Successful NFL Players in Modern Schemes

By Tommy Evans-Barton

Introduction

This year, the Green Bay Packers are in the unfamiliar position of having a new head coach, Matt LaFleur, and with him, an entirely new offense predicated on the "illusion of complexity" and the zone running scheme. While we could go on and on analyzing this scheme, a lot of people have already done this (I particularly like **this (http://www.packtothefuture.com/articles/xs-and-os-lafleurs-pass-game-in-week-2/)** series of breakdowns by **Pack to the Future's** Ben Clubb), and while I might throw my hat in the ring too, for now I wanted to try to do something a little bit different.

It's no secret that there have been some issues with the skill positions (Wide Receivers, Tight Ends, and Running Backs) in the past few seasons for the Packers. For Wide Receivers, it's a case of injuries and inexperience, with rookies playing heavy snap percentages on offense (data courtesy of **Football Outsiders (https://www.footballoutsiders.com/stats/snapcounts)**):

Rookie	Offensive Snap Percentage
M. Valdes-Scantling	64.4%
E. St. Brown	33.3%
J. Moore	6.9%
J. Kumerow	12.7%

due to injuries to Randall Cobb and Geronimo Allison. For the Tight End room, Jimmy Graham and Marcedes Lewis have been hit hard by father time, and Lance Kendricks, in my dad's words, is a J.A.G (Just A Guy). Running backs have also felt the sting of injury (with Aaron Jones having the second knee injury of his NFL career in as many years), but overall youth coupled with the borderline **criminal** misusage of this position group last year causes me to withhold most of my criticisms, at least for another season.

However, all of this is to say that the skill players could use an upgrade, or at the very least some reenforcements. But who will fit this new coach's schemes? Who can answer the call? That's what we hope to find out, so don't touch that dial.

In terms of success running this scheme, no two coaches have shown more promise than the Los Angeles Rams's Sean McVay and the San Francisco 49ers's Kyle Shanahan, LaFleur's two coaching mentors. Given the relative success of these two schemes (yes I know the 49ers went 4-12, but considering they were starting Nick Mullens, I'll cut Shanahan some slack), it seems reasonable to assume that LaFleur's scheme will run best with players like those that play well in L.A. and S.F., and that these are the types of players he will be telling Gutekuns to add in the draft. So the question is, who are these players?

In this analysis, we're going to go in depth on the position players from the Rams and 49ers that have helped catapult this new-age scheme into popularity, and determine which players have been good 'schematic fits', i.e. find who has succeeded in this scheme. From this, we're going to treat these players as prototypes, classify them as 'successful' and then use Logistic Regression and Support Vector Machines in order to predict which other players in the NFL may be successful.

In [279]:
```
%load_ext autoreload
%autoreload 2
```

```
The autoreload extension is already loaded. To reload it, use:
  %reload_ext autoreload
```

In [280]:
```
import SkillPlayerFunctions as spf
```

In [395]:
```
%matplotlib inline
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import glob
from scipy.stats import linregress
from scipy.stats import percentileofscore
import os
from copy import deepcopy
from sklearn.linear_model import LogisticRegression
from sklearn import svm
```

A Note on Coding, and Some Terms to Know

I know a lot of people who may be reading this just looked at the cell above and said "Uh-uh this ain't it chief," or "Well that's the second nerdiest thing I've ever seen" and to be honest the latter is spot on. I'm doing this analysis in the only way I know how, with coding and statistics, but I know a lot of people reading this won't have a very strong background in either, and may find a lot of the code hard to follow or even intimidating. However, I want to do my best to make this breakdown cater to everyone: from the stats nerds (like me), to the arm-chair GM's (also me), all the way to the casual fans who tune in every other week. That means I'll be doing my best to explain:

1. Why I decided to do what I did when it comes to the data, and why I decided to use the data I chose
2. What the purpose of each function I wrote and step I took was
3. How the code aims to accomplish these steps (where an explanation is easy)
4. What the statistical conclusions mean

and anything else that may come up along the way.

There are, however, some terms I may use casually that you might want to familiarize yourself with, such as:

- **Cell** - what you're reading this in right now! It can either be filled with text, like this one, or with code, like the one above.
- **Function** - essentially a section of code that will give you a value or values at the end. What this value is (a number vs. a group of numbers vs. a word) depends on the function, and can really be almost anything. If you see something in the form `spf.<>` in one of the code blocks, it's a function I have written that you can find in the SkillPlayerFunctions.py file.
- **Null/NaN(Not a Number)** - this means exactly what you think it means: Nothing. This happens in a data set when there's just nothing put in. It can either happen on purpose (i.e. if a receiver didn't play any games, their receiving yards might be `Null/NaN` , as there is no value entered for them) or on accident (i.e. someone forgot to put a piece of data in). The second of these is unlikely in our dataset, but just keep in mind that it CAN happen.
- **DataFrame** - whenever I say this, you can pretty much replace it with the word 'table'. They're basically the same thing, a DataFrame is just the coding word for this specific type of table.
- **Map** - when we take one value and replace it with another one. You're original value is often called a 'key' and what it maps to is the 'value'. So something like {'a' : 1 } means that the letter 'a' is 'mapped' to the value 1, i.e. that 'a' will be replaced with 1.
- **Comments** - When you see a line in a code cell with a hashtag in front of it (`#<...>`) this is just a comment that I've included to tell you something about how the code in that cell is working/what it is doing.

Overall, however, the moral of the story is: try not to get too worried about the code or the tables, because you'll be able to understand everything in here without it. On the other hand, if you ARE the type of person who's a statistics/data science nerd, and DOES want to look at the code, I've attached it all in a .py file in this directory.

Also, any feedback is more than welcome; I know this writeup isn't perfect, but I'm trying to improve my writing as much as anyone, and I can't do that without knowing what's wrong with it. So if a step I took is unclear, or you want more clarification on a decision I made, or if you even feel like some of the conclusions or assumptions I made are just wrong, let me know. Questions, comments, concerns, I want all of it, so hit me up.

Now, with all of that out of the way, let's get down to it and see how this all plays out!

The Data

Our NFL data is going to come from a mix of places, but mostly from **Pro Football Reference (https://www.pro-football-reference.com/)**, so a huge shoutout to them for having a good source to draw from.

Original NFL Player Data

What we're going to do first is get a list of the players by looking at the 49ers' and Rams' rosters. I've loaded in the 2017 and 2018 rosters below for each team below.

In [282]:
```
sf_2018_roster = pd.read_csv('data/49ersRoster.csv') #The complete San Fran
rams_2018_roster = pd.read_csv('data/RamsRoster.csv') #The complete Los Ang
sf_2017_roster = pd.read_csv('data/49ers2017Roster.csv') #49ers 2017 Roster
rams_2017_roster = pd.read_csv('data/Rams2017Roster.csv') #Rams 2017 Roster
```

Next I combined the two years for each team into one table per team. Below you can see what they look like before we clean them up.

In [283]:
```
sf_full_roster = pd.concat([sf_2018_roster, sf_2017_roster]) #The whole San
rams_full_roster = pd.concat([rams_2018_roster, rams_2017_roster]) #The who
```

In [284]:
```
sf_full_roster.head()
```

Out[284]:

	No.	Player	Age	Pos	G	GS	Wt	Ht	College/Univ	BirthDate	Yrs	AV	(tn
0	4.0	Nick Mullens\MullNi00	23.0	QB	8	8.0	210.0	6-1	Southern Miss	3/21/1995	Rook	6.0	
1	10.0	Jimmy Garoppolo\GaroJi00	27.0	qb	3	3.0	225.0	6-2	East. Illinois	11/2/1991	4	2.0	2r pi
2	3.0	C.J. Beathard\BeatC.00	25.0	qb	6	5.0	215.0	6-2	Iowa	11/16/1993	1	3.0	F 49 / 1
3	41.0	Jeff Wilson\WilsJe01	23.0	rb	6	2.0	194.0	6-0	NaN	11/16/1995	Rook	2.0	
4	36.0	Alfred Morris\MorrAl00	30.0	rb	12	1.0	224.0	5-10	Florida Atlantic	12/12/1988	6	3.0	Wa R 6t pi

In [285]:
```
rams_full_roster.head()
```

Out[285]:

	No.	Player	Age	Pos	G	GS	Wt	Ht	College/Univ	BirthDate	Yrs	AV
0	8.0	Brandon Allen\AlleBr00	26.0	NaN	1	0.0	209.0	6-2	Arkansas	9/5/1992	Rook	0.0
1	55.0	Brian Allen\AlleBr02	23.0	NaN	12	0.0	303.0	6-2	Michigan St.	10/11/1995	Rook	1.0
2	35.0	C.J. Anderson\AndeC.00	27.0	rb	2	2.0	225.0	5-8	California	2/10/1991	5	2.0
3	26.0	Mark Barron\BarrMa00	29.0	LB	12	12.0	230.0	6-2	Alabama	10/27/1989	6	5.0
4	66.0	Austin Blythe\BlytAu00	26.0	RG	16	16.0	298.0	6-3	Iowa	6/16/1992	2	10.0

Cleaning the Original Player Data

Unfortunately, as is often the case, our data is neither complete nor perfect, and there's a lot of work to be done on it before we can use it to make any conclusions or do any analysis. To be honest, unless you're extremely interested in the nitty-gritty of data science, I recommend you skip through this part (ahead to Players to Use as Prototypes), because preprocessing data is a little annoying, even more boring, and overall doesn't need to be fully read through to understand the analysis at the end.

Still here huh? Well alright, you've been warned. As we said before, we only care about the skill positions, but this data has every player. What we're going to do first is clean up the position data and filter out players we don't care about. We'll do this with the function `clean_position` from our .py file that will:

1. Get rid of players that either don't have a position listed, or have a position that's not WR, TE, or RB.
2. Uniformly format the position column (in this case just making them all capitalized) so that the data is easier to work with.

In [286]:
```
sf_skill_positions = spf.clean_position(sf_full_roster)
rams_skill_positions = spf.clean_position(rams_full_roster)
```

In [287]:
```
sf_skill_positions.head()
```

Out[287]:

	No.	Player	Age	Pos	G	GS	Wt	Ht	College/Univ	BirthDate	Yrs	AV	D (tm/
0	41.0	Jeff Wilson\WilsJe01	23.0	RB	6	2.0	194.0	6-0	NaN	11/16/1995	Rook	2.0	
1	36.0	Alfred Morris\MorrAl00	30.0	RB	12	1.0	224.0	5-10	Florida Atlantic	12/12/1988	6	3.0	Wasl Rec 6th pick
2	22.0	Matt Breida\BreiMa00	23.0	RB	14	13.0	190.0	5-10	Georgia Southern	2/28/1995	1	6.0	
3	18.0	Dante Pettis\PettDa00	23.0	WR	12	7.0	195.0	6-1	Washington	10/23/1995	Rook	3.0	Fra 49er / 44
4	13.0	Richie James\JameRi00	23.0	WR	13	2.0	185.0	5-9	Middle Tenn. St.	9/5/1995	Rook	2.0	Fra 49e / 240

In [288]:
```
rams_skill_positions.head()
```

Out[288]:

	No.	Player	Age	Pos	G	GS	Wt	Ht	College/Univ	BirthDate	Yrs	AV	(tm
0	35.0	C.J. Anderson\AndeC.00	27.0	RB	2	2.0	225.0	5-8	California	2/10/1991	5	2.0	
1	12.0	Brandin Cooks\CookBr00	25.0	WR	16	16.0	183.0	5-10	Oregon St.	9/25/1993	4	13.0	Sai / 2
2	30.0	Todd Gurley*+\GurlTo01	24.0	RB	14	14.0	224.0	6-1	Georgia	8/3/1994	3	16.0	S Ra / 1
3	89.0	Tyler Higbee\HigbTy00	25.0	TE	16	16.0	255.0	6-6	Western Kentucky	1/1/1993	2	3.0	Ra pic
4	18.0	Cooper Kupp\KuppCo00	25.0	WR	8	8.0	208.0	6-2	East. Washington	6/15/1993	1	6.0	Ra / 6

So now we've cleaned this data a little bit, but we can still see we have a few problems with it, namely:

1. We have columns we don't care about. We care about the player, their traits, their stats, their college and when they were drafted (because this will help us find some more information on them later), and that's about it. We're going to get rid of all the other extra stuff.
2. If you look at the player entries, there's a whole bunch of nonsense after they're names because of the way the data was originally formatted. We want to get rid of this, not only to make it look prettier, but also to make it easier to use.
3. We have duplicate entries for players who played in both 2017 and 2018 for their respective teams. We'll get rid of the second entry (in this case, arbitrarily the entry for 2017).

To do the first one, we'll write a quick function (`drop_unnecessary_columns_rosters`) to get rid of the columns we don't want and run each DataFrame through it:

In [289]:
```
sf_skill_positions = spf.drop_unnecessary_columns_rosters(sf_skill_position
rams_skill_positions = spf.drop_unnecessary_columns_rosters(rams_skill_posi
```

For the second and third issues, we'll have to write a (slightly more complicated) function (`clean_player_column`), and run IT on each DataFrame:

In [290]:
```
sf_skill_positions = spf.clean_player_column(sf_skill_positions)
rams_skill_positions = spf.clean_player_column(rams_skill_positions)
```

And now we can see that we have two cleaned and accurate tables without duplicates.

In [291]:
```
sf_skill_positions.head()
```

Out[291]:

	Player	Age	Pos	G	GS	Wt	Ht	College/Univ	Drafted (tm/rnd/yr)
0	Jeff Wilson	23.0	RB	6	2.0	194.0	6-0	NaN	NaN
1	Alfred Morris	30.0	RB	12	1.0	224.0	5-10	Florida Atlantic	Washington Redskins / 6th / 173rd pick / 2012
2	Matt Breida	23.0	RB	14	13.0	190.0	5-10	Georgia Southern	NaN
3	Dante Pettis	23.0	WR	12	7.0	195.0	6-1	Washington	San Francisco 49ers / 2nd / 44th pick / 2018
4	Richie James	23.0	WR	13	2.0	185.0	5-9	Middle Tenn. St.	San Francisco 49ers / 7th / 240th pick / 2018

In [292]:
```
rams_skill_positions.head()
```

Out[292]:

	Player	Age	Pos	G	GS	Wt	Ht	College/Univ	Drafted (tm/rnd/yr)
0	C.J. Anderson	27.0	RB	2	2.0	225.0	5-8	California	NaN
1	Brandin Cooks	25.0	WR	16	16.0	183.0	5-10	Oregon St.	New Orleans Saints / 1st / 20th pick / 2014
2	Todd Gurley	24.0	RB	14	14.0	224.0	6-1	Georgia	St. Louis Rams / 1st / 10th pick / 2015
3	Tyler Higbee	25.0	TE	16	16.0	255.0	6-6	Western Kentucky	Los Angeles Rams / 4th / 110th pick / 2016
4	Cooper Kupp	25.0	WR	8	8.0	208.0	6-2	East. Washington	Los Angeles Rams / 3rd / 69th pick / 2017

NFL Statistics

We've made some progress, but we want statistics to go along with these players, or else this information isn't all that useful, so we're going to have to go get more data. For our purposes we'll be using 2017 and 2018 because these are the years that McVay and Shanahan were head coaches for their respective teams, and we only care if the player is successful in these specific schemes.

In [293]:
```
rams_stats_2018 = pd.read_csv('data/RamsRecAndRush2018.csv', skiprows = [0]
rams_stats_2017 = pd.read_csv('data/RamsRecAndRush2017.csv', skiprows = [0]
sf_stats_2018 = pd.read_csv('data/49ersRecAndRush2018.csv', skiprows = [0])
sf_stats_2017 = pd.read_csv('data/49ersRecAndRush2017.csv', skiprows = [0])
```

In [294]:
```
rams_stats_2018.head()
```

Out[294]:

	No.	Player	Age	Pos	G	GS	Att	Yds	TD	Lng	...	TD.1	Lng.1	R/G	Y/G.
0	30.0	Todd Gurley*+\GurlTo01	24.0	RB	14	14.0	256	1251	17	36.0	...	4.0	56.0	4.2	41.4
1	34.0	Malcolm Brown\BrowMa03	25.0	NaN	12	0.0	43	212	0	19.0	...	1.0	18.0	0.4	4.3
2	35.0	C.J. Anderson\AndeC.00	27.0	rb	2	2.0	43	299	2	46.0	...	0.0	13.0	2.0	8.5
3	16.0	Jared Goff*\GoffJa00	24.0	QB	16	16.0	43	108	2	16.0	...	NaN	NaN	NaN	NaN
4	42.0	John Kelly\KellJo00	22.0	NaN	4	0.0	27	74	0	7.0	...	0.0	18.0	0.5	6.8

5 rows × 27 columns

Cleaning NFL Statistics

The data loaded in above is the stats for the Rams and 49ers for 2017 and 2018, but it needs to get worked on a little bit before we can combine it with our other data.

First, the column names don't exactly make it clear as to what the values are, so we'll rename them (`fix_column_names`) by looking at the original data (what we're doing here is making sure we can easily tell what are rushing numbers and what are receiving numbers before we get too deep in).

In [295]:
```
rams_stats_2018 = spf.fix_column_names(rams_stats_2018)
rams_stats_2017 = spf.fix_column_names(rams_stats_2017)
sf_stats_2018 = spf.fix_column_names(sf_stats_2018)
sf_stats_2017 = spf.fix_column_names(sf_stats_2017)
```

In [296]:
```
sf_stats_2018.head()
```

Out[296]:

	No.	Player	Age	Pos	G	GS	Rush Att	Rush Yds	Rush TD	Rush Lng	...	Receiving TD	Receiving Lng
0	22.0	Matt Breida\BreiMa00	23.0	RB	14	13.0	153	814	3	66.0	...	2.0	26.0
1	36.0	Alfred Morris\MorrAl00	30.0	rb	12	1.0	111	428	2	51.0	...	0.0	16.0
2	41.0	Jeff Wilson\WilsJe01	23.0	rb	6	2.0	66	266	0	18.0	...	0.0	24.0
3	31.0	Raheem Mostert\MostRa00	26.0	NaN	9	0.0	34	261	1	52.0	...	0.0	23.0
4	3.0	C.J. Beathard\BeatC.00	25.0	qb	6	5.0	19	69	1	13.0	...	NaN	NaN

5 rows × 27 columns

We also have the same issue with the player names that we had before, but thankfully we can just use our function from the previous part to do this too.

In [297]:
```
rams_stats_2018 = spf.clean_player_column(rams_stats_2018)
rams_stats_2017 = spf.clean_player_column(rams_stats_2017)
sf_stats_2018 = spf.clean_player_column(sf_stats_2018)
sf_stats_2017 = spf.clean_player_column(sf_stats_2017)
```

In [337]:
```
rams_stats_2018.head()
```

Out[337]:

	No.	Player	Age	Pos	G	GS	Rush Att	Rush Yds	Rush TD	Rush Lng	...	Receiving TD	Receiving Lng	R/G
0	30.0	Todd Gurley	24.0	RB	14	14.0	256	1251	17	36.0	...	4.0	56.0	4.2
1	34.0	Malcolm Brown	25.0	0	12	0.0	43	212	0	19.0	...	1.0	18.0	0.4
2	35.0	C.J. Anderson	27.0	rb	2	2.0	43	299	2	46.0	...	0.0	13.0	2.0
3	16.0	Jared Goff	24.0	QB	16	16.0	43	108	2	16.0	...	0.0	0.0	0.0
4	42.0	John Kelly	22.0	0	4	0.0	27	74	0	7.0	...	0.0	18.0	0.5

5 rows × 27 columns

Now, since we have two years worth of stats, we want to find a good way to combine these two seasons into a single feature. In this analysis, I have decided that it's probably best to go on a per game basis for attempts, receptions, touchdowns, and yards as well as a per reception/per attempt for yards, as I believe this will limit the affect that missing games will have, and with two years (a maximum of 32 games) as our sample size, this should mitigate the risk of having a few small or big games (looking at you Derrick Henrys of the world) greatly affect our data. Also, we'll adjust catch percentage to account for the two year span.

Before combining, however, we're going to replace all missing values in these DataFrames with zero, as after looking at the data, this seems to be what's called a `Null` that is `Missing by Design` , or that the `NaN` in this case just refers to 0 targets/receptions/etc.

In [299]:
```
rams_stats_2018 = rams_stats_2018.fillna(0) #fills NaN/null values with 0
rams_stats_2017 = rams_stats_2017.fillna(0)
sf_stats_2018 = sf_stats_2018.fillna(0)
sf_stats_2017 = sf_stats_2017.fillna(0)
```

And now we can combine the stats for 2017 and 2018 with `merge_stats_cols` :

In [300]:
```
rams_stats = spf.merge_stats_cols(rams_stats_2017, rams_stats_2018)
sf_stats = spf.merge_stats_cols(sf_stats_2017, sf_stats_2018)
```

In [352]:
```
rams_for_later = deepcopy(rams_stats)
rams_stats.head()
```

Out[352]:

	Player	G	GS	Rush Att	Rush Yds	Rush TD	Tgt	Rec	Receiving Yds	Receiving TD	Touch	Catch Percentage
0	Todd Gurley	29.0	29.0	535.0	2556.0	30.0	168.0	123.0	1368.0	10.0	658.0	0.732143
1	Malcolm Brown	23.0	1.0	106.0	458.0	1.0	18.0	14.0	105.0	1.0	120.0	0.777778
2	Tavon Austin	16.0	9.0	59.0	270.0	1.0	22.0	13.0	47.0	0.0	72.0	0.590909
3	Jared Goff	31.0	31.0	71.0	159.0	3.0	0.0	0.0	0.0	0.0	71.0	NaN
4	Lance Dunbar	4.0	0.0	11.0	51.0	1.0	3.0	1.0	1.0	0.0	12.0	0.333333

In [353]:
```
sf_for_later = deepcopy(sf_stats)
sf_stats.head()
```

Out[353]:

	Player	G	GS	Rush Att	Rush Yds	Rush TD	Tgt	Rec	Receiving Yds	Receiving TD	Touch	Catch Percentage
0	Carlos Hyde	16.0	16.0	240.0	938.0	8.0	88.0	59.0	350.0	0.0	299.0	0.670455
1	Matt Breida	30.0	13.0	258.0	1279.0	5.0	67.0	48.0	441.0	3.0	306.0	0.716418
2	C.J. Beathard	13.0	10.0	45.0	205.0	4.0	0.0	0.0	0.0	0.0	45.0	NaN
3	Jimmy Garoppolo	9.0	8.0	23.0	44.0	1.0	1.0	1.0	-6.0	0.0	24.0	1.000000
4	Kyle Juszczyk	30.0	24.0	15.0	61.0	0.0	83.0	63.0	639.0	2.0	78.0	0.759036

So we've been able to combine each team's years together, and now the easy part, normalizing the data based on games and attempts.

In [303]:
```
rams_stats_normalized = spf.normalize_stats(rams_stats)
sf_stats_normalized = spf.normalize_stats(sf_stats)
```

In [304]:
```
rams_stats_normalized.head()
```

Out[304]:

	Player	G	GS	Catch Percentage	Touch/G	Rush TD/G	Rush Att/G	Rush Yds/Att	Rush Yds/G	Tgt/G
0	Todd Gurley	29.0	29.0	0.732143	22.689655	1.034483	18.448276	4.777570	88.137931	5.793103
1	Malcolm Brown	23.0	1.0	0.777778	5.217391	0.043478	4.608696	4.320755	19.913043	0.782609
2	Tavon Austin	16.0	9.0	0.590909	4.500000	0.062500	3.687500	4.576271	16.875000	1.375000
3	Jared Goff	31.0	31.0	NaN	2.290323	0.096774	2.290323	2.239437	5.129032	0.000000
4	Lance Dunbar	4.0	0.0	0.333333	3.000000	0.250000	2.750000	4.636364	12.750000	0.750000

In [305]:
```
sf_stats_normalized.head()
```

Out[305]:

	Player	G	GS	Catch Percentage	Touch/G	Rush TD/G	Rush Att/G	Rush Yds/Att	Rush Yds/G	Tgt/(
0	Carlos Hyde	16.0	16.0	0.670455	18.687500	0.500000	15.000000	3.908333	58.625000	5.50000(
1	Matt Breida	30.0	13.0	0.716418	10.200000	0.166667	8.600000	4.957364	42.633333	2.23333
2	C.J. Beathard	13.0	10.0	NaN	3.461538	0.307692	3.461538	4.555556	15.769231	0.00000(
3	Jimmy Garoppolo	9.0	8.0	1.000000	2.666667	0.111111	2.555556	1.913043	4.888889	0.11111
4	Kyle Juszczyk	30.0	24.0	0.759036	2.600000	0.000000	0.500000	4.066667	2.033333	2.76666

Combining Roster Data and Statistic Data

Now we'll combine our roster data and our statistics data so that we can use it to determine the type of player we should be looking for.

In [306]:
```
sf_players = spf.merge_in_stats(sf_stats_normalized, sf_skill_positions)
rams_players = spf.merge_in_stats(rams_stats_normalized, rams_skill_positic
```

In [307]:
```
rams_players
```

Out[307]:

	Player	Age	Pos	Wt	Ht	College/Univ	Drafted (tm/rnd/yr)	G	GS	Catch Percentage	Touch/G	
0	C.J. Anderson	27.0	RB	225.0	5-8	California	NaN	2.0	2.0	0.666667	23.500000	1.
1	Brandin Cooks	25.0	WR	183.0	5-10	Oregon St.	New Orleans Saints / 1st / 20th pick / 2014	16.0	16.0	0.683761	5.625000	0.
2	Todd Gurley	24.0	RB	224.0	6-1	Georgia	St. Louis Rams / 1st / 10th pick / 2015	29.0	29.0	0.732143	22.689655	1.
3	Tyler Higbee	25.0	TE	255.0	6-6	Western Kentucky	Los Angeles Rams / 4th / 110th pick / 2016	32.0	32.0	0.620253	1.531250	0.
4	Cooper Kupp	25.0	WR	208.0	6-2	East. Washington	Los Angeles Rams / 3rd / 69th pick / 2017	23.0	14.0	0.684564	4.608696	0.
5	Josh Reynolds	23.0	WR	196.0	6-3	Texas A&M	Los Angeles Rams / 4th / 117th pick / 2017	32.0	9.0	0.519481	1.312500	0.
6	Robert Woods	26.0	WR	195.0	6-0	USC	Buffalo Bills / 2nd / 41st pick / 2013	28.0	27.0	0.660465	5.821429	0.
7	Tavon Austin	27.0	WR	179.0	5-8	West Virginia	St. Louis Rams / 1st / 8th pick / 2013	16.0	9.0	0.590909	4.500000	0.
8	Malcolm Brown	24.0	RB	222.0	5-11	Texas	NaN	23.0	1.0	0.777778	5.217391	0.
9	Derek Carrier	27.0	TE	244.0	6-4	Beloit	NaN	14.0	3.0	0.727273	0.571429	0.
10	Pharoh Cooper	22.0	WR	208.0	5-11	South Carolina	Los Angeles Rams / 4th / 117th pick / 2016	16.0	1.0	0.578947	0.750000	0.
11	Gerald Everett	23.0	TE	240.0	6-3	South Alabama	Los Angeles Rams / 2nd / 44th pick / 2017	32.0	2.0	0.597561	1.625000	0.

	Player	Age	Pos	Wt	Ht	College/Univ	Drafted (tm/rnd/yr)	G	GS	Catch Percentage	Touch/G	
12	Mike Thomas	23.0	WR	189.0	6-1	Southern Miss	Los Angeles Rams / 6th / 206th pick / 2016	8.0	1.0	0.714286	0.625000	0.
13	Sammy Watkins	24.0	WR	211.0	6-1	Clemson	Buffalo Bills / 1st / 4th pick / 2014	15.0	14.0	0.557143	2.600000	0.

In [308]:
```
sf_players
```

Out[308]:

	Player	Age	Pos	Wt	Ht	College/Univ	Drafted (tm/rnd/yr)	G	GS	Catch Percentage	Touch/G	
0	Jeff Wilson	23.0	RB	194.0	6-0	NaN	NaN	6.0	2.0	0.800000	13.000000	C
1	Alfred Morris	30.0	RB	224.0	5-10	Florida Atlantic	Washington Redskins / 6th / 173rd pick / 2012	12.0	1.0	0.615385	9.916667	C
2	Matt Breida	23.0	RB	190.0	5-10	Georgia Southern	NaN	30.0	13.0	0.716418	10.200000	C
3	Dante Pettis	23.0	WR	195.0	6-1	Washington	San Francisco 49ers / 2nd / 44th pick / 2018	12.0	7.0	0.600000	2.333333	C
4	Richie James	23.0	WR	185.0	5-9	Middle Tenn. St.	San Francisco 49ers / 7th / 240th pick / 2018	13.0	2.0	0.642857	0.692308	C
5	Marquise Goodwin	28.0	WR	180.0	5-9	Texas	Buffalo Bills / 3rd / 78th pick / 2013	27.0	24.0	0.533784	3.222222	C
6	Pierre Garcon	32.0	WR	211.0	6-0	Mount Union	Indianapolis Colts / 6th / 205th pick / 2008	16.0	16.0	0.566372	4.000000	C
7	Kendrick Bourne	23.0	WR	203.0	6-1	East. Washington	NaN	27.0	8.0	0.580000	2.148148	C
8	George Kittle	25.0	TE	250.0	6-4	Iowa	San Francisco 49ers / 5th / 146th pick / 2017	31.0	23.0	0.658291	4.258065	C
9	Garrett Celek	30.0	TE	252.0	6-5	Michigan St.	NaN	31.0	14.0	0.634146	0.838710	C
10	Carlos Hyde	27.0	RB	229.0	6-0	Ohio St.	San Francisco 49ers / 2nd / 57th pick / 2014	16.0	16.0	0.670455	18.687500	C
11	Louis Murphy	30.0	WR	200.0	6-2	Florida	Oakland Raiders / 4th / 124th pick / 2009	7.0	7.0	0.470588	1.142857	C
12	Logan Paulsen	30.0	TE	268.0	6-5	UCLA	NaN	NaN	NaN	NaN	NaN	
13	Aldrick Robinson	29.0	WR	185.0	5-10	SMU	Washington Redskins / 6th / 178th pick / 2011	16.0	1.0	0.395833	1.187500	C

	Player	Age	Pos	Wt	Ht	College/Univ	Drafted (tm/rnd/yr)	G	GS	Catch Percentage	Touch/G	
14	Trent Taylor	23.0	WR	180.0	5-8	Louisiana Tech	San Francisco 49ers / 5th / 177th pick / 2017	29.0	1.0	0.683168	2.379310	0

Determining Good Scheme Fits

Cuts Based on Small Sample Size/Low Usage

Now that we have merged our data, we can make a first round of removals based on small sample size and low usage. We defined low usage with a threshold of being active for at least 10 games as well as a threshold for receivers and tight ends of starting at least 25% of games, and for running backs of getting at least 6 touches a game. Usage numbers are very important when considering good players for these schemes, as a lack of usage demonstrates a lack of talent and or a lack of confidence from the coaching staff, who know better than anyone what works and what doesn't in their offense.

Unfortunately, it is with a heavy heart that we must say fairwell to `C.J. Anderson` (I can here the voice saying "you've been voted off the island" as I type). Yes, he had a good run at the end of the season. Yes he almost single handedly made an MVP ride the bench, for some reason (Todd Gurley missing flyers are still up all over the city of L.A.). And ultimately he did play well for the Rams. But 2 games is simply not a big enough sample size to draw any conclusions on whether or not he is a type of player that works in this system, so it's goodbye to everyone's favorite bowling ball.

As for low usage on the Rams, it is also fair to cut `Malcolm Brown` (only 5.2 touches per game), `Derek Carrier` (only started 3 of 14 games), `Pharoh Cooper` (only started 1 of 16 games), `Gerald Everett` (only started 2 of 32 games) and `Mike Thomas` (only active for 8 games) (and no not THAT Mike Thomas). An additional indication of these players' low usage is that all of the receivers averaged less than 2 touches a game and none had more than 3 starts.

For the 49ers' players, the cuts are a little less painful. First, we can certainly remove `Logan Paulsen` as he had no receiving or rushing statistics while on the 49ers (don't worry I double checked). We can also remove `Richie James` (only started 2 of 13 games), `Jeff Wilson` (only active for 6 games), `Aldrick Robinson` (only started 1 of 16 games), `Louis Murphy` (only active for 7 games), and `Trent Taylor` (only started 1 of 29 games).

In [309]:
```
rams_players = rams_players[~(rams_players['Player'].isin(['C.J. Anderson',
sf_players = sf_players[~(sf_players['Player'].isin(['Logan Paulsen', 'Rich
```

In order to make further conclusions on 'successfulness' and 'fit' beyond this, however, we're going to need to go deeper into thes statistics and deeper player by player. We'll start with the 49ers.

In [310]:
```
rams_players
```

Out[310]:

	Player	Age	Pos	Wt	Ht	College/Univ	Drafted (tm/rnd/yr)	G	GS	Catch Percentage	Touch/G	
0	Brandin Cooks	25.0	WR	183.0	5-10	Oregon St.	New Orleans Saints / 1st / 20th pick / 2014	16.0	16.0	0.683761	5.625000	0.0
1	Todd Gurley	24.0	RB	224.0	6-1	Georgia	St. Louis Rams / 1st / 10th pick / 2015	29.0	29.0	0.732143	22.689655	1.0
2	Tyler Higbee	25.0	TE	255.0	6-6	Western Kentucky	Los Angeles Rams / 4th / 110th pick / 2016	32.0	32.0	0.620253	1.531250	0.0
3	Cooper Kupp	25.0	WR	208.0	6-2	East. Washington	Los Angeles Rams / 3rd / 69th pick / 2017	23.0	14.0	0.684564	4.608696	0.0
4	Josh Reynolds	23.0	WR	196.0	6-3	Texas A&M	Los Angeles Rams / 4th / 117th pick / 2017	32.0	9.0	0.519481	1.312500	0.0
5	Robert Woods	26.0	WR	195.0	6-0	USC	Buffalo Bills / 2nd / 41st pick / 2013	28.0	27.0	0.660465	5.821429	0.0
6	Tavon Austin	27.0	WR	179.0	5-8	West Virginia	St. Louis Rams / 1st / 8th pick / 2013	16.0	9.0	0.590909	4.500000	0.0
7	Sammy Watkins	24.0	WR	211.0	6-1	Clemson	Buffalo Bills / 1st / 4th pick / 2014	15.0	14.0	0.557143	2.600000	0.0

Cuts Based on Negative Usage Trends

There is also a case of players who, while initially a part of the team and had decent production, were immediately phased out the following year are a few players who had a decent number of games and starts, but ultimately fell out of favor once other players came along. This shows that they are not ideal scheme fits, as their position was viewed by the coaches to be one that needed improvement.

The only real presence of a case like this that I'm going to argue can be removed is `Garrett Celek` for the following reasons:

1. He's 30 years old and has been on the team since 2012. He's not a player chosen by Shanahan, so he wasn't chosen for the scheme; he was kept around for depth and for a

veteran presence.
2. More importantly, after starting in 13 games last season and amassing 33 targets in 2017, this past season he started in just 1 game, and had only EIGHT targets over the ENTIRE season. EIGHT. This marks a player who is clearly not a preferred starter, and one who is being phased out as quickly as possible.

In [311]:
```
sf_players = sf_players[sf_players['Player'] != 'Garrett Celek']
sf_players
```

Out[311]:

	Player	Age	Pos	Wt	Ht	College/Univ	Drafted (tm/rnd/yr)	G	GS	Catch Percentage	Touch/G	
0	Alfred Morris	30.0	RB	224.0	5-10	Florida Atlantic	Washington Redskins / 6th / 173rd pick / 2012	12.0	1.0	0.615385	9.916667	0.16
1	Matt Breida	23.0	RB	190.0	5-10	Georgia Southern	NaN	30.0	13.0	0.716418	10.200000	0.16
2	Dante Pettis	23.0	WR	195.0	6-1	Washington	San Francisco 49ers / 2nd / 44th pick / 2018	12.0	7.0	0.600000	2.333333	0.00
3	Marquise Goodwin	28.0	WR	180.0	5-9	Texas	Buffalo Bills / 3rd / 78th pick / 2013	27.0	24.0	0.533784	3.222222	0.00
	Pierre				6-		Indianapolis Colts / 6th /					

Cuts Based on Statistics

Contextualizing Data in Terms of Position Statistics

Another one bites the dust. Here's where it gets a little tougher though. We've removed the people that we feel weren't getting used in the system. We've removed the people who weren't preferred starters in the system. But now we need to find those that were unproductive, even when used. We want to see if these players' receiving and rushing numbers are successful in this system by comparing their receiving and rushing stats to those of their peers at their position from the past year. (I'm using one year here because this should be a large enough sample to get reasonable values to compare our players against, and the receiving numbers shouldn't vary too much year to year). We're going to start by showing the process with the receiving data, and then do the same with the rushing data, albeit a little faster.

In [312]:
```
receiving_stats_2018 = pd.read_csv('data/NFLReceivingStats2018.csv')
```

Recleaning Statistics Data

We want to compare position by position for each player, that is, Kittle to the receiving/rushing numbers for Tight Ends; Goodwin, Garcon, Bourne, and Pettis to the receiving/rushing numbers for Wide Receivers; and Matt Breida and Alfred Morris to the receiving/rushing numbers for Running

Backs. However, we can see that our position values for this data set are a little strange.

In [313]:
```
receiving_stats_2018 = receiving_stats_2018.dropna(subset = ['Pos']) #Gets
receiving_stats_2018['Pos'] = receiving_stats_2018.Pos.apply(lambda x : str
pd.Series(receiving_stats_2018.Pos.unique()) #Prints out all of the unique
```

Out[313]:
```
0              WR
1              TE
2              RB
3           TE/WR
4           RB/WR
5          LCB/WR
6           FB/WR
7           QB/RB
8              FB
9       FB/RB/TE
10         RB/TE
11      FB/RB/WR
12             QB
13              T
14           T/TE
15              C
16         CB/RCB
17    DT/LDT/RDT
dtype: object
```

Ok, quick aside: who in God's green Earth has ever been a *__squints__* Left Corner Back and Receiver?? Sorry excuse me for one second...

In [314]:
```
receiving_stats_2018[receiving_stats_2018['Pos'] == 'LCB/WR']
```

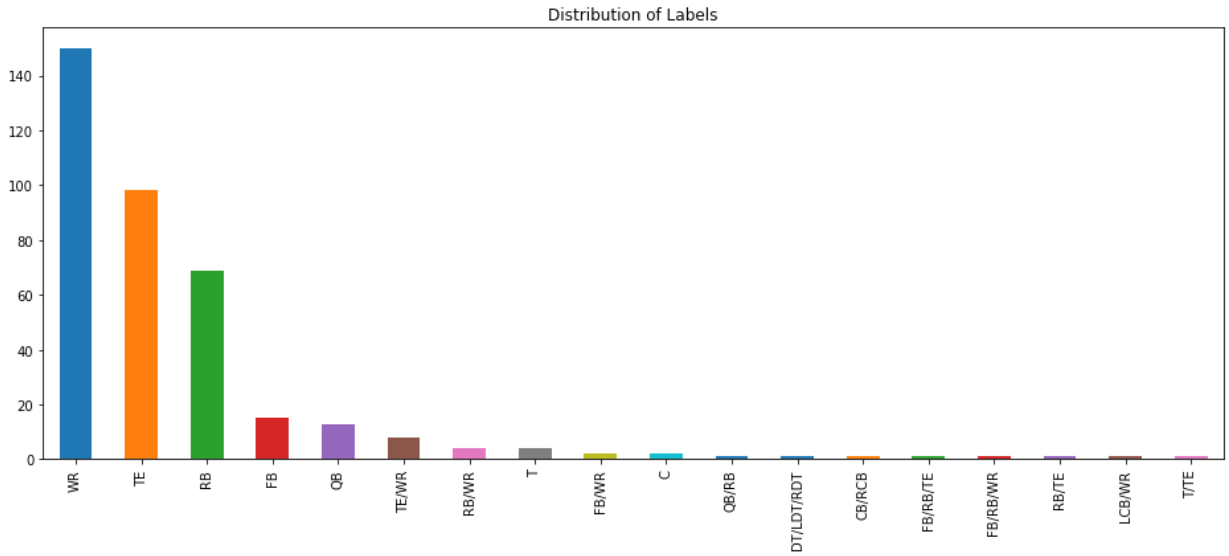
Out[314]:

	Rk	Player	Tm	Age	Pos	G	GS	Tgt	Rec	Ctch%	Yds	Y/R	TD	Lng	R/G
94	95	Tyrell Williams\WillTy00	LAC	26	LCB/WR	16	10	65	41	63.1%	653	15.9	5	75	2.6

Oh ok just Tyrell Williams then. Guess we'll just pretend like that's a thing and move on?

When we look at the distribution (the relative frequency) of these values, we can see that a lot of the more specific labels are very rare (see graph below).

In [315]:
```
receiving_stats_2018['Pos'].value_counts().plot(kind = 'bar', figsize = (16
```



Look at all those colors. Anyway, so what we're going to do in order to make this as faithful a calculation as possible is turn some of these awkward positions into normal position groups. This is referred to in Data Science as "reducing granularity". I went through by hand to ensure the accuracy of this dictionary, which can be viewed in the .py file. Sorry Tyrell Williams, you're just a receiver again.

In [316]:
```
receiving_stats_2018 = spf.position_map_receiving(receiving_stats_2018)
receiving_stats_2018[receiving_stats_2018['Pos'] == 'WR'].sort_values('Ctch
```

Out[316]:

	Rk	Player	Tm	Age	Pos	G	GS	Tgt	Rec	Ctch%	Yds	Y/R	TD	Lng
0	320	Cameron Meredith\MereCa00	NOR	26	WR	6	1	10	9	90.0%	114	12.7	1	46
1	321	Trey Quinn\QuinTr00	WAS	23	WR	3	2	10	9	90.0%	75	8.3	1	15
2	355	Kamar Aiken\AikeKa00	PHI	29	WR	5	1	7	6	85.7%	53	8.8	0	18
3	289	Eli Rogers\RogeEl00	PIT	26	WR	3	3	14	12	85.7%	79	6.6	0	17
4	11	Michael Thomas*+\ThomMi05	NOR	25	WR	16	16	147	125	85.0%	1405	11.2	9	72
5	74	Theo Riddick\RiddTh00	DET	27	WR	14	3	74	61	82.4%	384	6.3	0	20
6	145	Ryan Switzer\SwitRy00	PIT	24	WR	16	1	44	36	81.8%	253	7.0	1	24
7	84	Tyler Lockett\LockTy00	SEA	26	WR	16	14	70	57	81.4%	965	16.9	10	52
8	323	Taquan Mizzell\MizzTa00	CHI	25	WR	9	1	10	8	80.0%	78	9.8	1	26
9	377	Jacob Hollister\HollJa03	NWE	25	WR	8	1	5	4	80.0%	52	13.0	0	23
10	155	Phillip Dorsett\DorsPh00	NWE	25	WR	16	2	42	32	76.2%	290	9.1	3	20
11	281	Brandon LaFell\LaFeBr00	OAK	32	WR	6	5	16	12	75.0%	135	11.3	2	24
12	342	Rashad Greene\GreeRa00	JAX	26	WR	8	1	8	6	75.0%	60	10.0	0	12
13	65	Danny Amendola\AmenDa00	MIA	33	WR	15	15	79	59	74.7%	575	9.7	1	39
14	57	Cole Beasley\BeasCo00	DAL	29	WR	16	4	87	65	74.7%	672	10.3	3	32
15	178	Albert Wilson\WilsAl02	MIA	26	WR	7	3	35	26	74.3%	391	15.0	4	75
16	7	Adam Thielen*\ThieAd00	MIN	28	WR	16	16	153	113	73.9%	1373	12.2	9	68
17	263	Jaron Brown\BrowJa03	SEA	28	WR	16	2	19	14	73.7%	166	11.9	5	45
18	79	Chester Rogers\RogeCh02	IND	24	WR	16	10	72	53	73.6%	485	9.2	2	34
19	115	Rashard Higgins\HiggRa00	CLE	24	WR	13	1	53	39	73.6%	572	14.7	4	40
20	222	T.J. Jones\JoneT.00	DET	26	WR	15	3	26	19	73.1%	190	10.0	2	26
21	111	Sammy Watkins\WatkSa00	KAN	25	WR	10	9	55	40	72.7%	519	13.0	3	50
22	110	Cooper Kupp\KuppCo00	LAR	25	WR	8	8	55	40	72.7%	566	14.2	6	70
23	315	Jake Kumerow\KumeJa00	GNB	26	WR	5	2	11	8	72.7%	103	12.9	1	49

	Rk	Player	Tm	Age	Pos	G	GS	Tgt	Rec	Ctch%	Yds	Y/R	TD	Lng
24	313	Cameron Batson\BatsCa00	TEN	23	WR	11	2	11	8	72.7%	82	10.3	0	26
25	38	Emmanuel Sanders\SandEm00	DEN	31	WR	12	12	98	71	72.4%	868	12.2	4	64
26	33	Adam Humphries\HumpAd00	TAM	25	WR	16	10	105	76	72.4%	816	10.7	5	51
27	47	Taylor Gabriel\GabrTa00	CHI	27	WR	16	11	93	67	72.0%	688	10.3	2	54
28	165	Dontrelle Inman\InmaDo00	IND	29	WR	9	4	39	28	71.8%	304	10.9	3	29
29	55	Jordy Nelson\NelsJo00	OAK	33	WR	15	14	88	63	71.6%	739	11.7	3	66
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
121	37	Michael Crabtree\CrabMi00	BAL	31	WR	16	16	100	54	54.0%	607	11.2	3	27
122	53	Donte Moncrief\MoncDo00	JAX	25	WR	16	14	89	48	53.9%	668	13.9	3	80
123	153	Marquise Goodwin\GoodMa00	SFO	28	WR	11	8	43	23	53.5%	395	17.2	4	67
124	46	Robby Anderson\AndeRo04	NYJ	25	WR	14	9	94	50	53.2%	752	15.0	6	76
125	138	Pierre Garcon\GarcPi00	SFO	32	WR	8	8	46	24	52.2%	286	11.9	1	25
126	78	Marquez Valdes-Scantling\ValdMa00	GNB	24	WR	16	10	73	38	52.1%	581	15.3	2	60
127	134	DeVante Parker\ParkDe01	MIA	25	WR	11	7	47	24	51.1%	309	12.9	1	46
128	59	Courtland Sutton\SuttCo00	DEN	23	WR	16	9	84	42	50.0%	704	16.8	4	42
129	376	Jalen Tolliver\TollJa00	ARI	23	WR	3	1	6	3	50.0%	37	12.3	0	15
130	331	Vyncint Smith\SmitVy00	HOU	22	WR	7	1	10	5	50.0%	91	18.2	1	35
131	443	Darrius Heyward-Bey\HeywDa00	PIT	31	WR	14	2	2	1	50.0%	9	9.0	0	9
132	240	Travis Benjamin\BenjTr00	LAC	29	WR	12	3	24	12	50.0%	186	15.5	1	46
133	402	Jeremy Kerley\KerlJe00	BUF	30	WR	1	1	4	2	50.0%	7	3.5	0	4
134	118	David Moore\MoorDa03	SEA	23	WR	16	7	53	26	49.1%	445	17.1	5	54
135	73	Jermaine Kearse\KearJe01	NYJ	28	WR	14	9	76	37	48.7%	371	10.0	1	29
136	89	Michael Gallup\GallMi00	DAL	22	WR	16	8	68	33	48.5%	507	15.4	2	49
137	196	Marcell Ateman\AtemMa00	OAK	24	WR	7	6	31	15	48.4%	154	10.3	1	32

	Rk	Player	Tm	Age	Pos	G	GS	Tgt	Rec	Ctch%	Yds	Y/R	TD	Lng
138	248	Brandon Marshall\MarsBr00	SEA	34	WR	7	2	23	11	47.8%	136	12.4	1	27
139	211	Cody Core\CoreCo00	CIN	24	WR	14	3	28	13	46.4%	160	12.3	1	30
140	241	Andy Jones\JoneAn01	DET	24	WR	8	3	24	11	45.8%	80	7.3	1	15
141	40	John Brown\BrowJo02	BAL	28	WR	16	15	97	42	43.3%	715	17.0	5	71
142	168	James Washington\WashJa00	PIT	22	WR	14	6	38	16	42.1%	217	13.6	1	47
143	242	Michael Floyd\FloyMi00	WAS	29	WR	13	3	24	10	41.7%	100	10.0	1	20
144	139	Chad Williams\WillCh05	ARI	24	WR	10	7	46	17	37.0%	171	10.1	1	22
145	270	JJ Nelson\NelsJJ00	ARI	26	WR	14	2	19	7	36.8%	64	9.1	0	17
146	105	John Ross\RossJo00	CIN	24	WR	13	10	58	21	36.2%	210	10.0	7	39
147	365	Dwayne Harris\HarrDw00	OAK	31	WR	15	1	6	6	100.0%	40	6.7	0	13
148	409	Tommylee Lewis\LewiTo00	NOR	26	WR	7	3	3	3	100.0%	60	20.0	1	28
149	412	Brian Quick\QuicBr00	WAS	29	WR	6	3	3	3	100.0%	18	6.0	0	6
150	466	Matt Flanagan\FlanMa00	WAS	23	WR	3	1	1	1	100.0%	14	14.0	0	14

151 rows × 17 columns

Now we want to normalize our values so that they match up with the ones we have in our original dataset from before. We'll also drop the values that we won't be using (including our player names, because we're only using these stats to find total trends by position), and we'll also clean up the Ctch% value again.

In [317]:
```
receiving_stats_2018 = spf.normalize_all_receiving(receiving_stats_2018)
receiving_stats_2018.head()
```

Out[317]:

	Age	Pos	G	GS	Tgt/G	Rec/G	Receiving Yds/Rec	Receiving Yds/G	Receiving TD/G	Catch Percentage
0	29	WR	16	16	10.625000	7.062500	14.8	104.8	0.500000	0.664706
1	26	WR	15	15	11.266667	7.400000	12.5	92.4	0.866667	0.656805
2	30	WR	15	15	11.200000	6.933333	12.5	86.5	1.000000	0.619048
3	22	WR	16	13	10.375000	6.937500	12.8	89.1	0.437500	0.668675
4	26	WR	16	16	10.187500	7.187500	13.7	98.3	0.687500	0.705521

Changing Statistics to Percentiles

We're almost at a point that we can extract values to compare to our players stats. What I'm going to do next is find what percentile for the league each player's statistic is in based on their position, by creating dictionaries (there's an example in the cell below) out of the overall receiving stats where the keys are positions and the values are lists of the values of the statistic.

In [318]:
```
tgt_per_game = receiving_stats_2018.groupby('Pos').apply(lambda x : x['Tgt/
tgt_per_game
```

Out[318]:
```
{'RB': [7.75,
  7.6875,
  7.5625,
  7.0,
  6.333333333333333,
  5.6875,
  5.0625,
  5.0625,
  5.785714285714286,
  5.571428571428571,
  4.75,
  4.5625,
  5.461538461538462,
  4.1875,
  5.5,
  3.875,
  3.9285714285714284,
  3.7857142857142856,
  4.454545454545454,
```

We can now use these lists to find what percentile each of our players are for their relative receiving stats, and then use this information to determine their talent.

In [319]:
```
sf_players_percentiles = spf.receiving_percentiles(receiving_stats_2018, sf
sf_players_percentiles
```

Out[319]:

	Pos	Player	Age	Wt	Ht	College/Univ	Drafted (tm/rnd/yr)	G	GS	Touch/G	Rush TD/G	I A
0	RB	Alfred Morris	30.0	224.0	5-10	Florida Atlantic	Washington Redskins / 6th / 173rd pick / 2012	12.0	1.0	9.916667	0.166667	9.25
1	RB	Matt Breida	23.0	190.0	5-10	Georgia Southern	NaN	30.0	13.0	10.200000	0.166667	8.60
2	WR	Dante Pettis	23.0	195.0	6-1	Washington	San Francisco 49ers / 2nd / 44th pick / 2018	12.0	7.0	2.333333	0.000000	0.08
3	WR	Marquise Goodwin	28.0	180.0	5-9	Texas	Buffalo Bills / 3rd / 78th pick / 2013	27.0	24.0	3.222222	0.000000	0.29
4	WR	Pierre Garcon	32.0	211.0	6-0	Mount Union	Indianapolis Colts / 6th / 205th pick / 2008	16.0	16.0	4.000000	0.000000	0.00
5	WR	Kendrick Bourne	23.0	203.0	6-1	East. Washington	NaN	27.0	8.0	2.148148	0.000000	0.00
6	TE	George Kittle	25.0	250.0	6-4	Iowa	San Francisco 49ers / 5th / 146th pick / 2017	31.0	23.0	4.258065	0.000000	0.03
7	RB	Carlos Hyde	27.0	229.0	6-0	Ohio St.	San Francisco 49ers / 2nd / 57th pick / 2014	16.0	16.0	18.687500	0.500000	15.00

Now we'll do all of what we did for the receiving stats for the rushing stats.

In [320]:
```
rushing_stats_2018 = pd.read_csv('data/NFLRushingStats2018.csv', skiprows =
rushing_stats_2018.head()
```

Out[320]:

	Rk	Player	Tm	Age	Pos	G	GS	Att	Yds	TD	Lng	Y/A	Y/G	Fmb
0	1	Ezekiel Elliott*\ElliEz00	DAL	23	RB	15	15	304	1434	6	41	4.7	95.6	6
1	2	Saquon Barkley*\BarkSa00	NYG	21	RB	16	16	261	1307	11	78	5.0	81.7	0
2	3	David Johnson\JohnDa08	ARI	27	RB	16	16	258	940	7	53	3.6	58.8	3
3	4	Todd Gurley*+\GurlTo01	LAR	24	RB	14	14	256	1251	17	36	4.9	89.4	1
4	5	Adrian Peterson\PeteAd01	WAS	33	RB	16	16	251	1042	7	90	4.2	65.1	3

In [321]:
```
rushing_stats_2018 = rushing_stats_2018.dropna(subset = ['Pos'])
rushing_stats_2018['Pos'] = rushing_stats_2018.Pos.apply(lambda x : str(x).
```

In [322]:
```
rushing_stats_2018 = spf.position_map_receiving(rushing_stats_2018)
```

In [323]:
```
rushing_stats_2018 = spf.normalize_all_rushing(rushing_stats_2018)
```

In [324]:
```
sf_players_percentiles = spf.rushing_percentiles(rushing_stats_2018, sf_pla
```

In [325]:
```
rams_players_percentiles =  spf.receiving_percentiles(receiving_stats_2018,
rams_players_percentiles = spf.rushing_percentiles(rushing_stats_2018, rams
```

We're going to get rid of our Touch/Game stats as well, because we didn't find anything in our league data to compare it against.

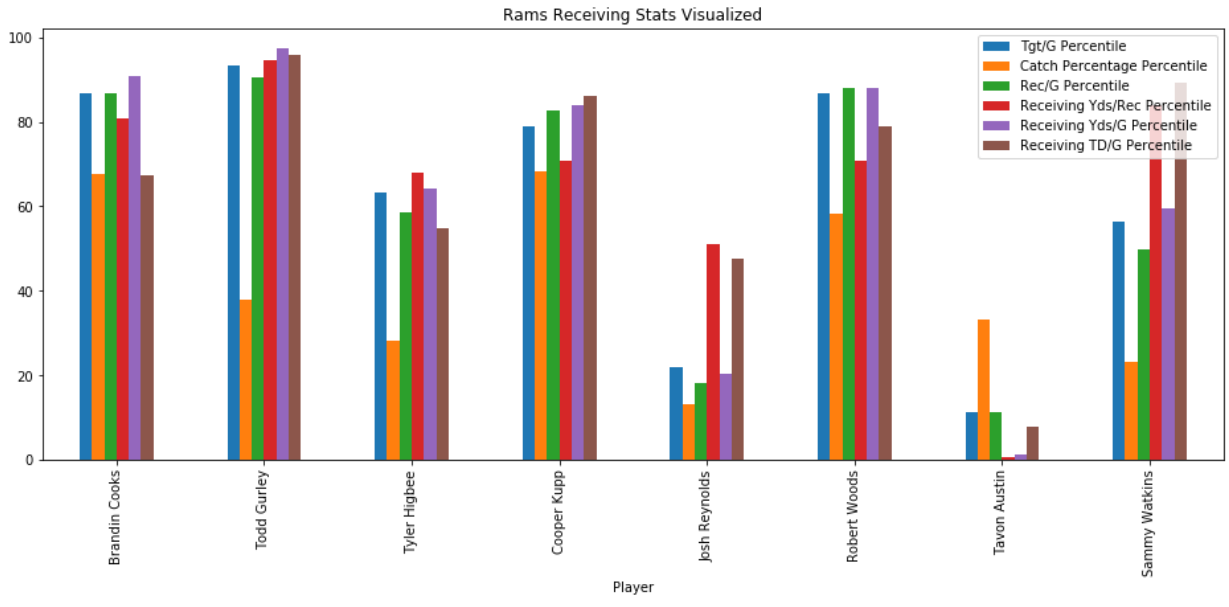
In [326]:
```
sf_players_percentiles = sf_players_percentiles.drop(['Touch/G'], axis = 1)
rams_players_percentiles = rams_players_percentiles.drop(['Touch/G'], axis
```

Final Cuts of Players by 'Success'

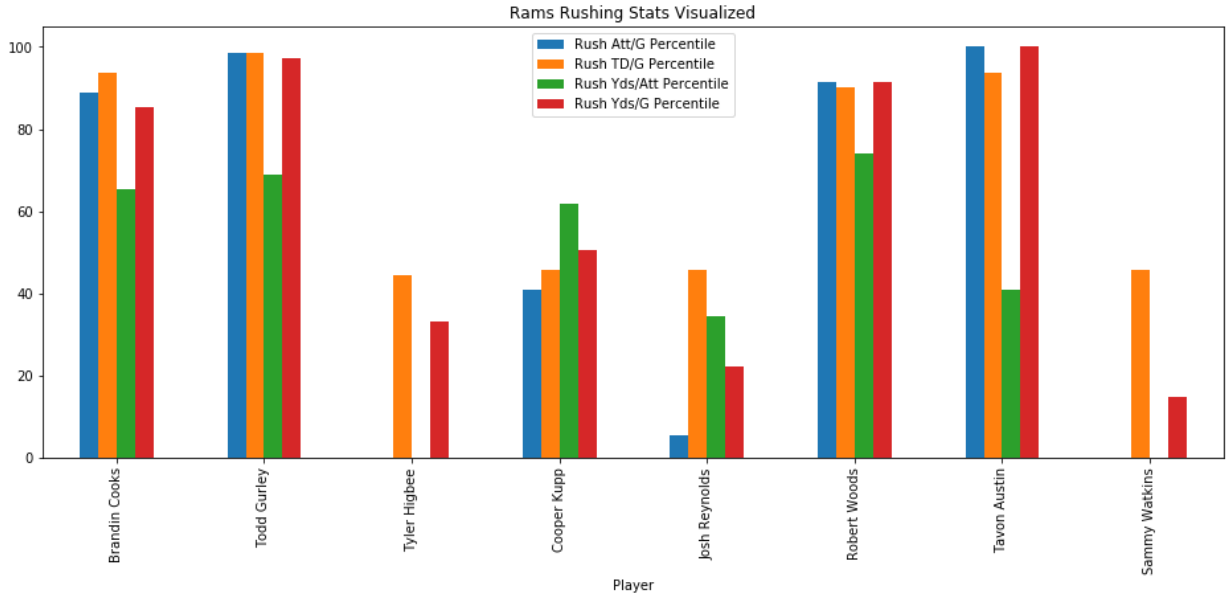
And so after all of that preprocessing (oh don't worry there's more, we still have all our college and combine data after all) we've taken our skill position players for each team, found their statistics, and then put their statistics in terms of how they compare to other players at their position. We can now use this information to quantitatively measure whether or not a player is successful in these schemes, and then choose the players to select as our prototypes to compare against college players. Let's start with the Rams this time:

Rams Final Cuts

In [327]:
```
rams_players_percentiles.drop(['Age', 'Wt', 'G', 'GS', 'Rush Att/G Percenti
```



In [328]:
```
rams_players_percentiles.drop(['Age', 'Wt', 'G', 'GS', 'Catch Percentage Pe
```



In [329]:
```
rams_players_percentiles
```

Out[329]:

	Pos	Player	Age	Wt	Ht	College/Univ	Drafted (tm/rnd/yr)	G	GS	Tgt/G Percentile	Catch Percentage Percentile	Pe
0	WR	Brandin Cooks	25.0	183.0	5-10	Oregon St.	New Orleans Saints / 1st / 20th pick / 2014	16.0	16.0	86.754967	67.549669	86
1	RB	Todd Gurley	24.0	224.0	6-1	Georgia	St. Louis Rams / 1st / 10th pick / 2015	29.0	29.0	93.243243	37.837838	90
2	TE	Tyler Higbee	25.0	255.0	6-6	Western Kentucky	Los Angeles Rams / 4th / 110th pick / 2016	32.0	32.0	63.207547	28.301887	58
3	WR	Cooper Kupp	25.0	208.0	6-2	East. Washington	Los Angeles Rams / 3rd / 69th pick / 2017	23.0	14.0	78.807947	68.211921	82
4	WR	Josh Reynolds	23.0	196.0	6-3	Texas A&M	Los Angeles Rams / 4th / 117th pick / 2017	32.0	9.0	21.854305	13.245033	18
5	WR	Robert Woods	26.0	195.0	6-0	USC	Buffalo Bills / 2nd / 41st pick / 2013	28.0	27.0	86.754967	58.278146	88
6	WR	Tavon Austin	27.0	179.0	5-8	West Virginia	St. Louis Rams / 1st / 8th pick / 2013	16.0	9.0	11.258278	33.112583	11
7	WR	Sammy Watkins	24.0	211.0	6-1	Clemson	Buffalo Bills / 1st / 4th pick / 2014	15.0	14.0	56.291391	23.178808	49

- `Brandin Cooks` : bordering on the verge of elite, Cooks is firmly in the realm of really, really good. Like really good. As a receiver, he's getting a lot of touches per game, while still
- `Todd Gurley` : Gurley has earned his status as an Elite player in this league (maybe play him in the SuperBowl if you get the chance), as he ranks over the 90th percentile in receptions per game, yards per reception, receiving yards per game, receiving touchdowns per game, and rush yards per game amongst running backs, all while maintaining heavy usage, ranking above the 90th percentile in targets per game and rush attempts per game. He is certainly a player to use as a model for future picks at running back, regardless of scheme.
- `Tyler Higbee` : Higbee's statistics strike us as remarkably average, except in catch rate, where he's remarkably BELOW average. He has no statistics that lie above the 70th percentile

for tight ends, and seems to not necessarily be just a mediocre tight end, at least in this offense.

- `Cooper Kupp` : certainly a good starter in this scheme, especially when only considering his receiving statistics (his rushing statistics are all below average, except for yards per attempt). Regardless, he still makes his mark on the offense, ranking near the 80th percentile in almost every major receiving category.

- `Josh Reynolds` : a disappointing surprise for me, as I expected his percentiles to be higher due to some pretty solid athleticism and opportunities. However, all but one of his statistics fall severely below the fiftieth percentile, with many lying in the twenties and teens.

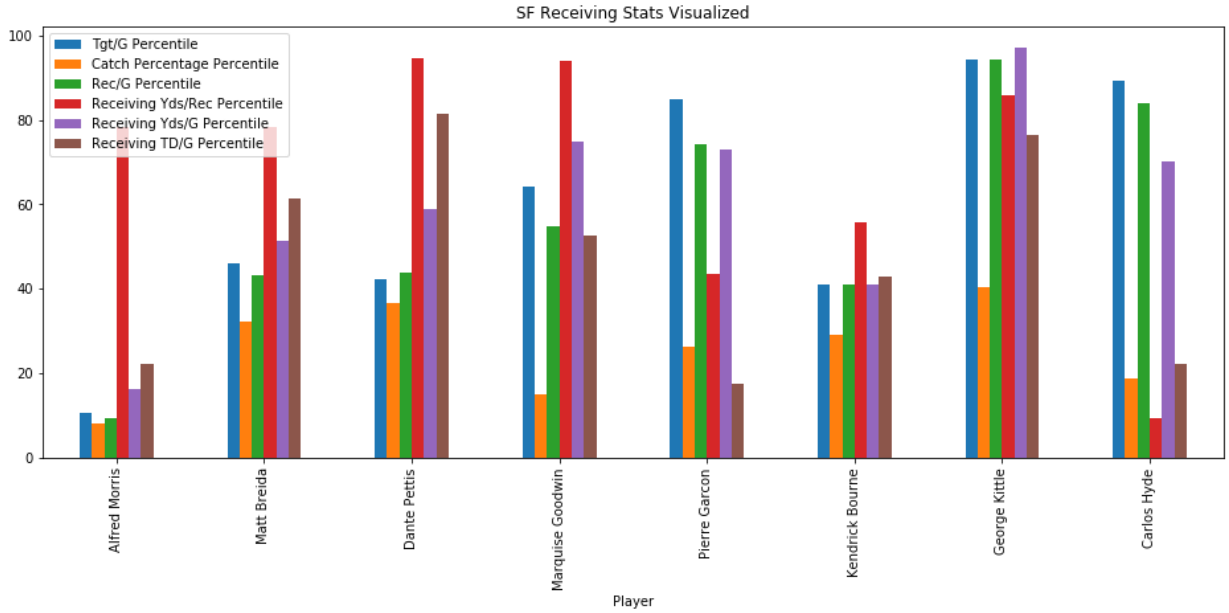
- `Robert Woods` : somewhere between Kupp and Cooks (aka between good and really good), as while he isn't as consistent as Kupp in terms of percentiles across categories, he provides more of a running threat, and is more productive when he does catch the ball.

- `Tavon Austin` : When looking at Austin's Receiving stats, he is downright horrible, in almost the 0th percentile for yards per reception, and in the single digits for several other categories. His rushing stats, however, are more impressive: he had the most rushes and most rushing yards per game for receivers in this system. However, we expect these two stats to correlate: the more attempts you get, the more yards you should have. His yards per attempt, on the other hand, is fairly unimpressive, in the 40th percentile, and even though he had more rushing touchdowns than most receivers, receivers don't get many rushing touchdowns to begin with, so although Austin's rushing stats may look impressive, they're to be expected, and therefore he can be ruled out as a prototype.

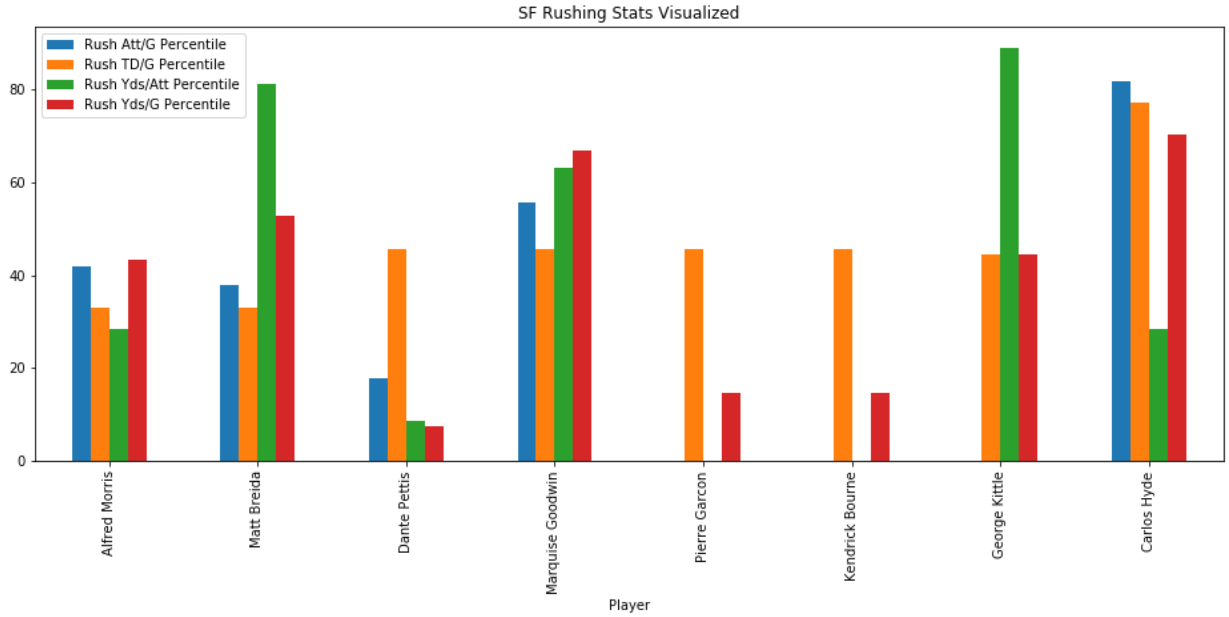
- `Sammy Watkins` : Watkins is an interesting case. When I think about Watkins' career I think about someone who never lived up to the Buffalo Bills trading up to the 4th overall pick to pick him. However, looking at the stats, he was clearly a very good big play threat for the Rams: 84th percentile for yards per reception and 90th percentile for receiving touchdowns per game for receivers. And a big play threat will always have their place in an offense, so he makes the prototype list.

49ers Final Cuts

In [330]:
```
sf_players_percentiles.drop(['Age', 'Wt', 'G', 'GS', 'Rush Att/G Percentile
```



In [331]:
```
sf_players_percentiles.drop(['Age', 'Wt', 'G', 'GS', 'Catch Percentage Perc
```



In [332]:
```
sf_players_percentiles
```

Out[332]:

	Pos	Player	Age	Wt	Ht	College/Univ	Drafted (tm/rnd/yr)	G	GS	Tgt/G Percentile	Catch Percentage Percentile	Pe
0	RB	Alfred Morris	30.0	224.0	5-10	Florida Atlantic	Washington Redskins / 6th / 173rd pick / 2012	12.0	1.0	10.810811	8.108108	9
1	RB	Matt Breida	23.0	190.0	5-10	Georgia Southern	NaN	30.0	13.0	45.945946	32.432432	43
2	WR	Dante Pettis	23.0	195.0	6-1	Washington	San Francisco 49ers / 2nd / 44th pick / 2018	12.0	7.0	42.384106	36.754967	44
3	WR	Marquise Goodwin	28.0	180.0	5-9	Texas	Buffalo Bills / 3rd / 78th pick / 2013	27.0	24.0	64.238411	15.231788	54
4	WR	Pierre Garcon	32.0	211.0	6-0	Mount Union	Indianapolis Colts / 6th / 205th pick / 2008	16.0	16.0	84.768212	26.490066	74
5	WR	Kendrick Bourne	23.0	203.0	6-1	East. Washington	NaN	27.0	8.0	41.059603	29.139073	41
6	TE	George Kittle	25.0	250.0	6-4	Iowa	San Francisco 49ers / 5th / 146th pick / 2017	31.0	23.0	94.339623	40.566038	94
7	RB	Carlos Hyde	27.0	229.0	6-0	Ohio St.	San Francisco 49ers / 2nd / 57th pick / 2014	16.0	16.0	89.189189	18.918919	83

A Preface: the Niners provide a slight challenge, as one can attempt to make excuses for a lot of poor performances by pointing to the rotation at quarterback. However, while we should keep this in mind, it's important to still be critical of unimpressive statistics.

- `Alfred Morris` : he needed more analysis earlier, but now it's safe to say that he's just not very good, at least in this scheme. With a catch percentage lying in the abysmally low 8th percentile, there are almost no statistical positives to his game since coming to San Francisco, aside from yards per reception. He's still left searching for that magic he had in Washington all those years ago.

- `Matt Breida` : an UDFA, Breida has average to slightly below average stats, except in two categories, but those categories stand out to me, as they are yards per reception and yards per rushing attempt. These two statistics both hint to me that Breida has enough talent to make noise with more usage (he was below average in both targets and rushing attempts)

- `Dante Pettis` : A rookie out of Washington, Pettis intrigues me because, while his percentiles are all over the map, the two extraordinarily high percentiles he had were in yards

per reception and receiving touchdowns per game, in the 95th and 80th percentiles, respectively. These two values are indicative of some serious big play ability, and if he can manage to get the other parts of his game up from the average state they are currently in, he has a lot of room for growth, especially as a rookie.

- `Marquise Goodwin` : While several of his stats are average, we do have to remember that there was severely inconsistent quarterback play, and he still had average to above average numbers in a lot of categories, with big play ability indicated by his incredibly high yards per reception numbers. He really needs to pick up his catch numbers though (15th percentile in catch percentage. Not EVERYTHING is on the quarterback when you've got the lowest catch rate on your team).
- `Pierre Garcón` : With very high usage numbers (84th percentile) comes the expectation of higher production. But this just didn't materialize for Garcón, as his catch percentage rate is the second lowest on the team, but without nearly any of the promising markers that Goodwin had.
- `Kendrick Bourne` : Just a Guy, slightly below average, nothing much special.
- `George Kittle` : Super. Star. Two words, all you need to know. High 90th percentile in every category, including in targets per game. Consistently dominant
- `Carlos Hyde` : A pretty successful rusher for the 49ers in this time period, having a lot of rushing attempts and good if not great yards and touchdowns per game numbers. His receiving wasn't great, as while he got a lot of targets and receptions, his yards per reception and catch percentage weren't great. I have decided he just barely misses the cut.

Players to Use as Prototypes

Ultimately, we come to the conclusion that the players that are the most successful in this system are:

Player	Position
Todd Gurley	RB
Brandin Cooks	WR
Cooper Kupp	WR
Robert Woods	WR
Sammy Watkins	WR
Matt Breida	RB
Dante Pettis	WR
Marquise Goodwin	WR
George Kittle	TE

For those of you who skipped ahead, good decision, but let me at least explain how we got here so you're not left spinning around wondering where you are and what year it is. To be brief, we pretty much went through Rams and 49ers skill players, getting rid of those who didn't get much playing time, and then compared some of their statistics to those of others at their position in the league. We took those who compared favorably to their peers in a majority of categories or in categories that we felt indicated room for improvement (especially in a San Francisco offense stunted by poor Quarterback play).

Next, we will use these players to try and model which other players could be successful in this scheme. We foresee a few issues with having such a small training set and large set that we're aiming to predict on, however this will still be a worthwhile excercise if nothing else.

In [379]:
```
successful_players = ['George Kittle', 'Todd Gurley', 'Brandin Cooks', 'Coc
```

In [338]:
```
nfl_receivers = pd.read_csv('data/NFLReceivingStats2018.csv')
```

In [354]:
```
nfl_receivers = nfl_receivers.dropna(subset = ['Pos']) #Gets rid of entries
nfl_receivers['Pos'] = nfl_receivers.Pos.apply(lambda x : str(x).upper()) #
nfl_receivers = spf.position_map_receiving(nfl_receivers)
nfl_receivers = spf.clean_player_column(nfl_receivers)
```

In [427]:
```
training_receiving = nfl_receivers[nfl_receivers['Tm'].isin(['LAR', 'SFO'])
training_receiving['Successful'] = training_receiving['Player'].isin(succes
training_receiving.head()
```

```
/Users/thomasevans-barton/anaconda3/lib/python3.7/site-packages/ipykernel
_launcher.py:2: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: http://pandas.pydata.org/pandas-doc
s/stable/indexing.html#indexing-view-versus-copy (http://pandas.pydata.or
g/pandas-docs/stable/indexing.html#indexing-view-versus-copy)
```

Out[427]:

	Rk	Player	Tm	Age	Pos	G	GS	Tgt	Rec	Ctch%	Yds	Y/R	TD	Lng	R/G	Y/G	Fn
14	15	George Kittle	SFO	25	TE	16	16	136	88	64.7%	1377	15.6	5	85	5.5	86.1	
15	16	Robert Woods	LAR	26	WR	16	16	130	86	66.2%	1219	14.2	6	39	5.4	76.2	
22	23	Brandin Cooks	LAR	25	WR	16	16	117	80	68.4%	1204	15.1	5	57	5.0	75.3	
63	64	Todd Gurley	LAR	24	RB	14	14	81	59	72.8%	580	9.8	4	56	4.2	41.4	
93	94	Kendrick Bourne	SFO	23	WR	16	8	66	42	63.6%	487	11.6	4	33	2.6	30.4	

In [423]:
```
test_receiving = nfl_receivers.drop(training_receiving.index)
```

In [391]:
```
nfl_rushing = pd.read_csv('data/NFLRushingStats2018.csv', skiprows = [0])
nfl_rushing = spf.clean_player_column(nfl_rushing)
nfl_rushing = spf.position_map_rushing(nfl_rushing)
training_rushing = nfl_rushing[nfl_rushing['Tm'].isin(['SFO', 'LAR'])]
training_rushing['Successful'] = training_rushing['Player'].isin(successful
training_rushing.head()
```

```
/Users/thomasevans-barton/anaconda3/lib/python3.7/site-packages/ipykernel
_launcher.py:5: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: http://pandas.pydata.org/pandas-doc
s/stable/indexing.html#indexing-view-versus-copy (http://pandas.pydata.or
g/pandas-docs/stable/indexing.html#indexing-view-versus-copy)
  """
```

Out[391]:

	Rk	Player	Tm	Age	Pos	G	GS	Att	Yds	TD	Lng	Y/A	Y/G	Fmb	Successful
3	4	Todd Gurley	LAR	24	RB	14	14	256	1251	17	36	4.9	89.4	1	True
27	28	Matt Breida	SFO	23	RB	14	13	153	814	3	66	5.3	58.1	1	True
133	134	Robert Woods	LAR	26	WR	16	16	19	157	1	56	8.3	9.8	0	True
153	154	Brandin Cooks	LAR	25	WR	16	16	10	68	1	17	6.8	4.3	1	True
211	212	Marquise Goodwin	SFO	28	WR	11	8	4	9	0	5	2.3	0.8	1	True

In [428]:
```
test_rushing = nfl_rushing.drop(training_rushing.index)
```

In [396]:
```
rec_log_model = LogisticRegression()
```

In [420]:
```
X_rec_train = np.array([training_receiving['Tgt'], training_receiving['Rec'
y_rec_train = np.array(training_receiving['Successful'])
```

In [422]:
```
rec_log_model.fit(X_rec_train, y_rec_train)
```

```
/Users/thomasevans-barton/anaconda3/lib/python3.7/site-packages/sklearn/l
inear_model/logistic.py:433: FutureWarning: Default solver will be change
d to 'lbfgs' in 0.22. Specify a solver to silence this warning.
  FutureWarning)
```

Out[422]:
```
LogisticRegression(C=1.0, class_weight=None, dual=False, fit_intercept=Tr
ue,
          intercept_scaling=1, max_iter=100, multi_class='warn',
          n_jobs=None, penalty='l2', random_state=None, solver='warn',
          tol=0.0001, verbose=0, warm_start=False)
```

In [429]:
```
X_test_rec = np.array([test_receiving['Tgt'], test_receiving['Rec'], test_r
test_receiving['Logistic Prediction of Success'] = rec_log_model.predict(X_
test_receiving.head()
```

Out[429]:

	Rk	Player	Tm	Age	Pos	G	GS	Tgt	Rec	Ctch%	Yds	Y/R	TD	Lng	R/G	Y/G	Fr
0	1	Julio Jones	ATL	29	WR	16	16	170	113	66.5%	1677	14.8	8	58	7.1	104.8	
1	2	Davante Adams	GNB	26	WR	15	15	169	111	65.7%	1386	12.5	13	57	7.4	92.4	
2	3	Antonio Brown	PIT	30	WR	15	15	168	104	61.9%	1297	12.5	15	78	6.9	86.5	
3	4	JuJu Smith-Schuster	PIT	22	WR	16	13	166	111	66.9%	1426	12.8	7	97	6.9	89.1	
4	5	DeAndre Hopkins	HOU	26	WR	16	16	163	115	70.6%	1572	13.7	11	49	7.2	98.3	

In [430]:
```
rush_log_model = LogisticRegression()
```

In [432]:
```
X_rush_train = np.array([training_rushing['Y/A'], training_rushing['Y/G'],
y_rush_train = np.array(training_rushing['Successful'])
```

In [433]:
```
rush_log_model.fit(X_rush_train, y_rush_train)
```

```
/Users/thomasevans-barton/anaconda3/lib/python3.7/site-packages/sklearn/l
inear_model/logistic.py:433: FutureWarning: Default solver will be change
d to 'lbfgs' in 0.22. Specify a solver to silence this warning.
  FutureWarning)
```

Out[433]:
```
LogisticRegression(C=1.0, class_weight=None, dual=False, fit_intercept=Tr
ue,
          intercept_scaling=1, max_iter=100, multi_class='warn',
          n_jobs=None, penalty='l2', random_state=None, solver='warn',
          tol=0.0001, verbose=0, warm_start=False)
```

In [437]:
```
X_test_rush = np.array([test_rushing['Y/A'], test_rushing['Y/G'], test_rush
test_rushing['Logistic Prediction of Success'] = rush_log_model.predict(X_t
test_rushing.head()
```

Out[437]:

	Rk	Player	Tm	Age	Pos	G	GS	Att	Yds	TD	Lng	Y/A	Y/G	Fmb	Logistic Prediction of Success
0	1	Ezekiel Elliott	DAL	23	RB	15	15	304	1434	6	41	4.7	95.6	6	True
1	2	Saquon Barkley	NYG	21	RB	16	16	261	1307	11	78	5.0	81.7	0	True
2	3	David Johnson	ARI	27	RB	16	16	258	940	7	53	3.6	58.8	3	True
4	5	Adrian Peterson	WAS	33	RB	16	16	251	1042	7	90	4.2	65.1	3	True
5	6	Jordan Howard	CHI	24	RB	16	15	250	935	9	42	3.7	58.4	2	True

In [439]:
```
rec_svm_model = svm.SVC()
```

In [440]:
```
rec_svm_model.fit(X_rec_train, y_rec_train)
```

```
/Users/thomasevans-barton/anaconda3/lib/python3.7/site-packages/sklearn/s
vm/base.py:196: FutureWarning: The default value of gamma will change fro
m 'auto' to 'scale' in version 0.22 to account better for unscaled featur
es. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
  "avoid this warning.", FutureWarning)
```

Out[440]:
```
SVC(C=1.0, cache_size=200, class_weight=None, coef0=0.0,
  decision_function_shape='ovr', degree=3, gamma='auto_deprecated',
  kernel='rbf', max_iter=-1, probability=False, random_state=None,
  shrinking=True, tol=0.001, verbose=False)
```

In [442]:
```
test_receiving['SVM Prediction of Success'] = rec_svm_model.predict(X_test_
test_receiving
```

Out[442]:

	Rk	Player	Tm	Age	Pos	G	GS	Tgt	Rec	Ctch%	Yds	Y/R	TD	Lng	R/G	Y
0	1	Julio Jones	ATL	29	WR	16	16	170	113	66.5%	1677	14.8	8	58	7.1	10
1	2	Davante Adams	GNB	26	WR	15	15	169	111	65.7%	1386	12.5	13	57	7.4	9
2	3	Antonio Brown	PIT	30	WR	15	15	168	104	61.9%	1297	12.5	15	78	6.9	8
3	4	JuJu Smith-Schuster	PIT	22	WR	16	13	166	111	66.9%	1426	12.8	7	97	6.9	8
4	5	DeAndre Hopkins	HOU	26	WR	16	16	163	115	70.6%	1572	13.7	11	49	7.2	9
5	6	Zach Ertz	PHI	28	TE	16	16	156	116	74.4%	1163	10.0	8	34	7.3	7
6	7	Adam Thielen	MIN	28	WR	16	16	153	113	73.9%	1373	12.2	9	68	7.1	8
7	8	Travis Kelce	KAN	29	TE	16	16	150	103	68.7%	1336	13.0	10	43	6.4	8
8	9	Stefon Diggs	MIN	25	WR	15	14	149	102	68.5%	1021	10.0	9	75	6.8	6
9	10	Jarvis Landry	CLE	26	WR	16	14	149	81	54.4%	976	12.0	4	51	5.1	6
10	11	Michael Thomas	NOR	25	WR	16	16	147	125	85.0%	1405	11.2	9	72	7.8	8
11	12	Mike Evans	TAM	25	WR	16	16	138	86	62.3%	1524	17.7	8	72	5.4	9
12	13	Tyreek Hill	KAN	24	WR	16	16	137	87	63.5%	1479	17.0	12	75	5.4	9
13	14	Keenan Allen	LAC	26	WR	16	14	136	97	71.3%	1196	12.3	6	54	6.1	7
16	17	Christian McCaffrey	CAR	22	RB	16	16	124	107	86.3%	867	8.1	6	38	6.7	5
17	18	Odell Beckham	NYG	26	WR	12	12	124	77	62.1%	1052	13.7	6	51	6.4	8
18	19	James White	NWE	26	RB	16	3	123	87	70.7%	751	8.6	7	42	5.4	4
19	20	Saquon Barkley	NYG	21	RB	16	16	121	91	75.2%	721	7.9	4	57	5.7	4
20	21	T.Y. Hilton	IND	29	WR	14	14	120	76	63.3%	1270	16.7	6	68	5.4	9
21	22	Kenny Golladay	DET	25	WR	15	13	119	70	58.8%	1063	15.2	5	60	4.7	7
24	25	Larry Fitzgerald	ARI	35	WR	16	16	112	69	61.6%	734	10.6	6	37	4.3	4
25	26	Corey Davis	TEN	23	WR	16	16	112	65	58.0%	891	13.7	4	51	4.1	5

	Rk	Player	Tm	Age	Pos	G	GS	Tgt	Rec	Ctch%	Yds	Y/R	TD	Lng	R/G	Y
26	27	Eric Ebron	IND	25	TE	16	8	110	66	60.0%	750	11.4	13	53	4.1	4
27	28	Tyler Boyd	CIN	24	WR	14	14	108	76	70.4%	1028	13.5	7	49	5.4	7
28	29	Julian Edelman	NWE	32	WR	12	12	108	74	68.5%	850	11.5	6	36	6.2	7
30	31	Sterling Shepard	NYG	25	WR	16	16	107	66	61.7%	872	13.2	4	58	4.1	5
31	32	Alvin Kamara	NOR	23	RB	15	13	105	81	77.1%	709	8.8	4	42	5.4	4
32	33	Adam Humphries	TAM	25	WR	16	10	105	76	72.4%	816	10.7	5	51	4.8	5
33	34	Zay Jones	BUF	23	WR	16	15	102	56	54.9%	652	11.6	7	57	3.5	4
34	35	Jared Cook	OAK	31	TE	16	14	101	68	67.3%	896	13.2	6	45	4.3	5
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
361	362	Delanie Walker	TEN	34	TE	1	1	7	4	57.1%	52	13.0	0	16	4.0	5
362	363	Rico Gathers	DAL	24	TE	15	4	7	3	42.9%	45	15.0	0	32	0.2	
363	364	Taysom Hill	NOR	28	TE	16	4	7	3	42.9%	4	1.3	0	5	0.2	
364	365	Dwayne Harris	OAK	31	WR	15	1	6	6	100.0%	40	6.7	0	13	0.4	
366	367	Jay Ajayi	PHI	25	RB	4	3	6	5	83.3%	20	4.0	0	12	1.3	
368	369	David Morgan	MIN	25	TE	11	6	6	5	83.3%	36	7.2	0	13	0.5	
369	370	Adam Shaheen	CHI	24	TE	6	4	6	5	83.3%	48	9.6	1	23	0.8	
371	372	Tyler Kroft	CIN	26	TE	5	2	6	4	66.7%	36	9.0	0	16	0.8	
374	375	Robert Tonyan	GNB	24	TE	16	1	6	4	66.7%	77	19.3	1	54	0.3	
375	376	Jalen Tolliver	ARI	23	WR	3	1	6	3	50.0%	37	12.3	0	15	1.0	1
376	377	Jacob Hollister	NWE	25	WR	8	1	5	4	80.0%	52	13.0	0	23	0.5	
379	380	Ben Braunecker	CHI	24	TE	15	2	5	3	60.0%	42	14.0	0	20	0.2	
380	381	Orson Charles	CLE	27	TE	13	2	5	3	60.0%	23	7.7	0	9	0.2	
382	383	Keith Ford	BUF	24	RB	2	1	5	3	60.0%	21	7.0	0	8	1.5	1
386	387	Alan Cross	TAM	25	TE	14	3	5	2	40.0%	9	4.5	0	6	0.1	
387	388	Chris Manhertz	CAR	26	TE	16	4	5	2	40.0%	52	26.0	1	50	0.1	

	Rk	Player	Tm	Age	Pos	G	GS	Tgt	Rec	Ctch%	Yds	Y/R	TD	Lng	R/G	Y
393	394	Dwayne Allen	NWE	28	TE	13	8	4	3	75.0%	27	9.0	0	21	0.2	2
396	397	Marcedes Lewis	GNB	34	TE	16	4	4	3	75.0%	39	13.0	0	30	0.2	2
401	402	Jeremy Kerley	BUF	30	WR	1	1	4	2	50.0%	7	3.5	0	4	2.0	7
403	404	Dion Sims	CHI	27	TE	8	4	4	2	50.0%	9	4.5	0	9	0.3	1
408	409	Tommylee Lewis	NOR	26	WR	7	3	3	3	100.0%	60	20.0	1	28	0.4	8
409	410	John Phillips	ARI	31	TE	8	4	3	3	100.0%	38	12.7	0	24	0.4	4
411	412	Brian Quick	WAS	29	WR	6	3	3	3	100.0%	18	6.0	0	6	0.5	3
426	427	Terrance Williams	DAL	29	WR	3	2	3	2	66.7%	18	9.0	0	12	0.7	6
431	432	Gus Edwards	BAL	23	RB	11	6	2	2	100.0%	20	10.0	0	13	0.2	1
441	442	Ryan Hewitt	IND	27	TE	12	2	2	1	50.0%	1	1.0	1	1	0.1	0
442	443	Darrius Heyward-Bey	PIT	31	WR	14	2	2	1	50.0%	9	9.0	0	9	0.1	0
460	461	Sean Culkin	LAC	25	TE	13	10	1	1	100.0%	24	24.0	0	24	0.1	1
465	466	Matt Flanagan	WAS	23	WR	3	1	1	1	100.0%	14	14.0	0	14	0.3	4
484	485	Tyrone Swoopes	SEA	24	TE	1	1	1	1	100.0%	23	23.0	0	23	1.0	23

315 rows × 19 columns

In [443]:
```
rush_svm_model = svm.SVC()
```

In [444]:
```
rush_svm_model.fit(X_rush_train, y_rush_train)
```

```
/Users/thomasevans-barton/anaconda3/lib/python3.7/site-packages/sklearn/svm/base.py:196: FutureWarning: The default value of gamma will change from 'auto' to 'scale' in version 0.22 to account better for unscaled features. Set gamma explicitly to 'auto' or 'scale' to avoid this warning.
  "avoid this warning.", FutureWarning)
```

Out[444]:
```
SVC(C=1.0, cache_size=200, class_weight=None, coef0=0.0,
  decision_function_shape='ovr', degree=3, gamma='auto_deprecated',
  kernel='rbf', max_iter=-1, probability=False, random_state=None,
  shrinking=True, tol=0.001, verbose=False)
```

In [447]:
```
test_rushing['SVM Prediction of Success'] = rush_svm_model.predict(X_test_r
test_rushing
```

Out[447]:

	Rk	Player	Tm	Age	Pos	G	GS	Att	Yds	TD	Lng	Y/A	Y/G	Fmb	Logistic Prediction of Success
0	1	Ezekiel Elliott	DAL	23	RB	15	15	304	1434	6	41	4.7	95.6	6	True
1	2	Saquon Barkley	NYG	21	RB	16	16	261	1307	11	78	5.0	81.7	0	True
2	3	David Johnson	ARI	27	RB	16	16	258	940	7	53	3.6	58.8	3	True
4	5	Adrian Peterson	WAS	33	RB	16	16	251	1042	7	90	4.2	65.1	3	True
5	6	Jordan Howard	CHI	24	RB	16	15	250	935	9	42	3.7	58.4	2	True
6	7	Chris Carson	SEA	24	RB	14	14	247	1151	9	61	4.7	82.2	3	True
7	8	Joe Mixon	CIN	22	RB	14	13	237	1168	8	51	4.9	83.4	0	True
8	9	Peyton Barber	TAM	24	RB	16	16	234	871	5	28	3.7	54.4	1	True
9	10	Christian McCaffrey	CAR	22	RB	16	16	219	1098	7	59	5.0	68.6	4	True
10	11	James Conner	PIT	23	RB	13	12	215	973	12	30	4.5	74.8	4	True
11	12	Derrick Henry	TEN	24	RB	16	12	215	1059	12	99	4.9	66.2	1	True
12	13	Lamar Miller	HOU	27	RB	14	14	210	973	5	97	4.6	69.5	1	True
13	14	Sony Michel	NWE	23	RB	13	8	209	931	6	34	4.5	71.6	1	True
14	15	Marlon Mack	IND	22	RB	12	10	195	908	9	49	4.7	75.7	2	True
15	16	Alvin Kamara	NOR	23	RB	15	13	194	883	14	49	4.6	58.9	1	True
16	17	Nick Chubb	CLE	23	RB	16	9	192	996	8	92	5.2	62.3	0	True
17	18	Phillip Lindsay	DEN	24	RB	15	8	192	1037	9	65	5.4	69.1	0	True
18	19	Kareem Hunt	KAN	23	RB	11	11	181	824	7	45	4.6	74.9	0	True
19	20	Melvin Gordon	LAC	25	RB	12	12	175	885	10	34	5.1	73.8	1	True
21	22	Doug Martin	OAK	29	RB	16	9	172	723	4	29	4.2	45.2	3	True
22	23	Tevin Coleman	ATL	25	RB	16	14	167	800	4	65	4.8	50.0	2	True

	Rk	Player	Tm	Age	Pos	G	GS	Att	Yds	TD	Lng	Y/A	Y/G	Fmb	Logistic Prediction of Success
24	25	Frank Gore	MIA	35	RB	14	14	156	722	0	39	4.6	51.6	1	True
26	27	LeGarrette Blount	DET	32	RB	16	8	154	418	5	27	2.7	26.1	2	True
34	35	Dalvin Cook	MIN	23	RB	11	10	133	615	2	70	4.6	55.9	2	True
35	36	Leonard Fournette	JAX	23	RB	8	8	133	439	5	25	3.3	54.9	0	True
36	37	Aaron Jones	GNB	24	RB	12	8	133	728	8	67	5.5	60.7	1	True
37	38	Royce Freeman	DEN	22	RB	14	8	130	521	5	24	4.0	37.2	1	True
38	39	Jamaal Williams	GNB	23	RB	16	8	121	464	3	20	3.8	29.0	0	True
43	44	Alex Collins	BAL	24	RB	10	10	114	411	7	19	3.6	41.1	3	True
124	125	Tyreek Hill	KAN	24	WR	16	16	22	151	1	33	6.9	9.4	0	True
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
200	201	Odell Beckham	NYG	26	WR	12	12	5	19	0	11	3.8	1.6	2	True
205	206	Adam Thielen	MIN	28	WR	16	16	5	30	0	15	6.0	1.9	1	True
206	207	Sammy Watkins	KAN	25	WR	10	9	5	52	0	31	10.4	5.2	1	True
218	219	John Ross	CIN	24	WR	13	10	4	9	0	7	2.3	0.7	0	True
219	220	Emmanuel Sanders	DEN	31	WR	12	12	4	53	1	35	13.3	4.4	1	True
222	223	Nelson Agholor	PHI	25	WR	16	16	3	32	0	16	10.7	2.0	1	True
224	225	John Brown	BAL	28	WR	16	15	3	4	0	3	1.3	0.3	0	True
228	229	Evan Engram	NYG	24	TE	11	8	3	36	0	14	12.0	3.3	0	True
232	233	Jarvis Landry	CLE	26	WR	16	14	3	60	1	51	20.0	3.8	1	True
239	240	Sterling Shepard	NYG	25	WR	16	16	3	33	0	27	11.0	2.1	1	True
242	243	Robby Anderson	NYJ	25	WR	14	9	2	-8	0	1	-4.0	-0.6	2	False
243	244	Tyler Boyd	CIN	24	WR	14	14	2	3	0	5	1.5	0.2	0	True
245	246	Antonio Callaway	CLE	21	WR	16	11	2	7	0	15	3.5	0.4	1	True
256	257	Adam Humphries	TAM	25	WR	16	10	2	11	0	7	5.5	0.7	2	True

	Rk	Player	Tm	Age	Pos	G	GS	Att	Yds	TD	Lng	Y/A	Y/G	Fmb	Logistic Prediction of Success
258	259	Julio Jones	ATL	29	WR	16	16	2	12	0	11	6.0	0.8	2	True
269	270	Marquez Valdes-Scantling	GNB	24	WR	16	10	2	29	0	21	14.5	1.8	0	True
275	276	Danny Amendola	MIA	33	WR	15	15	1	-2	0	-2	-2.0	-0.1	2	False
281	282	Trey Burton	CHI	27	TE	16	16	1	2	0	2	2.0	0.1	1	True
291	292	Quincy Enunwa	NYJ	26	WR	11	10	1	0	0	0	0.0	0.0	2	False
292	293	Kenny Golladay	DET	25	WR	15	13	1	8	0	8	8.0	0.5	1	True
300	301	DeAndre Hopkins	HOU	26	WR	16	16	1	-7	0	-7	-7.0	-0.4	2	False
306	307	Zay Jones	BUF	23	WR	16	15	1	0	0	0	0.0	0.0	1	False
312	313	Jordy Nelson	OAK	33	WR	15	14	1	-2	0	-2	-2.0	-0.1	1	False
320	321	Allen Robinson	CHI	25	WR	13	12	1	9	0	9	9.0	0.7	1	True
321	322	Chester Rogers	IND	24	WR	16	10	1	-4	0	-4	-4.0	-0.3	1	False
325	326	Tajae Sharpe	TEN	24	WR	16	13	1	16	0	16	16.0	1.0	0	True
328	329	JuJu Smith-Schuster	PIT	22	WR	16	13	1	13	0	13	13.0	0.8	1	True
329	330	Willie Snead	BAL	26	WR	16	10	1	13	0	13	13.0	0.8	0	True
331	332	Luke Stocker	TEN	30	TE	16	11	1	0	0	0	0.0	0.0	0	False
333	334	Courtland Sutton	DEN	23	WR	16	9	1	-1	0	-1	-1.0	-0.1	0	False

71 rows × 16 columns

In [ ]: