



# Baseball VII



Produced by Dr. Mario | UNC STOR 390



# Streakiness in Sports

- Question? When Can We Say a Batter is HOT or COLD?
- Hypothetical Batter With Batting Average of 0.333
  - Each Plate Appearance, Batter has a 33.3% Chance of Hitting
  - HOT = Player Has an Unusual # of Consecutive Hits
  - COLD = Player Has an Unusual # of Consecutive Misses
  - Ignore Walks and Hit-by-Pitches
- Simulation
  - 1,000,000 Plate Appearances
  - 33.3% Chance of Hitting & 66.7% Chance of Not Hitting
  - Consider Possible Hitting Streaks and Hitting Slumps of 1 to 15
  - In 1 Million Plate Appearances, What Would be Considered a HOT Hitting Streak and COLD Hitting Slump?





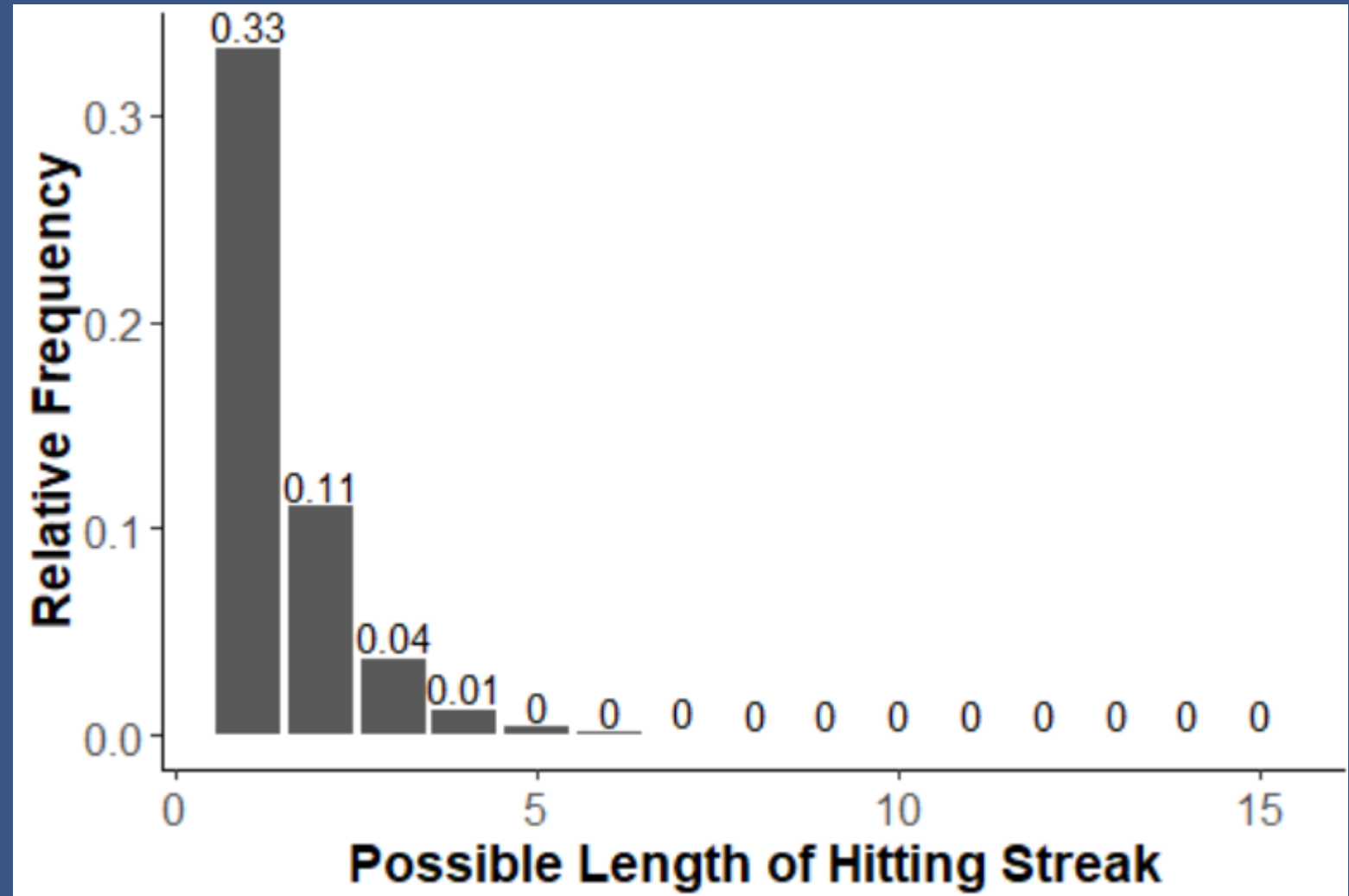
# Streakiness in Sports

```
#Random simulation of Hitting streaks of Good Batter
Batting.Average=0.333
hit.sim=sample(x=c(0,1),size=1000000,replace=T,
               prob=c(1-Batting.Average,Batting.Average))
hitting.streak=1:15
streak.count=1:15

for(i in hitting.streak){
  n.streak=0
  count=0
  for(j in 1:(length(hit.sim)-i+1)){
    count=count+1
    if(sum(hit.sim[j:(j+i-1)]==1)==i){
      n.streak=n.streak+1
    }else{
      n.streak=n.streak+0
    }
  }
  hitting.streak[i]=n.streak
  streak.count[i]=count
}
```



# Streakiness in Sports





# Streakiness in Sports

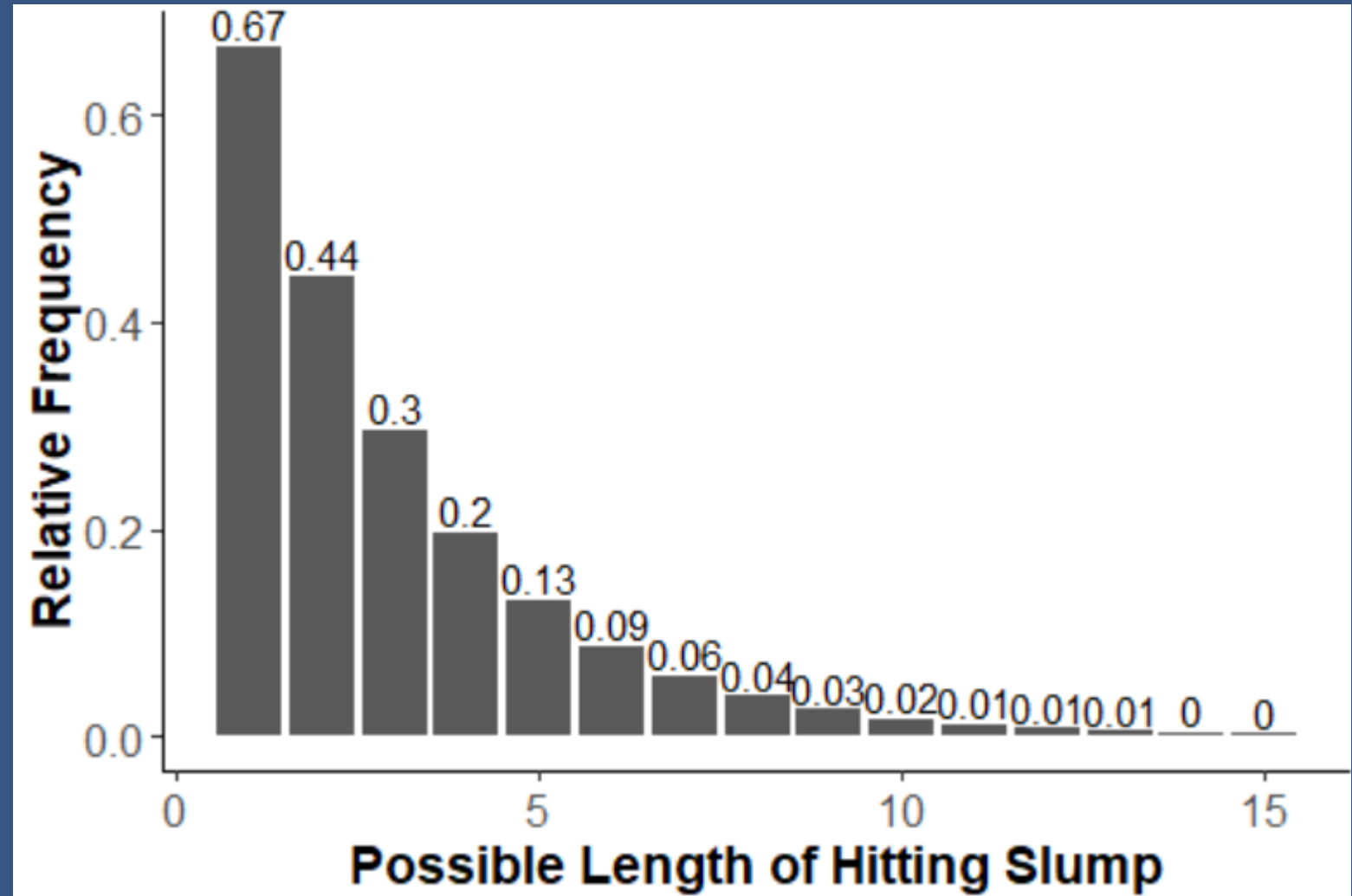
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    }
  }
  hitting.slump[i]=n.slump
  slump.count[i]=count
}
```





# Streakiness in Sports



# Streakiness in Sports

- R Code for Figures

```
ggplot(data=sim.data)+  
  geom_bar(aes(x=length,y=hitting.streak),stat="identity")+  
  geom_text(aes(x=length,y=hitting.streak,  
                label=round(hitting.streak,2)), vjust=-0.2)+  
  xlab("Possible Length of Hitting Streak")+  
  ylab("Relative Frequency")+  
  theme_classic()+  
  theme(axis.text=element_text(size=12),  
        axis.title=element_text(size=14,face="bold"))
```

```
ggplot(data=sim.data)+  
  geom_bar(aes(x=length,y=hitting.slump),stat="identity")+  
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```



# Streakiness in Sports



- **Wald Wolfowitz Runs Test (WWRT)**
  - Topic Streakiness Pertaining to Wins (W) and Losses (L)
  - Suppose a Teams Record is 5-5 (W-L)
  - Streaky Would Be WWWWWLLLLL (2 Runs)
  - Not Streaky Would Be WLWLWLWLWL (10 Runs)
  - Idea: Fewer Runs = More Streaky
  - Let W=# of Wins, L=# of Losses, and T=W+L
  - According to Wold and Wolfowitz, if X=Number of Runs,

$$E[X] = \mu = \frac{2 \times W \times L}{T} + 1 \quad \text{VAR}[X] = \sigma^2 = \sqrt{\frac{(\mu - 1)(\mu - 2)}{T - 1}}$$

- For Team with 5-5 Record,  $\mu = 6$  and  $\sigma = 1.49$

$$Z_1 = \frac{2 - 6}{1.49} = -2.68 \quad Z_2 = \frac{10 - 6}{1.49} = 2.68$$





# Streakiness in Sports



- Hypothesis Test

- Null: W's and L's are Randomly Distributed
- Alternative: W's and L's are Streaky
- Random Variable Z Has Approximate Normal Distribution if Number of Games T is Long Enough
- If  $Z < -2$ , We Would Determine That Team is Streaky
- Suppose in 162 Games, Team is 100-62 with 15 Runs
- Test Statistic

```
> mu=2*100*62/162+1  
> sd=sqrt((mu-1)*(mu-2)/(162-1))  
> z=(15-mu)/sd  
> print(c(mu,sd,z))  
[1] 77.543210 5.992915 -10.436192
```

- Conclusion: Ultra Streaky Bruh





# Evaluating the Greatest Streak

- Joe DiMaggio
  - Played 13 Seasons With the New York Yankees
  - Known for 56 Game Hitting Streak (1941)
  - “Most Enduring Record in Sports” -*New York Times*
- Johnny Vander Meer
  - Known for Time With the Cincinnati Reds
  - No-Hitter Against the Boston Bees (June 11, 1938)
  - No-Hitter Against the Brooklyn Dodgers (June 15, 1938)
  - No Other Pitcher Has Matched This
- What is the Most Difficult Achievement?



# Evaluating the Greatest Streak



- Modeling Probabilities Using Poisson Distribution
  - Useful for Random Variable  $X \in \{0,1,2,3, \dots\}$
  - Probability Mass Function

$$P(X = x) = \frac{\lambda^x e^{-\lambda}}{x!}$$

- Expected Value

$$E[X] = \lambda$$

- Usage in R: Super Mario Averages 5 Shrooms Per Day

```
> dpois(7, lambda=5, log=F)
[1] 0.1044449
```

$$E[X] = \lambda = 5$$



$$P(X = 7) = 10.4\%$$





# Evaluating the Greatest Streak

- Probability of Independent Events

- If Events A and B are Independent,

$$P(A \cap B) = P(A) \times P(B)$$

- Usage in R: Probability Super Mario Fast for 5 Straight Days

- Random Variables  $X_1, X_2, X_3, X_4, X_5$
- Assume They Are Independent and Identically Distributed

$$\begin{aligned} P(\text{FAST}) &= P(X_1 = 0) \times P(X_2 = 0) \cdots \times P(X_5 = 0) \\ &= P(X_1 = 0)^5 \end{aligned}$$

```
> dpois(0, lambda=5, log=F)^5  
[1] 1.388794e-11
```





# Evaluating the Greatest Streak

- How Rare Was Joe DiMaggio's Achievement?
  - Assumptions
    - Batters Need At Least 500 At-bats
    - Not Include Hitting Streaks Across Seasons
    - Batters with Over 500 At-bats Averaged 3.5 At-bats Per Game (Equivalent to 3 At-bats for Half Season and 4 At-bats for Remaining)
  - Suppose Batter Hits .333 in 1900 (154 Game Season)
  - Probability of Event A3 = Batter Gets a Hit in 3 At-bat Game

$$P(A3) = 1 - (1 - .333)^3 = 70.33\%$$

- Probability of Event A4 = Batter Gets a Hit in 4 At-bat Game

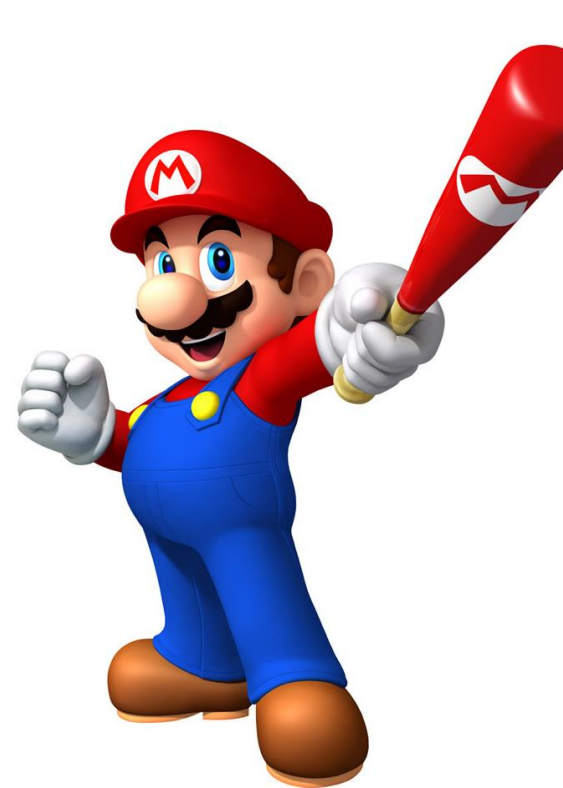
$$P(A4) = 1 - (1 - .333)^4 = 80.21\%$$

- Probability of Event A = Hit During 56 Consecutive Games

$$P(A) = P(A3)^{28} \times P(A4)^{28} = 0.000011\%$$







# Evaluating the Greatest Streak

- How Rare Was Joe DiMaggio's Achievement?
  - Number of Opportunities to Start Hitting Streak Where Batter is Hitless During the Previous Game

$$154 - 56 = 99 \text{ Opportunities}$$

- Approximate Probability of Event E = Hitless Game

$$P(E) = \frac{(1 - P(A3)) + (1 - P(A4))}{2} = 24.7\%$$

- Average Number of Opportunities to Start Winning Streak

$$1 + 98 \times 0.247 = 25.21 \text{ Opportunities}$$

- Expected Number of 56 Game Hitting Streaks in a Season

$$25.21 \times P(A) = 0.00027\%$$





# Evaluating the Greatest Streak

- How Rare Was Joe DiMaggio's Achievement?
  - Total Number of Batters Between 1900 and 2006 = 7179

```
> Data=Batting %>%  
+   filter(yearID>=1900 & yearID<=2006) %>%  
+   filter(AB>=500) %>%  
+   summarize(n=n())  
> Data$n  
[1] 7179
```

- Expected Number of 56 Game Winning Streaks for All Batters
$$\lambda = E[Player_1] + E[Player_2] + \dots + E[Player_{7179}] \approx .024$$
- Probability of Event H = At Least 1 Hitting Streak of 56 Games

$$P(H) = 1 - P(\bar{H}) = 1 - \frac{\lambda^0 e^{-\lambda}}{0!} \approx 2.4\%$$

- Batter With Batting Average of 0.333 Requires 9,926 Seasons to Have a 50% Chance of Getting the 56 Game Winning Streak





# Evaluating the Greatest Streak

- How Rare Was Johnny Vander Meer's Achievement?
  - Assumptions
    - All Games Are Started by Pitchers Who Start Exactly 35 Games (Exactly 883 Pitchers Under This Criteria from 1900 to 2006)
    - Assume Probability of No Hitter is 0.062% for All Pitchers for Every Single Game
  - Following Similar Ideas from DiMaggio, the Probability of Event N = At Least 1 Starting Pitcher Would Throw Consecutive No Hitters
$$P(N) = 11.8\%$$
- Both Achievements Are Unlikely But Possible
- Both Achievements Become More Likely As Time Passes





# Evaluating the Greatest Streak

- So What is the Most Difficult Achievement?

Trick Question...

Lebron James Winning  
a Championship for  
Cleveland #216







# Final Inspiration

So I'm ugly. So what?  
I never saw anyone hit with his face.

-Yogi Berra