Catch probability

Tim White

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```
library(tidyverse)
library(rjson)
```

Scrape data

We scrape individual play data for every fly ball hit to an outfielder during the 2024 season. This chunk only needs to be run once.

```
scrape_of_catch_prob_data <- function(year) {
  # Load in player IDs
  playerIDs <- read_csv(paste0("../data/of_playerIDs_", year, ".csv")) %>%
               select(player_id)

  # Scrape play-by-play data
  data <- lapply(1:nrow(playerIDs),
              function(j) {
                # Scrape data
                rawdata <- fromJSON(
                  file = paste0("https://baseballsavant.mlb.com/player-services/range?playerId=",
                                playerIDs[j,], "&season=2024&playerType=fielder"), simplify = TRUE
                )

                # If the URL exists:
                if (length(rawdata) > 0) {

                  # Change any null columns (e.g., sprint_speed) to NA
                  for (k in 1:length(rawdata)) {
                    rawdata[[k]][sapply(rawdata[[k]], is.null)] <- NA
                  }

                  # Convert raw data to tibble
                  tibble(data.frame(matrix(unlist(rawdata),
                                           nrow = length(rawdata),
                                           byrow = TRUE,
                                           dimnames = list(1:length(rawdata),
                                                           names(rawdata[[1]])))))) %>%
                    mutate(across(c(game_pk:name_display_first_last, pos),
                                  as.factor),
                           across(c(stars:distance, hang_time, out:sprint_speed),
                                  as.numeric))
```

```
              }
            }
           )

  return(tibble(do.call(rbind.data.frame, data)))
}
```

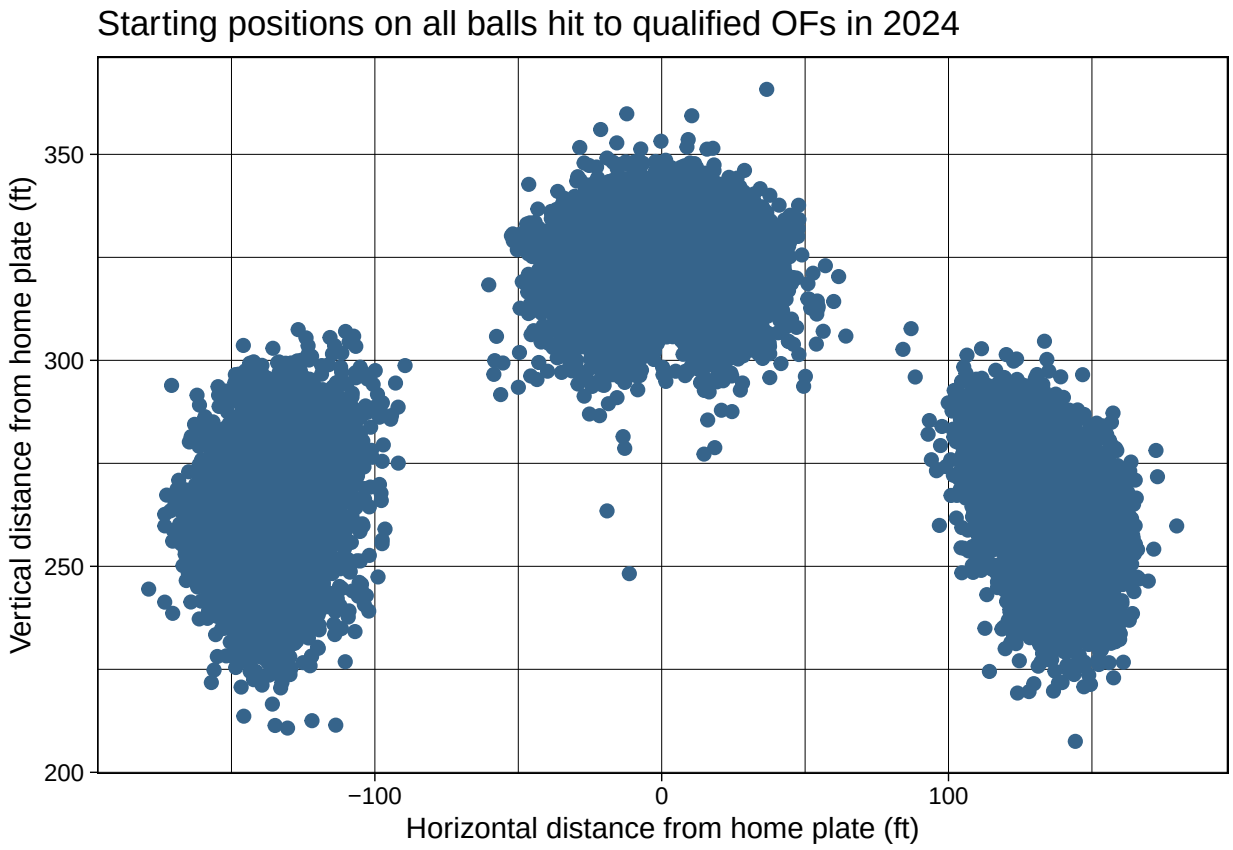
```
of_catch_prob_2024 <- scrape_of_catch_prob_data("2024")
of_catch_prob_2024 %>% write_csv("../data/of_catch_prob_2024.csv")

of_catch_prob_2023 <- scrape_of_catch_prob_data("2023")
of_catch_prob_2023 %>% write_csv("../data/of_catch_prob_2023.csv")
```

Load in data

```
of_catch_prob_2024 <- read_csv("../data/of_catch_prob_2024.csv")
of_catch_prob_2023 <- read_csv("../data/of_catch_prob_2023.csv")
```

January 2nd

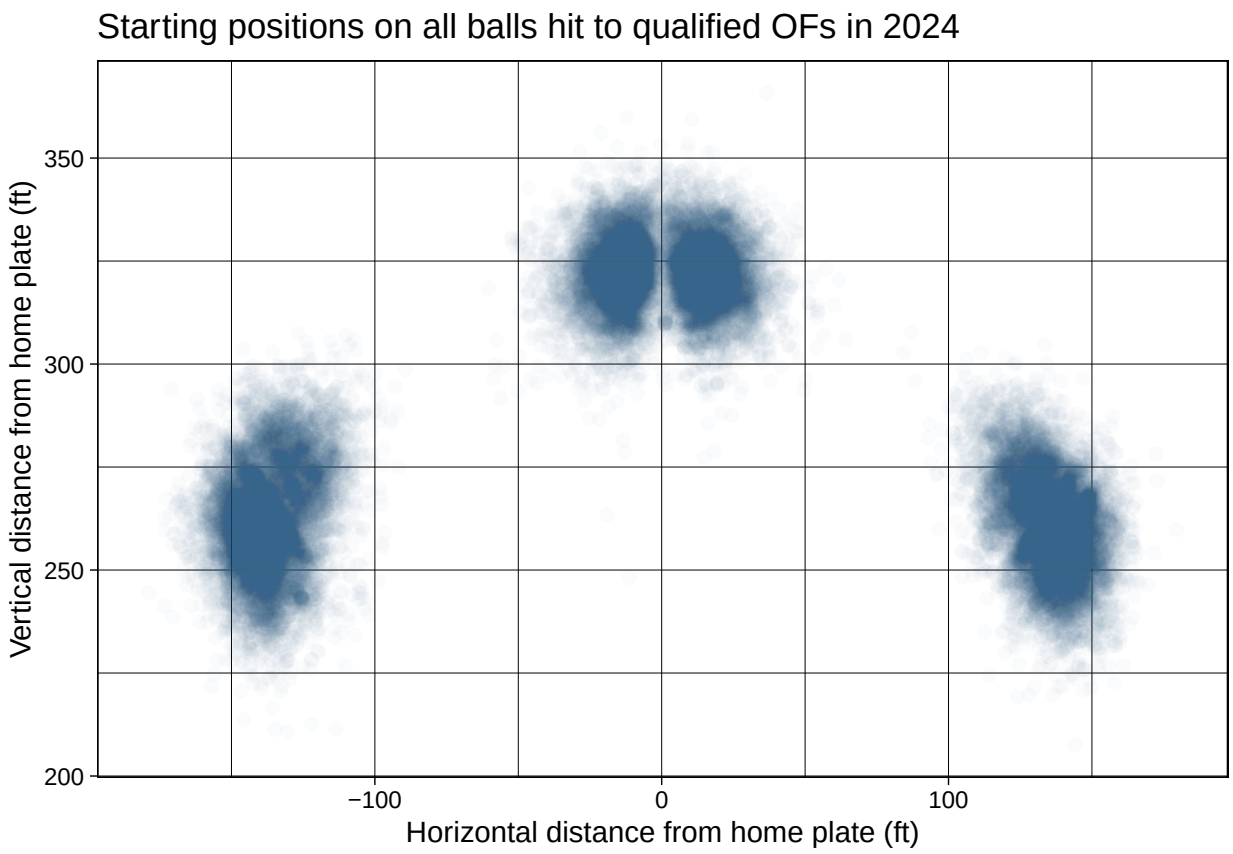
```
jan2_1 <- of_catch_prob_2024 %>%
            ggplot(aes(x = start_pos_x, y = start_pos_y)) +
            geom_point(col = "steelblue4", size = 2, shape = 19) +
            labs(title = "Starting positions on all balls hit to qualified OFs in 2024",
                 x = "Horizontal distance from home plate (ft)",
                 y = "Vertical distance from home plate (ft)") +
            theme_linedraw()

jan2_1
```




```
ggsave("../figures/jan2_1.png", plot = jan2_1)
```

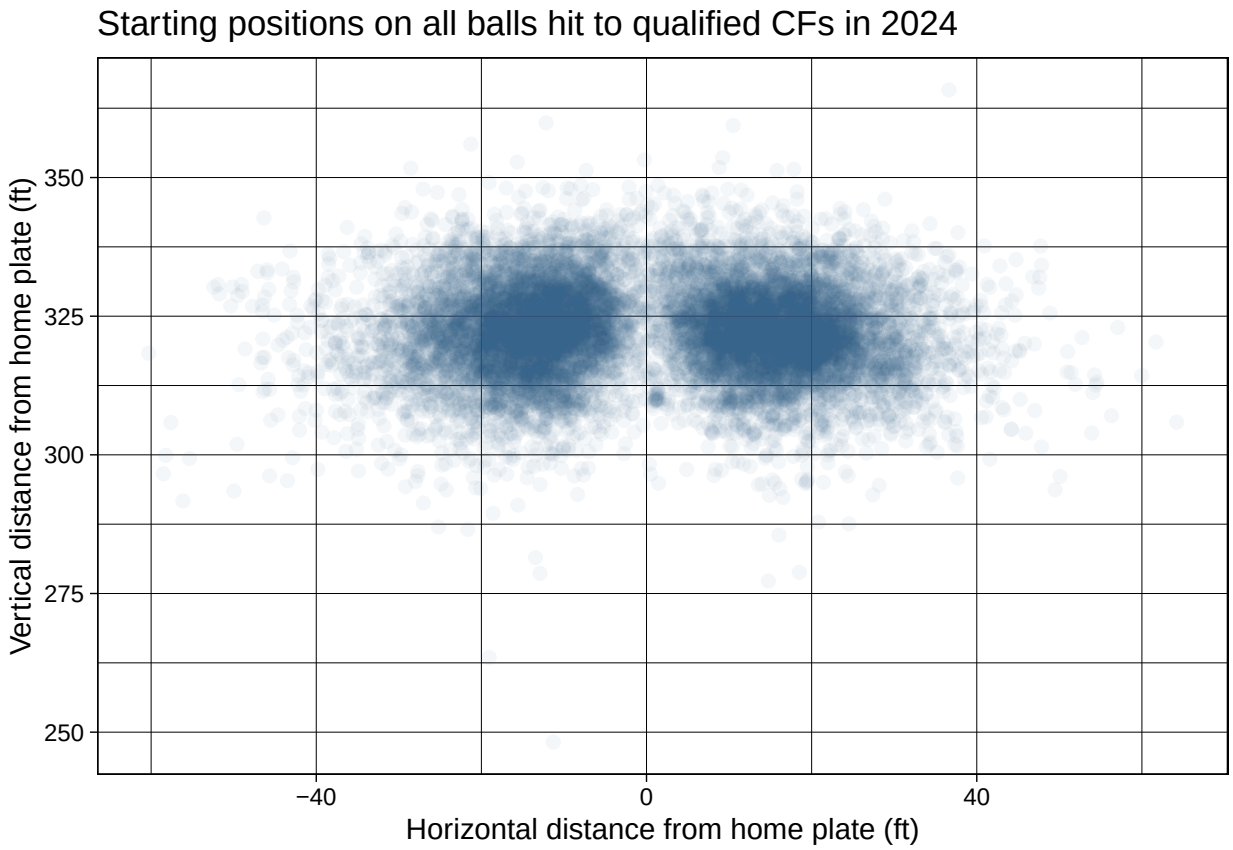
```
jan2_2 <- of_catch_prob_2024 %>%
            ggplot(aes(x = start_pos_x, y = start_pos_y)) +
```

```
            geom_point(col = "steelblue4", size = 2, shape = 19, alpha = 0.025) +
            labs(title = "Starting positions on all balls hit to qualified OFs in 2024",
                 x = "Horizontal distance from home plate (ft)",
                 y = "Vertical distance from home plate (ft)") +
            theme_linedraw()

jan2_2
```




```
ggsave("../figures/jan2_2.png", plot = jan2_2)
```

```
jan2_3 <- of_catch_prob_2024 %>%
            filter(pos == 8) %>%
            ggplot(aes(x = start_pos_x, y = start_pos_y)) +
            geom_point(col = "steelblue4", size = 2, shape = 19, alpha = 0.05) +
            labs(title = "Starting positions on all balls hit to qualified CFs in 2024",
                 x = "Horizontal distance from home plate (ft)",
                 y = "Vertical distance from home plate (ft)") +
            theme_linedraw()

jan2_3
```




```
ggsave("../figures/jan2_3.png", plot = jan2_3)
```

January 4th

```
single_game_oaa <- of_catch_prob_2024 %>%
                    group_by(game_pk, name_display_first_last) %>%
                    summarize(oaa = sum(out * (1 - catch_rate) - (1 - out) * catch_rate),
                              opportunities = n(),
                              catches = sum(out),
                              stars5_opps = sum(stars == 5),
                              stars5_catches = sum(stars == 5 & out == 1),
                              stars4_opps = sum(stars == 4),
                              stars4_catches = sum(stars == 4 & out == 1),
                              stars3_opps = sum(stars == 3),
                              stars3_catches = sum(stars == 3 & out == 1),
                              stars2_opps = sum(stars == 2),
                              stars2_catches = sum(stars == 2 & out == 1),
                              stars1_opps = sum(stars == 1),
                              stars1_catches = sum(stars == 1 & out == 1),
                              stars0_opps = sum(stars == 0),
                              stars0_catches = sum(stars == 0 & out == 1),
                              .groups = "drop")
```

```
single_game_oaa %>%
  arrange(desc(oaa)) %>%
  head(10)
```

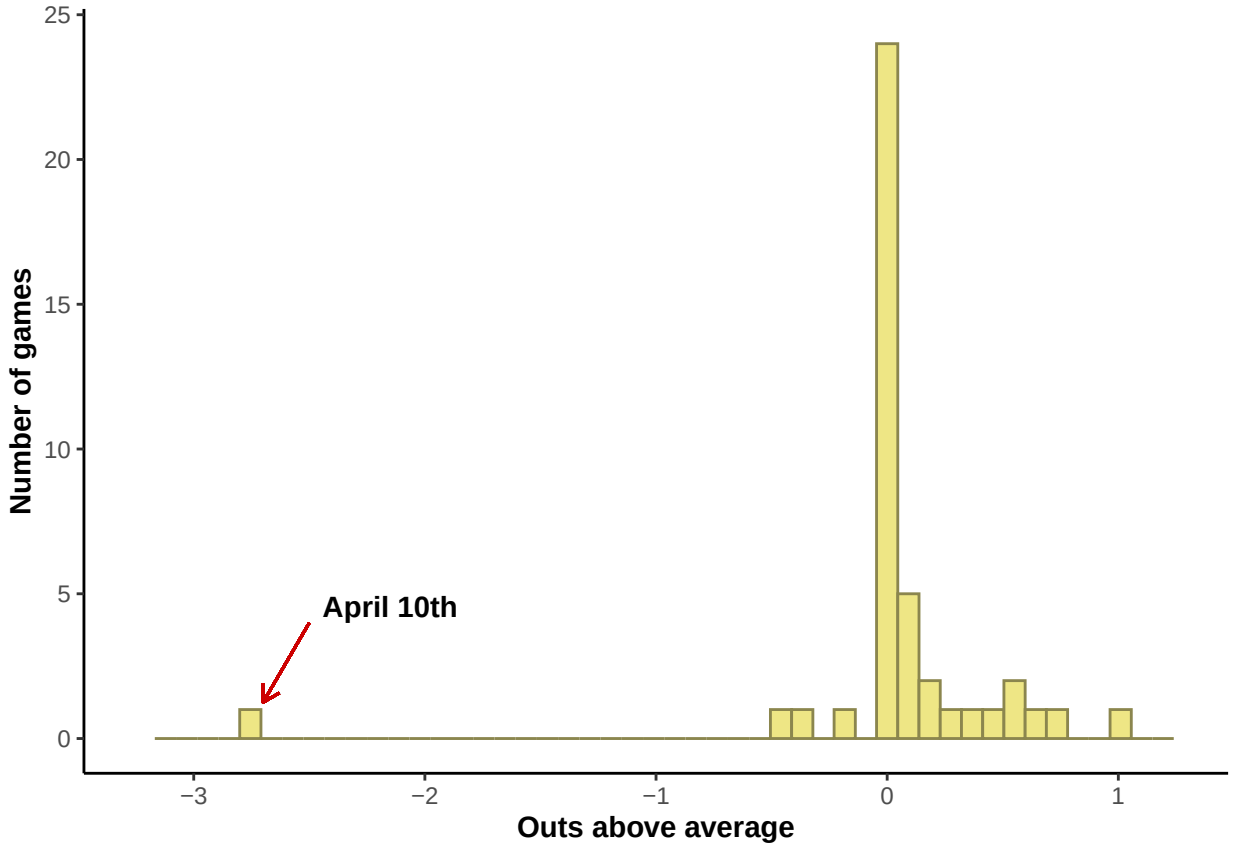
```
## # A tibble: 10 x 17
##    game_pk name_display_first_last   oaa opportunities catches stars5_opps
##      <dbl> <chr>                   <dbl>         <int>   <dbl>       <int>
##  1  746097 Pete Crow-Armstrong      1.68             6       6           2
##  2  745277 Julio Rodríguez          1.61             4       4           1
##  3  744844 Jacob Young              1.39             6       6           1
##  4  745716 Tyrone Taylor            1.31             3       3           1
##  5  745075 Pete Crow-Armstrong      1.3              2       2           1
##  6  745498 Michael A. Taylor        1.27             4       4           1
##  7  746101 Pete Crow-Armstrong      1.27             5       4           1
##  8  744997 Garrett Hampson          1.25             3       3           0
##  9  746030 Vidal Bruján             1.25             2       2           1
## 10  745270 Julio Rodríguez          1.22             5       5           1
## # i 11 more variables: stars5_catches <int>, stars4_opps <int>,
## #   stars4_catches <int>, stars3_opps <int>, stars3_catches <int>,
## #   stars2_opps <int>, stars2_catches <int>, stars1_opps <int>,
## #   stars1_catches <int>, stars0_opps <int>, stars0_catches <int>
```

January 6th

```
single_game_oaa %>%
  arrange(oaa) %>%
  head(10)
```

```
## # A tibble: 10 x 17
##    game_pk name_display_first_last   oaa opportunities catches stars5_opps
##      <dbl> <chr>                   <dbl>         <int>   <dbl>       <int>
##  1  745196 Victor Scott II         -2.71             6       3           0
##  2  746262 MJ Melendez             -2.57             6       2           0
##  3  746546 Charlie Blackmon        -2.34             5       1           1
##  4  746931 Tyler O'Neill           -2.33             5       2           0
##  5  746677 Will Benson             -2.11             6       3           1
##  6  745342 Luis Matos              -2.07             7       2           3
##  7  746971 Ian Happ                -2.04             4       1           0
##  8  745300 Ramón Laureano          -1.98             2       0           0
##  9  746546 Jack Suwinski           -1.97             6       2           1
## 10  746525 Ceddanne Rafaela        -1.94             5       2           1
## # i 11 more variables: stars5_catches <int>, stars4_opps <int>,
## #   stars4_catches <int>, stars3_opps <int>, stars3_catches <int>,
## #   stars2_opps <int>, stars2_catches <int>, stars1_opps <int>,
## #   stars1_catches <int>, stars0_opps <int>, stars0_catches <int>
```

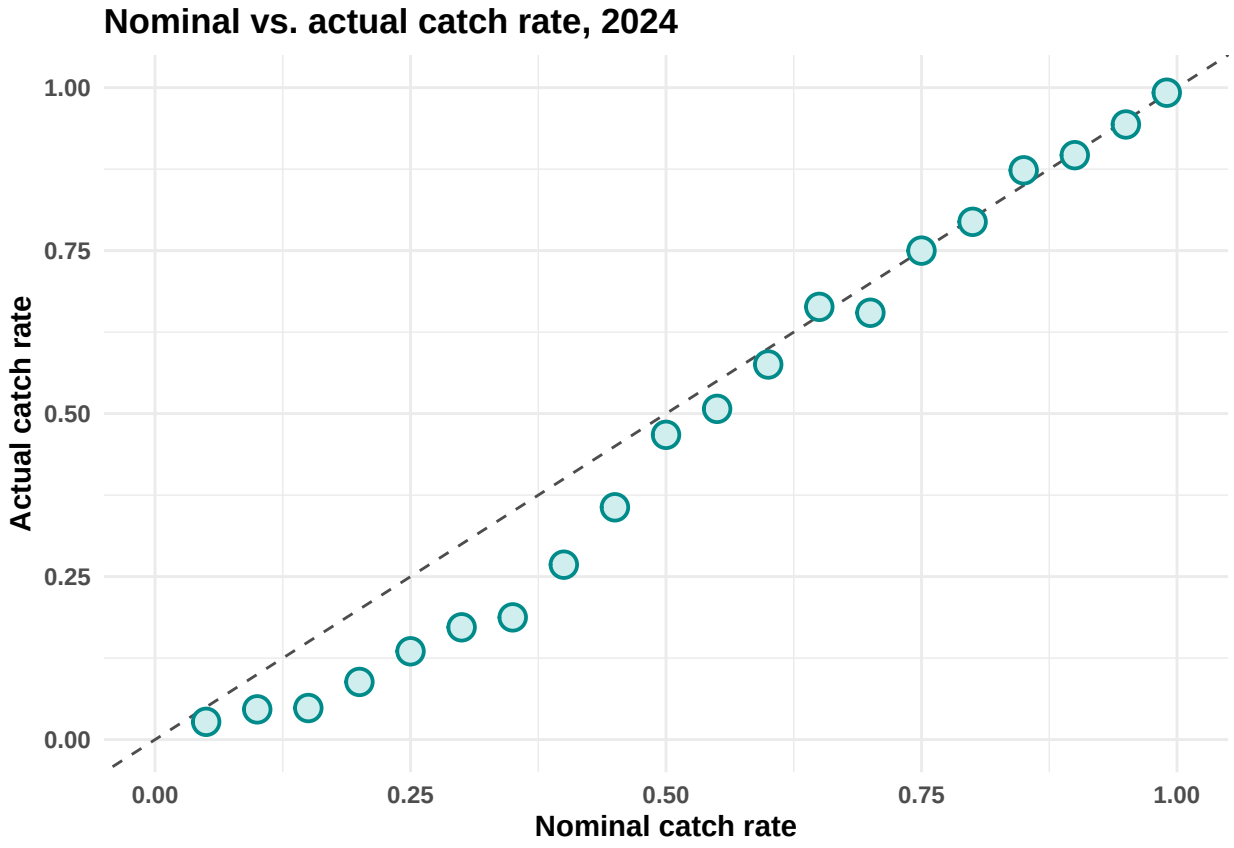
```
jan6 <- single_game_oaa %>%
          filter(name_display_first_last == "Victor Scott II") %>%
          ggplot() +
            geom_histogram(aes(x = oaa), bins = 50, fill = "khaki2", col = "khaki4") +
            geom_segment(x = -2.5, y = 4, xend = -2.7, yend = 1.25,
                         arrow = arrow(length = unit(0.25, "cm")),
                         col = "red3") +
            geom_text(x = -2.15, y = 4.55, label = "April 10th", check_overlap = TRUE, fontface = "bold
            labs(x = "Outs above average", y = "Number of games") +
            xlim(c(-3.25, 1.25)) +
            theme_classic() + theme(axis.title = element_text(face = "bold"))

jan6
```




```
ggsave("../figures/jan6.png", plot = jan6, height = 4, width = 6)
```

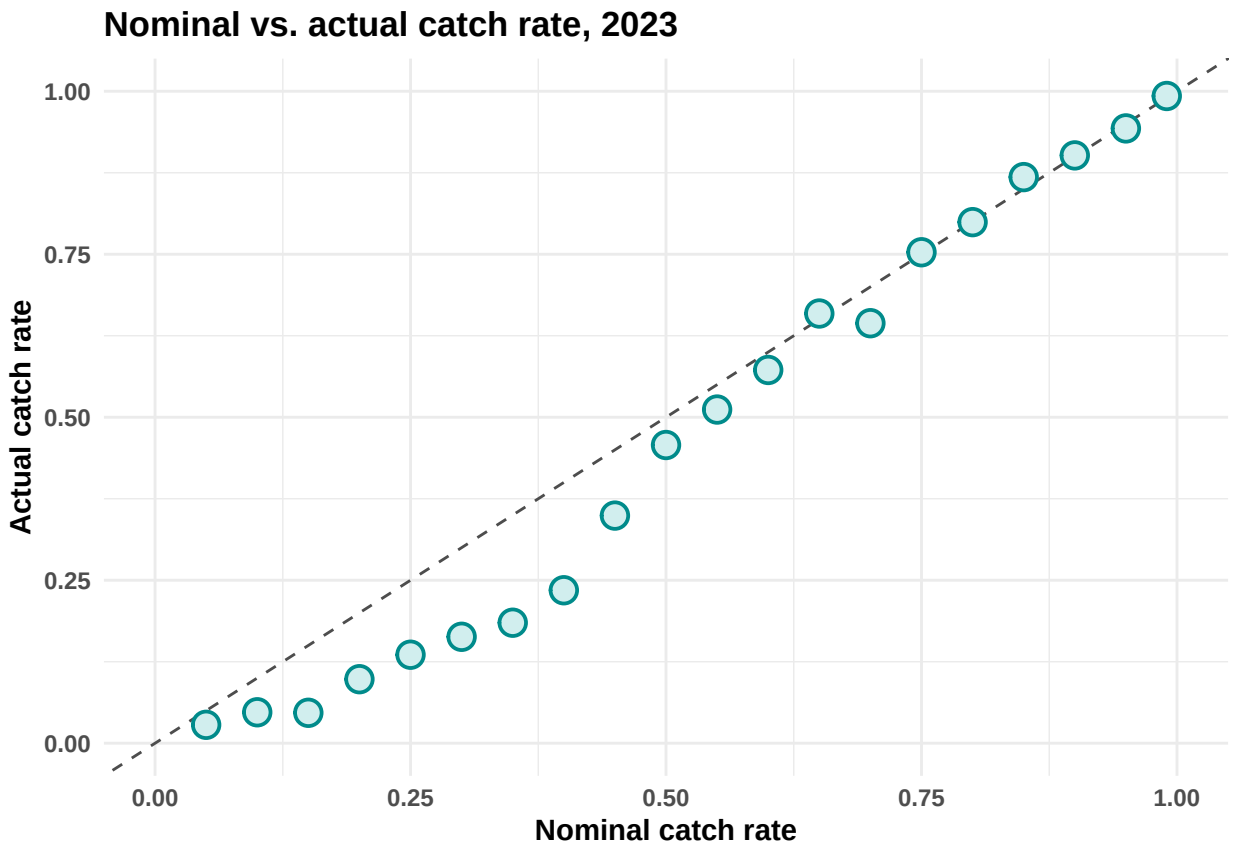
January 7th

```
calibration_table_2024 <- of_catch_prob_2024 %>%
                            group_by(catch_rate) %>%
                            summarize(actual_catch_rate = mean(out)) %>%
                            rename(nominal_catch_rate = catch_rate)

jan7_1 <- calibration_table_2024 %>%
            ggplot(aes(x = nominal_catch_rate, y = actual_catch_rate)) +
              geom_abline(intercept = 0, slope = 1,
                          color = "gray30", linetype = "dashed", linewidth = 0.5) +
              geom_point(pch = 21, col = "cyan4", fill = "lightcyan2",
                         size = 4, stroke = 1) +
              theme_minimal() +
              lims(x = c(0,1), y = c(0,1)) +
              labs(x = "Nominal catch rate", y = "Actual catch rate",
                   title = "Nominal vs. actual catch rate, 2024") +
              theme(axis.title = element_text(face = "bold"),
                    axis.text = element_text(face = "bold"),
                    title = element_text(face = "bold"))

jan7_1
```




```
ggsave("../figures/jan7_1.png", plot = jan7_1, height = 4, width = 6)
```

```r
calibration_table_2023 <- of_catch_prob_2023 %>%
                          group_by(catch_rate) %>%
                          summarize(actual_catch_rate = mean(out)) %>%
                          rename(nominal_catch_rate = catch_rate)

jan7_2 <- calibration_table_2023 %>%
            ggplot(aes(x = nominal_catch_rate, y = actual_catch_rate)) +
              geom_abline(intercept = 0, slope = 1,
                          color = "gray30", linetype = "dashed", linewidth = 0.5) +
              geom_point(pch = 21, col = "cyan4", fill = "lightcyan2",
                         size = 4, stroke = 1) +
              theme_minimal() +
              lims(x = c(0,1), y = c(0,1)) +
              labs(x = "Nominal catch rate", y = "Actual catch rate",
                   title = "Nominal vs. actual catch rate, 2023") +
              theme(axis.title = element_text(face = "bold"),
                    axis.text = element_text(face = "bold"),
                    title = element_text(face = "bold"))

jan7_2
```



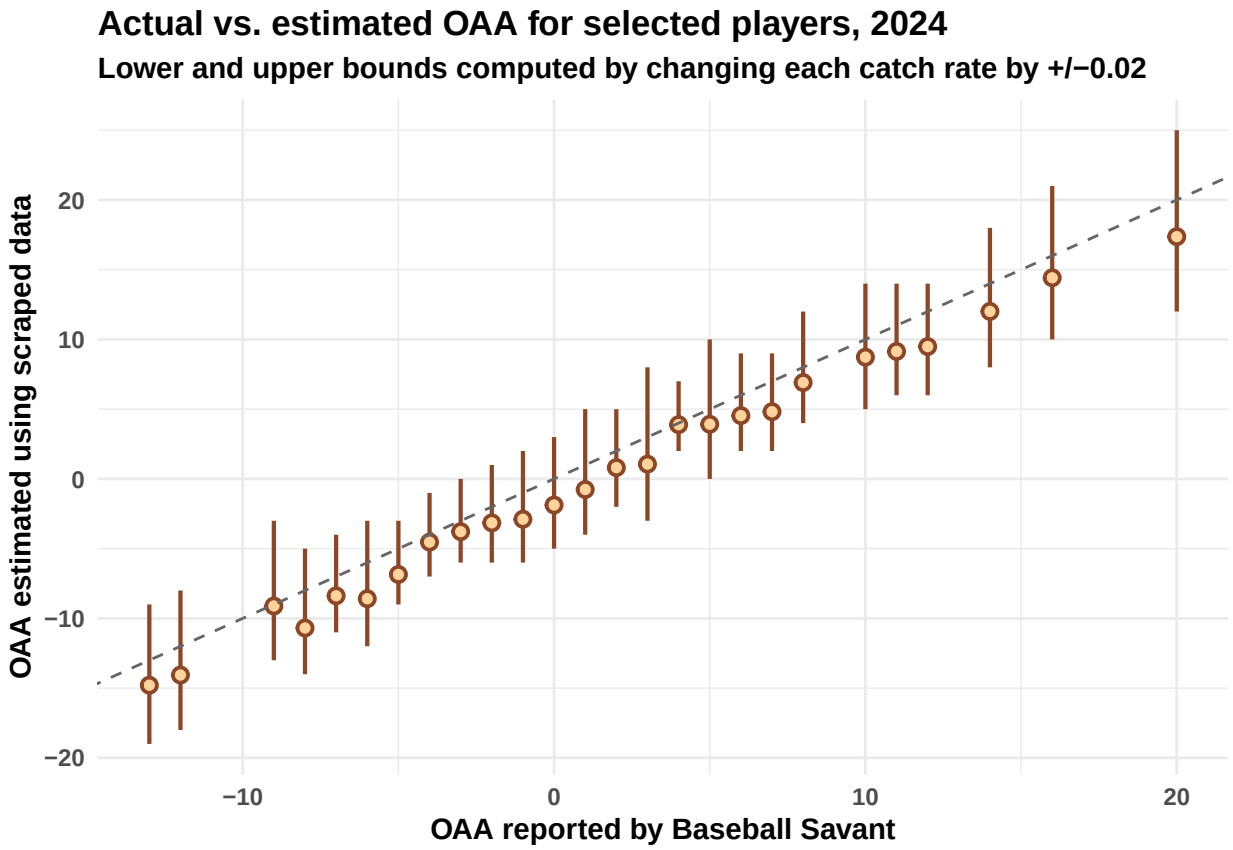

```r
ggsave("../figures/jan7_2.png", plot = jan7_2, height = 4, width = 6)
```

January 8th

```
of_oaa_2024 <- read_csv("../data/of_oaa_2024.csv")

oaa_rounding_check <- of_catch_prob_2024 %>%
                        mutate(catch_rate_upper = pmin(0.999999, catch_rate - 0.02),
                               catch_rate_lower = pmin(0.999999, catch_rate + 0.02)) %>%
                        group_by(player_id, name_display_first_last) %>%
                        summarize(opp = n(),
                                  oaa_lower = round(sum(out * (1 - catch_rate_lower) - (1 - out) * catch
                                  oaa_estimate = sum(out * (1 - catch_rate) - (1 - out) * catch_rate),
                                  oaa_upper = round(sum(out * (1 - catch_rate_upper) - (1 - out) * catch
                        ungroup() %>%
                        left_join(of_oaa_2024, by = "player_id") %>%
                        select(player_id, name = name_display_first_last, opp,
                               oaa_lower, oaa_estimate, oaa_upper, oaa_true = oaa)

oaa_rounding_check %>%
  summarize(any(oaa_true < oaa_lower | oaa_true > oaa_upper))
```

```
## # A tibble: 1 x 1
##   `any(oaa_true < oaa_lower | oaa_true > oaa_upper)`
##   <lgl>
## 1 FALSE
```

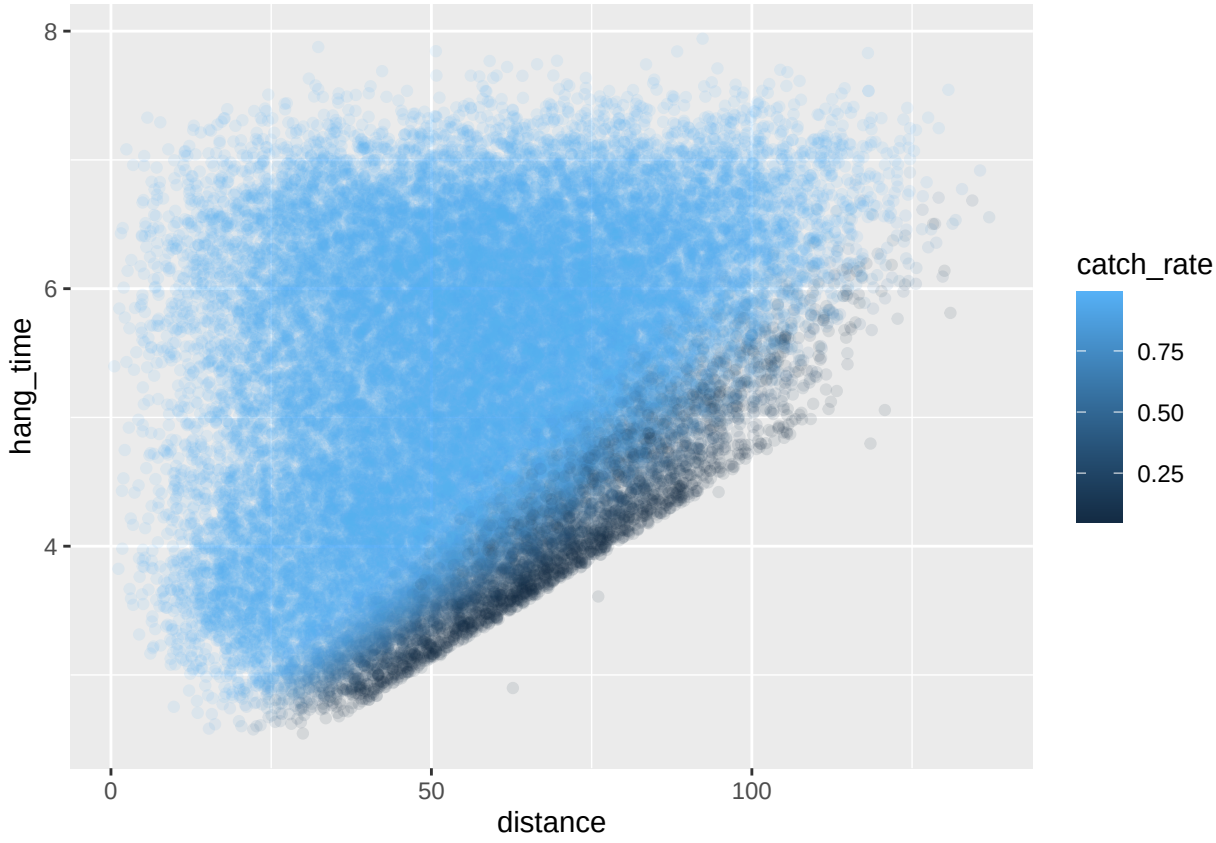
```
set.seed(0)
jan8 <- oaa_rounding_check %>%
          filter(opp > 162) %>%
          group_by(oaa_true) %>%
          sample_n(1) %>%
          ggplot(aes(x = oaa_true, y = oaa_estimate)) +
            geom_linerange(aes(ymin = oaa_lower, ymax = oaa_upper), col = "sienna4", linewidth = 0.75) +
            geom_point(size = 2, stroke = 1, pch = 21, fill = "burlywood1", col = "sienna4") +
            geom_abline(intercept = 0, slope = 1, linetype = "dashed", col = "gray40") +
            theme_minimal() +
            labs(x = "OAA reported by Baseball Savant",
                 y = "OAA estimated using scraped data",
                 title = "Actual vs. estimated OAA for selected players, 2024",
                 subtitle = "Lower and upper bounds computed by changing each catch rate by +/-0.02") +
            theme(axis.title = element_text(face = "bold"),
                  axis.text = element_text(face = "bold"),
                  title = element_text(face = "bold"))

jan8
```



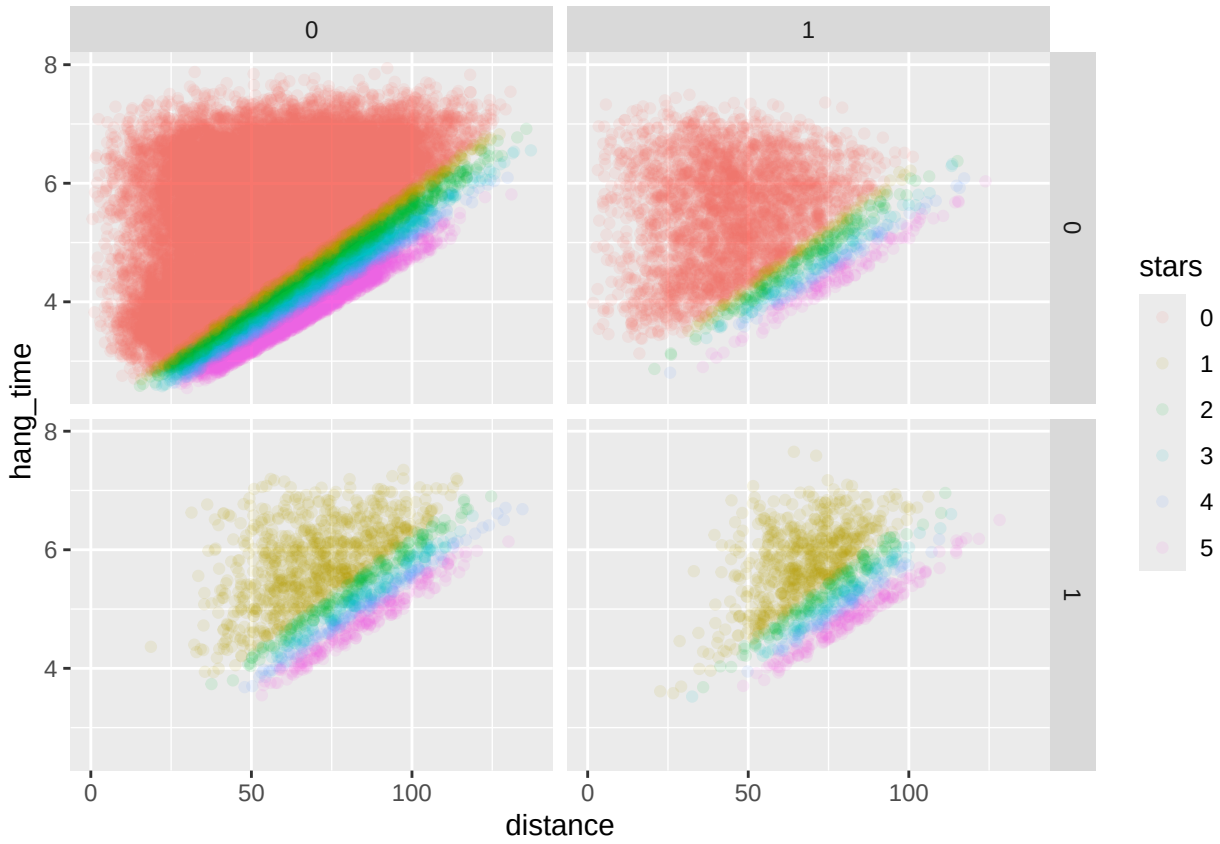

```
ggsave("../figures/jan8.png", plot = jan8, height = 4, width = 6)
```

Later

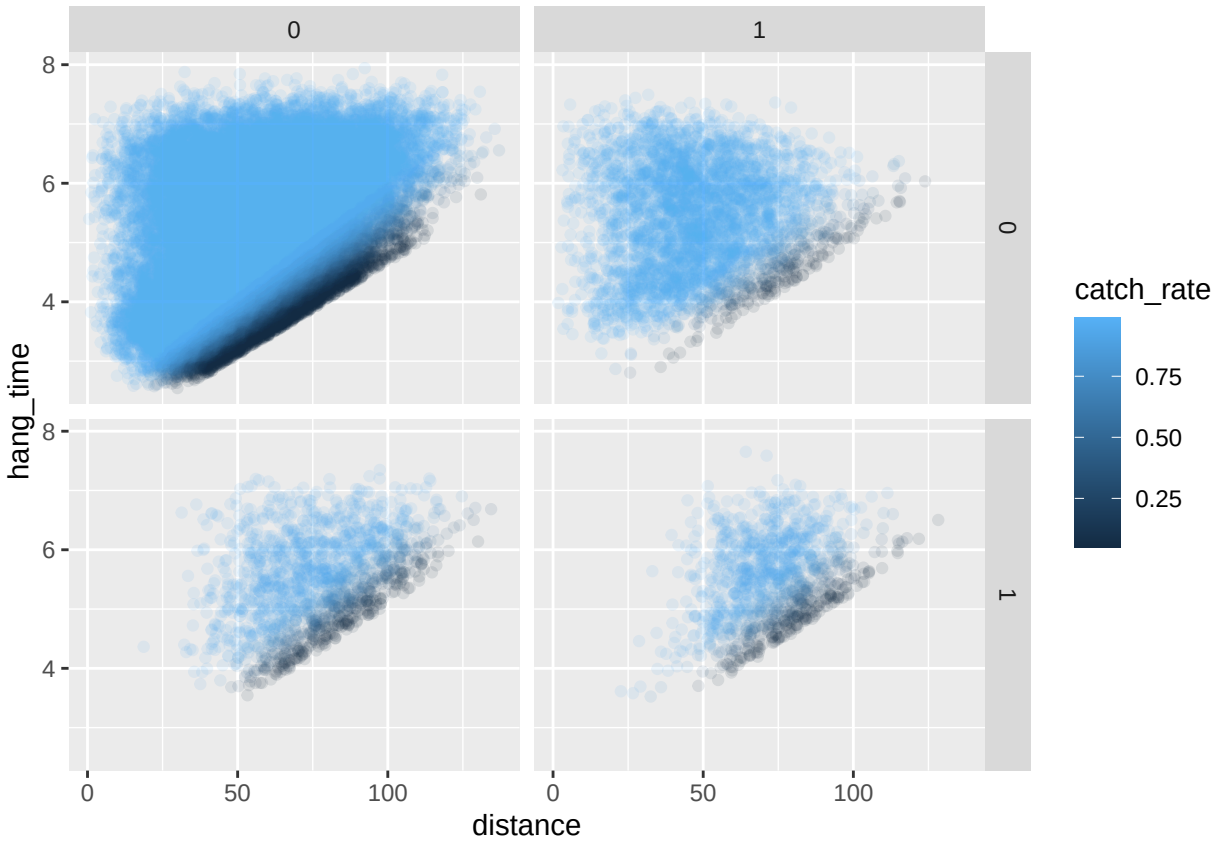
```
of_catch_prob_2024 %>%
  ggplot(aes(x = distance, y = hang_time, col = catch_rate)) +
    geom_point(alpha = 0.1)
```




```
of_catch_prob_2024 %>%
  filter(stars <= 5) %>%
  mutate(stars = as.factor(stars)) %>%
  ggplot(aes(x = distance, y = hang_time, col = stars)) +
    geom_point(alpha = 0.1) +
    facet_grid(rows = vars(wall), cols = vars(back))
```




```
of_catch_prob_2024 %>%
  filter(stars <= 5) %>%
  mutate(stars = as.factor(stars)) %>%
  ggplot(aes(x = distance, y = hang_time, col = catch_rate)) +
    geom_point(alpha = 0.1) +
    facet_grid(rows = vars(wall), cols = vars(back))
```


0
1
0
1
8
6
4
hang_time
0
50
100
distance
catch_rate
0.75
0.50
0.25