2021 Analytics Blitz:

Using Stochastic Simulation Methods to Model Optimal NFL Run/Pass Ratios

Sports and Data Analytics Club
University of Oklahoma

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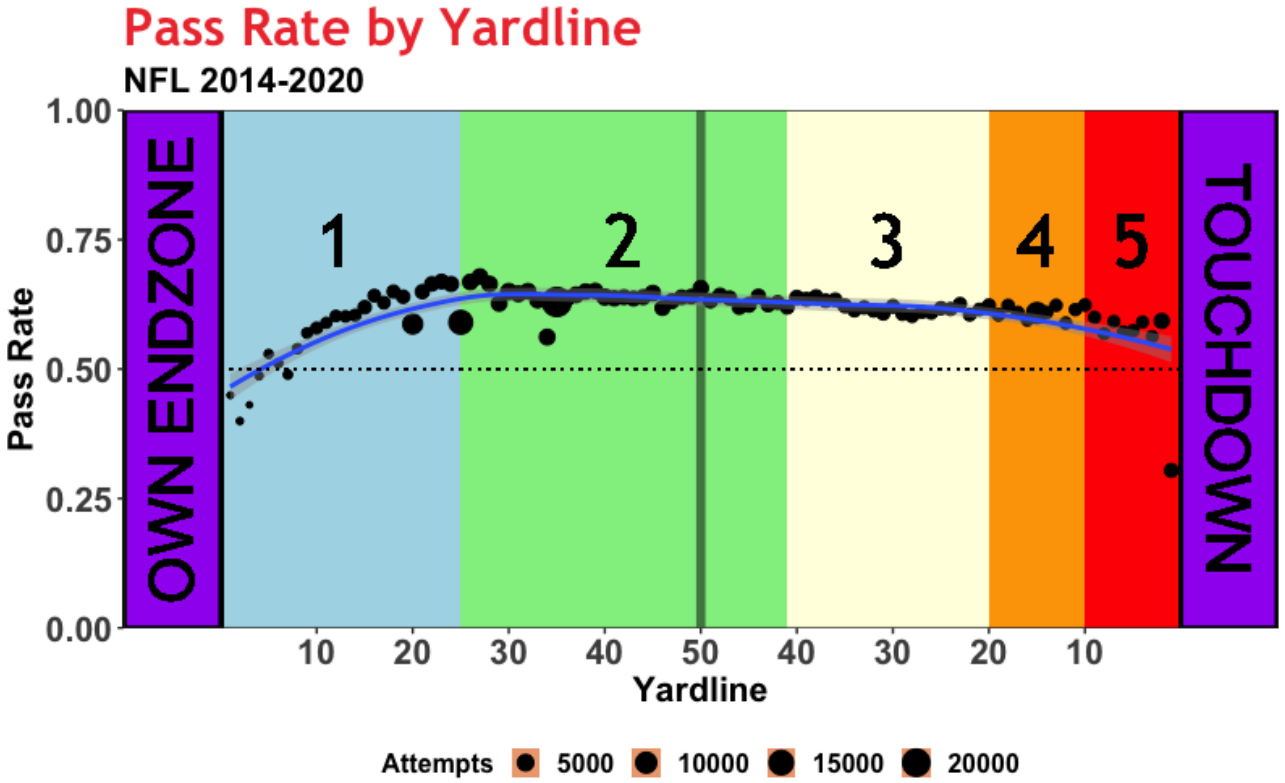
Presentation Overview

- Our Process
- The Simulation
- Modeling the Optimal Pass Rate
- 2020 Case Studies
- Play-Action Case Studies

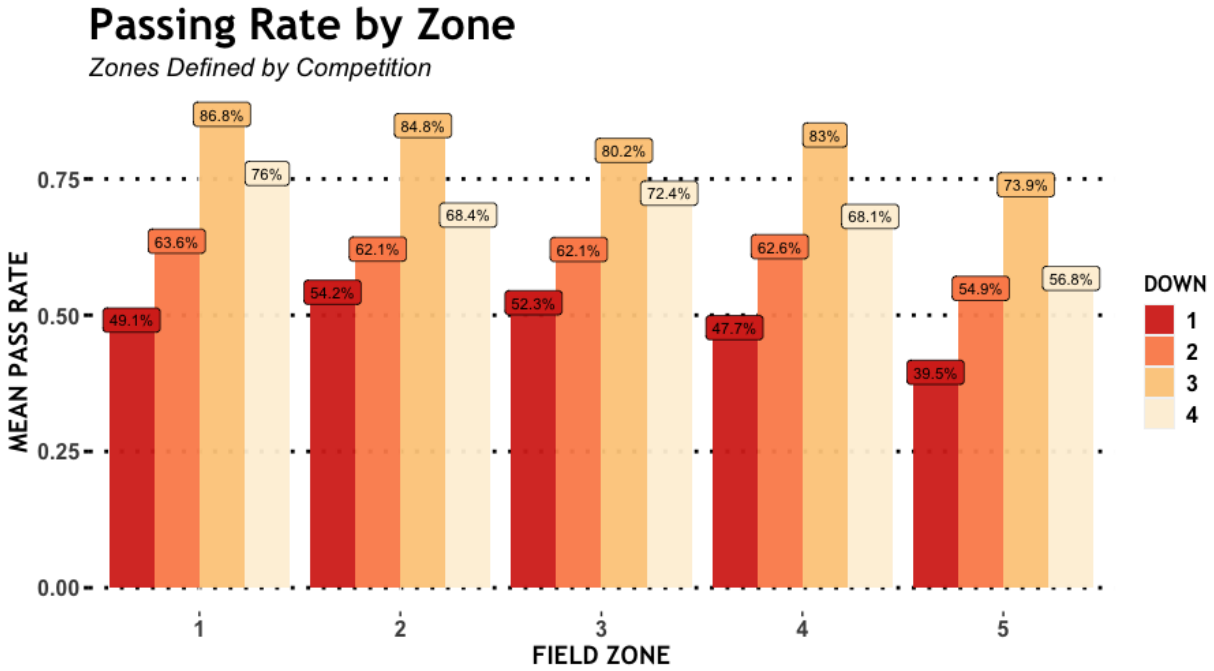
Our Process – Key Questions

- **Key Questions:**
  - What is needed to simulate an NFL game?
    - Play-level context is key
  - How do we define "situation"?
  - How do we isolate these situations?
  - What defines optimal?
  - How do we model optimal passing rate by zone ***AND*** situation?

Our Process – Searching for Context



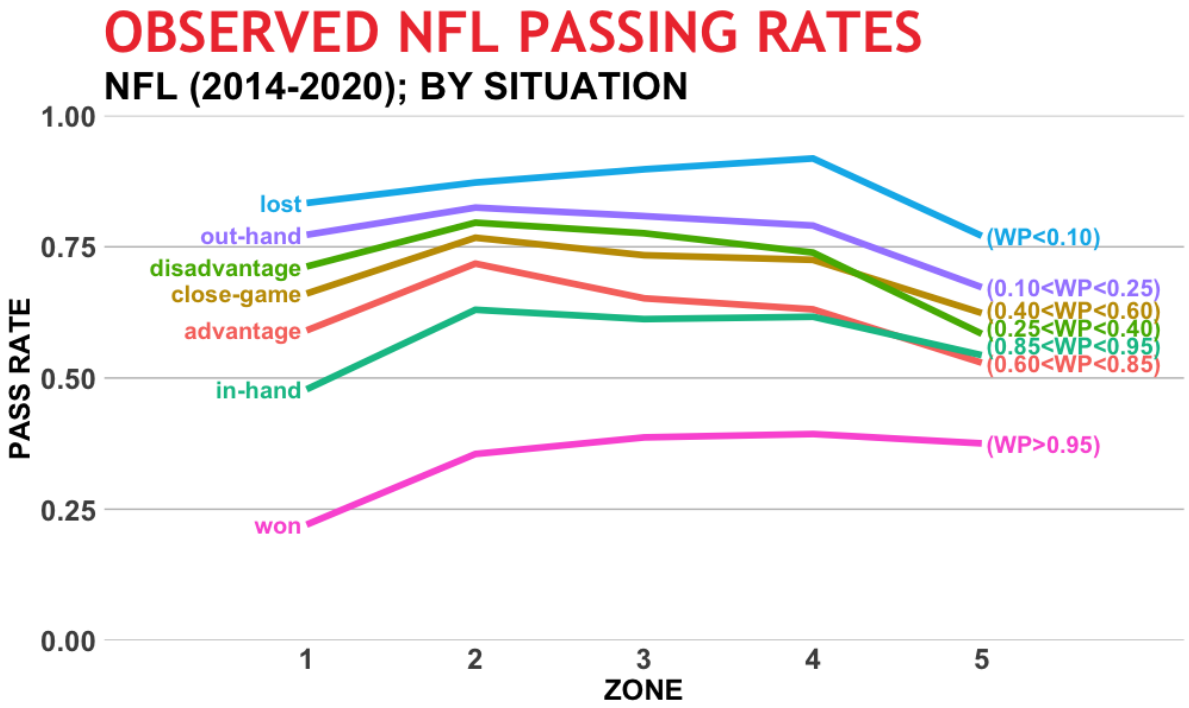
Our Process – Searching for Context



Our Process – Issues with Simplicity

- Even defining by zone, down, and distance does not give enough context
- Variables such as win probability can help us refine our situation

Our Process – Defining Situation



Win probability groupings give a better understanding of pass rates

Our Process – Defining Situation

- Variables:
  - Down
  - Distance
  - Field Zone (grouped)
  - Time Left (grouped)
  - Win Probability (grouped)

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The Simulation - Logic

- Model situation and track game flow
  - Our plays are “informed decisions”
- 3 Big Things This Can Do
  - Gives us insights into NFL plays called in certain situations
  - Models optimal pass rate in context of what has worked
  - Creates drives designed to optimize cumulative EPA within structure of an actual game

The Simulation - "Informed Decisions"

- Simulation is aware of situation pre-play call
- Simulation will ask:

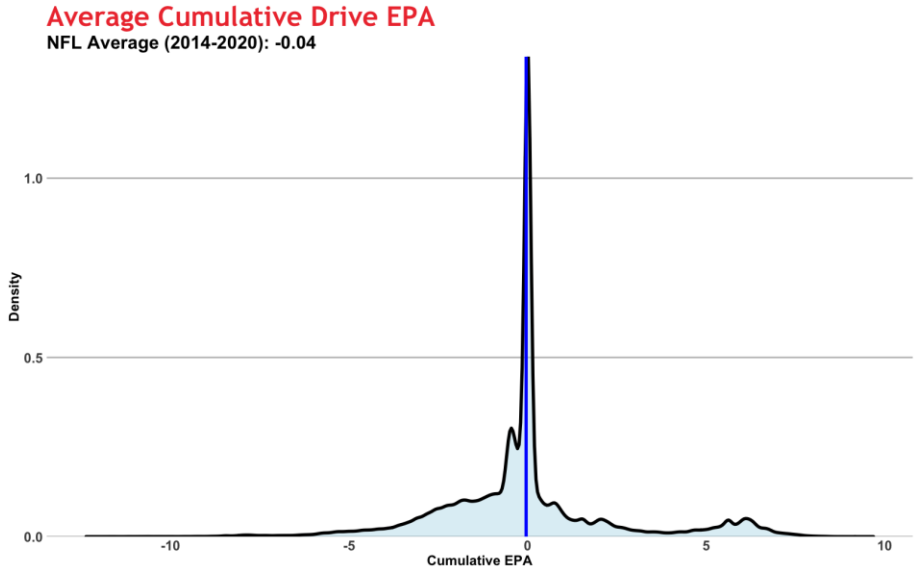
$$E[Stat|Play = Pass \ \& \ Situation = S]$$

$$E[Stat\ |Play = Run \ \& \ Situation = S]$$

- The higher value informs the situation which play type to call. "Stat" is whatever we find important (e.g., WPA).
- Simulation subsets situational data and a real NFL play is randomly picked

The Simulation – Key Metrics

- Average Zone Pass Rate, EPA, WPA
- Cumulative Drive EPA



The Simulation – Key Metrics

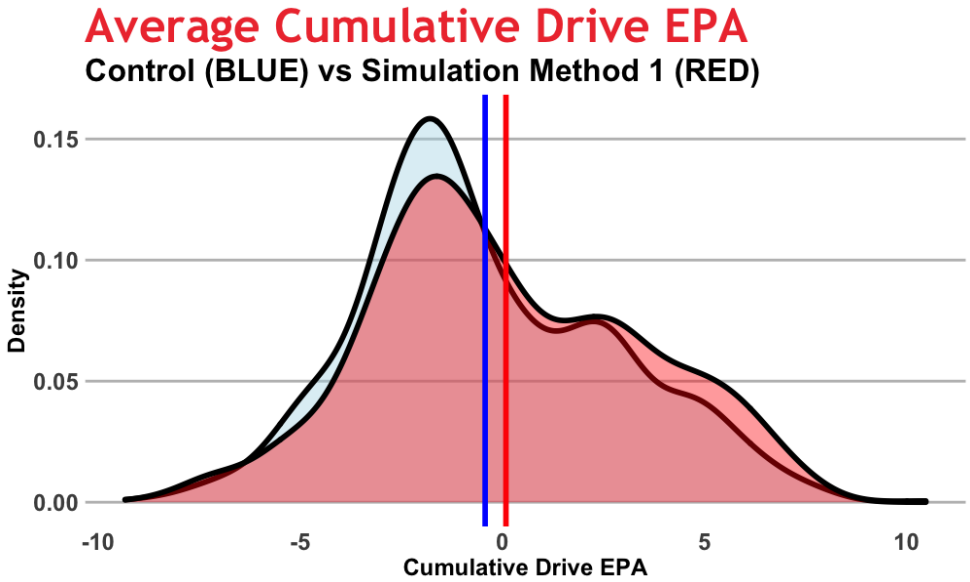
If the simulation produces a higher average cumulative drive EPA simply by changing the passing rates, the pass rates from the simulation will be considered optimal.

The Simulation – Bayesian Bootstrapping

1. Subset play-by-play data by situation
2. Bayesian Bootstrapping of the subset statistics (EPA/WPA) by play type (rush/pass)
3. Choose play type (rush vs. pass)
   - 3 simulation models using 3 different methods
4. Choose random play within chosen play type
   - No play-call intelligence beyond rush/pass choice

The Simulation – Method 1

- Run/Pass based only on average WPA



Shapiro-Wilk Results

- P_{m1} = 1.4e-08
- P_c = 2.1e-10

Welch T-Test Results

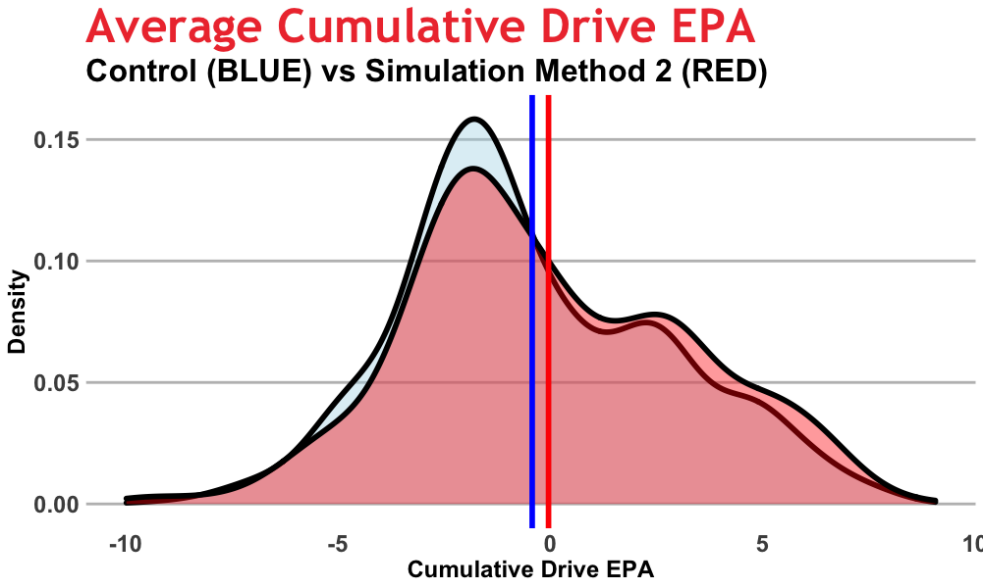
- P = 0.00039

Drive ΔcEPA 95% C.I.

- [+0.230,+0.799]

The Simulation – Method 2

- Run/Pass based only on average EPA



Shapiro-Wilk Results

- P_{m2} = 2.5e-08
- P_c = 2.1e-10

Welch T-Test Results

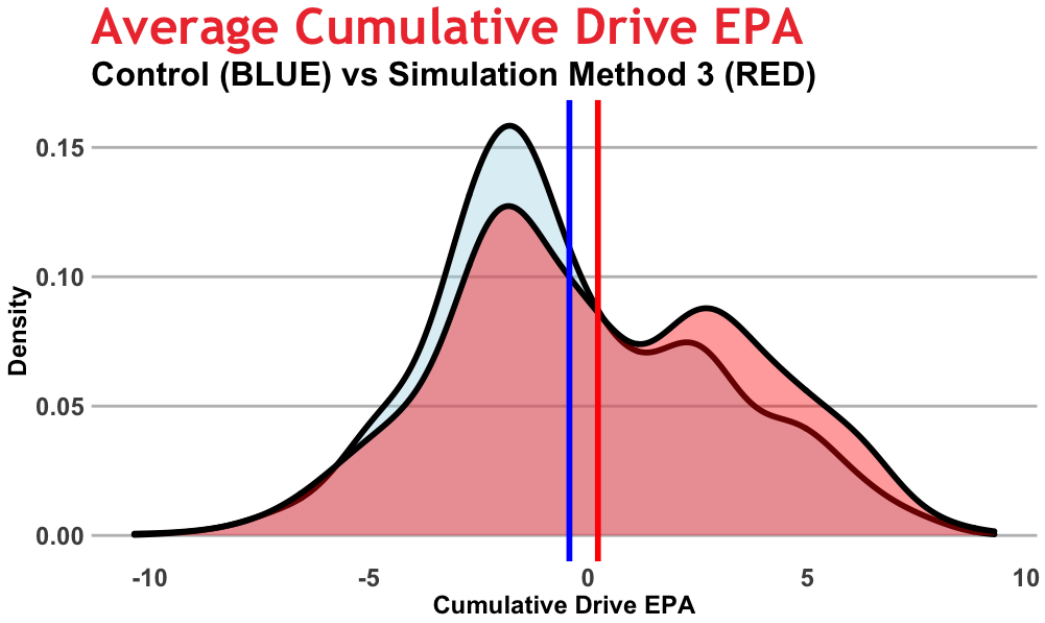
- P = 0.00782

Drive ΔcEPA 95% C.I.

- [+0.101,+0.668]

The Simulation – Method 3

- Run/Pass based on probability of $EPA_{pass} > EPA_{run}$



Shapiro-Wilk Results

- $P_{m3} = 1.1e\text{-}07$
- $P_c = 2.1e\text{-}10$

Welch T-Test Results

- **P = 9.344e-6**

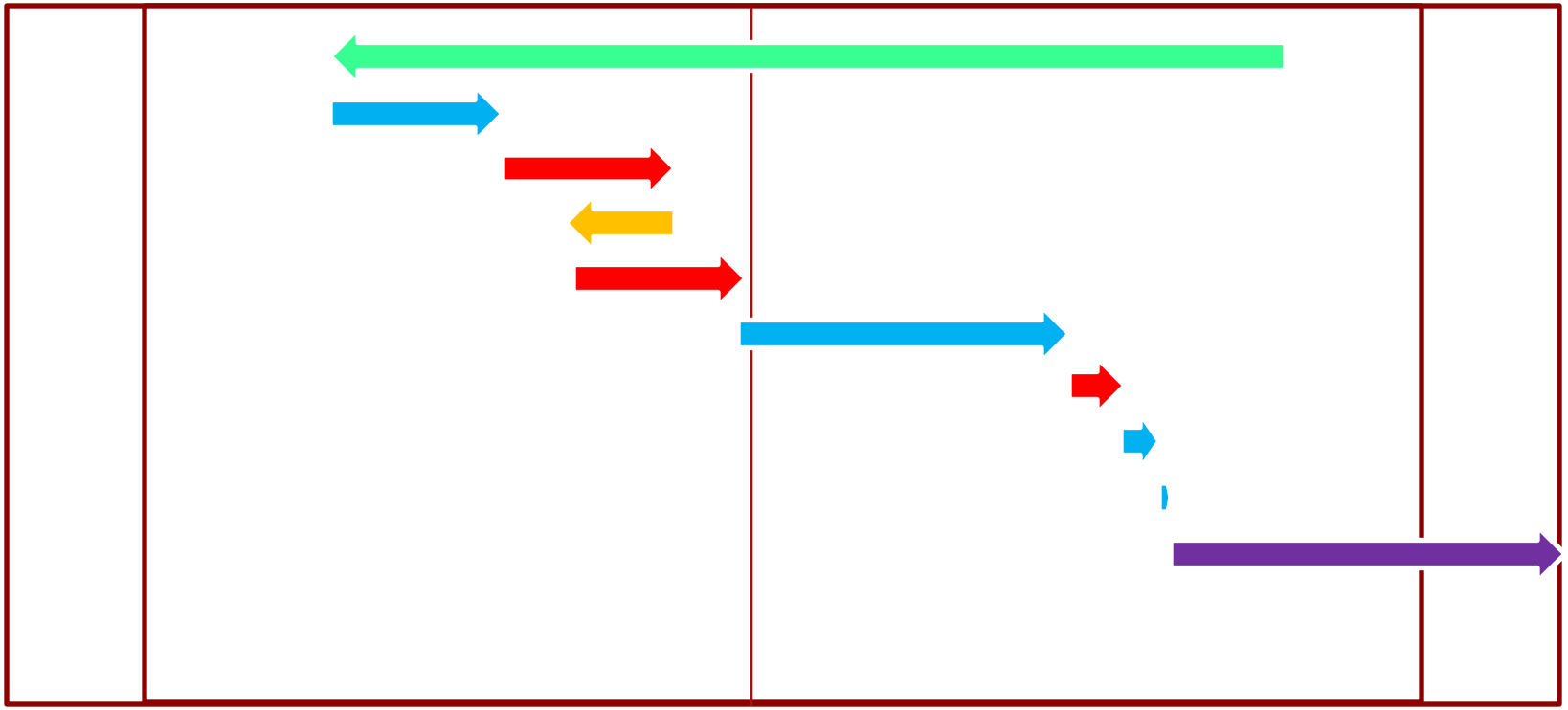
Drive ΔcEPA 95% C.I.

- **[+0.364,+0.939]**

The Simulation – Key Metrics

Method 3 produces the highest gain in cumulative drive EPA compared against the control group.

The Simulation - A Simulated Drive



FILTER ON SITUATION → *ASSESS HISTORICAL EPA DATA* → PICK RANDOM PLAY FROM SITUATION

The Simulation – Drawbacks

- Generality:
  - The simulation may attempt a situation that has never happened in an NFL Game before. In that case, the filtering becomes less specific and play calling is negatively affected.
  - There is no public play-by-play context as to defensive adjustments.

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- **Modeling the Optimal Pass Rate**
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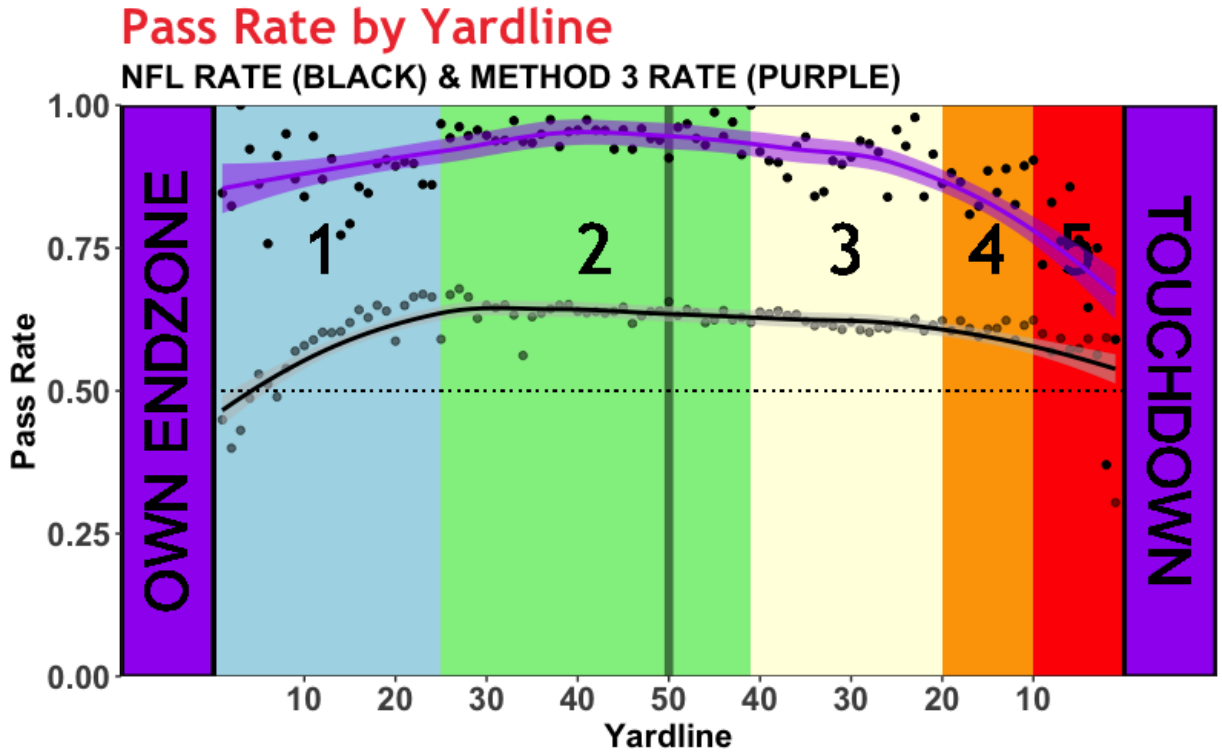
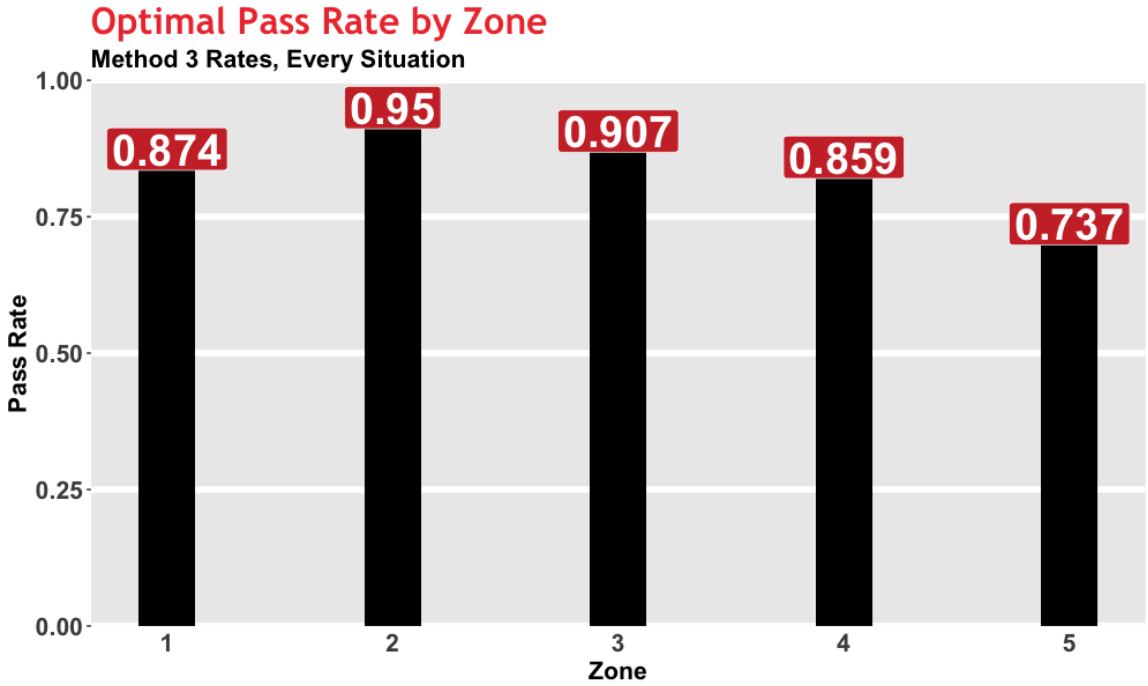
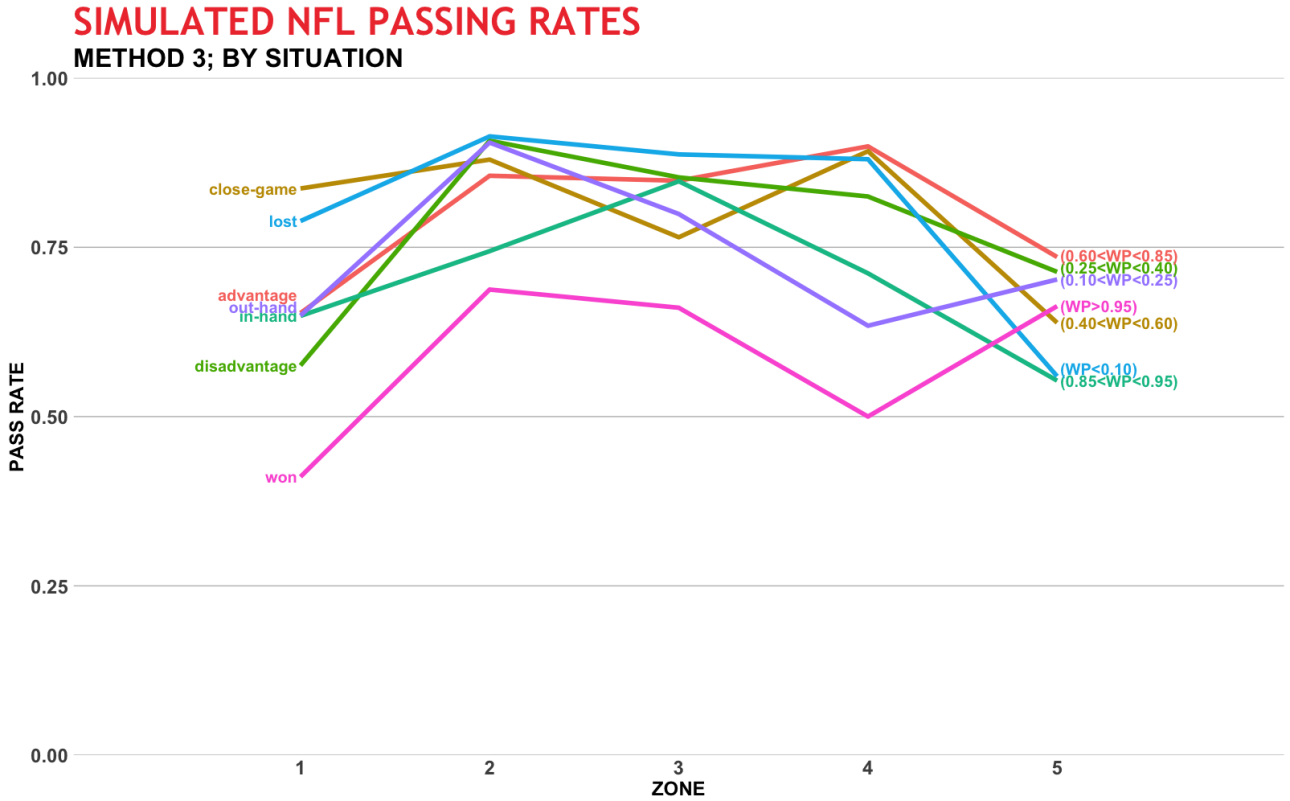
Modeling the Optimal Pass Rate



Modeling the Optimal Pass Rate



Modeling the Optimal Pass Rate



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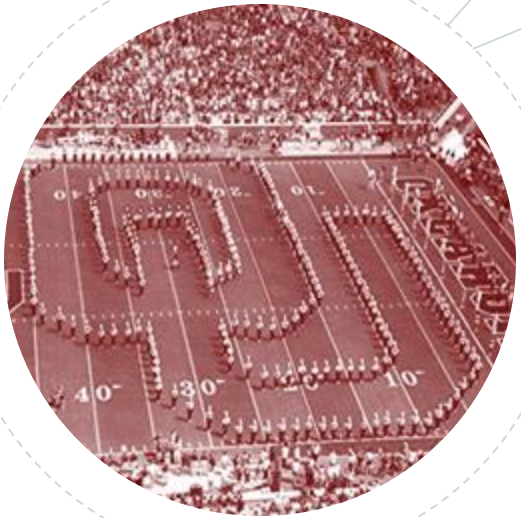


2020 Case Study - Method

Proposition: filtering for situation and teams with similar PFF grades will allow insight into how often the team should have passed in order to achieve a higher cumulative drive EPA.

2020 Case Study: Cleveland Browns

2020 Offensive Grades

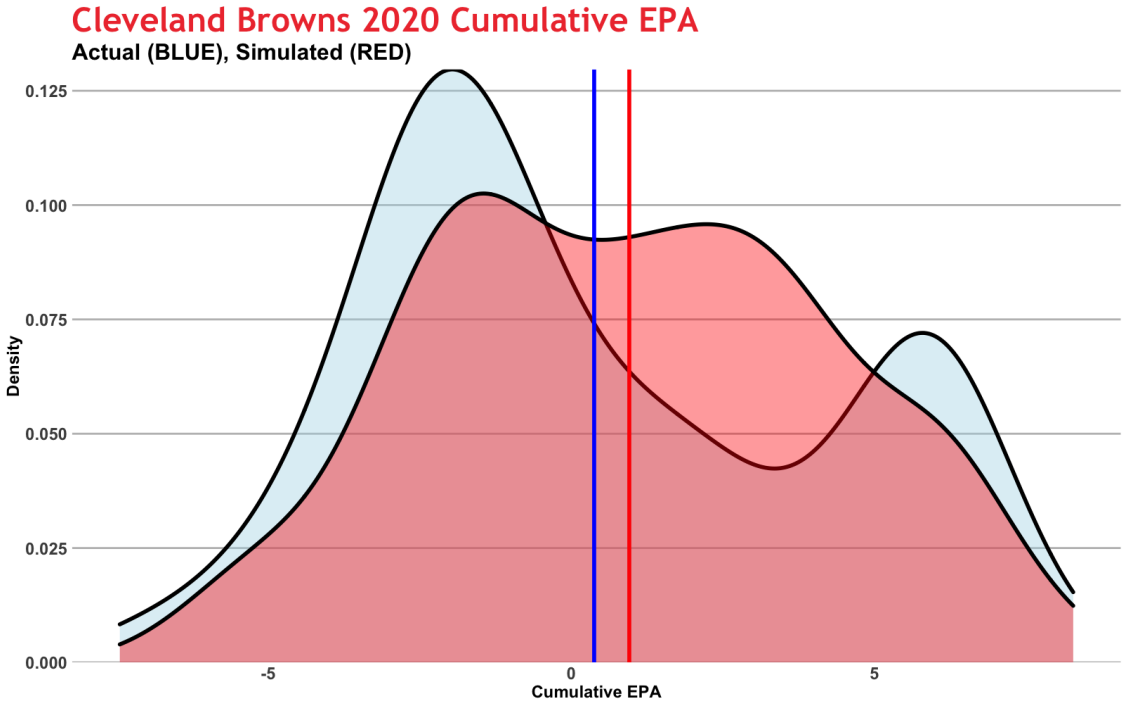
Pro Football Focus

Facet	Grade
Offense	87.8
Pass	85.2
Pass Block	84.4
Receiving	78.6
Run Block	82.6
Rushing	86.2

Motivation:

- Run-Heavy Offense (+1.23 s.d.)
  - 4th in NFL
- Average PA Offense (+0.080 s.d.)
- Baker Mayfield

2020 Case Study: Cleveland Browns



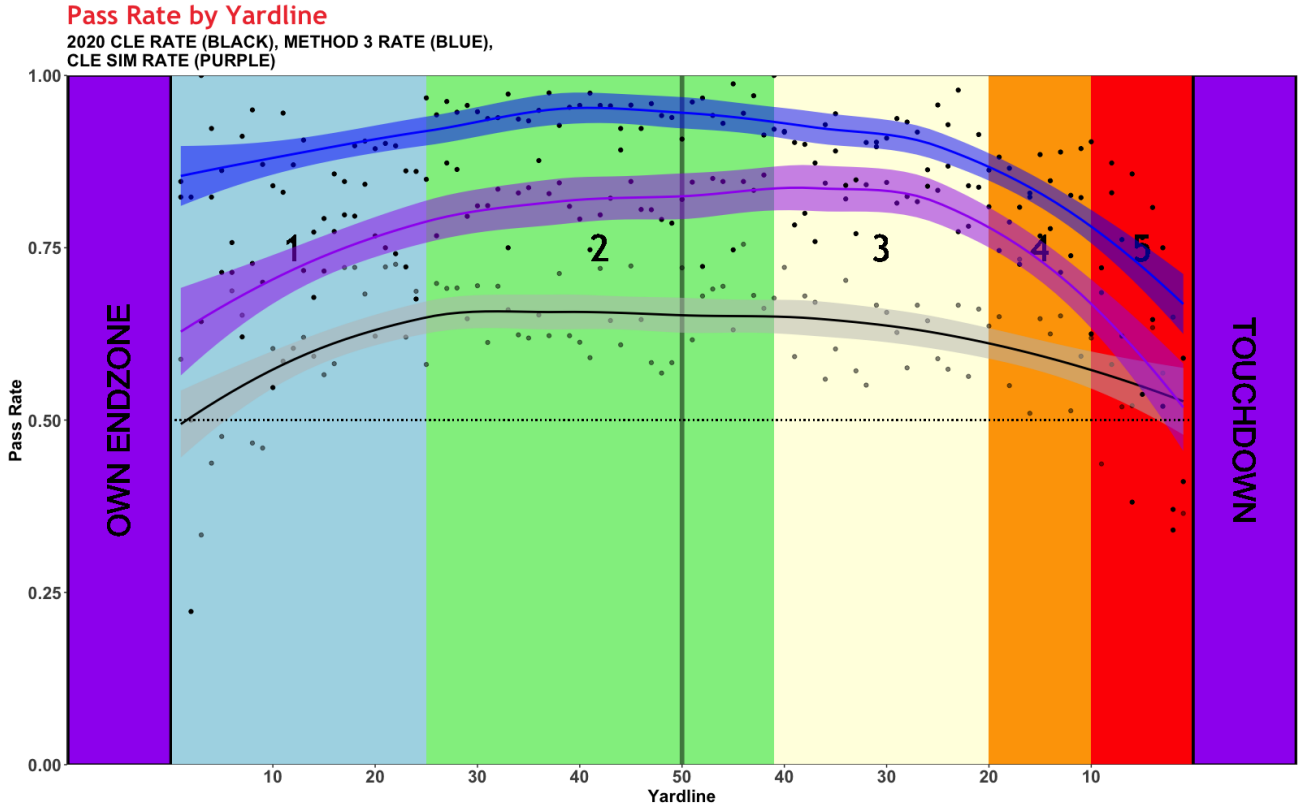
Welch T-Test Results

- P = 0.1162

Drive ΔcEPA 95% C.I.

- [-0.144,+1.303]

2020 Case Study: Cleveland Browns



Zone	Optimal Pass Rate
1	0.731
2	0.821
3	0.830
4	0.775
5	0.594

2020 Case Study: Arizona Cardinals

2020 Offensive Grades

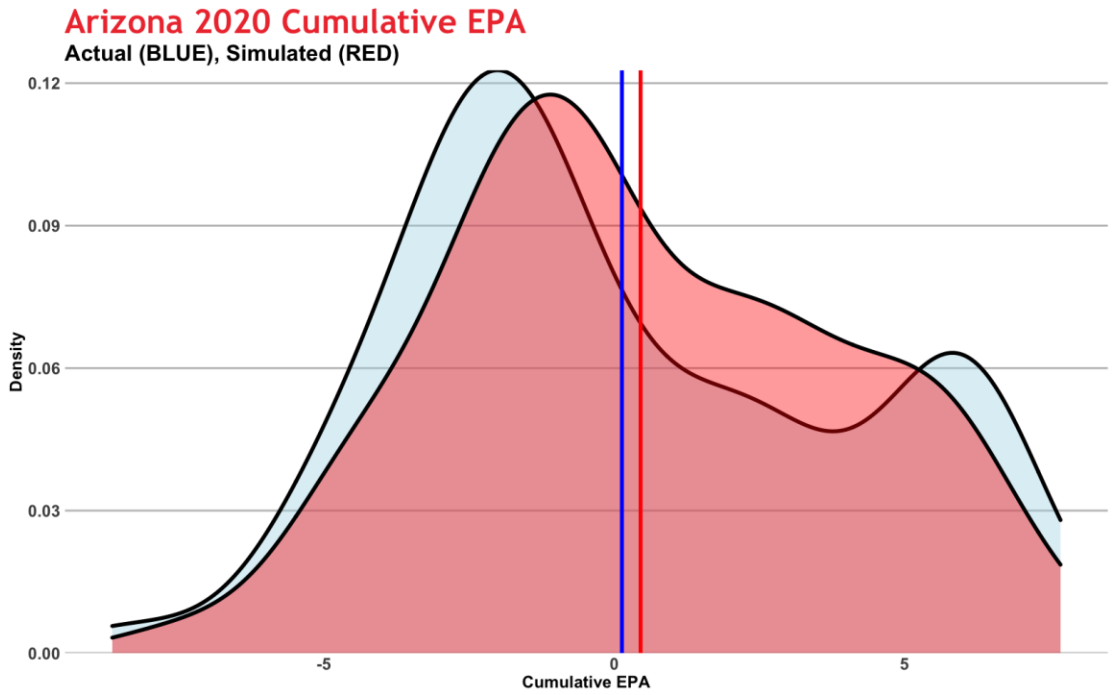
Pro Football Focus

Facet	Grade
Offense	74.5
Pass	74
Pass Block	73.9
Receiving	75.4
Run Block	60.7
Rushing	75.9

Motivation:

- Average Pass Offense (–0.039 s.d.)
- PA-Heavy Offense (+0.876 s.d.)
  - 6th in NFL
- Kyler Murray

2020 Case Study: Arizona Cardinals



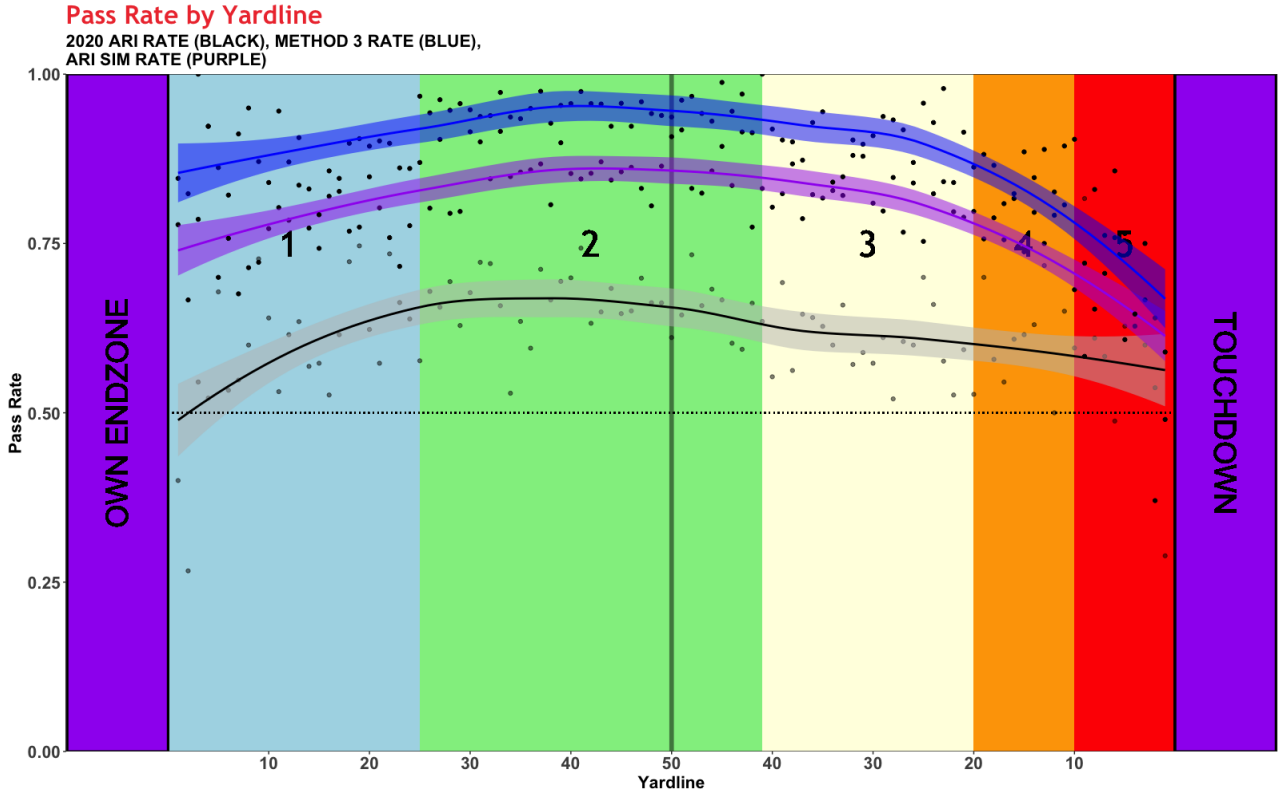
Welch T-Test Results

- P = 0.402

Drive ΔcEPA 95% C.I.

- [-0.432,+1.075]

2020 Case Study: Arizona Cardinals



Zone	Optimal Pass Rate
1	0.785
2	0.858
3	0.821
4	0.780
5	0.641

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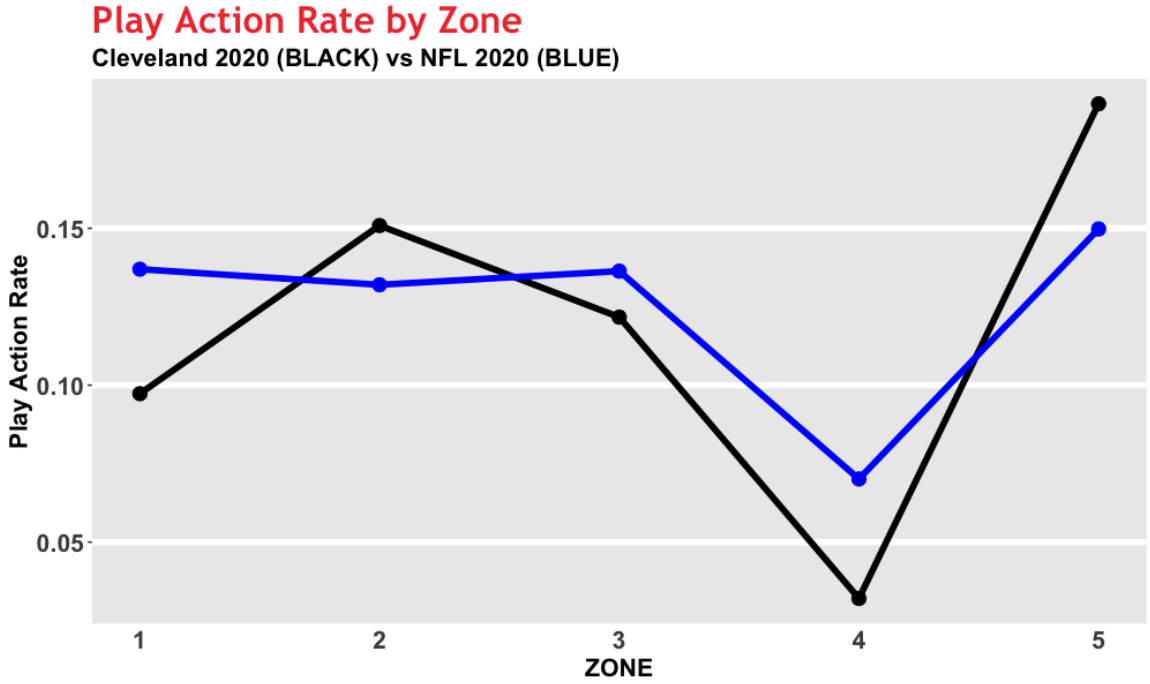
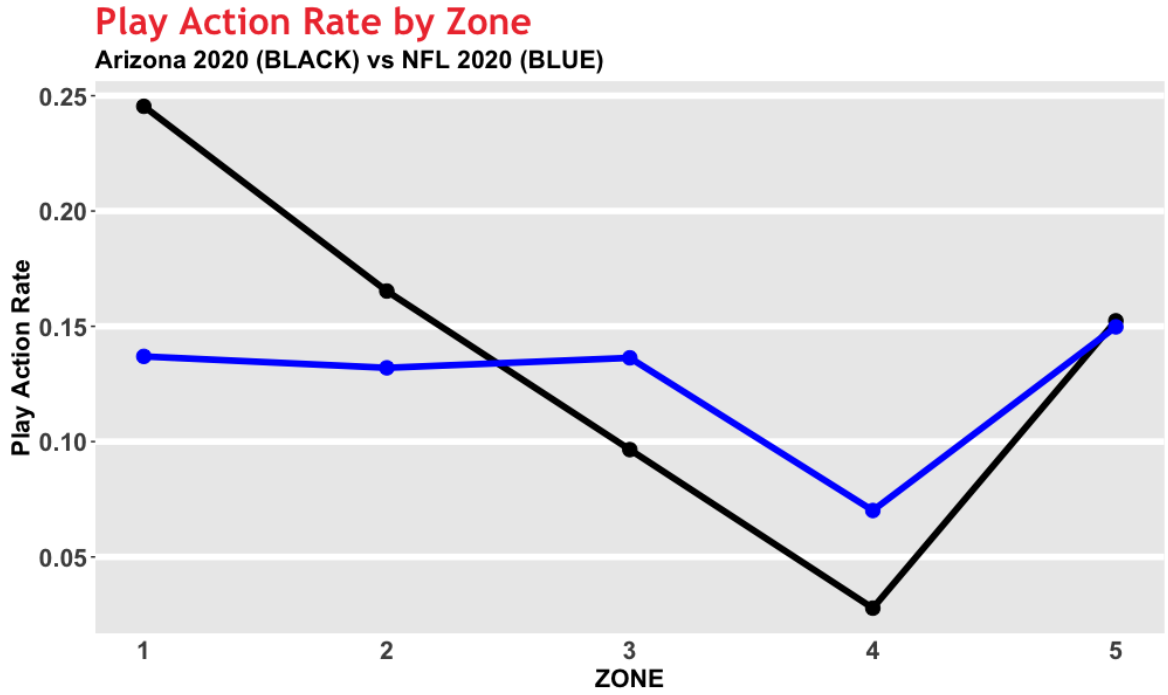
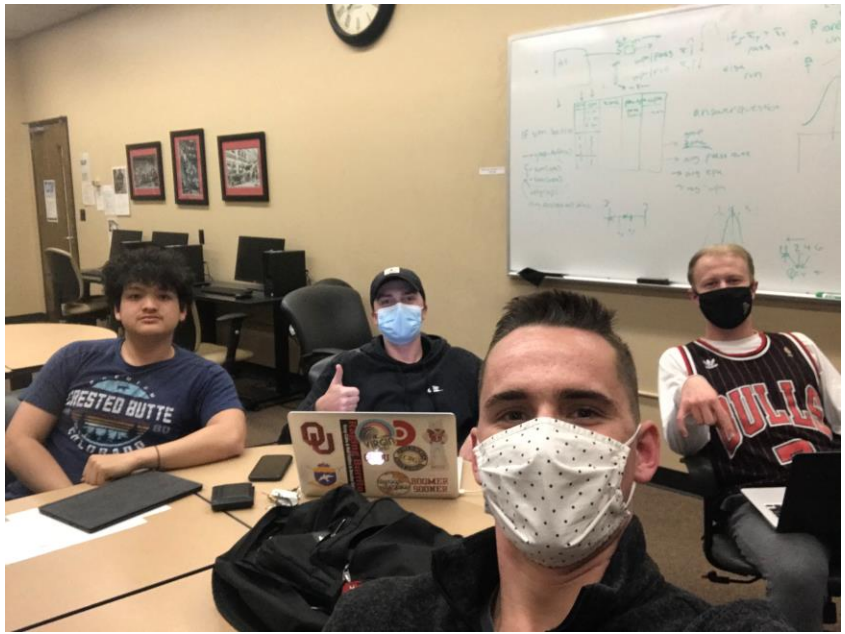
2020 PA Case Study: Cleveland Browns



2020 PA Case Study: Arizona Cardinals



Thank you!



Founding Members: OU SDA Club