Analytical Day Report

Step 0:

```
plays <- read.csv("plays.csv")
players <- read.csv("nfl-big-data-bowl-2025/players.csv")
```

Step 1: Clean data

```
colSums(is.na(plays))
```

```
                          gameId                           playId
                               0                                0
               playDescription                          quarter
                               0                                0
                            down                        yardsToGo
                               0                                0
                  possessionTeam                     defensiveTeam
                               0                                0
                    yardlineSide                   yardlineNumber
                             224                                0
                       gameClock                  preSnapHomeScore
                               0                                0
             preSnapVisitorScore             playNullifiedByPenalty
                               0                                0
          absoluteYardlineNumber     preSnapHomeTeamWinProbability
                               0                                0
preSnapVisitorTeamWinProbability                   expectedPoints
                               0                                0
                offenseFormation                receiverAlignment
                             188                              188
                 playClockAtSnap                       passResult
                               1                                0
                      passLength                          targetX
                            7398                             7748
                         targetY                       playAction
                            7748                                0
                   dropbackType                  dropbackDistance
```

```
                        5803                                  5966
           passLocationType                          timeToThrow
                        6812                                  7419
            timeInTackleBox                           timeToSack
                        7207                                 15516
           passTippedAtLine                     unblockedPressure
                        6788                                  6369
                    qbSpike                               qbKneel
                        6788                                     0
                    qbSneak                       rushLocationType
                        9336                                  9336
               penaltyYards                 prePenaltyYardsGained
                       15740                                     0
                yardsGained              homeTeamWinProbabilityAdded
                          0                                     0
 visitorTeamWinProbilityAdded                    expectedPointsAdded
                          0                                     0
                isDropback                   pff_runConceptPrimary
                          0                                  7053
     pff_runConceptSecondary                      pff_runPassOption
                      13303                                     0
           pff_passCoverage                           pff_manZone
                        192                                   192
```

```r
handle_missing_values <- function(df, threshold = 0.7) {
  # Step 1: Calculate percentage of missing values per column
  missing_percentage <- colMeans(is.na(df))

  # Step 2: Drop columns exceeding threshold
  cols_to_drop <- names(missing_percentage[missing_percentage > threshold])
  df <- df[ , !(names(df) %in% cols_to_drop)]
  message("Dropped columns with more than ", threshold * 100, "% missing values: ",
          paste(cols_to_drop, collapse = ", "))

  # Step 3: Separate numeric and categorical columns
  numeric_cols <- sapply(df, is.numeric)
  categorical_cols <- !numeric_cols

  # Step 4: Impute missing values
  # Numeric: replace NA with mean
  for (col in names(df)[numeric_cols]) {
    df[[col]][is.na(df[[col]])] <- mean(df[[col]], na.rm = TRUE)
  }

  # Categorical: replace NA with mode (most frequent value)
  mode_value <- function(x) {
    ux <- unique(na.omit(x))
```

```
    ux[which.max(tabulate(match(x, ux)))]
  }
  for (col in names(df)[categorical_cols]) {
    df[[col]][is.na(df[[col]])] <- mode_value(df[[col]])
  }

  # Step 5: Verify cleanup
  remaining_missing <- colSums(is.na(df))
  message("\nRemaining missing values after handling:\n")
  print(remaining_missing)

  return(df)
}

clean_plays<-handle_missing_values(plays)
```

```
Dropped columns with more than 70% missing values: timeToSack, penaltyYards, pff_runConceptSec
```

```
Remaining missing values after handling:
```

```
                          gameId                           playId
                               0                                0
               playDescription                          quarter
                               0                                0
                            down                        yardsToGo
                               0                                0
                  possessionTeam                     defensiveTeam
                               0                                0
                    yardlineSide                   yardlineNumber
                               0                                0
                       gameClock                  preSnapHomeScore
                               0                                0
             preSnapVisitorScore            playNullifiedByPenalty
                               0                                0
          absoluteYardlineNumber    preSnapHomeTeamWinProbability
                               0                                0
preSnapVisitorTeamWinProbability                   expectedPoints
                               0                                0
                offenseFormation                receiverAlignment
                               0                                0
                 playClockAtSnap                       passResult
                               0                                0
                      passLength                          targetX
                               0                                0
                         targetY                       playAction
```

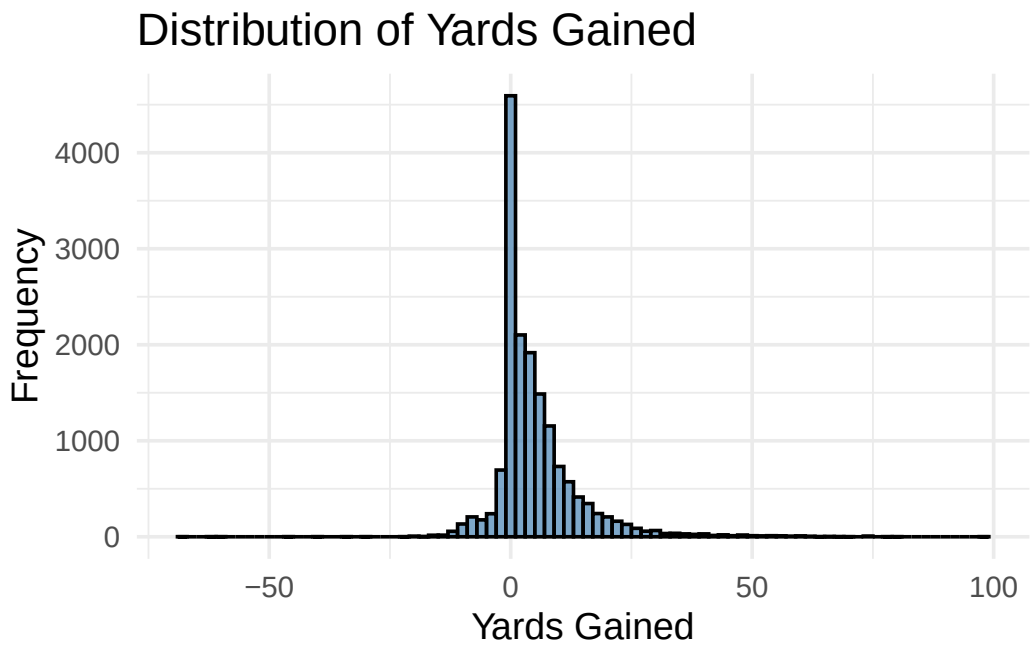
```
                          0                                   0
                dropbackType                dropbackDistance
                          0                                   0
            passLocationType                    timeToThrow
                          0                                   0
             timeInTackleBox                passTippedAtLine
                          0                                   0
           unblockedPressure                          qbSpike
                          0                                   0
                    qbKneel                          qbSneak
                          0                                   0
            rushLocationType          prePenaltyYardsGained
                          0                                   0
                yardsGained     homeTeamWinProbabilityAdded
                          0                                   0
visitorTeamWinProbilityAdded            expectedPointsAdded
                          0                                   0
                  isDropback          pff_runConceptPrimary
                          0                                   0
           pff_runPassOption               pff_passCoverage
                          0                                   0
                 pff_manZone
                          0
```

STEP 2: Relationship BETWEEN OFFENSE FORMATION AND YARDGAINED A: Basic distribtuion of YardGained

```
library(ggplot2)
```

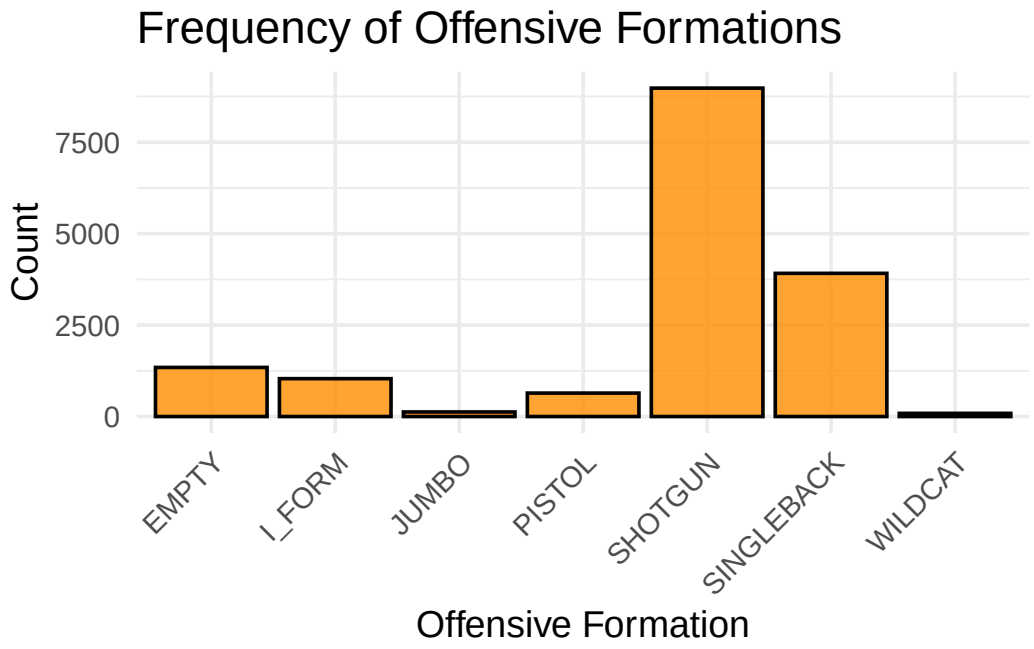
```
Warning: package 'ggplot2' was built under R version 4.5.1
```

```
ggplot(clean_plays, aes(x = yardsGained)) +
  geom_histogram(binwidth = 2, fill = "steelblue", color = "black", alpha = 0.7) +
  labs(title = "Distribution of Yards Gained",
       x = "Yards Gained",
       y = "Frequency") +
  theme_minimal(base_size = 14)
```



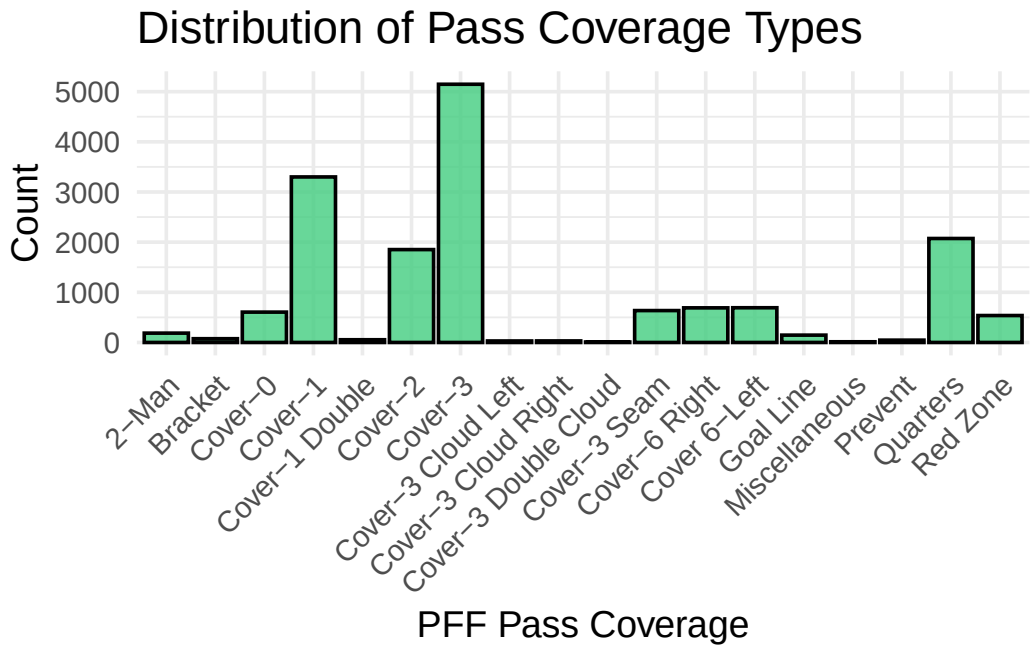
Barplot of OffenseFormation

```
ggplot(clean_plays, aes(x = offenseFormation)) +
  geom_bar(fill = "darkorange", color = "black", alpha = 0.8) +
  labs(title = "Frequency of Offensive Formations",
       x = "Offensive Formation",
       y = "Count") +
  theme_minimal(base_size = 14) +
  theme(axis.text.x = element_text(angle = 45, hjust = 1))
```



Bar plot of distribution of passCoverage

```
ggplot(clean_plays, aes(x = pff_passCoverage)) +
  geom_bar(fill = "seagreen3", color = "black", alpha = 0.8) +
  labs(title = "Distribution of Pass Coverage Types",
       x = "PFF Pass Coverage",
       y = "Count") +
  theme_minimal(base_size = 14) +
  theme(axis.text.x = element_text(angle = 45, hjust = 1))
```




```
library(tidyverse)
```

```
Warning: package 'tidyverse' was built under R version 4.5.1
```

```
Warning: package 'tibble' was built under R version 4.5.1
```

```
Warning: package 'tidyr' was built under R version 4.5.1
```

```
Warning: package 'readr' was built under R version 4.5.1
```

```
Warning: package 'purrr' was built under R version 4.5.1
```

```
Warning: package 'dplyr' was built under R version 4.5.1
```

```
Warning: package 'stringr' was built under R version 4.5.1
```

```
Warning: package 'forcats' was built under R version 4.5.1

Warning: package 'lubridate' was built under R version 4.5.1

-- Attaching core tidyverse packages ------------------------ tidyverse 2.0.0 --
v dplyr     1.1.4     v readr     2.1.5
v forcats   1.0.0     v stringr   1.5.1
v lubridate 1.9.4     v tibble    3.3.0
v purrr     1.1.0     v tidyr     1.3.1
-- Conflicts ------------------------------------------ tidyverse_conflicts() --
x dplyr::filter() masks stats::filter()
x dplyr::lag()    masks stats::lag()
i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to become
```

```r
formation_success <- clean_plays %>%
  group_by(offenseFormation) %>%
  summarise(Average_Yards_Gained = mean(yardsGained, na.rm = TRUE)) %>%
  arrange(desc(Average_Yards_Gained))

# Step 2: Print results in styled console output
cat("\nAverage Yards Gained by Formation:\n")
```

```
Average Yards Gained by Formation:
```

```r
cat(strrep("=", 50), "\n")
```

```
==================================================
```

```r
cat(sprintf("%-25s %-25s\n", "Formation", "Average Yards Gained"))
```

```
Formation                 Average Yards Gained
```

```r
cat(strrep("-", 50), "\n")
```

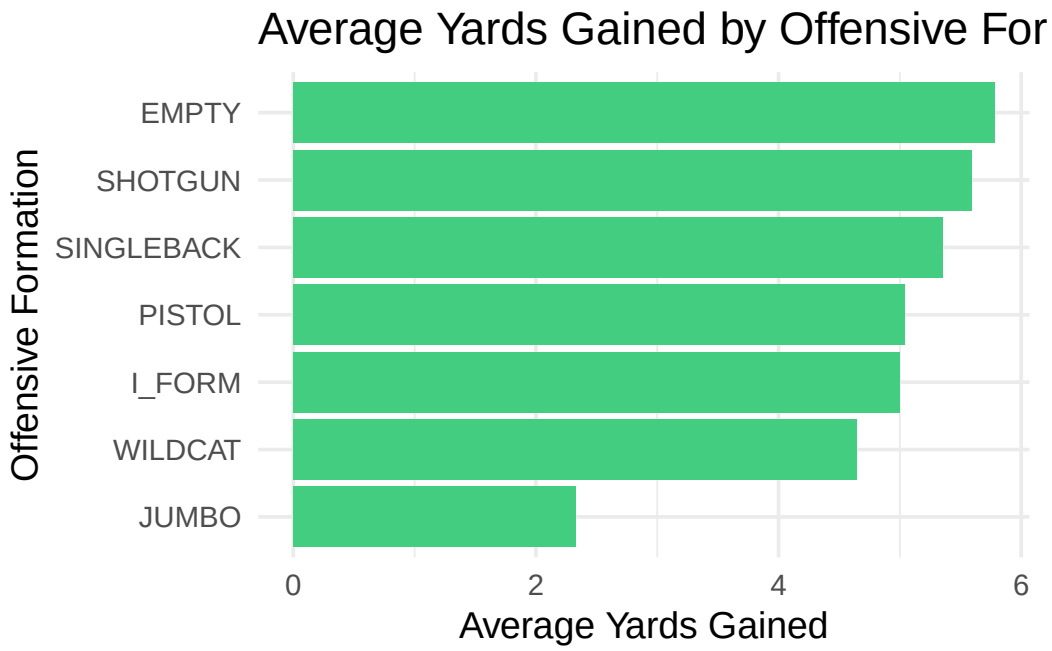
```
--------------------------------------------------
```

```r
for (i in seq_len(nrow(formation_success))) {
  formation <- formation_success$offenseFormation[i]
  yards <- formation_success$Average_Yards_Gained[i]


  cat(sprintf("%-25s %-25.2f\n", formation, yards))
}
```

```
EMPTY                   5.78
SHOTGUN                 5.59
SINGLEBACK              5.35
PISTOL                  5.04
I_FORM                  5.00
WILDCAT                 4.64
JUMBO                   2.33
```

```r
# Step 3: Visualization (bar chart)
ggplot(formation_success, aes(x = reorder(offenseFormation, Average_Yards_Gained),
                              y = Average_Yards_Gained,
                              fill = Average_Yards_Gained>0))+
  geom_bar(stat = "identity") +
  scale_fill_manual(values = c("TRUE" = "seagreen3", "FALSE" = "firebrick2")) +
  coord_flip() +
  labs(
    title = "Average Yards Gained by Offensive Formation",
    x = "Offensive Formation",
    y = "Average Yards Gained"
  ) +
  theme_minimal(base_size = 14) +
  theme(legend.position = "none")
```

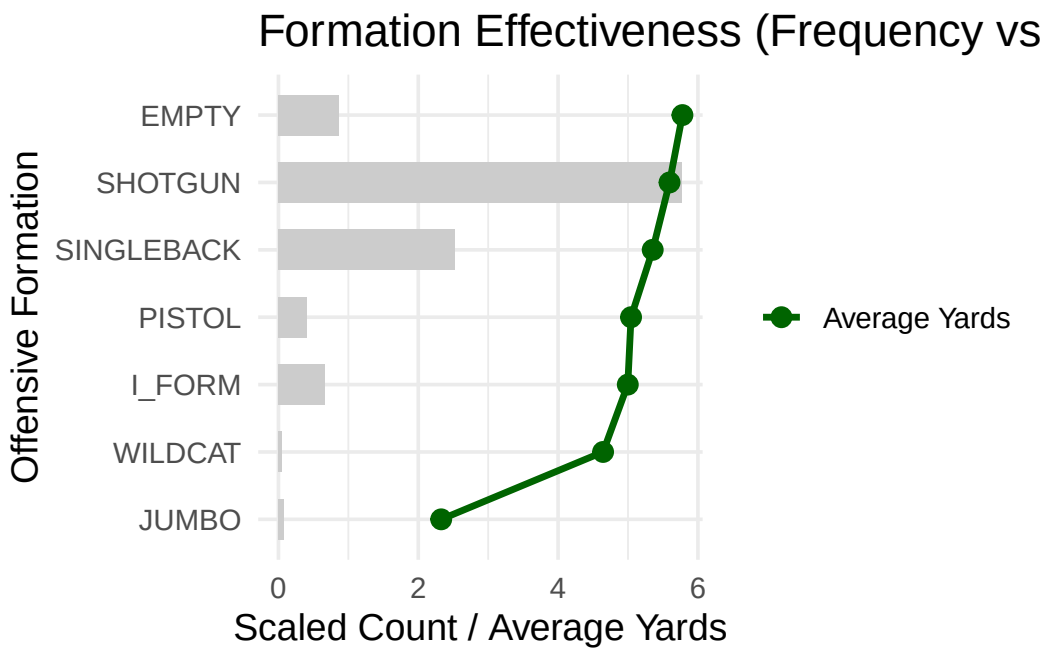


Ok trying new plot with freq added to the graph

```r
formation_summary <- clean_plays %>%
  group_by(offenseFormation) %>%
  summarise(
```

```
    avg_yards = mean(yardsGained, na.rm = TRUE),
    count = n()
  )

ggplot(formation_summary, aes(x = reorder(offenseFormation, avg_yards))) +
  geom_col(aes(y = count / max(count) * max(avg_yards)),
           fill = "gray80", width = 0.6) +
  geom_line(aes(y = avg_yards, group = 1, color = "Average Yards"), linewidth = 1.2) +
  geom_point(aes(y = avg_yards, color = "Average Yards"), size = 3) +
  coord_flip() +
  scale_color_manual(values = c("Average Yards" = "darkgreen")) +
  labs(
    title = "Formation Effectiveness (Frequency vs Average Yards)",
    x = "Offensive Formation",
    y = "Scaled Count / Average Yards"
  ) +
  theme_minimal(base_size = 14) +
  theme(legend.title = element_blank())
```



Ok next is OffenseFormation by PassCoverage

Let's group the pass_coverage to smaller group

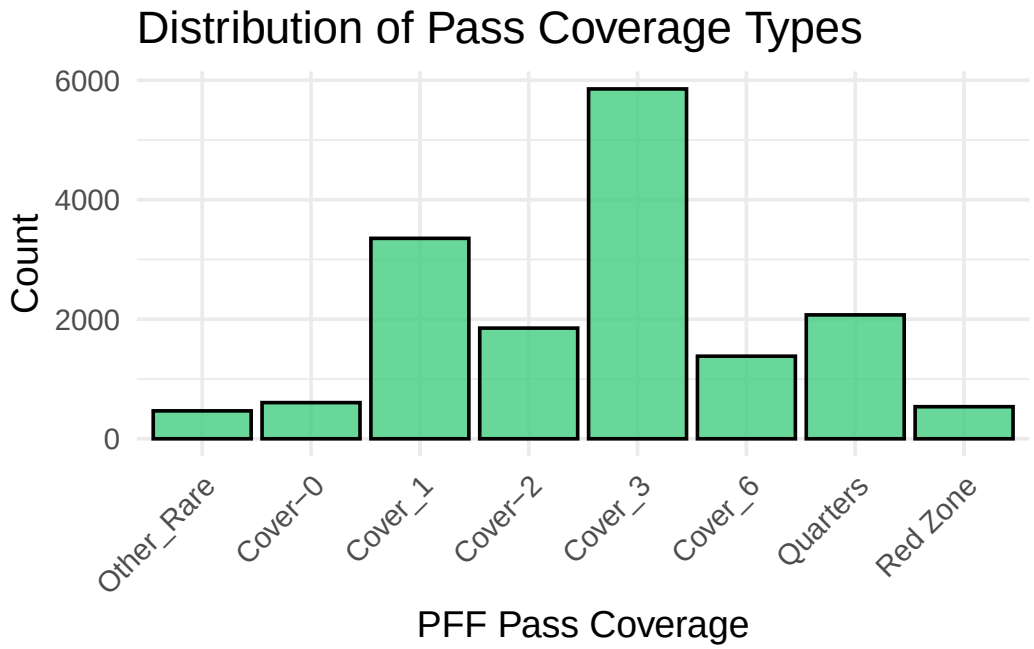
```
clean_plays$coverage_group <- clean_plays$pff_passCoverage

clean_plays$coverage_group <- forcats::fct_collapse(
  clean_plays$coverage_group,
  Cover_3 = c("Cover-3", "Cover-3 Cloud Left", "Cover-3 Cloud Right",
```

```
              "Cover-3 Seam", "Cover-3 Double Cloud"),
  Cover_6 = c("Cover 6-Left", "Cover-6 Right"),
  Cover_1 = c("Cover-1", "Cover-1 Double"),
  Other_Rare = c("Bracket", "Miscellaneous", "Prevent", "2-Man", "Goal Line")
)
```

See the distribution after grouping

```
ggplot(clean_plays, aes(x = coverage_group)) +
  geom_bar(fill = "seagreen3", color = "black", alpha = 0.8) +
  labs(title = "Distribution of Pass Coverage Types",
       x = "PFF Pass Coverage",
       y = "Count") +
  theme_minimal(base_size = 14) +
  theme(axis.text.x = element_text(angle = 45, hjust = 1))
```



Now run the plot

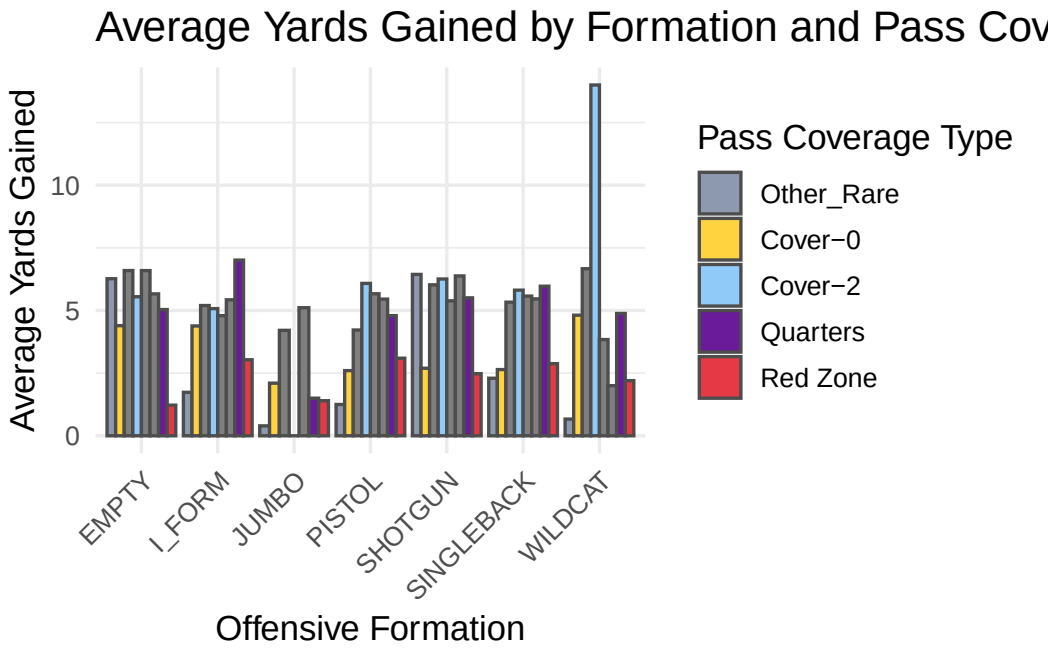
```
library(dplyr)

yards_by_formation_cov <- clean_plays %>%
  group_by(offenseFormation, coverage_group) %>%
  summarise(
    avg_yards = mean(yardsGained, na.rm = TRUE),
    play_count = n(),
    .groups = "drop"
  )
```

Visualize it

```
library(ggplot2)

ggplot(yards_by_formation_cov,
       aes(x = offenseFormation, y = avg_yards, fill = coverage_group)) +
  geom_bar(stat = "identity", position = position_dodge(width = 0.9), color = "gray30") +
  scale_fill_manual(
    values = c(
      "Cover-0"   = "#FFD23F",  # golden yellow
      "Cover-1"   = "#FFB703",  # orange-yellow
      "Cover-2"   = "#90CAF9",  # light blue
      "Cover-3"   = "#2196F3",  # mid blue
      "Cover-6"   = "#1565C0",  # deep blue
      "Quarters"  = "#6A1B9A",  # purple accent
      "Red Zone"  = "#E63946",  # red
      "Other_Rare"= "#8D99AE"   # neutral gray
    )
  ) +
  labs(
    title = "Average Yards Gained by Formation and Pass Coverage",
    x = "Offensive Formation",
    y = "Average Yards Gained",
    fill = "Pass Coverage Type"
  )+
  theme_minimal(base_size = 13) +
  theme(axis.text.x = element_text(angle = 45, hjust = 1))
```



OK NOW OFFENSIVE FORMATION IN DIFFERENT QUARTER

Compute the yardGain by formation

```
library(dplyr)

# Summarize average yards by formation and quarter
yards_by_quarter <- clean_plays %>%
  group_by(offenseFormation, quarter) %>%
  summarise(
    avg_yards = mean(yardsGained, na.rm = TRUE),
    play_count = n(),
    .groups = "drop"
  )

# Print results
cat("\nAverage Yards Gained by Formation and Quarter:\n")
```

```
Average Yards Gained by Formation and Quarter:
```

```
cat(strrep("=", 60), "\n")
```

```
============================================================
```

```
cat(sprintf("%-15s %-10s %-20s %-10s\n",
            "Formation", "Quarter", "Average Yards", "Plays"))
```

```
Formation       Quarter    Average Yards        Plays
```

```
cat(strrep("-", 60), "\n")
```

```
------------------------------------------------------------
```

```
for (i in seq_len(nrow(yards_by_quarter))) {
  formation <- yards_by_quarter$offenseFormation[i]
  quarter <- yards_by_quarter$quarter[i]
  yards <- yards_by_quarter$avg_yards[i]
  count <- yards_by_quarter$play_count[i]

  cat(sprintf("%-15s %-10s %-20.2f %-10d\n", formation, quarter, yards, count))
}
```

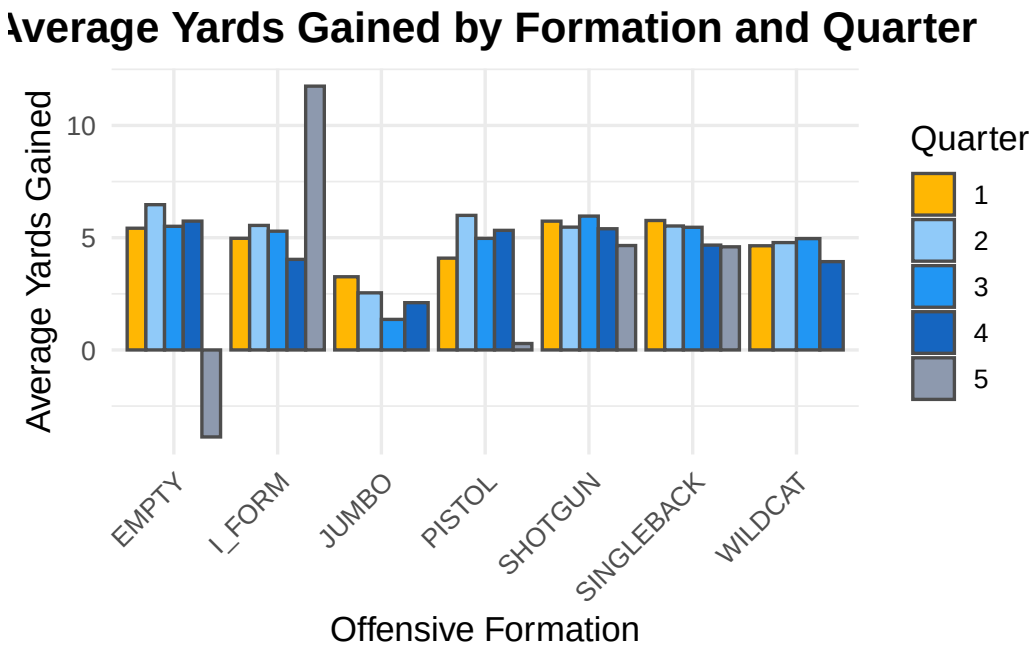
EMPTY	1	5.42	313
EMPTY	2	6.47	402
EMPTY	3	5.51	278
EMPTY	4	5.74	341
EMPTY	5	-3.88	8
I_FORM	1	4.97	320
I_FORM	2	5.55	251
I_FORM	3	5.29	228
I_FORM	4	4.03	232
I_FORM	5	11.75	4
JUMBO	1	3.26	27
JUMBO	2	2.54	35
JUMBO	3	1.36	25
JUMBO	4	2.11	38
PISTOL	1	4.09	159
PISTOL	2	5.99	164
PISTOL	3	4.97	164
PISTOL	4	5.33	147
PISTOL	5	0.29	7
SHOTGUN	1	5.74	1774
SHOTGUN	2	5.47	2583
SHOTGUN	3	5.96	1844
SHOTGUN	4	5.40	2695
SHOTGUN	5	4.65	83
SINGLEBACK	1	5.77	984
SINGLEBACK	2	5.52	918
SINGLEBACK	3	5.46	1034
SINGLEBACK	4	4.67	947
SINGLEBACK	5	4.59	32
WILDCAT	1	4.64	25
WILDCAT	2	4.78	23
WILDCAT	3	4.96	24
WILDCAT	4	3.93	15

GGPlot

```
library(ggplot2)

ggplot(yards_by_quarter,
       aes(x = offenseFormation, y = avg_yards, fill = factor(quarter))) +
  geom_bar(stat = "identity", position = position_dodge(width = 0.9), color = "gray30") +
  scale_fill_manual(
    values = c(
      "1" = "#FFB703",  # orange-yellow
      "2" = "#90CAF9",  # light blue
      "3" = "#2196F3",  # mid blue
      "4" = "#1565C0",   # deep blue
```

```
      "5" = "#8D99AE"   # gray-blue for OT
    )
  ) +
  labs(
    title = "Average Yards Gained by Formation and Quarter",
    x = "Offensive Formation",
    y = "Average Yards Gained",
    fill = "Quarter"
  ) +
  theme_minimal(base_size = 13) +
  theme(
    axis.text.x = element_text(angle = 45, hjust = 1),
    plot.title = element_text(face = "bold", hjust = 0.5)
  )
```



CONDUCT AN ANOVA TEST

```
# Fit model with interaction term
model_interaction <- lm(yardsGained ~ offenseFormation *coverage_group , data = clean_plays)

# Show summary
summary(model_interaction)
```

```
Call:
lm(formula = yardsGained ~ offenseFormation * coverage_group,
    data = clean_plays)
```

```
Residuals:
    Min      1Q  Median      3Q     Max
-74.024  -5.385  -1.970   2.620  91.560

Coefficients: (1 not defined because of singularities)
                                                    Estimate Std. Error t value
(Intercept)                                           6.2683     1.3730   4.565
offenseFormationI_FORM                               -4.5350     2.1123  -2.147
offenseFormationJUMBO                                -5.8721     1.8285  -3.211
offenseFormationPISTOL                               -5.0183     4.6053  -1.090
offenseFormationSHOTGUN                               0.1714     1.4695   0.117
offenseFormationSINGLEBACK                           -3.9720     1.8211  -2.181
offenseFormationWILDCAT                              -5.6016     5.2583  -1.065
coverage_groupCover-0                                -1.8739     1.7245  -1.087
coverage_groupCover_1                                 0.3258     1.4732   0.221
coverage_groupCover-2                                -0.7191     1.5118  -0.476
coverage_groupCover_3                                 0.3241     1.4475   0.224
coverage_groupCover_6                                -0.6047     1.6087  -0.376
coverage_groupQuarters                               -1.2313     1.4843  -0.829
coverage_groupRed Zone                               -5.0461     1.8981  -2.658
offenseFormationI_FORM:coverage_groupCover-0          4.5229     2.7971   1.617
offenseFormationJUMBO:coverage_groupCover-0           3.5777     3.4873   1.026
offenseFormationPISTOL:coverage_groupCover-0          3.2239     5.0387   0.640
offenseFormationSHOTGUN:coverage_groupCover-0        -1.8700     1.8703  -1.000
offenseFormationSINGLEBACK:coverage_groupCover-0      2.2205     2.2265   0.997
offenseFormationWILDCAT:coverage_groupCover-0         6.0198     5.7939   1.039
offenseFormationI_FORM:coverage_groupCover_1          3.1387     2.2741   1.380
offenseFormationJUMBO:coverage_groupCover_1           3.4863     2.6171   1.332
offenseFormationPISTOL:coverage_groupCover_1          2.6454     4.7093   0.562
offenseFormationSHOTGUN:coverage_groupCover_1        -0.7411     1.5760  -0.470
offenseFormationSINGLEBACK:coverage_groupCover_1      2.7104     1.9235   1.409
offenseFormationWILDCAT:coverage_groupCover_1         5.6742     5.8631   0.968
offenseFormationI_FORM:coverage_groupCover-2          4.0602     2.3842   1.703
offenseFormationJUMBO:coverage_groupCover-2           0.3228     4.8029   0.067
offenseFormationPISTOL:coverage_groupCover-2          5.5502     4.8681   1.140
offenseFormationSHOTGUN:coverage_groupCover-2         0.5361     1.6201   0.331
offenseFormationSINGLEBACK:coverage_groupCover-2      4.2343     1.9880   2.130
offenseFormationWILDCAT:coverage_groupCover-2        14.0524     7.3358   1.916
offenseFormationI_FORM:coverage_groupCover_3          2.7364     2.1980   1.245
offenseFormationJUMBO:coverage_groupCover_3           4.3908     2.5330   1.733
offenseFormationPISTOL:coverage_groupCover_3          4.0937     4.6568   0.879
offenseFormationSHOTGUN:coverage_groupCover_3        -1.3788     1.5480  -0.891
offenseFormationSINGLEBACK:coverage_groupCover_3      2.9540     1.8893   1.564
offenseFormationWILDCAT:coverage_groupCover_3         2.8492     5.5634   0.512
offenseFormationI_FORM:coverage_groupCover_6          4.2982     2.4712   1.739
offenseFormationJUMBO:coverage_groupCover_6               NA         NA      NA
offenseFormationPISTOL:coverage_groupCover_6          4.8092     4.8650   0.989
```

```
offenseFormationSHOTGUN:coverage_groupCover_6       0.5447     1.7172   0.317
offenseFormationSINGLEBACK:coverage_groupCover_6    3.7711     2.0790   1.814
offenseFormationWILDCAT:coverage_groupCover_6       1.9380    10.2784   0.189
offenseFormationI_FORM:coverage_groupQuarters       6.5081     2.3598   2.758
offenseFormationJUMBO:coverage_groupQuarters        2.3350     6.5045   0.359
offenseFormationPISTOL:coverage_groupQuarters       4.7776     4.7162   1.013
offenseFormationSHOTGUN:coverage_groupQuarters      0.2967     1.5948   0.186
offenseFormationSINGLEBACK:coverage_groupQuarters   4.9051     1.9525   2.512
offenseFormationWILDCAT:coverage_groupQuarters      5.4469     5.7021   0.955
offenseFormationI_FORM:coverage_groupRed Zone       6.3461     2.9590   2.145
offenseFormationJUMBO:coverage_groupRed Zone        6.0498     4.5299   1.336
offenseFormationPISTOL:coverage_groupRed Zone       6.8913     5.1582   1.336
offenseFormationSHOTGUN:coverage_groupRed Zone      1.0839     2.0309   0.534
offenseFormationSINGLEBACK:coverage_groupRed Zone   5.6270     2.3900   2.354
offenseFormationWILDCAT:coverage_groupRed Zone      6.5794     6.0907   1.080
                                                  Pr(>|t|)
(Intercept)                                       5.02e-06 ***
offenseFormationI_FORM                             0.03181 *
offenseFormationJUMBO                              0.00132 **
offenseFormationPISTOL                             0.27587
offenseFormationSHOTGUN                            0.90713
offenseFormationSINGLEBACK                         0.02919 *
offenseFormationWILDCAT                            0.28676
coverage_groupCover-0                              0.27720
coverage_groupCover_1                              0.82498
coverage_groupCover-2                              0.63435
coverage_groupCover_3                              0.82284
coverage_groupCover_6                              0.70702
coverage_groupQuarters                             0.40684
coverage_groupRed Zone                             0.00786 **
offenseFormationI_FORM:coverage_groupCover-0       0.10589
offenseFormationJUMBO:coverage_groupCover-0        0.30495
offenseFormationPISTOL:coverage_groupCover-0       0.52229
offenseFormationSHOTGUN:coverage_groupCover-0      0.31741
offenseFormationSINGLEBACK:coverage_groupCover-0   0.31863
offenseFormationWILDCAT:coverage_groupCover-0      0.29883
offenseFormationI_FORM:coverage_groupCover_1       0.16755
offenseFormationJUMBO:coverage_groupCover_1        0.18284
offenseFormationPISTOL:coverage_groupCover_1       0.57430
offenseFormationSHOTGUN:coverage_groupCover_1      0.63820
offenseFormationSINGLEBACK:coverage_groupCover_1   0.15883
offenseFormationWILDCAT:coverage_groupCover_1      0.33317
offenseFormationI_FORM:coverage_groupCover-2       0.08859 .
offenseFormationJUMBO:coverage_groupCover-2        0.94641
offenseFormationPISTOL:coverage_groupCover-2       0.25426
offenseFormationSHOTGUN:coverage_groupCover-2      0.74073
offenseFormationSINGLEBACK:coverage_groupCover-2   0.03319 *
offenseFormationWILDCAT:coverage_groupCover-2      0.05544 .
```

```
offenseFormationI_FORM:coverage_groupCover_3       0.21316
offenseFormationJUMBO:coverage_groupCover_3        0.08304 .
offenseFormationPISTOL:coverage_groupCover_3       0.37937
offenseFormationSHOTGUN:coverage_groupCover_3      0.37309
offenseFormationSINGLEBACK:coverage_groupCover_3   0.11794
offenseFormationWILDCAT:coverage_groupCover_3      0.60856
offenseFormationI_FORM:coverage_groupCover_6       0.08200 .
offenseFormationJUMBO:coverage_groupCover_6             NA
offenseFormationPISTOL:coverage_groupCover_6       0.32290
offenseFormationSHOTGUN:coverage_groupCover_6      0.75109
offenseFormationSINGLEBACK:coverage_groupCover_6   0.06971 .
offenseFormationWILDCAT:coverage_groupCover_6      0.85045
offenseFormationI_FORM:coverage_groupQuarters      0.00582 **
offenseFormationJUMBO:coverage_groupQuarters       0.71961
offenseFormationPISTOL:coverage_groupQuarters      0.31107
offenseFormationSHOTGUN:coverage_groupQuarters     0.85243
offenseFormationSINGLEBACK:coverage_groupQuarters  0.01201 *
offenseFormationWILDCAT:coverage_groupQuarters     0.33947
offenseFormationI_FORM:coverage_groupRed Zone      0.03199 *
offenseFormationJUMBO:coverage_groupRed Zone       0.18172
offenseFormationPISTOL:coverage_groupRed Zone      0.18157
offenseFormationSHOTGUN:coverage_groupRed Zone     0.59355
offenseFormationSINGLEBACK:coverage_groupRed Zone  0.01857 *
offenseFormationWILDCAT:coverage_groupRed Zone     0.28005
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 8.792 on 16069 degrees of freedom
Multiple R-squared:  0.01268,   Adjusted R-squared:  0.009358
F-statistic: 3.821 on 54 and 16069 DF,  p-value: < 2.2e-16
```

```
anova(model_interaction)
```

```
Analysis of Variance Table

Response: yardsGained
                                  Df  Sum Sq Mean Sq F value    Pr(>F)
offenseFormation                   6    1960  326.61  4.2256 0.0002958 ***
coverage_group                     7    9581 1368.72 17.7081 < 2.2e-16 ***
offenseFormation:coverage_group   41    4406  107.46  1.3903 0.0497594 *
Residuals                      16069 1242028   77.29
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

GGPlot interaction plot

```r
library(ggplot2)
library(dplyr)

interaction_summary <- clean_plays %>%
  group_by(offenseFormation, coverage_group) %>%
  summarise(mean_yards = mean(yardsGained, na.rm = TRUE))
```

```
`summarise()` has grouped output by 'offenseFormation'. You can override using
the `.groups` argument.
```

```r
ggplot(interaction_summary,
       aes(x = coverage_group, y = mean_yards, color = offenseFormation, group = offenseFormati
  geom_line(linewidth = 1.1) +
  geom_point(size = 2) +
  labs(
    title = "Interaction of Offensive Formation and Pass Coverage on Yards Gained",
    x = "Pass Coverage Type",
    y = "Average Yards Gained",
    color = "Offensive Formation"
  ) +
  theme_minimal(base_size = 14) +
  theme(axis.text.x = element_text(angle = 45, hjust = 1))
```