Introducing STRAIN: A simple and interpretable pass rush metric inspired by materials science

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Abstract. Abstract goes here

Table 1. A summary of previously-existed pass rush metrics.

Metric	Description
Sacks	a
Hits	a
Hurries	a
QB Pressures	a
Pass-Rush Productivity (PRP)	a
Time In Pocket (TIP)	a
Pass Rush Win Rate (PRWR)	Rate at which pass rusher beats pass block within 2.5 seconds after snap

1. Introduction

In recent years, tracking data have replaced traditional box-score statistics and play-by-play data as the state-of-the-art tool in sports analytics. Numerous sports have been collecting and releasing data on player and ball locations on the playing surface over the course of a game. This spatio-temporal multi-resolution source of data have provided exceptional opportunities for researchers to perform advanced studies at a more complex level to deepen the understanding of different sports. For complete surveys on how tracking data have transformed sports analytics, see Macdonald (2020), Baumer et al. (2023), and Kovalchik (2023).

The National Football League (NFL) introduced their player tracking system known as Next Gen Stats (NGS) in 2016 BDB `https://operations.nfl.com/gameday/technology/nfl-next-gen-stats/`

Previous research bdb this year: linemen Importance of D-linemen, pass rush (Maybe talk about role of each position, edge vs interior, defensive formation)

1.1. Previous Pass Rush Metrics

Limitations

Table 1

Sacks, hits, hurries, pressures

Officially tracked by the NFL since 1982, the most well known statistic for evaluating defensive linemen on pass rushing plays is the sack, which occurs when a defensive player

tackles the quarterback behind the line of scrimmage before the quarterback is able to throw a pass.

https://www.pro-football-reference.com/about/advanced_stats.htm

Pressures: QB pressures (hurries + knockdowns + sack plays). Note that "sack plays" in this instance include both sacks and assists.

Hurried: Times QBs were hurried - defined as a situation when the QB is forced to throw the ball earlier than intended or is chased around/out of the pocket as the result of defensive pressure

Hit: Times QBs were hit - occurs when the QB hits the ground after a throw, not marked on a sack play

PFF's Pass-Rush Productivity (PRP)

https://www.pff.com/news/pro-signature-stats-spotlight-defensive-line

More recently metrics such as Time In Pocket (TIP) and Pass Rush Win Rate (PRWR) have also been proposed and are substantial improvements over the less sophisticated counting statistics.

Pocket Time: Number of seconds the quarterback was in the pocket between the snap of the ball and a pass or the collapse of the pocket

Burke (2018)

https://www.espn.com/nfl/story/_/id/24892208

2.5 seconds, arbitrary

While PRWR is certainly a step in the right direction, it takes continuous data and converts it to a binary win/loss, which is generally not recommended in statistical analysis

1.2. Contributions of STRAIN

The remainder of this paper is outlined as follows.

2. Methods

2.1. Data

2023 bdb (Howard et al. 2022)

first 8 weeks 2021 season

tracking: locations of players and ball, 10 fps,

pre-processing standardize

PFF scouting: pass rush role

sample restriction: remove plays w multiple QB

frames between snap and QB outcome (pass forward, sack)

sample size

2.2. Strain rate in materials science

2.3. Application to pass-rushing in football

3. Results

3.1. Example play

Figure 1 shows snapshots

Figure 2 shows Crosby throughout the play

3.2. Positional STRAIN curves

Figure 3 shows pos curves

3.3. Ranking the best pass-rushers

3.4. Corr with pressure rate = (hits + sacks + hurries) per snap

Figure 4 shows cor with pressure

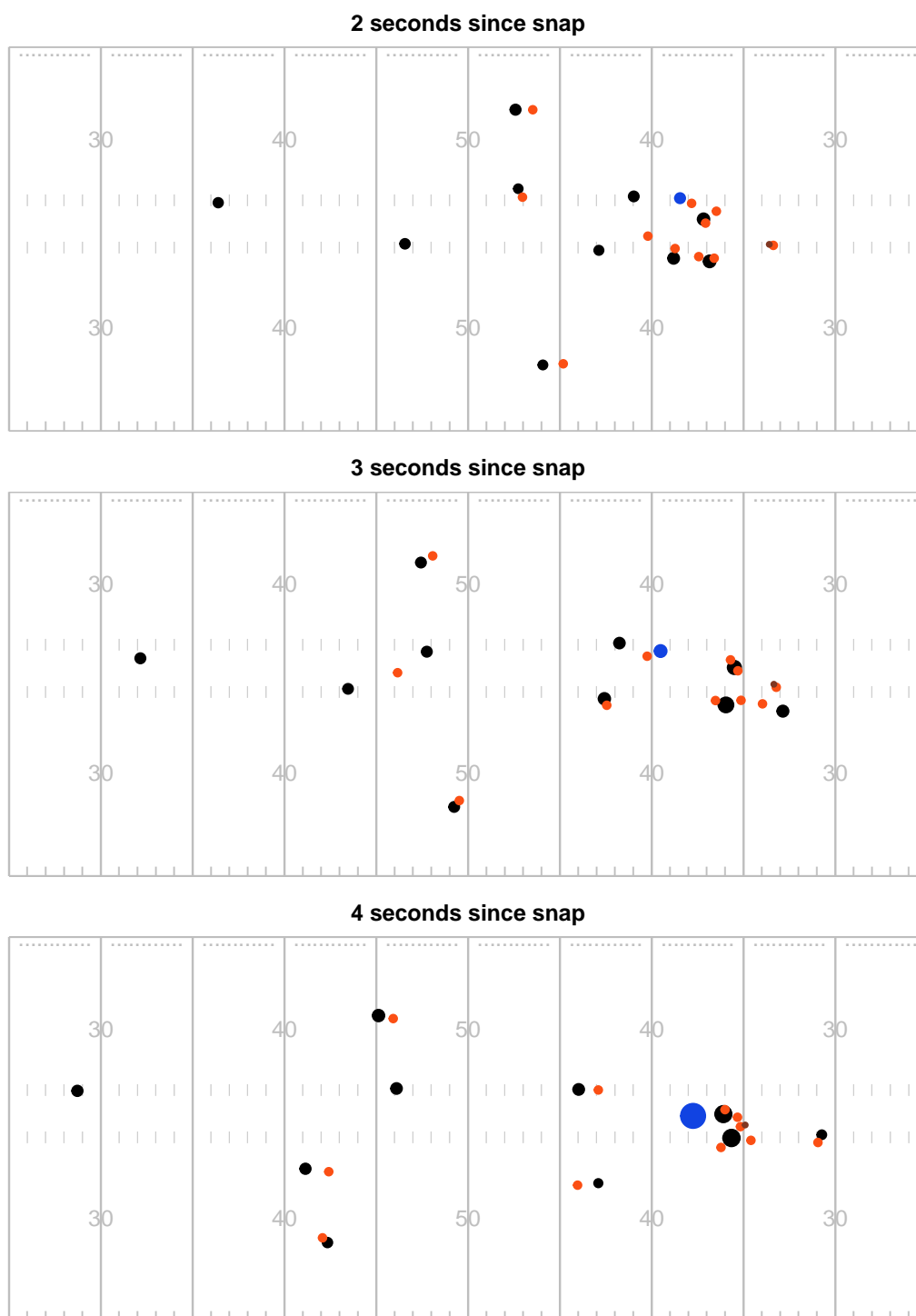Fairly strong correlation (r = 0.6254943) between average STRAIN & hurries + sacks + hits per snaps

2 seconds since snap

3 seconds since snap

4 seconds since snap

Figure 1. snapshots
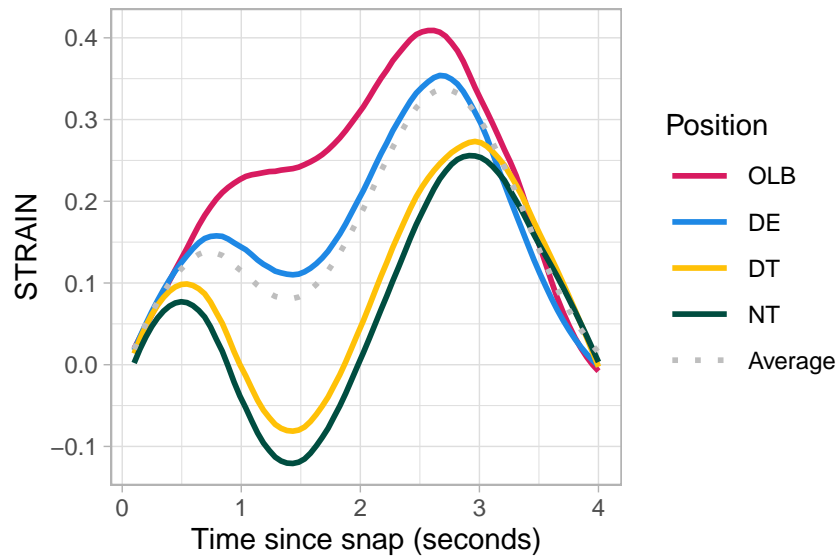
Figure 2. crosby

Figure 3. STRAIN curves for different positions
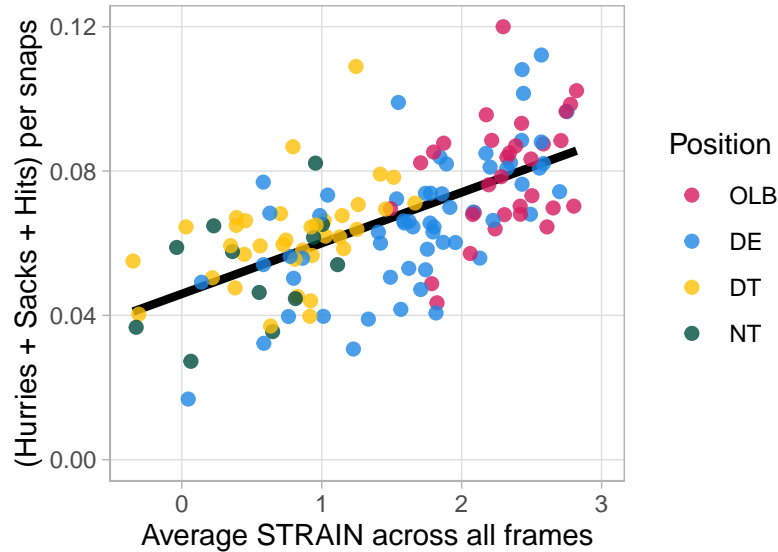
Figure 4. Cor with

3.5. Statistical Properties of STRAIN

From Franks et al. (2016) (github `https://github.com/afranks86/meta-analytics`)

Discrimination: Does the metric reliably differentiate between players?

Stability: Does the metric measure a quantity which is stable over time?

Independence: Does the metric provide new information?

0.8544865

Figure 5 shows

Average STRAIN across all frames played in first and last 4 weeks

Strong correlation shows great metric stability

4. Discussion

References

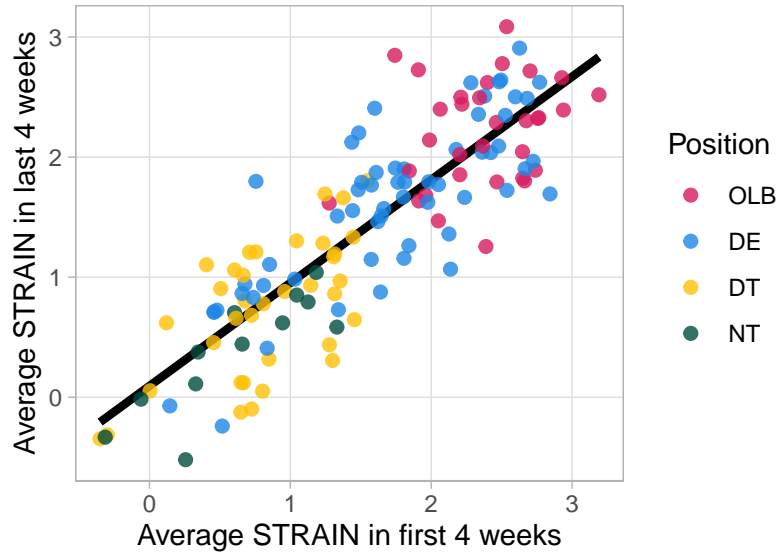Baumer, B. S., Matthews, G. J. and Nguyen, Q. (2023) Big Ideas in Sports Analytics and Statistical Tools for their Investigation. URL: `https://arxiv.org/abs/2301.04001`.

Figure 5. Metric stability

Burke, B. (2018) We created better pass-rusher and pass-blocker stats: How they work. ESPN.com. URL: `https://www.espn.com/nfl/story/_/id/24892208`. [Accessed 10-Mar-2023].

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