Baseball IV

Produced by Dr. Mario | UNC STOR 390

Monte Carlo Simulation

- Recall Evaluation of Hitter Effectiveness
  - Runs Created
  - Linear Weights
  - Both Based on Team Data
  - Scaled Player Information for Prediction
- Problem: Player Hits HR 50% of Time = 54 RC/G
- Definition of Monte Carlo Simulation
  - Developing a Computer Model to Repeatedly Play Out an Uncertain Situation
  - Used Across All Industries
  - Term Coined by Polish Physicist Stanislaw Ulam
  - Simple Simulation Shows Previously Discussed Player = 27 RC/G

Monte Carlo Simulation

- Monte Carlo Simulation in R
  - Theoretical Player Either Hits a Home Run or Gets an Out

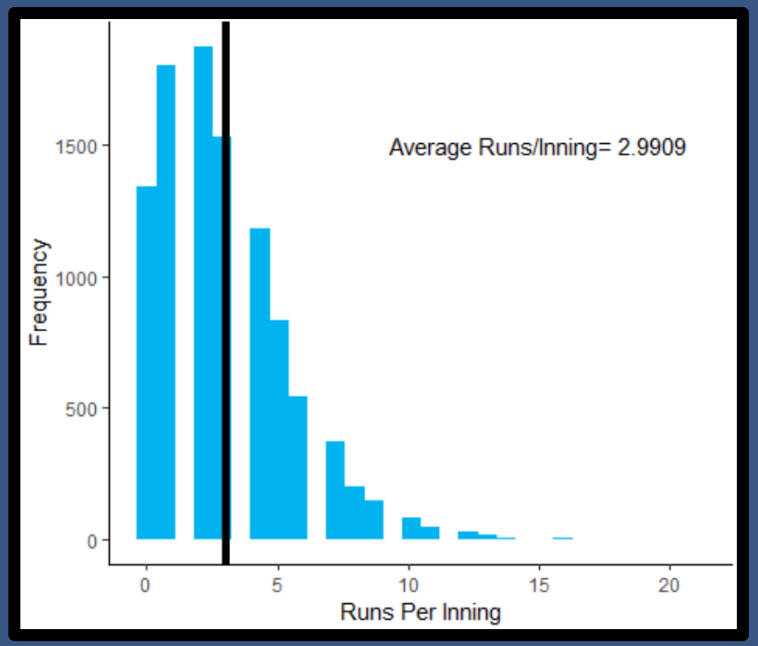
```
HR.OUT.MC=function(home.run.percent,n.Sim){
  runs.result = rep(NA,n.Sim)
  for(i in 1:n.Sim){
    runs=0
    outs=0
    while(outs<3){
      sample=runif(1)
      if(sample>home.run.percent){
        outs=outs+1
      }else{
        runs=runs+1
      }
    }
    runs.result[i]=runs
  }
  return(runs.result)
}
```

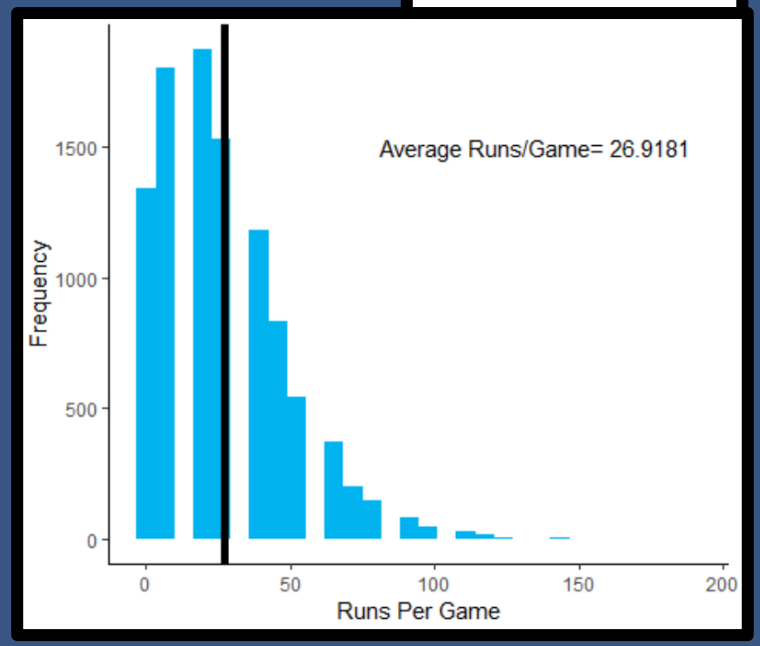
Monte Carlo Simulation

- Monte Carlo Simulation in R
  - Suppose Player Hits Home Run 50% of the Time

```
Player.5=HR.OUT.MC(0.5,10000)
Player.5=tibble(R.per.I=Player.5,
                R.per.G=Player.5*9)
```

```
head(Player.5)
A tibble: 6 x 2
R.per.I R.per.G
  <dbl>   <dbl>
      1       9
      1       9
      0       0
```





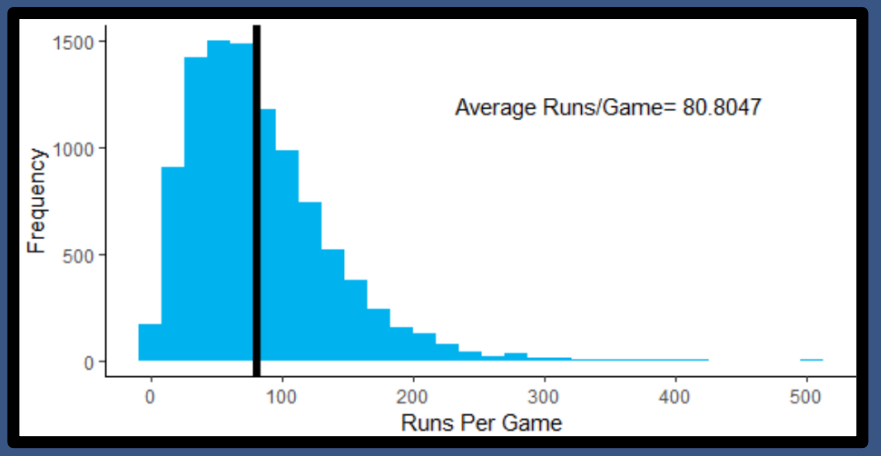
Monte Carlo Simulation

- Monte Carlo Simulation in R
  - Suppose Player Hits Home Run 75% of the Time

```
Player.75=HR.OUT.MC(0.75,10000)
Player.75=tibble(R.per.I=Player.75,
                 R.per.G=Player.75*9)
```

```
ggplot(Player.75) +
  geom_histogram(aes(x=R.per.G),fill="deepskyblue2") +
  geom_vline(xintercept=mean(Player.75$R.per.G),size=2) +
  ylab("Frequency") + xlab("Runs Per Game")+
  annotate("text", x = 350, y = 1200,size=4,
    label = paste("Average Runs/Game=",mean(Player.75$R.per.G))) +
  theme_classic()
```

```
head(Player.75)
A tibble: 6 x 2
R.per.I R.per.G
  <dbl>   <dbl>
     11      99
      7      63
     23     207
     13     117
      1       9
      3      27
```



Monte Carlo Simulation

- Simulating Runs from Team Full of Ichiros
  - Possible Plate Appearances Events →
  - Long List of Assumptions
    - Errors Advance All Base Runners 1 Base
    - Long Single Advances Each Runner 2 Bases
    - Short Single Advances All Runners 1 Base
    - Short Double Advances Each Runner 2 Bases
    - Long Double Scores a Runner from First
    - Etc.
  - Assign Probabilities According to Relative Frequencies of Player
  - Program for Simulation

Event
Strikeout
Walk
Hit by pitch
Error
Long single (advance 2 bases)
Medium single (score from 2nd)
Short single (advance one base)
Short double
Long double
Triple
Home run
Ground into double play
Normal ground ball
Line drive or infield fly
Long fly
Medium fly
Short fly

Monte Carlo Simulation

- Simulating Runs from Team Full of Ichiros
  - Probabilities Based on Ichiro 2004 Statistics

	Number	Probability
Plate Appearances	762	
At Bats +Sac. Hits + Sac. Bunts	709	
Errors	13	0.0170604
Outs (in play)	371	0.4868766
Strikeouts	63	0.0826772
BB	49	0.0643045
HBP	4	0.0052493
Singles	225	0.2952756
2B	24	0.0314961
3B	5	0.0065617
HR	8	0.0104987

Monte Carlo Simulation

- Simulating Runs from Team Full of Ichiros
  - Probabilities of Special Cases
    - 30% of Singles are Long Singles
    - 50% of Singles are Medium Singles
    - 20% of Singles are Short Singles
    - 53.8% of Outs in Play are Ground Balls
    - 15.3% of Outs in Play are Infield Flies
    - 30.9% of Outs in Play are Fly Balls
    - Etc.
  - Result of Simulation = Within 1% of True Actual Runs Per Game
  - Specific to Ichiro
    - Random Number < 0.295 = Single
    - 0.295 < Random Number < (0.295+0.487) = Out (In-Play)
  - Goal of Simulation
    - Estimate # of Runs for Thousands of Innings
    - Average Across All Innings
    - Multiply by $\frac{26.72}{3} \approx 9$ to estimate RC/G

Monte Carlo Simulation

- **Results Under Simulation**

Player	Year	RC/G
Ichiro	2004	6.92
Nomar	1997	5.91
Bonds	2004	21.02

Problem: Unusual # of Intentional Walks
Eliminating Intentional Walks: 15.98 RC/G

Monte Carlo Simulation

- **Added Value of Albert Pujols Measured by Runs**

Team Without

Outcome	Number
Plate Appearances	5591
At Bats + Sac. Hits + Sac. Bunts	5095
Errors	92
Outs (in Play)	2824
Strikeouts	872
BB	439
HPB	57
Singles	887
2B	259
3B	26
HR	135

Pujols Alone

Outcome	Number
Plate Appearances	634
At Bats +Sac. Hits + Sac. Bunts	538
Errors	10
Outs (in play)	301
Strikeouts	50
BB	92
HBP	4
Singles	94
2B	33
3B	1
HR	49

Team With

Outcome	Number
Plate Appearances	6236.27
At Bats +Sac. Hits + Sac. Bunts	5658.03
Errors	102
Outs (in play)	3027.23
Strikeouts	1026.37
BB	528.23
HBP	50
Singles	986.67
2B	304.5
3B	31.73
HR	179.53

Pitching Evaluation and Forecast

ER = Earned Run
IP = Innings

- Hypothetical Pitcher Ricky Vaughn
  - Situation 1
    - Ricky Lets 2 Batters on Base
    - Next Batter Gets Single and 1 Batter Scores
    - Ricky is Charged with 1 Earned Run
  - Situation 2
    - Ricky Lets 2 Batters on Base
    - Next Batter Hits Ball to Outfielder Who Drops the Ball
    - This Unearned Run is Not Charged to Ricky
  - Recall: ERA = Earned Run Average

    $$ERA = 9 \times \frac{ER}{IP}$$

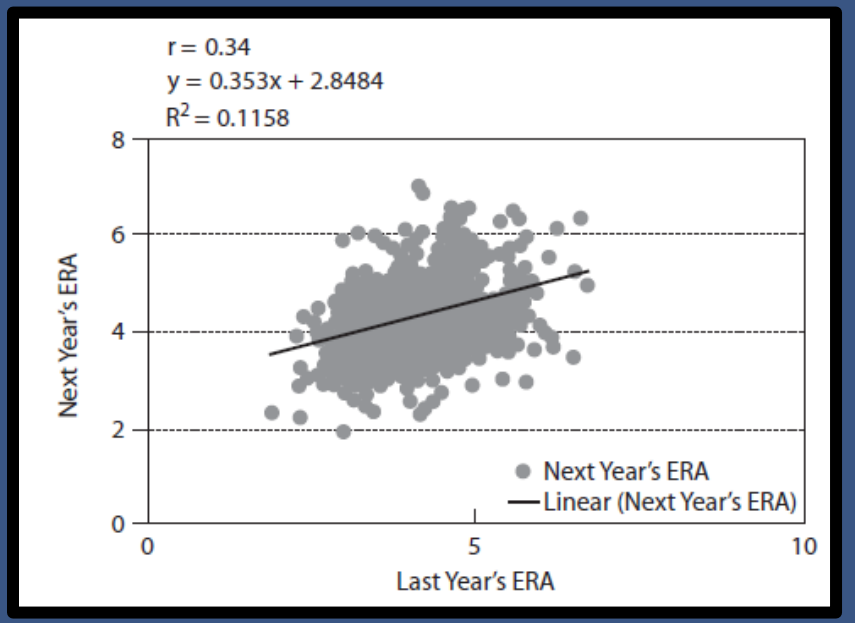
  - Ricky Gives Up 22 Earned Runs in 72 innings

    $$ERA = 9 \times \frac{22}{72} = 2.75$$

Pitching Evaluation and Forecast

ER = Earned Run
IP = Innings

- **Problems with ERA**
  - Influenced by Errors (Subjective)
  - Influenced by Relief Pitcher
  - Influenced by Fielding Performance
- **Different Pitchers Evaluated Differently**
  - Starting Pitchers = Wins
  - Relief Pitchers = Saves
- **Past ERA to Predict Future ERA**
  - Why Predict Future ERA?
  - Weak Relationship
  - Low Linear Correlation
  - Results Based on Pitchers with More than 10 Innings



Pitching Evaluation and Forecast

- **Evaluating Forecast Error**
  - Mean Absolute Deviation (MAD)

$$MAD = \frac{1}{n} \times \sum_{i=1}^{n} |y_i - \hat{y}_i|$$

  - From ERA Model, MAD = 0.68

y = Current ERA
$\hat{y}$ = Forecast ERA
K = Strikeout
BB = Walk
HBP = Hit by Pitch
HR = Home Run

- **Additional Measures of Pitcher Effectiveness**
  - Analysis by Voros McCracken (2001)
  - Fraction of Batters Faced by Pitchers That Result in Balls in Play
  - Fraction of Balls in Play That Result in Hits
  - Fraction of Batters Faced by Pitchers That Do Not Result in Balls in Play
  - Defense Independent Pitching Stats (DIPS)
    - K, BB, HBP, and HR
    - Independent of Teams Fielding Ability

Pitching Evaluation and Forecast

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Pitching Evaluation and Forecast

- **Defense-Independent Component ERA**
  - Formula

$$DICE = 3 + \frac{13 \times HR + 3(BB + HBP) - 2K}{IP}$$

  - Only DIPS Involved in Formula for DICE
  - Forecast Model

$$ERA_t = 1.975 + 0.56 \times DICE_{t-1}$$

  - Correlation is 0.44 Compared to 0.34 when Last Year's ERA is Used
  - MAD is 0.51 Compared to 0.68 when Last Year's ERA is Used
  - Conclusion: Previous DICE is a Better Predictor of ERA than Previous ERA

- **Holy Grail of Mathletics = Forecasting Performance**

K = Strikeout
BB = Walk
HBP = Hit by Pitch
HR = Home Run
IP = Inning Pitched
t = Time (Years)

America’s Greatest Pastime

Final Inspiration

Politicians are like batters.
The best do their job 1/3 of the time.

-Mahatma Mario