PassPredictR: Contextualizing NFL Throwing Decisions By Modeling Receiver Choice

TEAMWORKS

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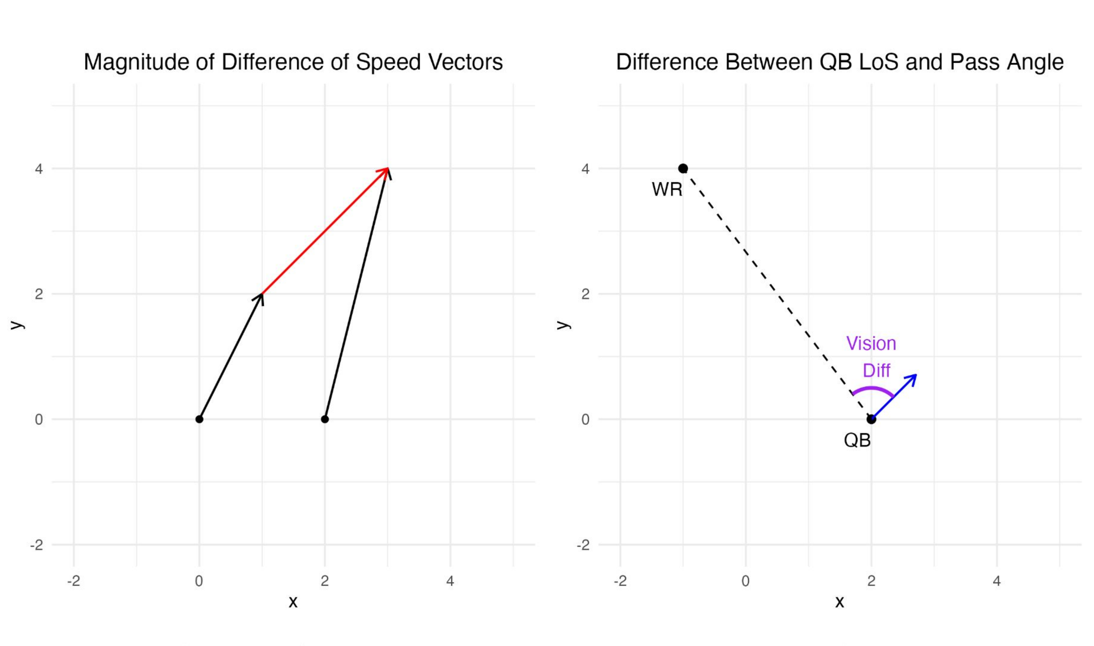
Motivation

- Choice of receiver can be the difference between a touchdown or interception during a throwing play in football
  - A quarterback's decision-making ability is extremely important to the success of a team
- Therefore, it is important to contextualize throwing decisions by comparing with the expected decision
- This work provides this contextualization by building a model which predicts the likely throwing decision
  - Using tracking and event data from the 2024 NFL Big Data Bowl,[1] describing the first 9 weeks of the 2022 season

Methodology

- Like similar approaches in soccer,[2] we model receiver targeting as a learning-to-rank(LTR) problem using an XGBoost model on hand-crafted features:
  - Full feature set and methods can be found in presentation (see *Further Information*)
- Separation: Magnitude of the difference of speed vectors at throw as a proxy for future separation
  - Strong correlation with future separation (0.81)
- QB Vision: Derived estimate of QB's center line of sight (LoS), difference between LoS and pass angle



- After random search tuning and 5-fold cross-validation, with folding along games, the model yields 59.9% top-1 accuracy, significantly outperforming both a naive guess (20%) and a separation-based heuristic (31.6%)

Results

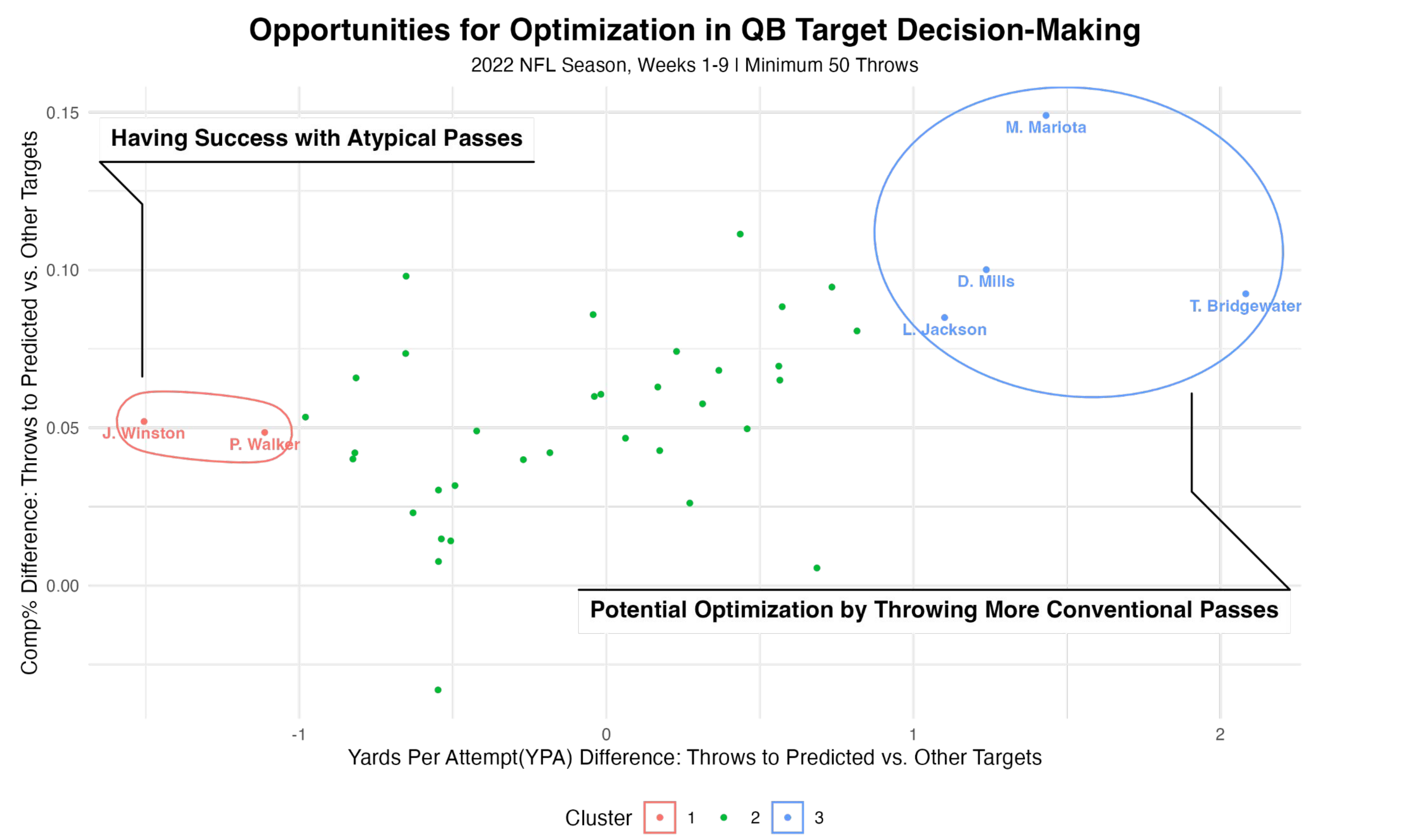


Fig. 1 - Differences in YPA and Completion % between model-agreeing throws and other receivers. Some QBs perform better when aligned with the model, indicating potential opportunities to optimize by favoring expected targets

Top 10 Least Predictable QBs
2022 NFL Season, Weeks 1-9 - Minimum 50 Throws

Quarterback	Team	Total Throws	% Throws to Predicted Receiver
Tua Tagovailoa	MIA	205	52.680
Jameis Winston	NO	105	59.050
Dak Prescott	DAL	74	60.810
P.J. Walker	CAR	86	66.280
Tom Brady	TB	359	66.300
Josh Allen	BUF	262	68.700
Derek Carr	LV	255	69.020
Davis Mills	HOU	236	69.490
Joe Flacco	NYJ	138	70.290
Andy Dalton	NO	177	70.620

Top 10 Most Predictable QBs
2022 NFL Season, Weeks 1-9 - Minimum 50 Throws

Quarterback	Team	Total Throws	% Throws to Predicted Receiver
Justin Fields	CHI	171	80.700
Ryan Tannehill	TEN	128	80.470
Jared Goff	DET	249	79.520
Matt Ryan	IND	270	78.890
Trevor Lawrence	JAX	274	78.830
Jalen Hurts	PHI	215	77.210
Bailey Zappe	NE	86	76.740
Baker Mayfield	CAR	146	76.710
Kyler Murray	ARI	321	76.640
Geno Smith	SEA	232	76.290

Fig. 2 - Quarterback "predictability", measured by proportions of throws to the expected targets

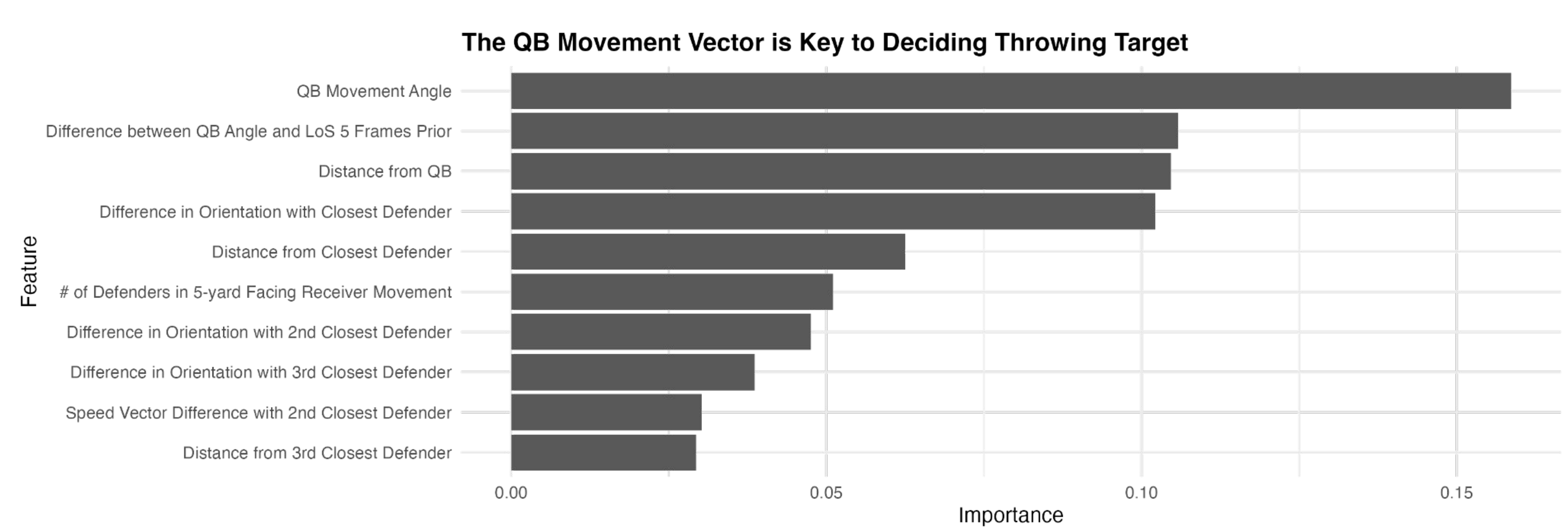


Fig. 3 - Variable Importance for the XGBoost Model, determining the expected throw target

Discussion

- This work builds an XGBoost learning-to-rank model with handcrafted features to predict the likely target of a typical quarterback
  - We can then contextualize individual QB decisions by comparing them to model-predicted choices.
- By analyzing YPA and completion rate by model agreement, we can highlight QBs who succeed with unconventional pass options or might benefit from more conventional throws
- However, quarterbacks will encounter different game states, so some may have more opportunities to make more typical throws
  - To better evaluate QB decisions, future work should estimate yards and completion probability for receivers to find the optimal decision
- Additionally, future work includes pre-snap factors (coverage mismatches, motions, receiver skill) to update target probabilities from the snap to the pass

Acknowledgements

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References

.**1.** Michael Lopez, Thompson Bliss, Ally Blake, Andrew Patton, Jonathan McWilliams, Addison Howard, and Will Cukierski. NFL Big Data Bowl 2024. https://kaggle.com/competitions/nfl-big-data-bowl-2024, 2023. Kaggle.

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Further Information

Presentation and Code:

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