Baseball II

Produced by Dr. Mario | UNC STOR 538

Pythagorean Theorem

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

- 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

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

  - Example: Kansas City in 2014 World Series
    - 651 Runs Scored
    - 624 Runs Allowed

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

Pythagorean Theorem

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

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

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

Error

  - 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

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

- **Evaluation of Runs Created Formula**
  - Evaluated For Teams from 2010 to 2016
  - Formula for Mean Percentage Error:

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

  - Based off Formula for RC, MPE = 3% (21 Runs)

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

Model Based On Teams → Predict on Players

- **Results**

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

    $$AB - H - (0.018)AB = (0.982)\mathrm{AB} - \mathrm{H}$$

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

    $$\mathrm{TO} = (0.982)\mathrm{AB} - \mathrm{H} + \mathrm{GIDP} + \mathrm{SF} + \mathrm{SAC} + \mathrm{CS}$$

  - Observation 3: Sometimes 27 Outs Per Game

    $$Average\ Outs\ Per\ Game = 26.83$$

  - 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**

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

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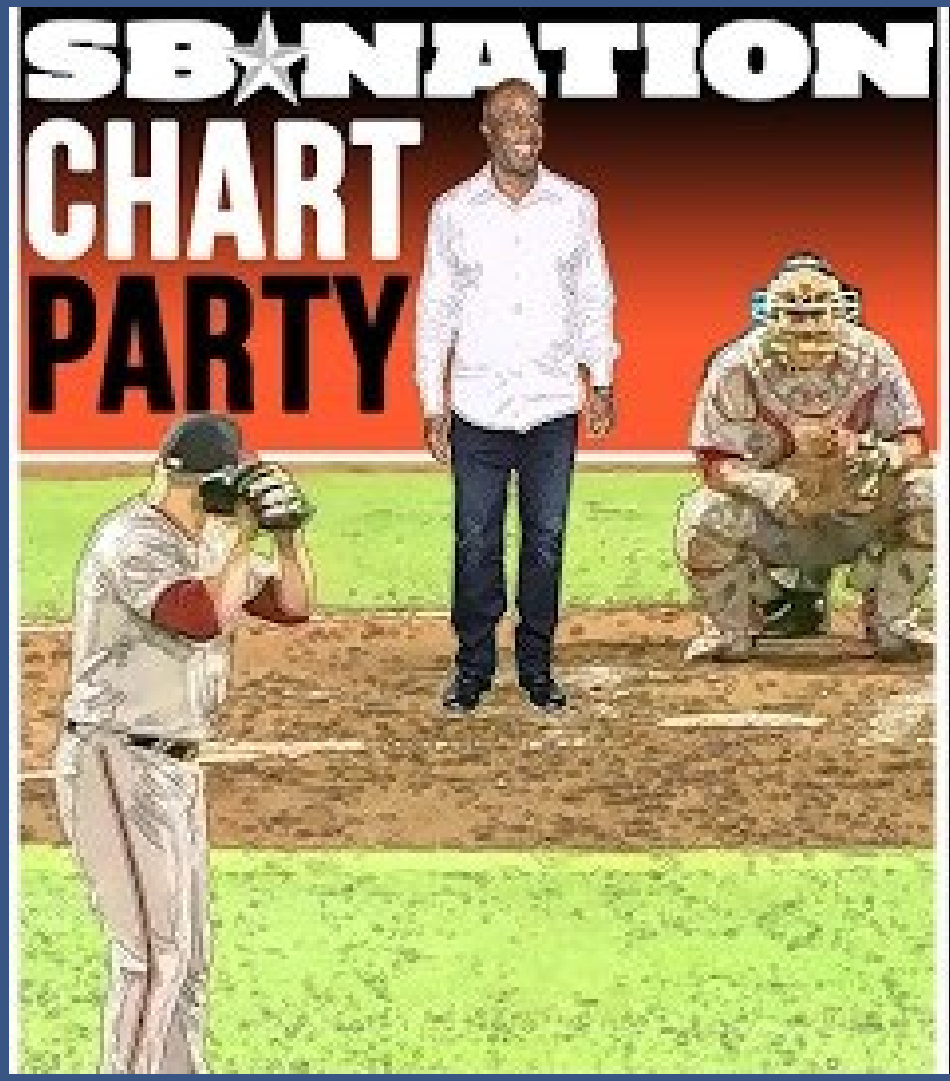
- **Results Updated**

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

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