



Baseball II



Produced by Dr. Mario | UNC STOR 538

Pythagorean Theorem



- **Classic Pythagorean Theorem**
 - Relationship Between the Sides of a Right Triangle
 - $a^2 = b^2 + c^2$
- **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

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

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

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

- Minimization of Sum of Squared Errors
- Optimal: $\alpha = 1.82$
- Alternative Expression

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

- Useful for Forecasting Playoff Series Winners
 - Pythagorean Method: 53.8% Accurate
 - Games Won Approach: 50% Accurate



Pythagorean Theorem

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

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

$$WP \approx \frac{\left(\frac{870}{800}\right)^{1.82}}{\left(\frac{870}{800}\right)^{1.82} + 1} = 0.538$$

- After Trade:

$$WP \approx \frac{\left(\frac{890}{800}\right)^{1.82}}{\left(\frac{890}{800}\right)^{1.82} + 1} = 0.548$$





Runs-Created Approach

- Motivation: Nomar Vs. Ichiro

Statistics for Ichiro Suzuki and Nomar Garciaparra		
Event	Ichiro 2004	Nomar 1997
AB	704	684
Batting average	.372	.306
SLG	.455	.534
Hits	262	209
Singles	225	124
2B	24	44
3B	5	11
HR	8	30
BB+HBP	53	41





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:

$$RC \approx \underbrace{(H + BB + HBP)}_{\text{\# of Base Runners}} \times \frac{TB}{\underbrace{AB + BB + HBP}_{\text{Rate Players are Advancing}}}$$

H = Hit

S = Single

D = Double

T = Triple

HR = Home Run

AB = At-bat

BB = Walk

HBP = Hit-by-Pitch





Runs-Created Approach

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

- **Evaluation of Runs Created Formula**

- Mean Percentage Error (MPE)
- Formula for MPE:

$$MPE = \frac{100\%}{n} \times \sum_{i=1}^n \frac{y_i - \hat{y}_i}{y_i}$$

- Based off Formula for RC, MPE = 4%

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

Model Based On Teams



Predict on Players

- **Results**

Playa and Year	Runs Created
Ichiro 2004	133.16
Nomar 1997	125.86
Bonds 2004	185.74





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

$$\text{Average Outs Per Game} = 26.72$$

- Observation 4: Following in Units of Game

$$\frac{TO}{26.72}$$

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

$$\frac{RC}{G} = \frac{RC}{\frac{TO}{26.72}}$$

- Interpretation of RC/G

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

- Results Updated

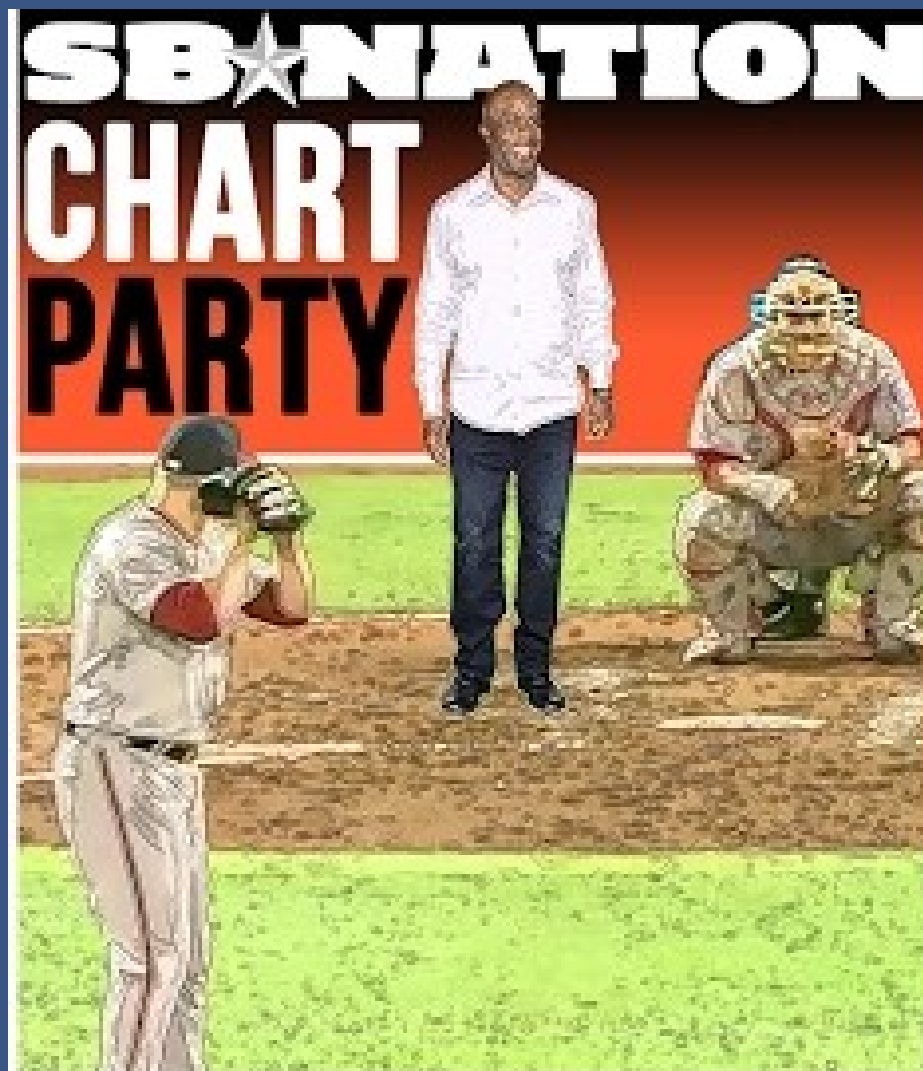
Playa and Year	RC	RC/G
Ichiro 2004	133.16	7.88
Nomar 1997	125.86	6.72
Bonds 2004	185.74	20.65

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