

## BoxCount:

A Machine Learning tool for Player Evaluation and Play Calling Analysis In the NFL

### Project Description

**“Analytics is being embraced more because people are starting to separate the *decision* from the *execution* of that decision.”**

-Neil Hornsby

My project will cover the development of a sports analytics tool specialised in player evaluation and play by play analysis in the NFL. Using R and machine learning, the tool will provide statistics and information for a coaching staff. This could be used to inform game scenario play calling and team building/personnel decisions. An accurate, predictive software that can directly inform game decisions and strategy would be an incredibly valuable asset to NFL teams, who are constantly striving for a competitive advantage.

### Rationale For Project Choice

Analytics in sports has always faced resistance from traditionalists, despite the abundance of evidence supporting its value. Analytics will soon become the norm and be accepted as the most accurate way to predict sports. The leaders in this analytics movement have often been mocked for their new approach to team building and coaching, but this is starting to change. “For well over a century, those in baseball ignored the very idea of using objective data to inform decisions(The Ringer, 2019). Whereas now, “Analytics are getting bigger and bigger” (Fouriezios, 2019).

The abundance of NFL data seems to leave some coaches and GMs bewildered as a lot of programs are still championing traditional methods and have yet to fully embrace analytical approaches. According to NFL Draft Analyst Tony Pauline, certain NFL GMs and scouts are ‘starting to detest’ analytics as a means of decision making and evaluation (Rotoworld.com, 2019) According to Pauline, many scouts and coaches present at the recent East-West college All Star game ‘remain of the belief analytics have little to do with Xs and Os’.

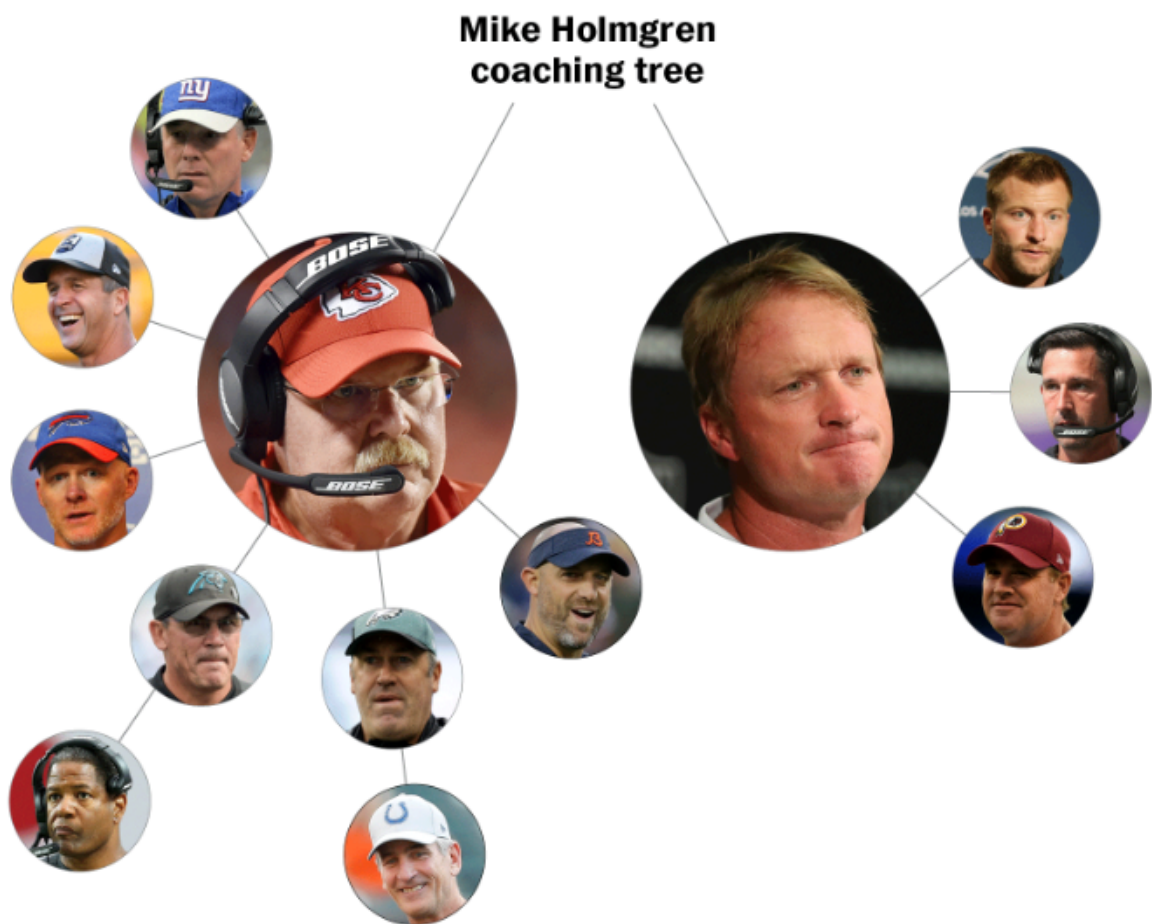
Some coaches have fully embraced advanced statistics and employed new methods supported by data. “Methods of discrete event simulation can be especially useful in providing advice to coaches and managers regarding game-day decisions. Alternative game-day, in game strategies may be explored by running the simulation thousands of times under each alternative strategy. A coach or manager can observe the range of scoring outcomes and select the outcome that provides the highest probability of winning”. (Miller, n.d.)

There is a clear gap in the market for a football statistics tool that coaches at every level can utilise to inform key decisions in their gameplans. Perhaps if data was more accessible for coaches at lower levels of the game, such as University of Senior league teams, it could begin to change attitudes towards analytics in football.

### Background Research

This difference of opinion regarding football methodology has the coaching world divided, even amongst coaching staffs. The average NFL coach begins their career at an assistant/intern coach level, many working as a scout or in quality control. New coaches tend to bounce around teams and roles for years before getting a chance at a high level coaching job such as Head Coach,

Offensive/Defensive Coordinator and QB Coach. This can lead to a lot of turnover in an organisation over the span of a decade.



**Figure 1. Mike Holmgren's Coaching Tree**  
(Branching Out, Washington Post)

Typically, someone's coaching tree is a reflection on their team management skills and can provide insight to their deeper coaching philosophy. Kansas City Head Coach, Andy Reid, is famed for having a expansive coaching tree with a keen interest in advanced football statistics. His former assistants include SB LII Champion Coach Doug Pederson (Former OC under Reid in Kansas City from '13-15 before becoming HC of the Eagles in 2016), SB XLVII Champion Coach John Harbaugh (Special teams and defensive backs coach '98-07), Ron Rivera (Former Eagles LB coach '99-03) and Matt Nagy (Former Chiefs QB coach and Offensive Coordinator). All have used analytics to shape their football philosophy and game-planning methodology.

Both Kyle Shanahan and Sean McVay also come from Mike Holmgren's coaching tree via Jon Gruden, who is far from a fan of the numbers:

**“There’s a stack of analytical data... that people don’t even know how to read it. It’s one thing to have the data, it’s another thing to know how to read the [expletive] thing.”**

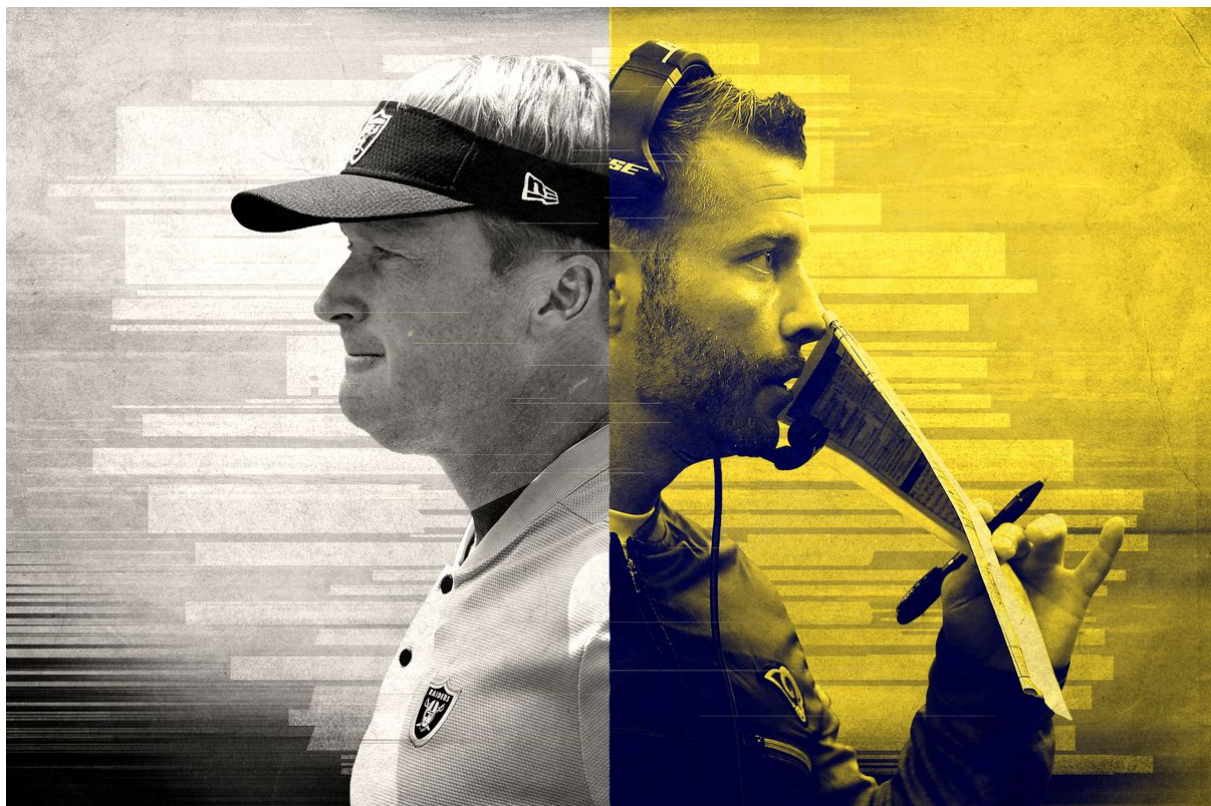
- Jon Gruden, Coach of Super Bowl XXXVII Champion Tampa Bay Buccaneers, current Oakland Raiders Coach

Shanahan and McVay both surprisingly had their first NFL jobs under Jon Gruden, despite their

differences in opinion of football statistics (SI.com, 2019). Shanahan begun as an offensive quality control coordinator in 2004, and McVay would later join as assistant receiver coach in 2008. Both McVay and Shanahan are seen as pioneers of statistics, often looked upon as the future of coaching in the NFL.

Despite working alongside some of the league's youngest and brightest analytical minds for years, Gruden is still resistant to the idea that numbers can accurately describe the world of football. Is it possible to disprove this? Is there a perfect way to play football?

There is a growing need for the use of advanced analytics in sports as a new generation of coaching is just upon the horizon. Sports analytics will play a major part in teams' success in the coming years, and serve as an invaluable advantage in one of the most competitively balanced professional leagues on the planet (Larsen, Fenn and Spenner, n.d.). Traditional coaches, like Jon Gruden, must adapt to the new age of football, or be left in the dust by innovators such as McVay. There is legitimate application for predictive software and data modelling in the NFL, as organisations have begun handling analytics in house, hiring their own programmers and data scientists.



**“I’m trying to throw the game back to 1998... I’m not going to rely on modern technology. I will certainly have some people that are professional that can help me from that regard. But I still think doing things the old fashioned way is a good way.”**

**- Jon Gruden  
(Ruiz, 2019)**

**“Naturally curious, McVay operates almost like a journalist. He digs, as a reporter would, for anything and everything that could inch his team a little closer to a breakthrough. He is obsessively in love with the process: the day-to-day drag of clawing for details, mining for advantages.”**

**-(Fader, 2019)**

## **Areas of Investigation**

### **Player Evaluation: Star Player or Scheme?**

**“What is a player’s value to his team? What if he were replaced by a player of average ability at the same position?”**

- Thomas W. Miller, Predictive Analytics Program Faculty Director at Northwestern University  
(Miller, n.d.)

Personnel evaluation in the NFL is perhaps the largest factor separating elite programs from the average. From a football performance standpoint, there are many variables that can influence how a player is assessed. Each organisation will approach teambuilding and scouting differently, each likely having a unique preferred criteria for certain players or positions. Because of the differences in football philosophy as a whole each organization has a different outlook on advanced football statistics. How should an organisation use numbers to inform personnel decisions? How can analytics be used to form a team building philosophy?

From comparing the offensive production of a top NFL offense with and without a key star player, we can investigate the players value. The hypothesis is that we can quantify the value of a star player based on how the offense produces without him. Take for example Kareem Hunt, former Running Back for the Kansas City Chiefs. Hunt was widely considered a top five talent at his position prior to his suspension (Profootballfocus.com, 2019), but just how important was Hunt to the success of the Chiefs offense? Who gets the credit? Star player or the scheme?

Play success rates is another area this project will explore. With new NFL tracking data it is now possible to track player position on the field. This will make it possible to track play success rates versus certain defensive formations. With enough data, this could give coaches a meaningful advantage.

**“The point we made with our coaches is: We have all this information but so does everyone else. What advantage does it give us to get it? None. It’s what we do with it, the way we use it.”**

- Kevin Colbert, Steelers general manager

## **Methodology**

Quantitative and qualitative data will be used throughout the project. Firstly, qualitative data will to provide context on current attitudes towards analytics in coaching circles. Table 1.1 in Sports Analytics (Alamar, n.d.) was motivational in surveying local coaches to provide some information about the perception of analytics. Aimed at local coaches of multiple levels (division 1/2 & premier University squads plus Senior league teams), the survey will contain a series of statements, and participants will indicate how much they agree or disagree with said statement. For example, ‘Analytics has changed or influenced my playcalling tendencies.’

Quantitative will be extensively employed, as the software will be presenting data to prove certain hypothesis. This hypothesis may differ in each simulation. It may be simple, something like 'Teams that run on 3rd and Long don't convert the first down at a high rate' is something that most casual fans would know is common knowledge. The tool will be of much more use tackling harder queries, such as, 'What is the most efficient play when it's 4th Down in the Fourth Quarter and you're on your opponents' 1 yard line?'. As the predictive software will be dealing with increasingly complex queries the data set must be expansive. The available data from various sources such as nflscrapR and Pro Football Reference goes back multiple decades and is now very detailed. When there is a multitude of informative data that is easily accessed, the possible simulations and quality tests on this data increases significantly.

As stated in Areas of Investigation player evaluation is a large part of this project. This is the method of evaluating a player, in this case Kareem Hunt. During the 2018-19 NFL season the Kansas City Chiefs had by far the most prolific offense in the NFL, ranking 1st in most major offensive statistics. Finishing the season top of the league in Points Per Game (Pts/G): 35.3, Yards Per Game (Yds/G): 425.6 and first in Total Points (TotPts): 565. Kansas City also finished first in season offensive DVOA (Defense-adjusted Value Over Average) rating (footballoutsiders, n.d), with 34.2%, approximately ten percent higher than the second place Los Angeles Rams. The Chiefs had the rank 1 Passing Offensive DVOA at a staggering 63%, and the rank 4 Rushing Offensive DVOA with 10.9%.

In 2018, the Chiefs played 11 games with Hunt and 8 without him. Basic stats paint an interesting picture over these games:

#### Offensive Stats Through Week 11 (With Hunt)

Chiefs Rushing Yards Per Game: **115.8**  
Offense Points Per Game: **36.7**  
First Downs Per Game: **24.2**  
Average Rank of Opposing Defence in DVOA: **13.8**

#### Offensive Stats Post Hunt Suspension

Chiefs Rushing Yards Per Game: **114.6**  
Offense Points Per Game: **31.9**  
First Downs Per Game: **23.4**  
Average Rank of Opposing Defence in DVOA: **15.9**

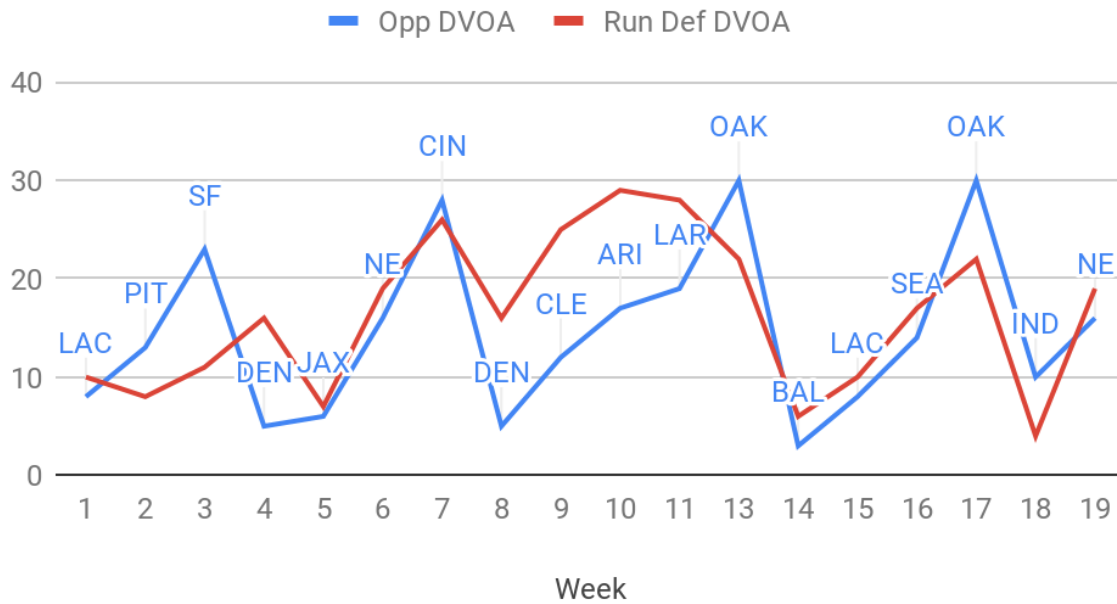
While a difference of 1.2 rushing yards per game and .8 fewer first downs per game is basically nothing, the points difference of -4.8 is certainly interesting. To give these results some context explore DVOA ratings for the opponents Kansas City faced over both stretches.

Charted the total defensive DVOA rating (footballoutsiders, n.d) and run defense DVOA rating of every Kansas City opponent in 2018. DVOA stands for Defense-adjusted Value Over Average, a stat based on "success value" of every play. Note: Because positive numbers represent more scoring, defensive DVOA is better when it is negative. The higher the offensive rating the better, the lower the defensive the better.

As can be seen from the results below in the stretch without Hunt, while Kansas City faced an overall worse quality of defense (arguably due to the two games versus the Oakland Raiders, rank 30), they actually faced significantly better rated run defenses (average of rank 17.8 with Hunt, 14.3 without).



## Opp Def DVOA Rank & Run Def DVOA Rank per Week

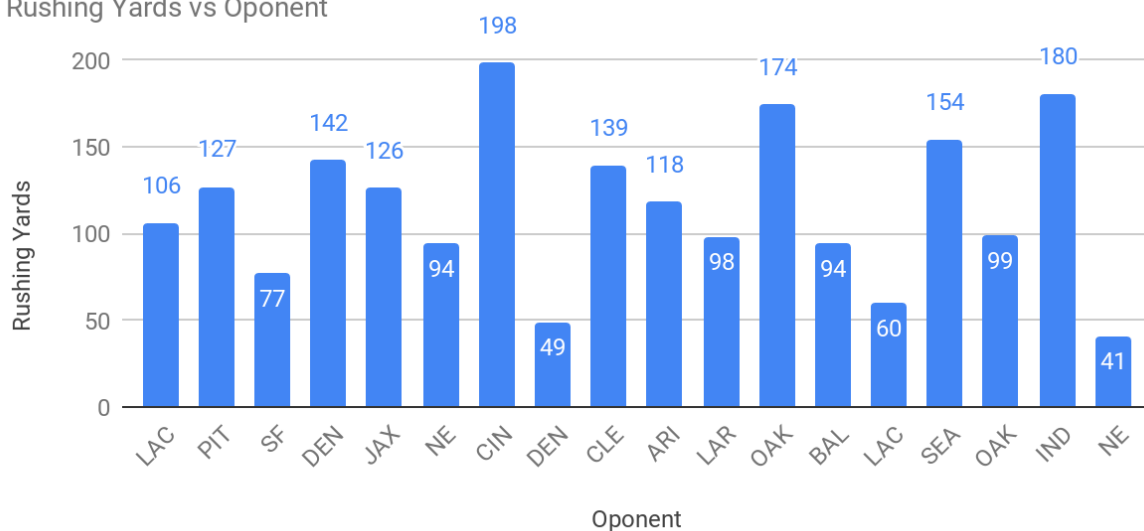


**Figure 2. KC Opponent Run & Overall DVOA per Week**  
Data from Football Outsiders (Footballoutsiders.com, 2019).

It's easy to see how looking at overall defensive DVOA only could be misleading, and how it could seem that Kansas City must have had an easier time running the ball during this stretch. However, after we include run defense DVOA we can see the opposite is true. Post Hunt, the Chiefs tended to face much better run defenses.

Knowing this, how can we get some useful information?

## Rushing Yards vs Oponent



Looking at total rush yards per game, we can see that three of the top four rushing performances came after the Hunt suspension. The second highest of the season came versus the Colts, who finished fourth in rushing DVOA. Even with a very basic look it seems that Hunt's presence was not a huge factor in the success of the Chiefs offense. The software will process much more data in order to get a more accurate outlook on the value of individual players. Data from Pro Football Reference (Pro-Football-Reference.com, 2019).

Agile development will be used to manage and plan the project. The structure of weekly 'sprints' works really well for projects of this length, and allows for clear documentation of progress made. A burndown chart can be maintained with story points based on the scale of each task. The burndown chart will help in tracking the pace of development and ensure tasks are completed on time. A project diary will be in the form of a weekly blog, detailing the stages of development.

While Agile has its advantages, it is not without downsides. As this is a solo project, there will of course be no use for the conventional stand up meetings, nor will the project workload be split amongst a team of developers and a project manager.

R was chosen as the language and platform for this project due to its frequent use in sports analytics. After researching the process of gathering NFL data, it became clear the industry often used an R package called nflscrapR. There's a large football analysis community online and many writers and analysts use the nflscrapR package to aggregate and scrape NFL data. Using nflscrapR, both casual fans and professional sports analysts have access to data which provides a high level of insight into a complex game.

As well as the existing tools in a similar field, R was chosen as the language and platform due to its proficiency performing statistical computations, data analysis and graphical representation of data (newgenapps, n.d) Each of which will be a large feature of this project.

Various football statistic sites were observed to see how they presented their data. Football Outsiders DVOA ratings has a intuitive but simple interface, which allows the user to seamlessly switch between various data sets. Football Outsiders and Pro Football Reference are more geared towards just presenting large amounts of statistics. Sites like Pro Football Focus and 538 Sports do still provide statistics, but from the angle of providing analysis.

## **Proposed Project Artefact**

The project artefact will be aimed at the professional sports analytics market, meaning it will be targeting NFL and college football coaching staffs. To best serve this user base, The software will have a desktop application frontend, which will feature a simple interface which can display charts and results based on user queries. Returned graphs and results can be saved along with a series of plays with high success rates in the specified scenario.

## **Project Plan**

Week 1 - Project Proposal Deadline Week

Week 2 - Initial R testing, Project Diary set up

Week 3 - Coaches survey, R script programming

Week 4 - Continued R development

Week 5 - Progress Review (Friday, Feb 22nd):  
Presenting data representation capabilities of software & initial findings  
survey results & takeaways

Week 6 - Progress Review Second Presentation (Monday 25th)

Continued R development

Week 7 - Week 12

Continued R development, front end UI (either web or desktop application)

2nd May - Artefact Submission

3rd May - Project Report/Documentation Submission

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### Statistics and Figures Resources:

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