NFL OPTIMIZATION PROJECT

Data-Driven Insights for Optimal Offensive Decisions

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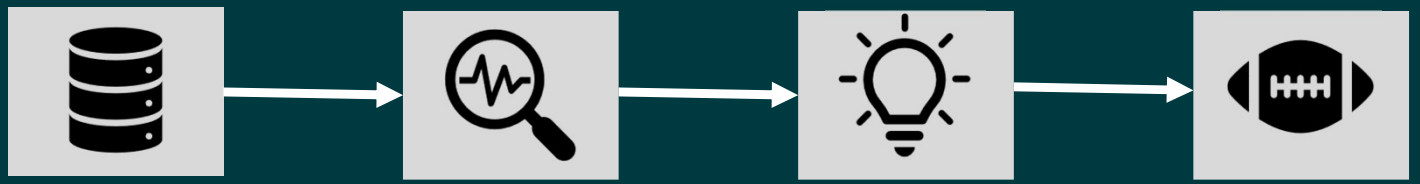
BEYOND THE SIDELINES:

COMBINING FOOTBALL INSTINCT WITH DATA SCIENCE

- This project challenges long-standing assumptions in NFL offensive play-calling by combining firsthand football experience with data-driven analysis.
- As a former collegiate football player at the University of Wisconsin-Eau Claire and a dedicated fan of the sport, I have often shared the reaction of many viewers and players who question the rationale behind certain play calls.
- The Big Question: This project will address through rigorous statistical investigation whether certain situational calls may be misunderstood or misapplied.
- What this presentation offers: Clear, data-backed guidance on how to maximize offensive efficiency and scoring, thus contributing to a broader evolution in how NFL offenses operate.

OUR PLAYBOOK: DATA-DRIVEN DISCOVERY

- **Data Collection:** We started by collecting and cleaning detailed play-by-play data from the NFL Big Data Bowl on Kaggle
- **Defining Success:** We defined key performance metrics such as Expected Points Added (EPA) and success rate
- **Rigorous Analysis:** We applied formal hypothesis tests to confirm or dispel conventional wisdom on offensive decision-making.
- **Predictive Models:** Looking forward, our aim is to create predictive models that quantify the value of adopting more optimal situational plays.



ANALYZING KEY OFFENSIVE SITUATIONS: OUR ROADMAP

- **Third Down Pass Conversion Rate:** Optimizing passing decisions to secure crucial first downs.
- **Run Plays with Motion vs. Without Motion:** Quantifying the advantage of pre-snap movement.
- **Shot Plays:** Understanding when and how to maximize explosive passing plays.
- **Gap vs. Zone Run Plays:** Comparing effectiveness of foundational run schemes.
- **Optimal Play Selection on 2nd and 6 at Midfield:** Unlocking drive potential in critical field positions.
- **4th and 1:** Data-driven insights for high-leverage short-yardage decisions.

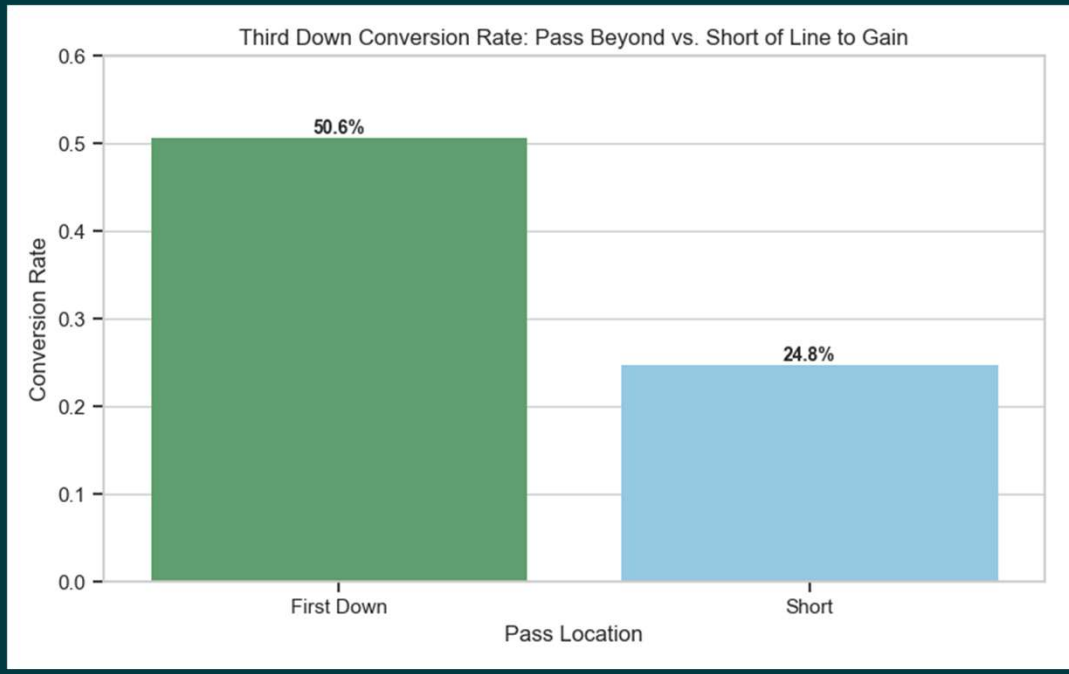
ELEVATING 3RD DOWN EFFICIENCY:

THE POWER OF THROWING BEYOND THE STICKS

- On third down, passing beyond the line to gain significantly increases conversion likelihood compared to throwing short.

- Conversion Rates:
  - Beyond the sticks: 50.6%
  - Short of sticks: 24.8%.
  - Passes targeting receivers past the sticks are twice as effective.

- Statistical Significance: A two-proportion z-test confirmed the difference is statistically significant. The p-value was 5.65×10−33, meaning the advantage is not due to random variation.



Strategic Priorities: Optimizing Third Down Passing

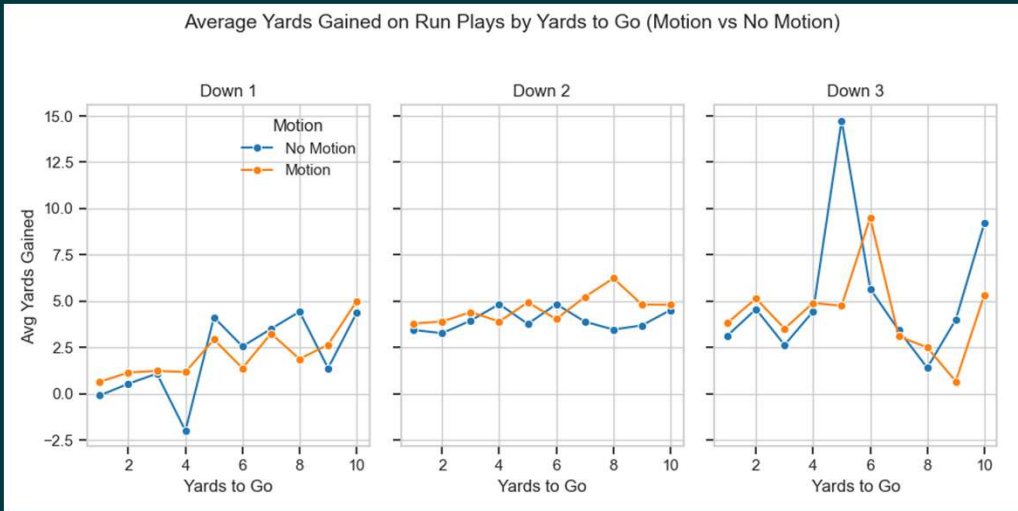
- Teams relying on short passes in these scenarios likely put themselves at a disadvantage by depending on YAC, which is unpredictable under tight coverage.
- Offensive coordinators should emphasize routes that extend beyond the first-down marker, particularly in must-convert situations.
- Quarterbacks should be encouraged to look for primary reads that break beyond the sticks rather than checking down early.
- Situational adjustments should be made based on coverage.
- While the data strongly favors throwing beyond the line to gain, there may be cases where defensive schemes (e.g., soft zone coverage) make short passes viable.
- Further analysis could focus on the impact of defensive alignment (man vs. zone coverage) on short vs. deep passing efficiency

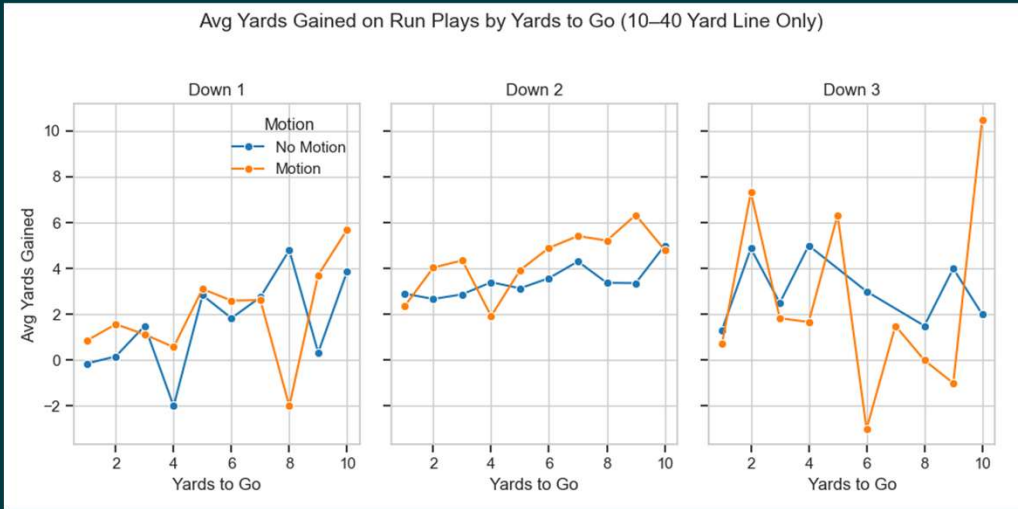
RUN PLAYS WITH MOTION VS. WITHOUT MOTION

- This analysis evaluates whether run plays with motion are more effective than plays without motion.
- Teams use motion in a variety of different ways, which include getting the defense to expose their coverage or draw eyes in the run game.
- We will explore different situations (down and distances) along with the field position to find the most optimal type of run plays.

MOTION'S TANGIBLE IMPACT ON RUN YARDS

- When motion was used on 1st and 10 inside the opponent's 40-yard line, teams gained 5.7 yards on average, compared to 3.9 yards without motion, a difference of nearly 2 full yards.
- This is a huge impact when trying to stay ahead of the chains or get into the red zone
- Across all situations studied (1st and 10, 2nd and short, and 3rd and very short inside the 40), motion plays gained 5.1 yards on average versus just 3.7 yards for no-motion plays , a difference of 1.4 yards per carry.
- This difference was statistically proven to be real, not just a fluke in the data. We ran three different types of tests to confirm this, and all three showed that motion leads to better results.





FINDING 2 IMPLICATIONS: STRATEGIC PRIORITIES FOR THE RUN GAME

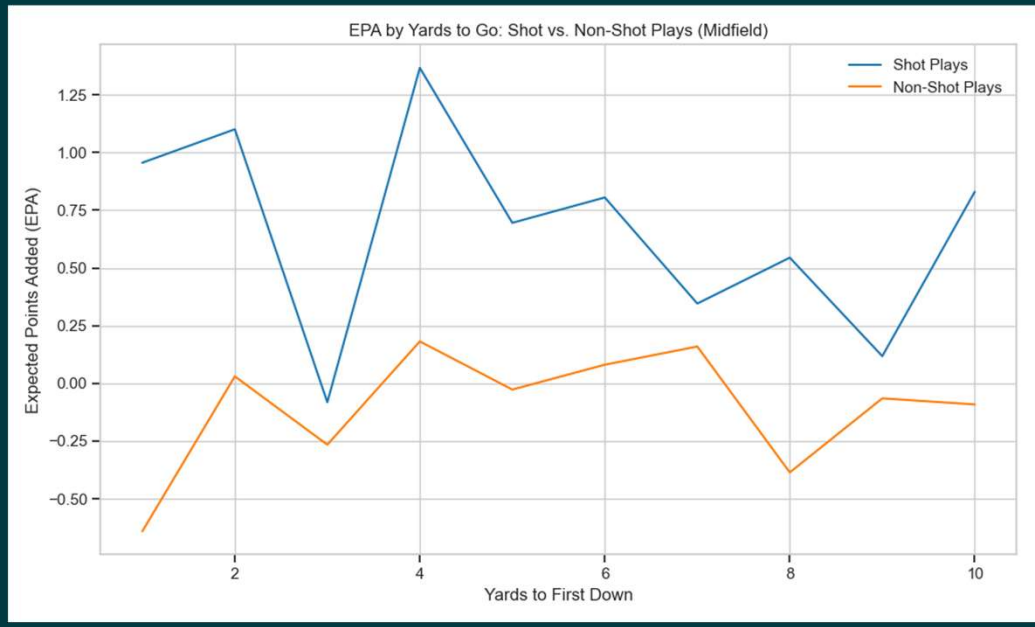
- Using motion in the run game, especially close to the end zone, consistently leads to better results. Teams gain more yards.
- This makes it easier to get first downs, stay on schedule, and finish drives with touchdowns instead of field goals.
- Coaches who aren't using motion in these situations may be leaving yards and points on the field.
- NFL offenses should emphasize motion on run plays in early down situations, particularly once they cross the opponent's 40-yard line.
- The data clearly shows that motion makes a difference, and the impact is large enough to shape game strategy.

UNLEASHING EXPLOSIVE OFFENSE: THE VALUE OF SHOT PLAYS

- This analysis aims to optimize when offenses should attempt shot plays.
- Shot plays, deep pass attempts designed to create explosive gains, often occur on 2nd down with short yardage, especially around midfield.
- The logic is sound: if incomplete, a team still has 3rd and short; if complete, they've significantly increased their scoring probability

SHOT PLAYS: PERFORMANCE & CAUSAL IMPACT

- **Yards Gained:** On 3rd down at midfield, shot plays averaged 12.0 yards vs. 6.2 yards for non-shot plays.
- **EPA Boost:** Shot plays significantly boost scoring probability (EPA +0.73) vs. non-shot plays (EPA -0.06). This difference was highly significant ($p < 0.001$).
- **High Correlation:** Despite being aggressive, shot plays had a 92.2% completion vs. non-shot 37.2%. This suggests excellent execution.
- **Causal Effect:** Advanced modeling confirmed shot plays *cause* better outcomes, not just correlate. Estimated causal effect: +1.088 EPA



FINDING 3 IMPLICATIONS: STRATEGIC PRIORITIES FOR SHOT PLAYS

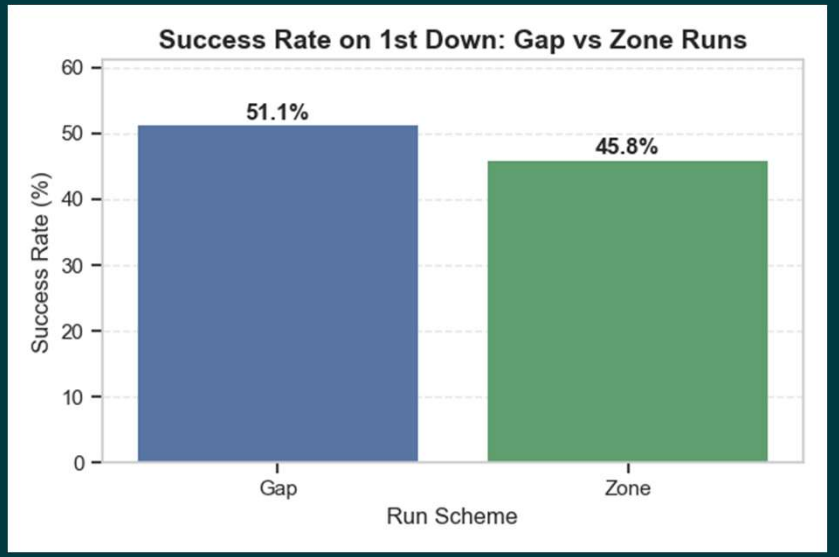
- Offensive coordinators should prioritize deep passing concepts on 3rd down between the 40s
- Contrary to the perception that deep shots are risky, they are executed with high precision when called in these scenarios.
- After accounting for play context, shot plays cause better outcomes, not just correlate with them.
- Conservative 3rd-down play-calling in this zone likely leaves significant value on the field.
- These findings also suggest potential for exploitative defensive preparation, if shot plays are not used frequently, defenses may overcommit to short coverage, leaving deep threats open.
- Rather than treating them as high-risk options, they should recognize the high reward and high success rate that these plays offer when deployed in the right zone and down situation.

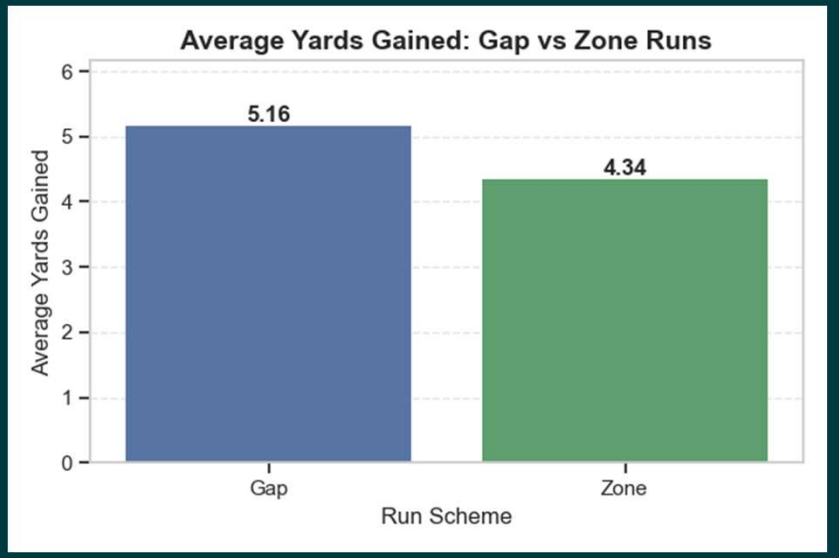
POWER VS. FLOW: OPTIMIZING YOUR RUN SCHEME

- This analysis explores whether Gap or Zone run schemes are more effective across all downs in the NFL.
- Zone schemes stretch the defense laterally and allow the running back to cut based on flow, while Gap schemes use pulling linemen and predetermined lanes to attack the defense vertically or with misdirection.
- The goal is to determine which approach delivers more consistent and valuable outcomes in both early and late-down situations, informing optimal run game strategy and play selection.

GAP VS. ZONE: PERFORMANCE METRICS

- Overall Performance & Efficiency:
  - Gap runs gained 5.16 yards per carry, compared to Zone runs at 4.34 yards per carry.
  - This +0.83-yard difference was statistically significant (p=0.0139).
- Explosive Play Potential (runs gaining 10+ yards)
  - Gap runs had an explosive rate of 15.3%, while Zone runs had 10.3%.
  - This difference was statistically significant
    - (Chi-Square = 22.71, p<0.0001).
- Drive Sustaining (Success Rate):
  - Overall, Gap runs had a success rate of 53.8%, compared to Zone runs at 50.1%.
  - Important Note: For 1st down, "success" is defined as gaining 4 or more yards.
  - On 1st down, Gap success rate was 51.1%, while Zone success rate was 45.8%. This difference was statistically significant (p=0.0125).





STRATEGIC PRIORITIES FOR GAP VS. ZONE RUN PLAYS

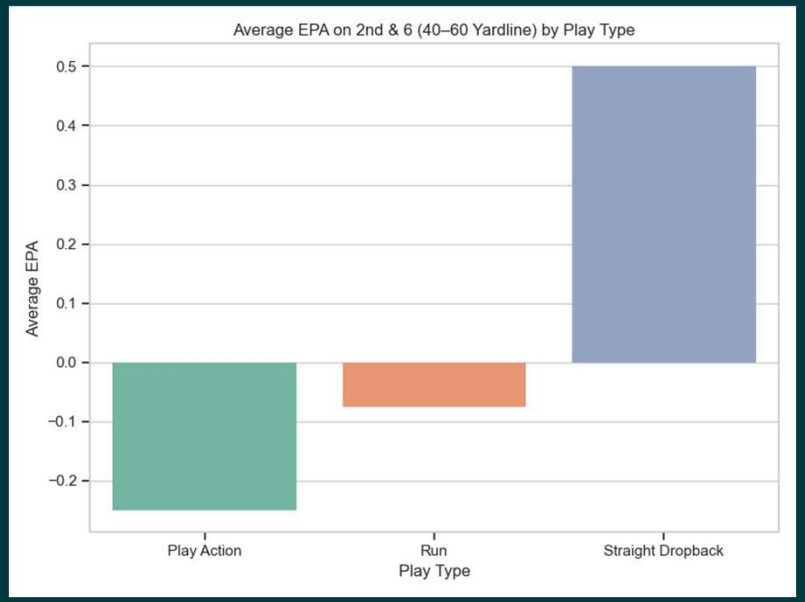
- Increase usage of Gap scheme runs, especially on 1st down, where they offer higher efficiency and success.
- Gap runs provide both more consistent yardage and a greater likelihood of explosive gains.
- While Zone schemes remain effective and more frequently used, this analysis suggests Gap concepts (Counter, Power, Pull Lead, Trap) should play a larger role in modern NFL run game strategy.

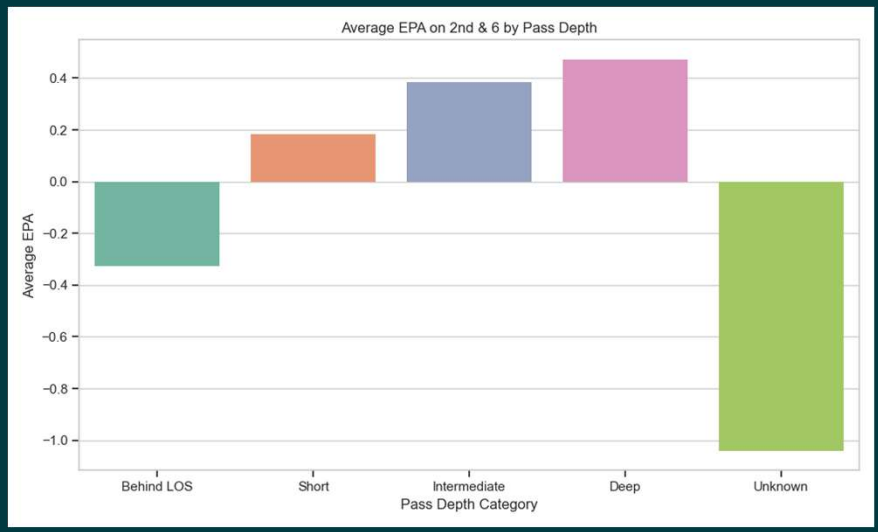
OPTIMIZING 2ND & 6 AT MIDFIELD: THE PLAY-ACTION ADVANTAGE

- This analysis aims to evaluate the effectiveness of play action compared to straight dropbacks and run plays on 2nd down with 6 yards to go.
- Building on our understanding of aggressive passing at midfield (from our Shot Plays analysis), we further analyze play calls on 2nd & 6 in this critical zone.
- Specifically, we look for advantages in Expected Points Added (EPA) when isolating plays between the 40- and 60-yard lines ("midfield").

2ND & 6 AT MIDFIELD: PERFORMANCE & TRENDS

- EPA at Midfield (40-60 Yardline):
  - Play action produced significantly higher EPA than straight dropbacks (p=0.0311)
  - Straight dropbacks also showed significantly higher EPA than run plays (p=0.0386).
- EPA Outside Midfield:
  - Outside midfield, no significant differences in EPA were observed across play types.
- EPA by Pass Depth:
  - Deep passes yielded the highest average EPA (+0.47), followed by intermediate (+0.38) and short passes (+0.18).
  - Passes behind the line of scrimmage had a negative EPA (-0.33)





STRATEGIC PRIORITIES: OPTIMIZING YOUR 2ND & 6 APPROACH

- Offenses should lean heavily toward passing concepts, especially at midfield, when facing 2nd and 6 situations.
- While run plays can remain part of the mix to maintain unpredictability, over-reliance on rushing reduces overall efficiency.
- Considering all performance indicators: yards gained, first down rate, and downstream EPA impact, approximately 80% of 2nd and 6 plays at midfield should be dropbacks, with the remaining 20% allocated to run plays.
- The use of play action appears to offer downstream value in terms of increasing the expected points on the next play, even when it doesn't produce immediate yardage gains. This suggests a sequencing benefit where play action sets up future offensive success.
- Teams should further evaluate when play action is most effective, based on formation, personnel, or defensive alignment, to unlock its full potential.

HIGH-STAKES DECISIONS: OPTIMIZING 4TH AND 1

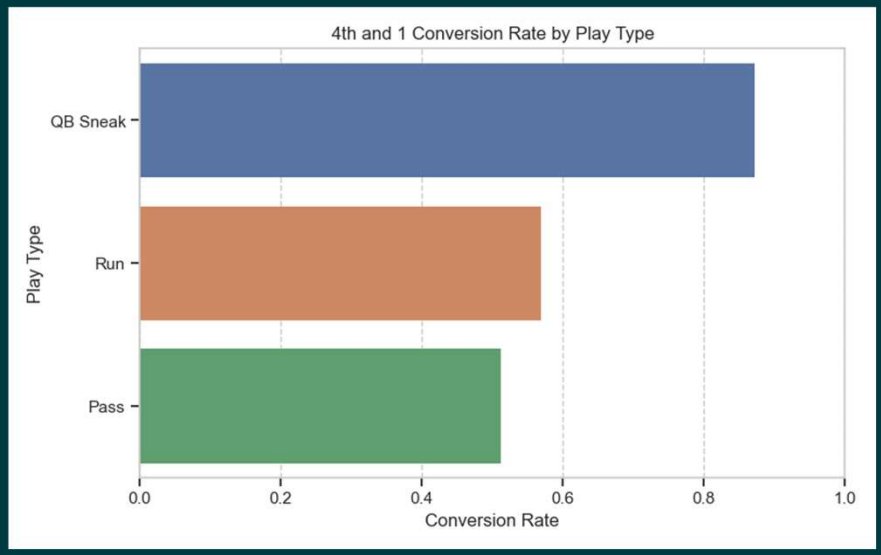
- This analysis investigates optimal decision-making on 4th and 1, one of the most pivotal moments in football strategy.
- Coaches often face a high-stakes choice: punt, attempt a field goal, or go for it.
- Our goal is to understand when going for it is justified and which types of plays give teams the highest chance of success.
- Given the widespread belief that quarterback sneaks are the most effective option in these situations, we test that assumption directly and explore whether any other strategies rival or surpass it under specific conditions.
- Important Note: One limitation is the absence of explicit field goal and punt attempt data in this dataset, which limits our ability to quantify the true opportunity cost of going for it on fourth down; however, we can still begin to analyze play type effectiveness.

4TH & 1: CONVERSION RATES & EXPECTED POINTS

- Play Type Effectiveness:
  - QB sneaks had the highest conversion rate at 87.1%, far surpassing traditional runs (56.9%) and pass plays (51.2%).
  - This confirms that QB sneaks are the most efficient play call in 4th-and-1 situations.

- QB Sneak Usage:
  - Over a dozen teams called zero QB sneaks on 4th-and-1, suggesting a systemic underutilization of the most effective play

- Expected Points (EPA) Analysis:
  - The average EPA for all go-for-it attempts on 4th-and-1 was -0.76
  - **Important Note on Data:** Punts and field goal attempts could not be evaluated due to the lack of special teams' data in the dataset.



STRATEGIC PRIORITIES: MASTERING 4TH & 1

- Teams should prioritize QB sneaks on 4th-and-1. The data overwhelmingly shows that sneaks are the most reliable way to convert.
- Many teams are likely underutilizing sneaks, which may be costing them key conversions.
- Coaching decisions following failed 3rd-and-1 plays appear overly conservative and may leave value on the field.
- The complete absence of attempts following failed 3rd-and-1 plays reveals a coaching tendency toward risk aversion, even in situations where analytics suggest aggression may be justified.
- Fourth-and-1 is a high-leverage down where optimal decision-making can significantly impact a team's chances of winning.
- With further data and simulation, teams could refine their 4th-down strategies to better align with expected value and long-term win probability.

WHAT'S NEXT: REFINING OUR ANALYTICAL PLAYBOOK

- **Limitations:** One key limitation of this analysis is the absence of explicit field goal and punt attempt data in the dataset. Without complete play classification or special teams outcome data, we are unable to quantify the expected points or win probability associated with those alternative choices.

- Opportunities for Further Analysis:
  - Compare decision-making by coach/team tendencies.
  - Include kicking/punting EPA to simulate true opportunity cost.
  - Analyze 4th down strategy in game-state contexts (e.g., trailing in Q4, red zone, etc.)
  - Assess defensive coverages most vulnerable to shot plays.
  - Examine coach-level tendencies, which play callers are leveraging these findings, and which are not?
  - Consider using tracking data to quantify the separation or speed of receivers on these plays.

THANK YOU & LET'S CONNECT!

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