

RUSH INDEPENDENT PASSING PLAYER EFFICIENCY NUMBER (RIPPEN)

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RIPPEN, Rush Independent Passing Player Efficiency Number, is a new measurement of passer performance. In a simulated world, how would a passer perform starting from their twenty yard line and only performing pass plays? The aspects of each play are simulated using a Bayesian model. This allows rookies and backups with minimal data to be fairly evaluated. Drives would end in a touchdown, field goal or turnover. A player's RIPPEN is the average number of points they would be expected to score per drive. Our metric improves on existing passer rating systems because it is updated to current NFL data, does not weight passing touchdowns, and it is able to be more intuitively understood.

1. Introduction. The current passer rating measure has been around since 1973. NFL's Quarterback Rating:
Using the notation from [van Dohlen \(2011\)](#):

$$QBR = \left(\frac{\frac{C}{A} - 0.3}{0.2} + \frac{\frac{Y}{A} - 3}{4} + \frac{\frac{T}{A}}{0.05} + \frac{0.095 - \frac{I}{A}}{0.04} \right) \left(\frac{100}{6} \right)$$

where C = Number of Completions

Y = Number of Yards

A = Number of Attempts

T = Number of Touchdowns

I = Number of Interceptions

Each of these four components has a maximum of 2.375, so a “perfect” passer rating in the NFL is $\frac{(2.375)(4)(100)}{6} = 158.3$.

The NCAA passer rating is: $\frac{8.4Y+330T+100C-200I}{A}$

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This number ranged from -731.6 to 1261.6. Ridiculous.

Passer rating is bad. RIPPEN is better. The NCAA and NFL formulas are different. Mention this.

2. Articles. [Tim Tebow example of why QBR is bad:](#)

Read more about this ([pareto-frontier](#)). Might be interesting

- Would we add something like this to our results

[DYAR and DVOA:](#)

[nih: charles poliquin](#)

[JQAS](#)

A Statistical Analysis of NFL Quarterback Rating Variables
Derek Stimel, Journal of Quantitative Analysis in Sports

The Quarterback Prediction Problem: Forecasting the Performance of College Quarterbacks Selected in the NFL Draft
Julian Wolfson et al., Journal of Quantitative Analysis in Sports

Analyzing dependence matrices to investigate relationships between national football league combine event performances
Brook T. Russell et al., Journal of Quantitative Analysis in Sports

Isolating the Effect of Individual Linemen on the Passing Game in the National Football League
Benjamin C Alamar et al., Journal of Quantitative Analysis in Sports

Quantifying NFL Coaching: A Proof of New Growth Theory
Kevin P. Braig, Journal of Quantitative Analysis in Sports

CITE Passer Rating
CITE QBR

[Don Steinberg: How I Learned to Stop Worrying and Love the Bomb](#)

[Quarterback Rating:](#)

[NFL Passer rating:](#)

College Passer efficiency:

Defending Passer rating: Kerry Byrne

PRO FOOTBALL; The N.F.L.'s Passer Rating, Arcane and Misunderstood

Stimel (2009) Looking for structural breaks in QBR.

van Dohlen (2011)

2.1. *Criticism of QBR.* Arbitrary scale (0 to 158.3??) Hard to interpret (What does 121.6 mean?) QBR overly credits QBs for scoring TDs – discuss whether or not this is entirely wrong. Something to be said for "getting er done", but they weight this a bit too much for a metric which assesses QB efficacy.

3. Methods. We propose Rush Independent Passing Player Efficiency Number (RIPPEN). Describe what we did.

3.1. *Data - Open Source.* In this pursuit of an understandable and intuitive passer ranking system, it makes sense to use the simplest statistics which surround a quarterback's time on the field. Further, as this strives to remain an open source project, the variables pulled in must remain easily accessible and, likewise, public. For this reason, the data pulled in for each quarterback when all was said and done were completions, yards, interceptions and touchdowns, for each time they were snapped the ball and opted to throw.

A pleasant duality of this data decision lies within how closely it mirrors the NFL's passer rating formula described above. In so much as this newly improved metric looks to build upon and redefine the NFL's method, it is not an attempt at reinventing the wheel.

3.1.1. *nflscrapr.* The data used and simulated upon within RIPPEN is scraped from and publically available in another open-source R package, [nflscrapr](#). This project, created and maintained by Rob Yurko, pulls, parses, and groups data from the NFL API for easy use. Although many of the added capabilities were not used for this paper, the building block data for our simulations was. Before diving into talk of simulations, the variables gathered should be ironed out and explained. Below is an example of 4 successive rows in our table, from a game between the Steelers and the Colts.

This table houses the name of the quarterback, binary variables for whether the pass was complete or incomplete, intercepted or not, fumbled or not, and an integer value of yards obtained on the play. An interesting subdivision which *nflscrapr* has to offer is the breakdown of TotalYards into "air yards" and "yards after reception". Although future versions of RIPPEN might factor in these variables separately, it was deemed wisest to aggregate them for TotalYards as a good quarterback can be recognized by his ability to pick a receiver in the most advantageous receiving position.

Sample Data				
Passer	PassOutcome	InterceptionThrown	Fumble	TotalYards
B.Roethlisberger	1	0	0	5
B.Roethlisberger	0	1	0	0
K.Collins	1	0	0	4
B.Roethlisberger	1	0	0	30

Additionally, solely tracking air yards would hurt the rating of quarterbacks who are effective in deploying a short pitch play to a receiver now open to run 20 yards. Altogether, as RIPPEN looks to capture the effect the throwing quarterback had on the team's state at that moment in the game, these are the variables chosen, simple as they may be.

3.2. *How we use our data.* Taking this data, broken down by player over seasons we looked to implement a sampling notion, allowing us to build upon our finite examples and imagine a world in which each team put their quarterbacks on the field to throw thier hearts out. The only downside to generating this data is that we lose context. Therefore, we needed to structure a proxy measure of whether or not a scoring drive (now just a series of yards gained or incomplete/intercepted passes) led to a touchdown or a favorable position on the field for a fieldgoal.

3.2.1. *Simulation! Bayseian?.* I think we have a prior, look at probability within, run it millions of times.. something like this.

3.2.2. *Markov Chain Notion:.* I know what this is! Describe overall concept and explain how it applies to what we are doing – borderline survival analysis.

-Markov-	Down 1	Down 2	Down 3	Down 4
Down 1	a	b	0	0
Down 2	c	0	d	0
Down 3	e	0	0	f
Down 4	0	0	0	1

$$a = Pr(y_{d,1} > 10)$$

$$b = 1 - a$$

$$c = Pr(y_{d,2} > 10 - y_{d,1})$$

$$d = 1 - c$$

$$e = Pr(y_{d,3} > 10 - y_{d,2} - y_{d,1})$$

$$f = 1 - e$$

3.2.3. *Variable description! (More i's than Mississippi).* Dedicated to the variables noted in Markov Chain – make sense of each one and explain significance.

1. $y_{d,i}$: The i^{th} pass of the d^{th} down series. Therefore, $i \in 1, 2, 3, 4$ and d is loosely less than 8.
2. G : The result of the drive/simulation. Either 7 for TD, 3 for FG or 0 for interception or missed FG.
3. $I(\dots)$: Indicator function: ...
4. $C_{d,i}$...
5. $I_{d,i}$: $E[I(D = 4)] = P(D = 4)$
6. $C_{d,i}$: $t'_1 \cdot M = t'_2 = [a \ b \ 0 \ 0]$
7. : $t'_2 \cdot M = t'_3 = [a^2 + bc \ ab \ bd \ 0]$
- 8.

$$Pr(G_j = 3) = Pr(FG \cap (\sum_{i=1}^{n-1} I(D_n = 4) = 0) \cap (\sum_{i=1}^{n-1} y_i < 80 | Q = \sum_{i=1}^{n-1} y_i)) \cdot P(Q = q)$$

$$\dots Pr(FG \cap Q = q)$$

9.

$$Pr(G = 7) = \sum_{n=1}^{\infty} Pr(\sum_{i=1}^n y_i > 80 | \sum_{i=1}^n I(D_i = 4) = 0) \cdot P(\dots)$$

3.3. *How we visualize, parse our analyses?*. Idk, Look at other sections of this paper and prep for that. Suppose we could at least speak to breaking it down by season, game, player and whatnot.

3.4. *Theoretical Results*. Do we have any?

3.5. *Correlation between RIPPEN and winning*. Compare RIPPEN and winning to QBR and winning.

3.6. *Preliminary Results & Notes*.

4. Results.

4.1. *Bayesian Posterior Distributions Stuff*. What do the posterior parameters look like?

4.2. *Rodgers vs Tebow Example*. .

4.3. *Distribtuion of RIPPEN.*

4.4. *Best Games/Seasons.*

5. Conclusion and Future Work. RIPPEN is good. We will do more eventually.

Adding a defensive adjustment.

Do we even want to add these things? How do we deal with pass interference? Defensive Holding? Sacks? Add another layer. Fumbles? Could treat similar to interceptions? Should interceptions ever result in negative numbers? How do we assign the negative numbers for interceptions?

References.

- STIMEL, D. (2009). A Statistical Analysis of NFL Quarterback Rating Variables. *Journal of Quantitative Analysis in Sports* **5** 1.
- VAN DOHLEN, P. (2011). Tweaking the NFL's Quarterback Passer Rating for Better Results. *Journal of Quantitative Analysis in Sports* **7** 22.

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