%**	**3.3%**	**4.6%**	**0.8%**
Team Average	**11.9**	**4.6%**	**4.6%**	**4.6%**	**4.6%**	**4.7%**	**4.6%**	**4.5%**	**4.6%**	**4.6%**	**4.3%**	**4.5%**	**4.7%**	**4.6%**

APPLICATIONS: Positional line contributions

Forwards

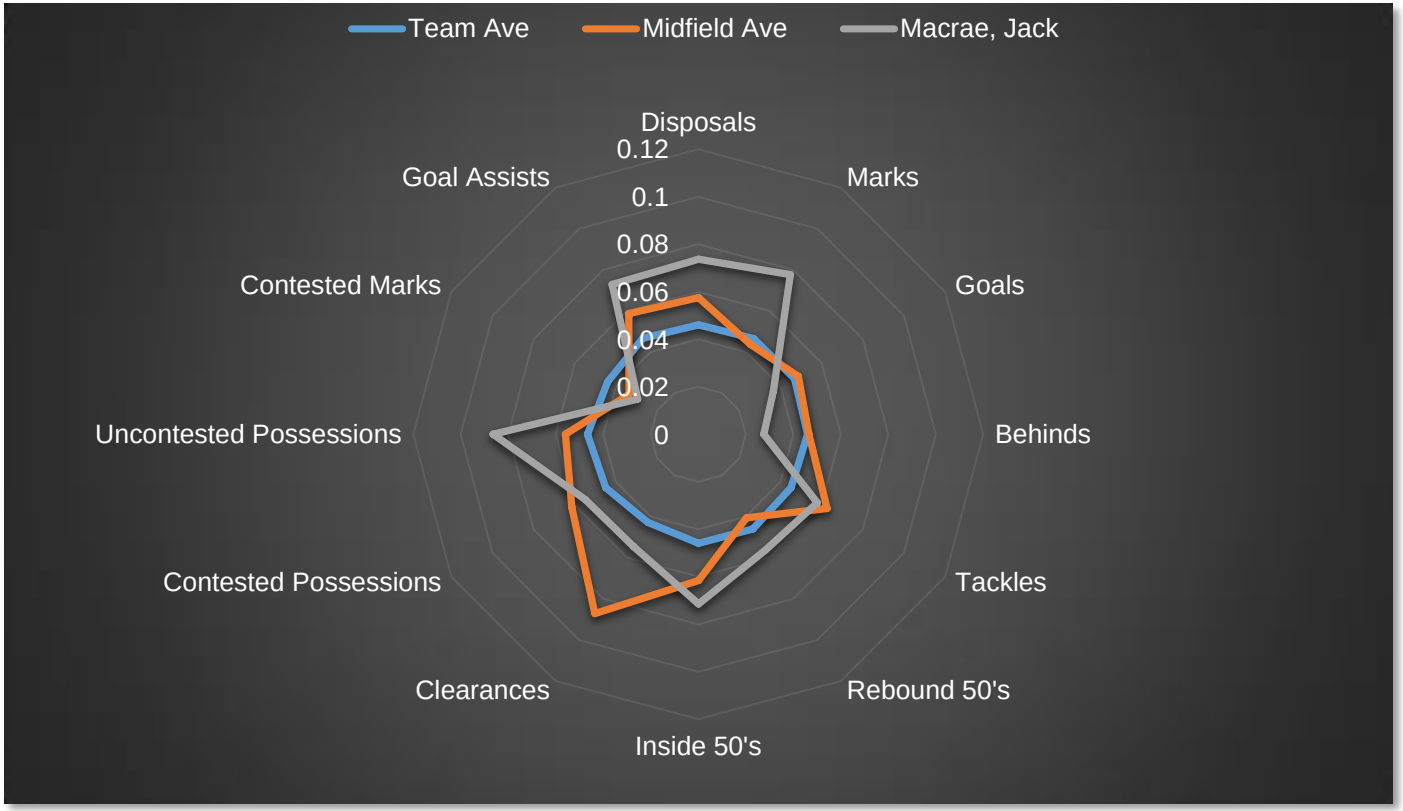
FORWARDS	Games Played	Kicks	Marks	Handballs	Disposals	Goals	Behinds	Tackles	Rebound 50s	Inside 50s	Clearances	Contested Possessions	Uncontested Possessions	Marks Inside 50
Campbell, Tom	7	1.6%	2.3%	2.0%	1.8%	6.7%	3.2%	4.6%	0.0%	2.2%	3.3%	3.4%	0.8%	6.2%
Cordy, Ayce	1	1.9%	0.9%	3.4%	2.6%	0.0%	0.0%	5.0%	0.0%	0.0%	6.3%	4.5%	1.6%	0.0%
Crameri, Stewart	22	4.0%	5.6%	3.6%	3.8%	13.9%	8.5%	3.6%	0.3%	5.3%	0.8%	3.9%	4.0%	15.1%
Dahlhaus, Luke	21	6.0%	5.0%	6.0%	6.0%	8.2%	12.5%	5.9%	3.6%	5.5%	4.9%	6.8%	5.4%	8.9%
Dickson, Tory	4	2.3%	2.7%	2.8%	2.6%	6.3%	2.5%	3.8%	0.0%	3.3%	1.3%	2.4%	2.6%	7.1%
Giansiracusa, Daniel	15	3.5%	3.6%	2.4%	2.9%	8.1%	6.6%	1.7%	2.3%	3.9%	1.4%	1.9%	3.5%	8.0%
Grant, Jarrad	4	3.3%	5.7%	3.3%	3.3%	3.5%	0.0%	3.3%	0.0%	3.7%	2.5%	2.5%	4.2%	6.3%
Honeychurch, Mitch	3	1.5%	3.1%	3.4%	2.3%	2.4%	6.7%	4.0%	0.0%	2.6%	2.2%	1.9%	2.9%	0.0%
Hrovat, Nathan	12	4.4%	4.9%	5.2%	4.8%	6.3%	5.5%	4.4%	2.1%	4.2%	4.3%	5.1%	4.8%	6.1%
Hunter, Lachie	14	4.7%	5.5%	3.2%	4.0%	5.6%	12.6%	3.7%	2.0%	6.0%	3.7%	3.9%	4.0%	9.1%
Jones, Liam	10	3.1%	5.2%	2.5%	2.8%	8.6%	4.6%	2.6%	0.3%	3.7%	1.8%	4.0%	2.3%	14.8%
Redpath, Jack	3	1.5%	2.7%	2.3%	1.8%	4.9%	0.0%	2.2%	0.0%	1.4%	1.4%	1.6%	2.0%	11.4%
Stringer, Jake	18	3.8%	4.2%	2.9%	3.4%	11.4%	11.3%	3.4%	3.5%	3.8%	1.4%	4.4%	3.0%	14.5%
Williams, Tom	7	3.6%	5.0%	2.3%	2.9%	7.4%	1.3%	1.3%	2.5%	2.5%	0.6%	2.7%	2.9%	2.7%
Forwards Average	**10.1**	**3.9%**	**4.6%**	**3.5%**	**3.7%**	**8.6%**	**7.8%**	**3.6%**	**1.8%**	**4.3%**	**2.5%**	**4.0%**	**3.6%**	**9.9%**
Team Average	**11.9**	**4.6%**	**4.6%**	**4.6%**	**4.6%**	**4.7%**	**4.6%**	**4.5%**	**4.6%**	**4.6%**	**4.3%**	**4.5%**	**4.7%**	**4.6%**

APPLICATIONS: Positional line contributions

Midfielders

MIDFIELDERS	Games Played	Kicks	Marks	Handballs	Disposals	Goals	Behinds	Tackles	Rebound 50s	Inside 50s	Clearances	Contested Possessions	Uncontested Possessions	Marks Inside 50
Bontempelli, Marcus	16	4.3%	4.6%	4.4%	4.4%	8.7%	7.4%	4.7%	3.4%	7.9%	5.3%	5.1%	4.2%	8.7%
Boyd, Matthew	19	6.8%	4.8%	7.9%	7.3%	3.2%	6.7%	6.3%	3.9%	6.6%	11.8%	8.0%	6.8%	3.5%
Cooney, Adam	18	5.6%	4.9%	5.4%	5.4%	6.3%	4.7%	4.9%	5.1%	6.1%	7.0%	5.2%	5.6%	3.6%
Griffen, Ryan	19	6.0%	2.2%	6.9%	6.4%	4.6%	6.5%	7.3%	3.6%	7.7%	12.3%	7.2%	5.8%	3.7%
Jong, Lin	6	2.4%	2.2%	3.9%	3.2%	3.5%	2.1%	6.6%	5.1%	3.3%	4.0%	3.9%	2.8%	0.0%
Liberatore, Tom	22	5.7%	4.0%	7.4%	6.6%	2.8%	2.7%	11.0%	5.7%	6.6%	17.4%	9.5%	4.9%	1.3%
Macrae, Jack	21	7.4%	7.8%	7.2%	7.4%	3.6%	2.8%	5.8%	5.6%	7.1%	5.5%	5.5%	8.6%	2.8%
Smith, Clay	1	4.3%	1.4%	3.0%	3.7%	0.0%	9.1%	2.6%	3.4%	4.8%	7.9%	3.5%	3.0%	0.0%
Stevens, Koby	20	3.7%	5.0%	5.9%	4.7%	6.9%	5.2%	3.6%	2.6%	3.0%	4.5%	4.2%	5.3%	6.9%
Tutt, Jason	7	5.1%	2.9%	2.7%	3.9%	11.1%	5.4%	5.5%	1.3%	7.0%	1.3%	3.6%	4.4%	5.1%
Wallis, Mitch	13	3.1%	2.0%	6.0%	4.5%	1.1%	1.7%	5.9%	2.2%	4.6%	8.7%	5.4%	4.1%	1.7%
Midfield Average	**14.7**	**5.3%**	**4.4%**	**6.2%**	**5.8%**	**4.9%**	**4.7%**	**6.3%**	**4.1%**	**6.2%**	**8.7%**	**6.2%**	**5.6%**	**3.8%**
Team Average	**11.9**	**4.6%**	**4.6%**	**4.6%**	**4.6%**	**4.7%**	**4.6%**	**4.5%**	**4.6%**	**4.6%**	**4.3%**	**4.5%**	**4.7%**	**4.6%**

APPLICATIONS: Player evaluation



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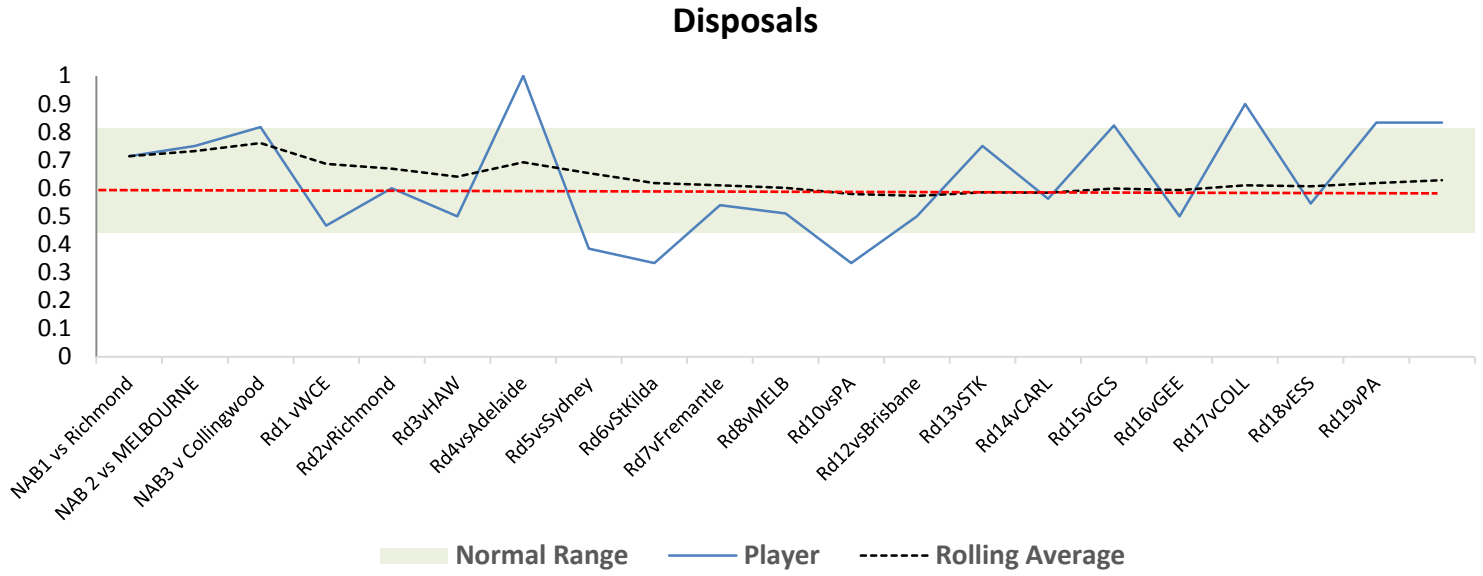
APPLICATIONS: Actual vs expected



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LIMITATIONS

- Observational dependencies:
  - Only controlled for team dependence within GEE model
- Choice of correlation structure?
- Issues with linear models? Mixed effect models?
- Interpretability of data format by coaches?

FUTURE DIRECTIONS

- Combined with magnitude data
  - Preliminary analyses are positive
- Additional of further data types
  - Player couplings
  - Ball movement motifs
  - Other performance factors?
- Which elements of the game do we most need versatility and player flexibility?
- Other analysis techniques

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Questions?

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