Day 15 - Intro to Hypothesis Testing cont.

Learning outcomes and terms to know

Today, we will further develop our intuition with hypothesis testing, motivated by an interesting research question that requires a unique statistic.

Hot Hand: phenomenon or fallacy?



Photo of Curry

To motivate today's activity, let's watch this see this brief clip.

Basketball players who make several shots in succession are described as having a *hot hand*. Fans and players long believed in the hot hand phenomenon, **which suggests that each shot is not independent of the next.** However, a 1985 paper by Gilovich, Vallone, and Tversky collected evidence that contradicted this belief and showed that successive shots are independent events. More recently, Miller and Sanjurjo (2018) revisited this topic and suggested that there may be a small hot hand effect, but it is weaker than people intuitively think.

We are not going to solve the hot hand debate today, however what we *will* do is think about one way to approach questions like this using statistics. The goal for this activity is to understand the steps for conducting a hypothesis test to answer a research question.

Step 1: Frame the research question in terms of hypotheses

1. Write out the null and alternative hypotheses for the hot hand question in words.

> H_0:
> H_a:

Step 2: Collect data

We will work with data from the NBA game between the Golden State Warriors and the Atlanta Hawks that took place on February 3, 2024. In particular, we will look at 38 shot attempts by Steph Curry over the course of the game and investigate whether Curry appears to have a hot hand. The data are stored in the `curry` object; we are interested in the `outcome` column (H for "hit" and M for "miss").

```
library(tidyverse)
curry <- read_csv("curry_shots.csv")

head(curry, 10)
```

```
# A tibble: 10 x 6
   date      opponent quarter time   description                          outcome
   <chr>     <chr>    <chr>   <time> <chr>                                <chr>
 1 2/3/2024  ATL      1       08:40  S. Curry misses 27' pullup three     M
 2 2/3/2024  ATL      1       08:19  S. Curry misses 26' three            M
 3 2/3/2024  ATL      1       07:14  S. Curry makes running finger roll   H
 4 2/3/2024  ATL      1       04:48  S. Curry makes 26' three             H
 5 2/3/2024  ATL      1       04:03  S. Curry makes 11' pullup            H
 6 2/3/2024  ATL      2       05:47  S. Curry misses 26' three            M
 7 2/3/2024  ATL      2       05:16  S. Curry makes 27' three             H
 8 2/3/2024  ATL      2       04:04  S. Curry misses driving finger roll  M
 9 2/3/2024  ATL      2       03:47  S. Curry makes cutting finger roll   H
10 2/3/2024  ATL      2       01:59  S. Curry makes 25' pullup three      H
```

2. Look at the data with your group and discuss whether Curry appears to have a hot hand?

Looking at the string of hits and misses, it can be difficult to gauge whether or not it seems like Curry was shooting with a hot hand. One method for approaching this question is to consider that hot hand shooters go on shooting streaks. For this activity, we define the length of the shooting streak to be the *number of consecutive baskets made until a miss occurs.*

For example, in these data, the outcomes of the first 11 shots are:

M | M | H H H M | H M | H H M |

In the first 11 shots there are 5 streaks, separated by "|"; the streaks lengths are zero, zero, three, one, and two.

3. What does a streak length of 1 mean? How many hits and misses are in a streak of 1? What about a streak of 0?

4. How long would a streak need to be for you to feel convinced that Curry was shooting with a hot hand during this game?

5. Calculate the streak lengths using the `calc_streak` function from the `openintro` package. In these data, what is the longest streak before a miss? What is the typical streak length? Make sure to include a plot of all of the streak lengths to support your answer.

```
library(openintro)

# calculate all streaks - see ?calc_streaks
```

Step 3: Model the randomness that would occur under H_0

6. With your group, discuss the following question: *If the shots are independent (i.e. the null hypothesis is true), does the order of the shots matter?* Why or why not?

7. With your group, discuss the following code. What does this code do?

```
set.seed(10092025)
newdata <- sample(curry$outcome, length(curry$outcome), replace = F)
newdata
```

```
 [1] "H" "M" "H" "M" "H" "M" "H" "M" "M" "H" "M" "M" "M" "H" "H" "H" "M" "H" "M"
[20] "M" "H" "H" "H" "M" "H" "H" "H" "M" "H" "H" "M" "H" "M" "H" "M" "H" "H" "H"
```

8. Calculate the streak lengths for the `newdata`. What is the longest streak that we see in `newdata`?

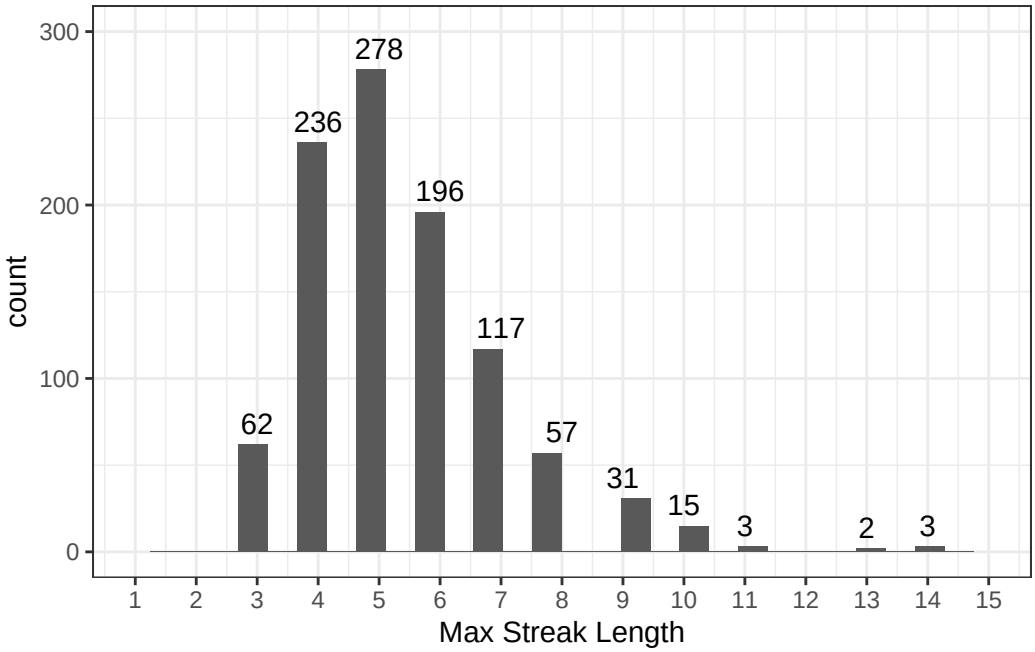
9. Does the new streak lengths calculated in question 8 change your answer about whether you think Curry was shooting with a hot hand during this game? Why or why not?

What about if we repeated this many times?

```
nsims <- 1000

max_streak <- matrix(NA, nrow = nsims, ncol = 1)
for(i in 1:nsims){
  newdata <- sample(curry$outcome, length(curry$outcome), replace = F)
  max_streak[i] <- calc_streak(newdata) %>%
    max()
}

max_streak %>%
  as_tibble() %>%
  ggplot(aes(x = max_streak)) +
  geom_histogram() +
  scale_x_continuous(limits = c(1, 15),
                     breaks = c(1:15),
                     labels = c(1:15)) +
  geom_text(aes(label = after_stat(count)),
            stat = "count",
            vjust = -0.5,
            size = 4) +
  ylim(0, 300) +
  labs(x = "Max Streak Length") +
  theme_bw()
```



10. Does the above figure change your answer about whether you think Curry was shooting with a hot hand during this game? Why or why not?

11. Calculate the p-value. In words, what does the p-value represent in the context of the problem?

12. Is there evidence to suggest Curry's shots in the game are **not** independent?

13. Comment on the scope of inference for this problem.