Breaking Down Motion: Categorizing Pre-Snap Behavior based on Post-Snap actions

Simple Analysis for High Levels of Insight

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Concept: Motion Categorization

Motion in Modern Offenses

Pre-snap motion is a cornerstone of modern football, used extensively by offenses to gain strategic advantages. However, there is currently no universal way to evaluate motion effectively. Without a standardized system, its impact remains unclear.

Connecting the dots; Pre - Snap Motion to Post Snap Action

To truly understand motion, it must be classified not just by pre-snap movement but also by what happens after the ball is snapped. After all, points are scored only after the snap. By tying pre-snap motion to post-snap action, we can determine which motions create meaningful advantages and which are less effective.

The Power in Simple Classification

A straightforward system—categorizing motion into roles like ball carrier, target, blocker. decoy, and diagnostic—provides actionable insights. This approach enables both offenses and defenses to plan more effectively, turning motion analysis into a practical tool for improving performance.

Dataset

Data Source

Data from NFL Next Gen Stats

Total Plays: 16,124

Motion Plays: 6,862

Non-Motion Plays: 9,262

Total Players who went in motion:9940

Motion in the Data

- **In motion at ball snap**
  - Player is moving at the moment the ball is snapped.
- **Shift Since Lineset**
  - Player shifted Position after the Offensive Line Set
- **Motion Since Lineset**
  - Player moved after the line was set

Tools

Python and SQL for data cleaning, analysis, and categorization. https://www.kaggle.com/code/thomasgermano/motion-classification

Objective

Primary goal

- To classify pre-snap motion players based on their post-snap roles, bridging the gap between pre-snap strategy and post-snap execution.

Key Objective

- Simplify Motion Analysis: Create a straightforward system that categorizes motion into actionable roles: Ball Carrier, Target, Decoy, Diagnostic, and Blocker.
- Reveal Trends: Identify patterns in motion types that correlate with successful offensive or defensive outcomes.
- Provide Coaching Insights: Deliver practical, data-driven recommendations for both offensive and defensive game planning.

Why?

- For Offenses: Use motion insights to design effective plays and exploit defensive weaknesses.
- For Defenses: Anticipate motion roles to neutralize offensive advantages and improve alignment strategies.

Assumptions

Exclusive Motion Categories:

Plays are assigned to one motion type (Target, Rusher, Blocker, Decoy, Diagnostic) based on a priority ranking.Ensures clarity in analysis but may overlook nuanced interaction

Aggregated League-Wide Data

The analysis combines data from all teams, assuming general trends apply across the league

All Movement is pre snap motion

Shifts are considered in pre snap motion. We do not differ between a shift and a motion

Method

Data Prep

Combine inMotionAtBallSnap shiftSinceLineset and motionSinceLineset to create a single motion metric

Categorize

Plays were classified into five motion types (Target, Rusher, Blocker, Decoy, Diagnostic) based on their post-snap action. A priority ranking system ensures each motion play is assigned a single category

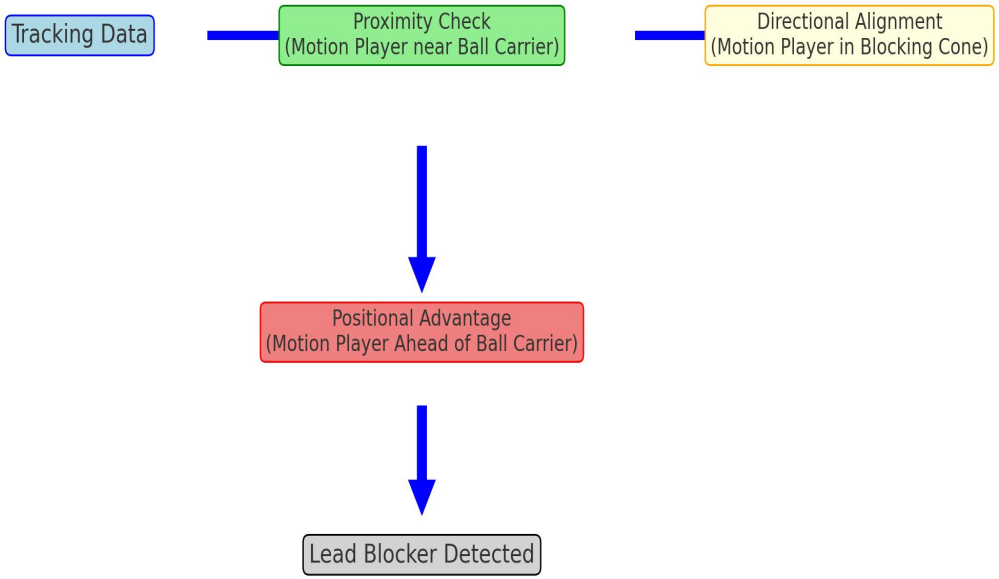
Ranking

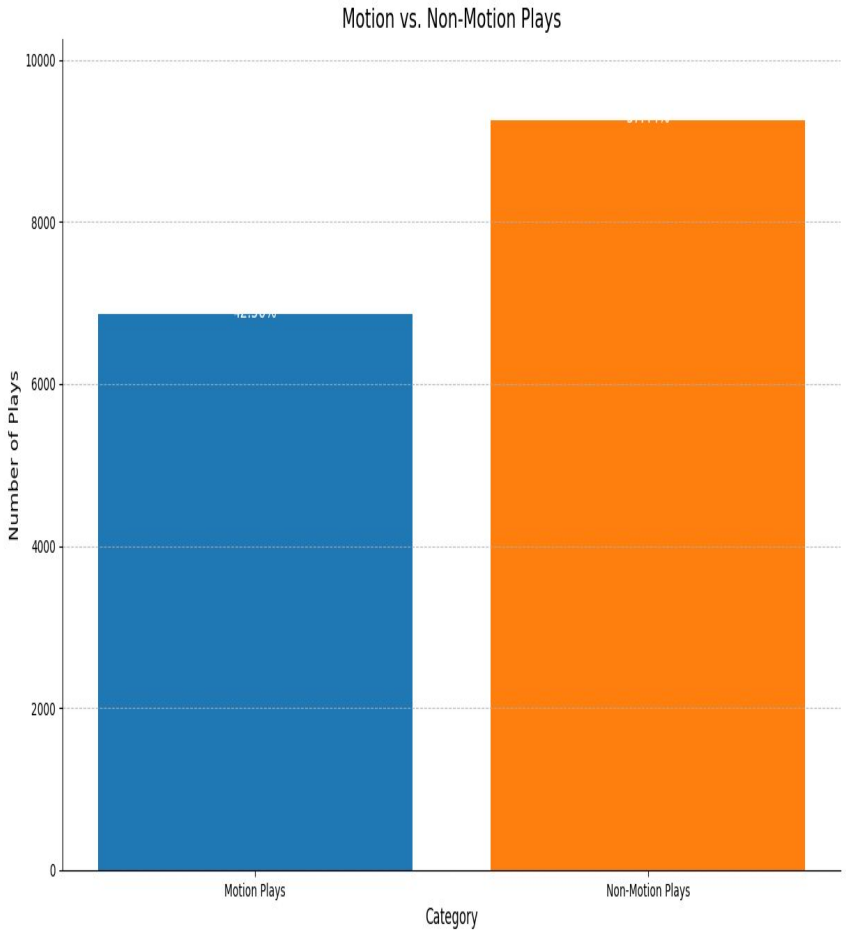
Plays can only be considered a single type of motion, therefore they follow the following order of priority. 1 Target, 2 Rusher, 3 Blocker, 4 Decoy, 5 Diagnostic

Lead Blocker Detection

Lead blockers were identified by analyzing tracking data

Proximity Check: The motion player had to be within a defined distance (tolerance = 0.3) of the ball carrier.
Directional Alignment: The motion player had to remain within the ball carrier's blocking cone (direction_tolerance = 45 degrees).
Positional Advantage: The motion player must be ahead of the ball carrier relative to their movement direction.
Frame-by-Frame Analysis: Intersections were examined across frames to confirm consistent alignment and positional advantage over time.





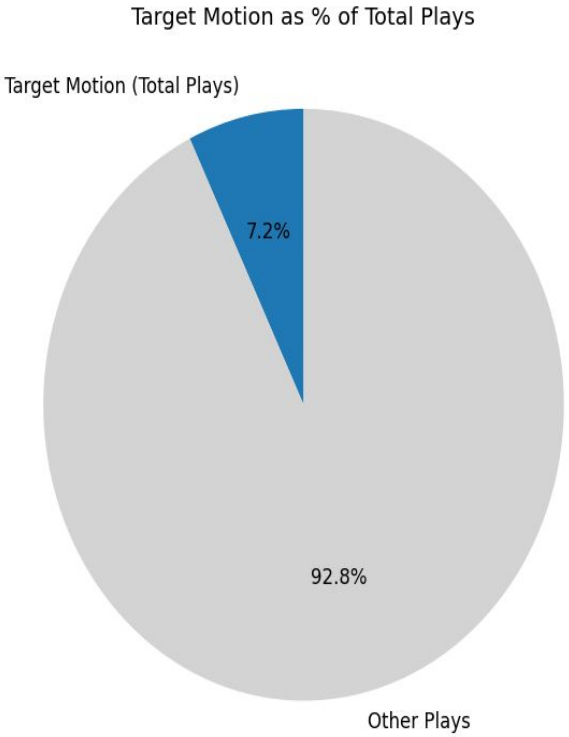
How often do we see motion?

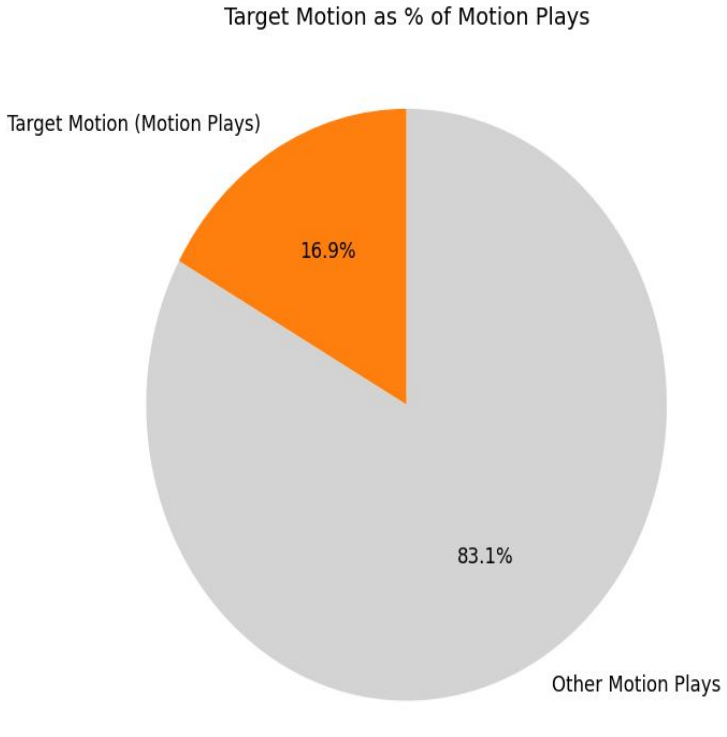
- Pre-snap motion happens on 43% of plays (6862/16124)
- This split tells us how common motion is, but not how it impacts the game
- High-level data is only the first step. To generate actionable insights, we must categorize motion by post-snap roles.

Motion Categories defined

Category	Definition
Target Motion	Player who goes in motion is the target of a pass
Rusher Motion	Player who goes in motion receives a handoff and becomes a rusher
Blocker Motion	Player who goes in motion becomes the lead blocker. This motion type is currently limited to running plays
Decoy Motion	Player goes in motion for purpose of distracting/shifting defense but does not impact the post snap play. In order to be considered a decoy, the player must be in motion at ball snap
Diagnostic Motion	A player goes in motion to help the offense identify what defensive scheme is currently being used. In order to be considered diagnostic, the player must set before the snap in order to give the offense time to diagnose the defensive shift

Target Motion

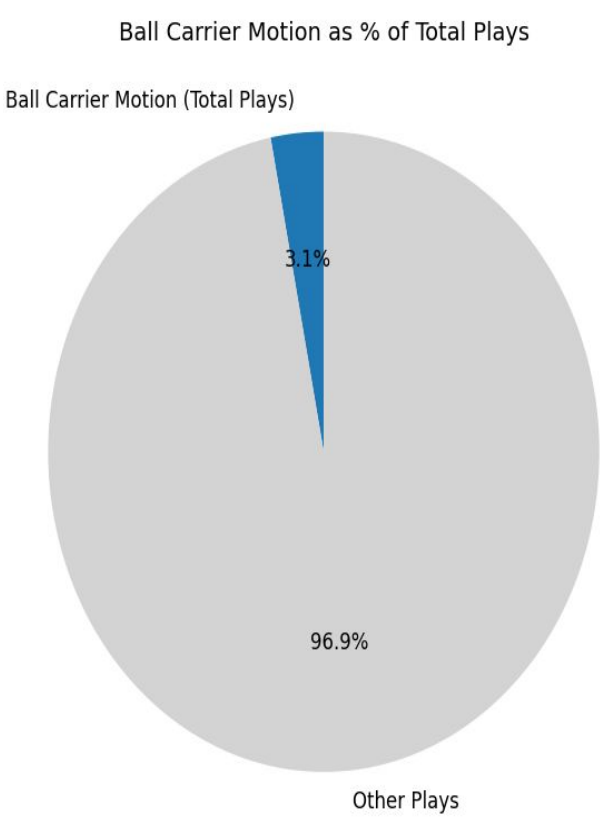


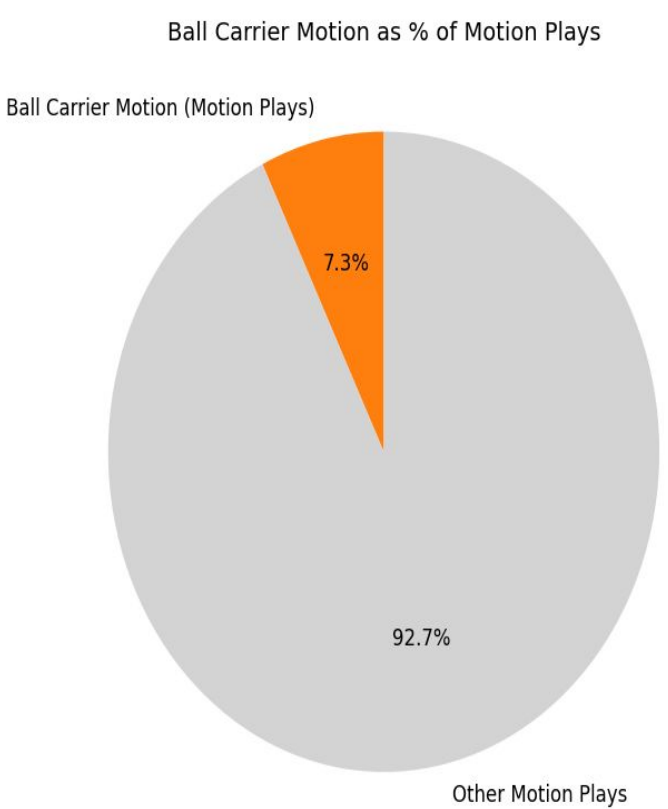


Target Motion as 7% of All Plays

Target Motion as 17% of All Motion Plays

Ball Carrier Motion

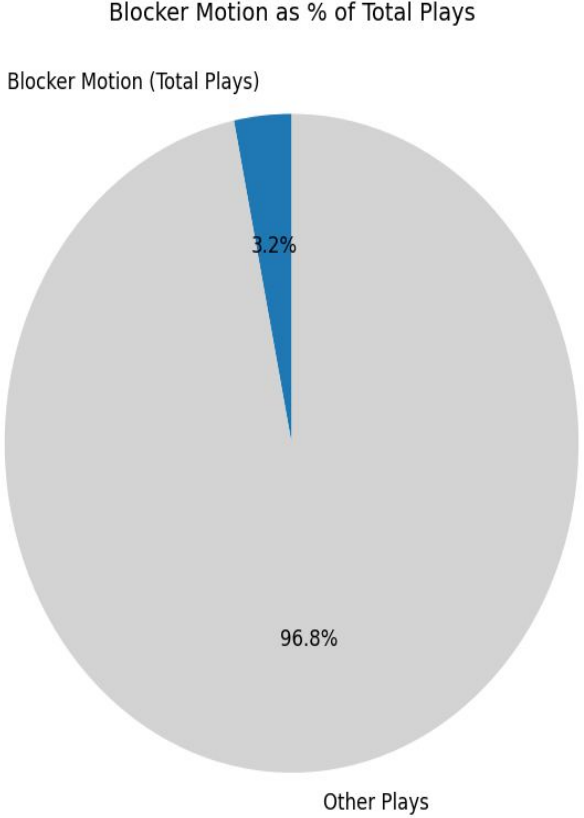


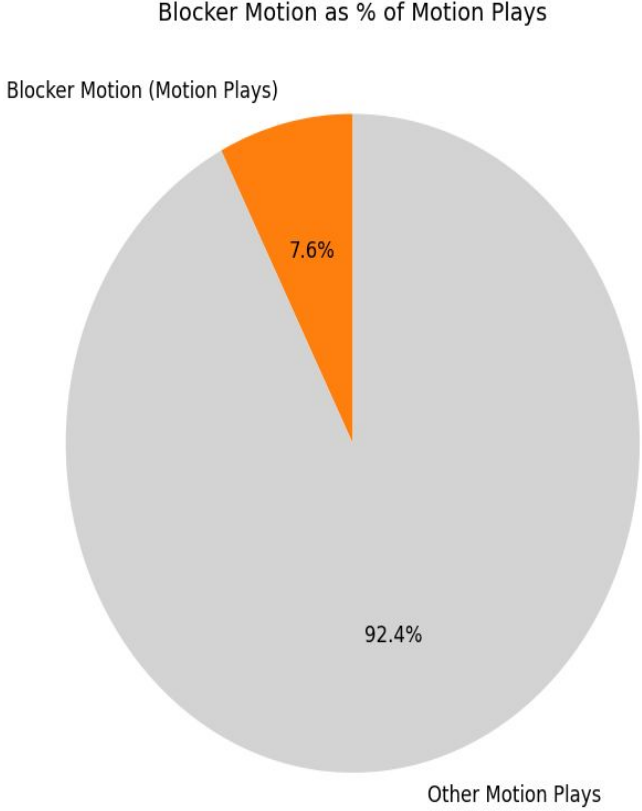


Ball Carrier Motion as 3% of All Plays

Ball Carrier Motion as 7% of All Motion Plays

Blocker Motion

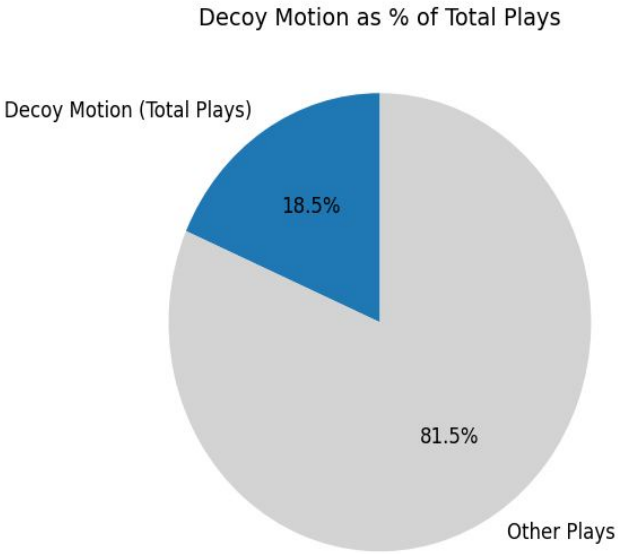


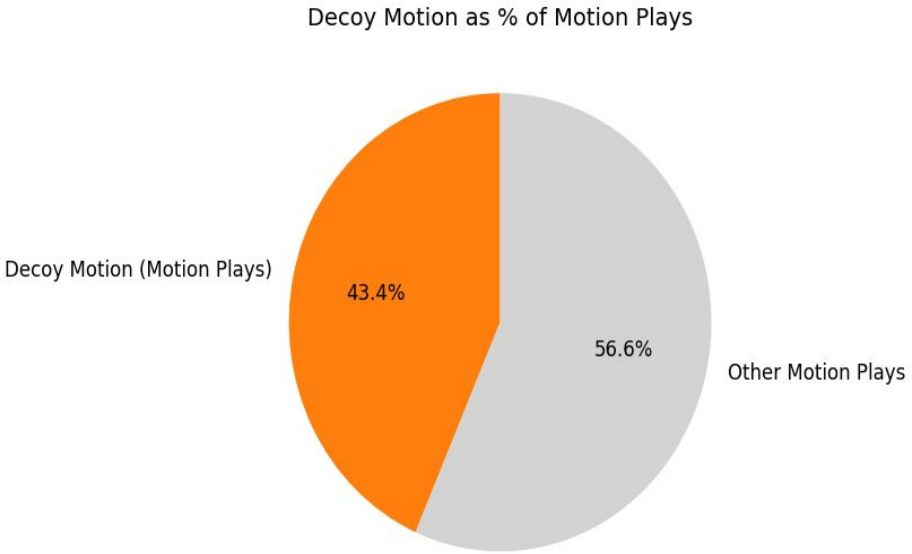


Blocker Motion as 3% of All Plays

Blocker Motion as 7% of All Motion Plays

Decoy Motion

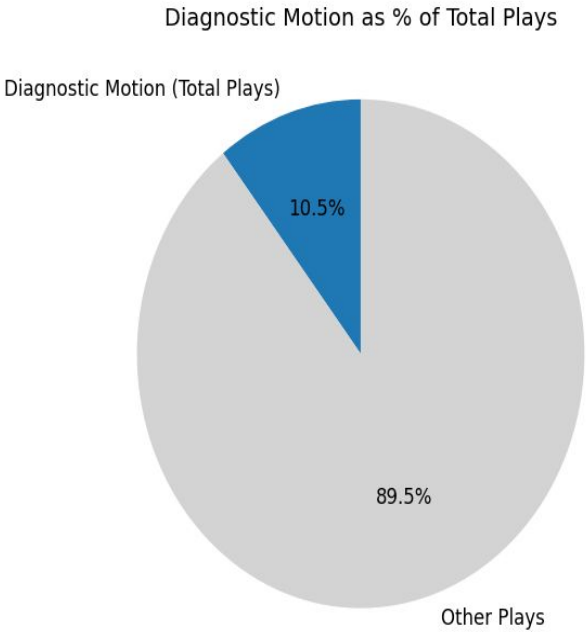


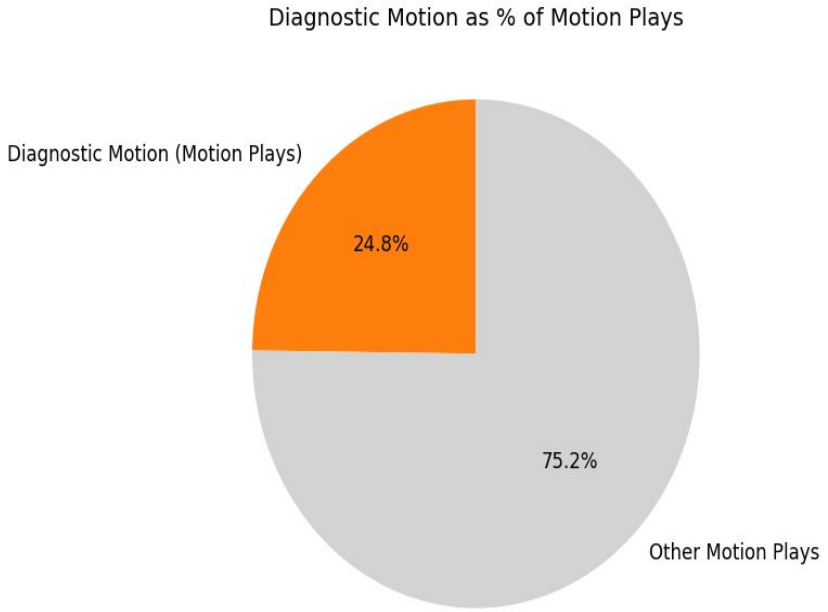


Decoy Motion as 18.5% of All Plays

Decoy Motion as 43% of All Motion Plays

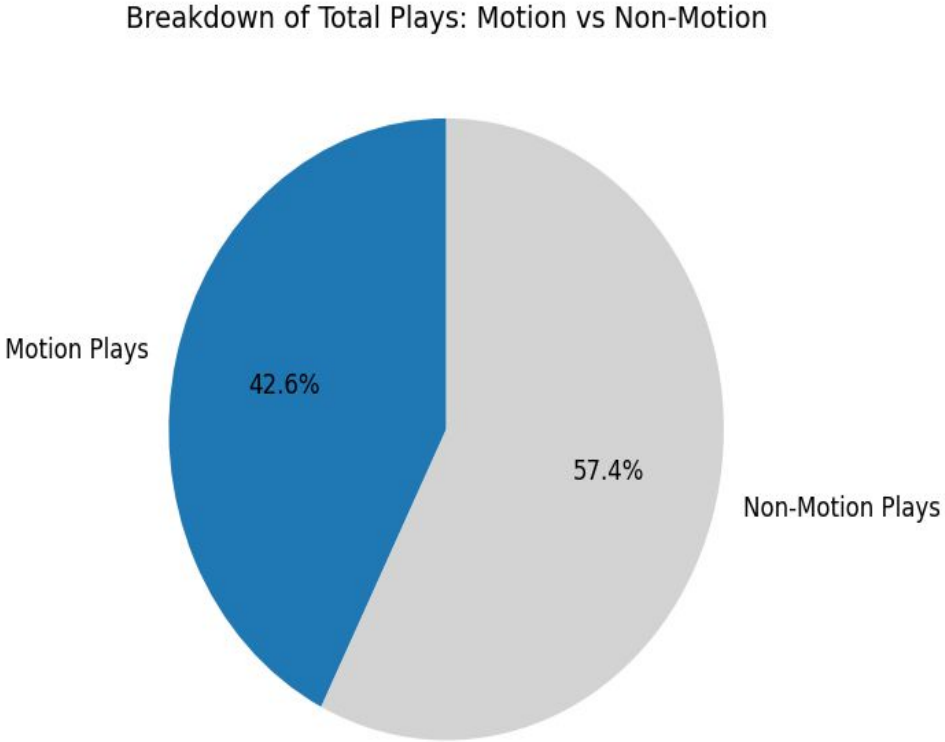
Diagnostic Motion

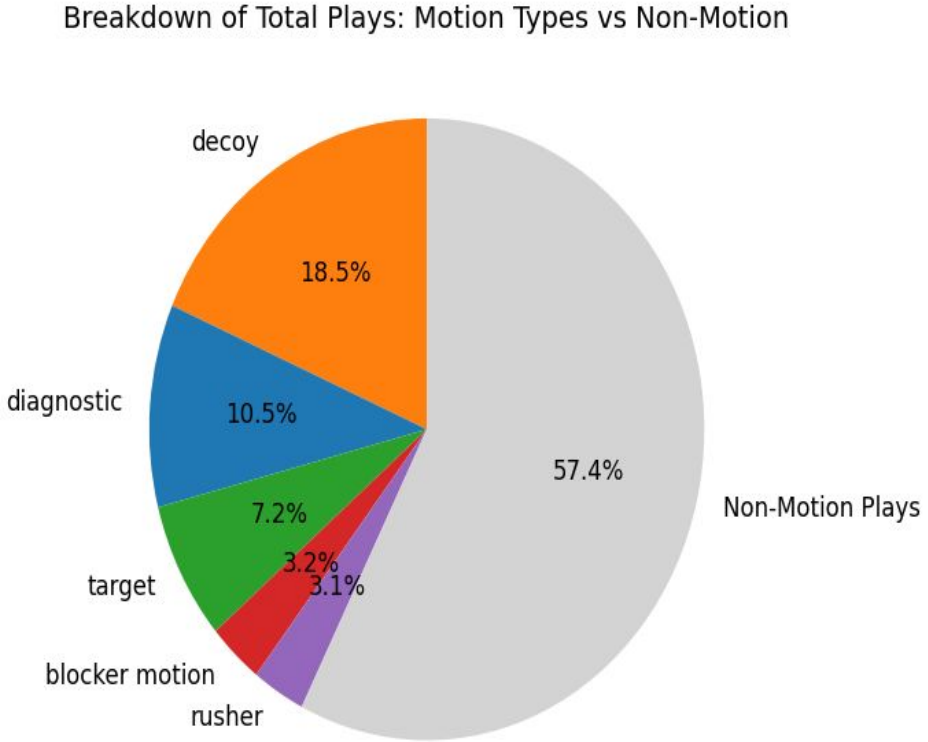




Diagnostic Motion as 10% of All Plays

Diagnostic Motion as 25% of All Motion Plays


Breakdown of Total Plays: Motion vs Non-Motion
Motion Plays
42.6%
57.4%
Non-Motion Plays


Breakdown of Total Plays: Motion Types vs Non-Motion
decoy
18.5%
diagnostic
10.5%
57.4%
Non-Motion Plays
7.2%
3.2%
target
3.1%
blocker motion
rusher

Unlocking offensive potential: motion insights

Deploy the Decoy!	43.5% of motion plays use the motion player as a decoy, and 18.5% of all plays include a motion decoy at the snap.	• Decoy motion is a cornerstone of modern football. Offenses can use decoy motion to draw defensive attention and exploit mismatches. • Pair decoy motion with target motion to confuse defenses about the intended recipient of the ball.
Throw me the ball !	Players in motion receive a pass on 17% of motion plays, yet motion plays where the motion is a decoy represents 43.5% of motion plays	• Offenses should focus on increasing the use of target motion for designed passes. • Decreasing the gap between decoy motion and target motion will force defenses to always respect the motion player. • This will help offenses shift defenders in and out of the box
Bring in the blocks	7.6% of motion plays the motion player becomes a lead blocker, and only 3% of total plays	• Motion allows players to increase speed and directional force prior to snap. Motion as a lead blocker is minimal on the large scale of plays • Increasing the blocker motion to be a staple in the run game may see benefits in other motion forms by creating less predictability
Hand me the rock, coach	Players in motion are more than twice as likely to receive a pass as they are to receive a handoff.	• Incorporate more rushing plays involving motion players to diversify the offensive attack and keep defenses guessing. • Similar to blocking motion, a player can gain momentum that can be used to take advantage of static defenders

Locking up the motion: Defensive insights

Hes (probably) not getting the ball	43.5% of motion plays use the motion player as a decoy, and 18.5% of all plays include a motion decoy at the snap.	• Avoid over committing resources to follow decoy motion. Focus on recognizing patterns that indicate decoy motion versus impactful motion (e.g., rusher or target). • Assign linebackers or safeties to key post-snap motion reads rather than chasing pre-snap movement.
Right back at you	24.8% of motion plays involve diagnostic motion, allowing offenses to adjust pre-snap.	• Use defensive shifts or late alignments to disguise coverage and prevent the offense from gaining valuable pre-snap information. • Implement man-zone hybrid schemes to counter offenses exploiting pre-snap diagnostics.
I know you!	Motion players get the ball on 24% of motion plays and account for 10% of total plays when they are the rusher or target.	• Prioritize identifying high-value motion plays (target or rusher motion) by observing formation and personnel tendencies • It is not common for the player in motion to get the ball • This can be used to increase the awareness of defense of which players DO get the ball when in motion • Early identification of if the player is getting the ball
I see you !	Players in motion are more than twice as likely to receive a pass as they are to receive a handoff.	• Assign defenders to anticipate and disrupt passing lanes to motion players. Use linebackers and safeties to shadow high-value motion players pre-snap. • Focus on pass coverage against motion players, particularly in short and intermediate zones where quick passes to motion players are common.

Failure Points

One motion type per play

Multiple players can go in motion on a single play. This analysis uses a priority order to rank the motion type. Therefore a single play will only have a single form of motion, which will miss some players in motion. For the sake of this analysis, we are at the play level, not the player level

Blocker Motion in run game only

Blocker motion is only counted in the run game. There are circumstances, such as RPOs, where a player will go in motion to be a lead blocker for a pass play

Based on outcome not the plan

We cannot get into the mind of the offensive coordinator nor the QB. We measure what actually happened, but that may not be reflective of the play design for multitudes of reasons.

Next Steps - Areas for improvement

Positional Analysis

When a certain position goes in motion, do they fall into a certain category

Example: TE Crack block

Success Rate insights

How do certain offenses and defenses stand against the different categories of motion

Team Differences

Evaluate how each team deploys different motion categories

Pattern Recognition

Identify patterns of offensive coordinators and play callers on how they utilize motion during certain parts of game. Can be used for defensive game planning

Thank you!

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Appendix

Juypter Notebook:https://www.kaggle.com/code/thomasgermano/motion-classification

Github: https://github.com/TJGermano/NFL_25_big_data_bowl

Motion rates for 2022 on 9/19 (post week 2): https://x.com/SethWalder/status/1571907998750056448?lang=en

Competition: https://www.kaggle.com/competitions/nfl-big-data-bowl-2025/overview

Let go Giants !!!!