



Baseball II



Produced by Dr. Mario | UNC STOR 538

Pythagorean Theorem



- **Classic Pythagorean Theorem**
 - Relationship Between the Sides of a Right Triangle
 - $c^2 = a^2 + b^2$
- **What is Known: More Runs = More Wins**
- **Relationship Between Runs and Wins?**
 - Bill James' Pythagorean Method

WP = Win %
RS = Runs Scored
RA = Runs Allowed

$$WP \approx \frac{RS^2}{RS^2 + RA^2}$$

- **Example: Kansas City in 2014 World Series**

- 651 Runs Scored
- 624 Runs Allowed

$$89 \text{ Wins} \approx 162 \times \frac{651^2}{651^2 + 624^2} = 84.43$$



Pythagorean Theorem



- Optimization of Relationship
 - What is the Best Choice of α ?

$$WP = \frac{RS^\alpha}{RS^\alpha + RA^\alpha} + \epsilon \longrightarrow \text{Error}$$

WP = Win %
RS = Runs Scored
RA = Runs Allowed

- Minimization of Mean Absolute Deviation (MAD)
- Optimal: $\alpha = 1.8$ (MAD=0.0199)
- Alternative Expression

$$WP = \frac{(RS/RA)^\alpha}{(RS/RA)^\alpha + 1} + \epsilon$$

- Forecasting Playoff Series Winners (2005-2016)
 - Pythagorean Method: 54.8% Accurate
 - Games Won Approach: 55% Accurate
 - Interesting Case: 2005 Nationals



Pythagorean Theorem

WP = Win %
RS = Runs Scored
RA = Runs Allowed

- Useful for Valuing Players in Trades
 - Example: Cleveland Guardians
 - Currently: RS=870 and RA=800
 - Trade Bing Crosby (100 Runs)
 - For Frank Sinatra (120 Runs)
 - Difference: +20 Runs
 - Before Trade:

$$WP \approx \frac{\left(\frac{870}{800}\right)^{1.8}}{\left(\frac{870}{800}\right)^{1.8} + 1} = 0.538$$

- After Trade:

$$WP \approx \frac{\left(\frac{890}{800}\right)^{1.8}}{\left(\frac{890}{800}\right)^{1.8} + 1} = 0.548$$



Runs-Created Approach

- Motivation: Mike Trout Vs. Kris Bryant

Mike Trout and Kris Bryant 2016 Statistics

Event	Trout (2016)	Bryant (2016)
At Bats	549	603
Batting Average	.315	.292
Slugging Percentage	.550	.554
Hits	173	176
Singles	107	99
Doubles	32	35
Triples	5	3
Home Runs	29	39
Walks + Hit by Pitcher	127	93



Runs-Created Approach



- **Argument**
 - Hitting Causes Good and Bad Things
 - Hits and Walks Create Scoring Opportunities
 - Better Hitter = More Scoring Opportunity
 - Relationship of Runs and {S,D,T,HR,BB,HBP}

- **Runs-Created Formula**

- Bill James (1979)
- Recall: Total Bases (TB)
 $TB \approx S + 2D + 3T + 4HR$
- Formula:

$$RC \approx (H + BB + HBP) \times \frac{TB}{AB + BB + HBP}$$

of Base Runners

Rate Players are
Advancing

H = Hit

S = Single

D = Double

T = Triple

HR = Home Run

AB = At-bat

BB = Walk

HBP = Hit-by-Pitch



Runs-Created Approach



- **Evaluation of Runs Created Formula**
 - Evaluated For Teams from 2010 to 2016
 - Off by About 21 Runs on Average
 - Average Team Scored 693 Runs in a Season
 - Error Measured as a Percentage is 3% (21/693)

y = Actual Runs
 \hat{y} = Predicted Runs
 n = Sample Size

- **Problem: Formula Developed Off Team Statistics**

Model Based On Teams



Predict on Players

- **Results When Applied to Players**

Playa and Year	Runs Created
Bryant 2016	129.09
Trout 2016	134.02
Cabrera 2013	147.54



Runs-Created Approach



- **Runs Created Per Game**

- RC Flaw= Biased Toward Plate Appearances
- Observation 1: 1.8% of AB are E

$$AB - H - (0.018)AB = (0.982)AB - H$$

- Observation 2: Additional Outs Caused by GIDP, SF, SAC, and CS

$$TO = (0.982)AB - H + GIDP + SF + SAC + CS$$

- Observation 3: Sometimes 27 Outs Per Game

$$\textit{Average Outs Per Game} = 26.83$$

- Observation 4: Following in Units of Game

$$\frac{TO}{26.83}$$

RC = Runs Created

AB = At-bat

E = Errors

H = Hits

TO = Total Outs

GIDP = Double-Play

SF = Sacrifice Fly

SAC = Sacrifice Bunt

CS = Caught Stealing



Runs-Created Approach



- **Runs Created Per Game**
 - Final Formula for RC/G

$$\frac{RC}{G} = \frac{RC}{\frac{TO}{26.83}}$$

- Interpretation of RC/G

$$\frac{RC}{G} = \frac{\text{Runs Created by Batter}}{\text{\# of Games Worth of Outs Used by Batter}}$$

- **Results Updated**

Playa and Year	RC	RC/G
Bryant 2016	129.09	8.11
Trout 2016	134.02	9.39
Cabrera 2013	147.54	10.6

RC = Runs Created

AB = At-bat

E = Errors

H = Hits

TO = Total Outs

GIDP = Double-Play

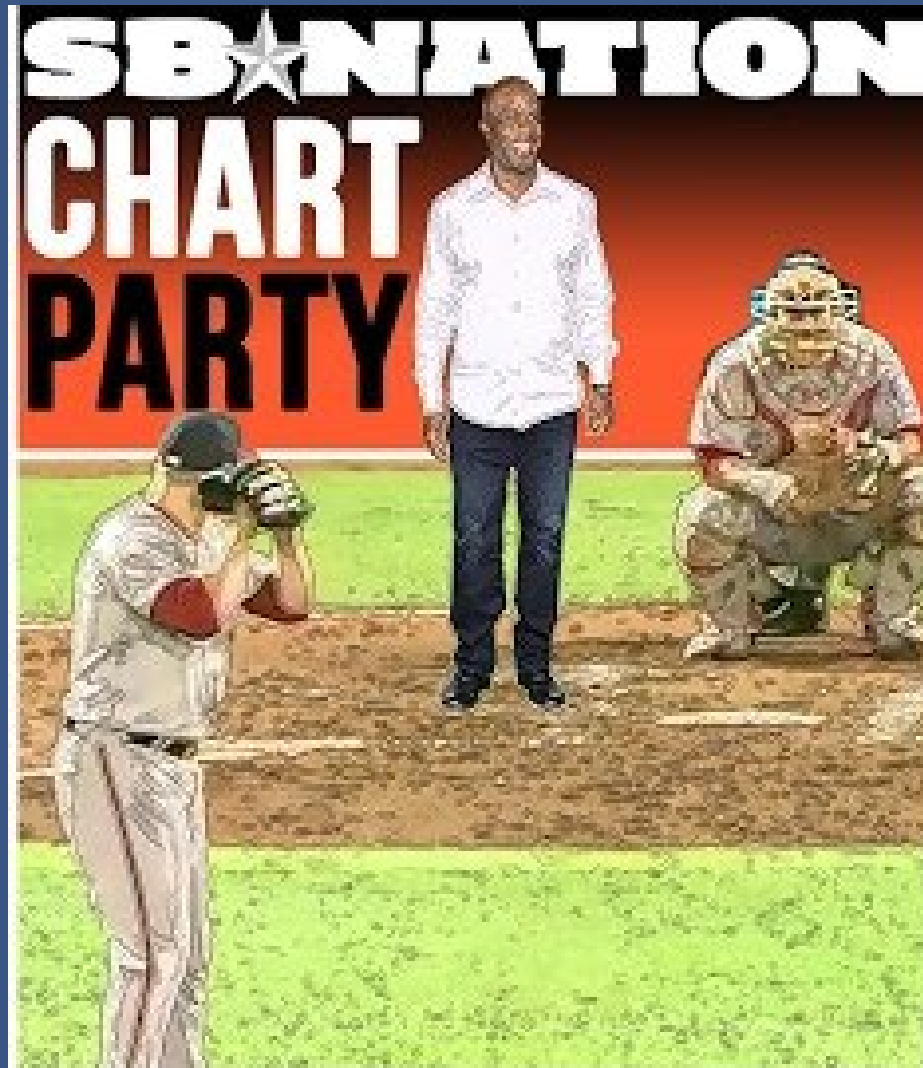
SF = Sacrifice Fly

SAC = Sacrifice Bunt

CS = Caught Stealing



America's Greatest Pastime



What if
Barry Bonds
had played
baseball
without
a bat?



America's Greatest Pastime





Final Inspiration

Well, it took me 17 years to get 3,000 hits in baseball, and I did it in one afternoon on the golf course.

- Hank Aaron