Skill Importance in Volleyball

Gilbert W. Fellingham, Ph. D.
Michelle Miskin, M. S.
C. Shane Reese, Ph. D.
Dept. of Statistics
Brigham Young University

gwf@byu.edu

September 26, 2009

Table of Contents

Original Motivation

- 2004 Olympics, US Men's Volleyball Team
- Limited practice time, essentially two months
- Question — how do we maximize practice time?
- That is, what skills matter most?

Follow Up Issues

- 2006 BYU Women's Volleyball Team
- How should we value setting?
- How does setting compare in importance to passing, hitting, etc?
- Again, what skills matter most?

The Data

- Men - USA National Team
  1. Data from 2002 World Championships and 2003 World Cup
  2. Every skill except setting rated
  3. 21,990 observations for USA
- Women - BYU
  1. Data from 2006 season
  2. Every skill rated for every home game (setting done via film)
  3. 7,356 observations for BYU

Notion of Skill Importance

- How do we determine what matters?
- Statistical model
- Parameter β_i associated with every skill
- Importance Score $= \dfrac{E(\beta_i)}{\sqrt{V(\beta_i)}}$
- Question – appropriate way to estimate $\dfrac{E(\beta_i)}{\sqrt{V(\beta_i)}}$?

Ratings

- Each skill rated
- Scale depended on skill
- Slight differences for men and women
- Passing and serving rated from 0-4
- Setting rating based on distance from net, only for women
- Ratings for digging and blocking less consistent

Men

Logistic model used to relate the response to the skill ratings

$$\log\left(\frac{\Pr[Y=1|\textbf{skill}=\textbf{i}]}{\Pr[Y=0|\textbf{skill}=\textbf{i}]}\right)=\beta_i$$

for $i=1,\ldots,66$.
Note: The β_j are interpreted as the effect of performing a skill at the noted level on the *Log Odds Ratio* of scoring a point.

Predicted probabilities of scoring points from

$$\Pr[Y=1|\textbf{skill}=\textbf{i}]=\frac{1}{1+\exp(\beta_i)},$$

Used a Bayesian approach to provide a posterior distribution of β_i for each of the skills.

Women

Logistic Regression Model

Logistic model used to relate the response to the skill ratings

$$\log\left(\frac{\Pr[Y=1|\textbf{skill}=\textbf{i}]}{\Pr[Y=0|\textbf{skill}=\textbf{i}]}\right) = \beta_{0i} + \beta_{1i}R_{ik}$$

- Model assumes skill rating linearly related on log odds scale to positive outcome
- Bayesian χ^2 goodness-of-fit tests indicated the logistic regression model does reasonably well modeling th probability of a score
- Importance score for skill, $\frac{E[\beta_{1i}|Y]}{\sqrt{V[\beta_{1i}|Y]}}$, based on slope parameter

Women

Markov Model

- Sequences of events (serve-outcome, pass-set-attack-outcome, and dig-set-attack-outcome) first-order Markov chains.
- Transition matrix – elements of the matrix probability of moving from one state to another (e.g., a four-point pass to a set 3–5 feet off the net).
- The 36×36 transition matrix contained the transitions for float serves, jump serves, passes, set distances off the net, attacks, digs, and possible outcomes.
- Outcomes of a rally were: rally continues, point for home team, point for visiting team.

Women

Markov Model - continued

- A multinomial likelihood

$$f(y_{i1}, \ldots, y_{ik} | \pi_{i1}, \ldots, \pi_{ik}) \propto \pi_{i1}^{y_{i1}} \pi_{i2}^{y_{i2}} \ldots \pi_{ik}^{y_{ik}}, \quad (1)$$

  for each row, $i = 1, \ldots, m$, of the count matrix. π_{ij} represents the probability of moving from state i to state j.

- We assumed the prior probability densities of each row were distributed as Dirichlet random variables

$$f(\pi_{i1}, \ldots, \pi_{ik} | \alpha_{i1}, \ldots, \alpha_{ik}) \propto \pi_{i1}^{\alpha_{i1}-1} \pi_{i2}^{\alpha_{i2}-1} \ldots \pi_{ik}^{\alpha_{ik}-1}, \quad (2)$$

Women

Markov Model - continued

- Importance score – unconditional probability of moving from a state (eg a four-point pass) fo a positive outcome.
- Called β_i
- To compute β_i, used all possible sequences of touches that could occur between the state and the outcome
- For each sequence, summed the appropriate probabilities at each MCMC draw, and used the resulting posterior to compute $E[\beta_i|Y]$ and $\sqrt{V[\beta_i|Y]}$

Importance Scores

Table: Skill/Rating Importance Scores.

Productive Skills		Counter Productive Skills	
I_j	skill code	I_j	skill code
27.94	Attack - Kill	-18.67	Serve - 1Pt
21.39	Receive - 4Pt	-12.11	Serve - 2Pt
15.45	Receive - 3Pt	-11.00	Attack - Error
11.06	Defend - StfBlk	-8.07	Serve - Error
6.46	Serve - Ace	-7.12	Attack - Blocked
6.37	Serve - 4Pt	-4.96	Receive - Error
3.35	Defend - BlkDigSame	-4.22	Receive - 1Pt
1.87	Defend - NoBlkDig	-4.22	Defend - BlkErr
1.62	Serve - 3Pt	-2.19	Defend - BlkDigOpp
1.04	Attack - DugNoBlk	-0.38	Receive - 2Pt
0.62	Attack - DugTchBlk		

Logistic Model

Table: Importance scores for the volleyball logistic regression analysis.

Skill	$E(\beta_1 \mid Y)$	$V(\beta_1 \mid Y)$	Importance Score
Pass	0.51946	0.00375	8.48683
Float Serve	0.81906	0.00992	8.22162
Jump Serve	0.74160	0.00949	7.61225
Set Distance	0.33156	0.00271	6.36639
Digs	0.51379	0.00951	5.26835

Markov Model

Table: Importance scores for the volleyball Markov chain analysis.

Skill	$E(\beta\|Y)$	$V(\beta\|Y)$	I_j
3 point Pass	0.50551	0.00017	38.32173
Set 3–5 feet off the net	0.51304	0.00018	37.88245
4 point Pass	0.51001	0.00020	36.51091
2 point Pass	0.48935	0.00019	35.78412
4 point Dig	0.43787	0.00016	34.67090
Set 5–8 feet off the net	0.49893	0.00025	31.60894
5 point Dig	0.50061	0.00025	31.58385
Left Attack	0.49665	0.00033	27.46854
Set 0–3 feet off the net	0.50669	0.00044	24.27541
Middle Attack	0.53806	0.00070	20.30614
Right Attack	0.55130	0.00101	17.35607
Set 8–10 feet off the net	0.42340	0.00066	16.50323
1 point Pass	0.36451	0.00054	15.67747

Markov Model

Table: Importance scores for the volleyball Markov chain analysis.

Skill	$E(\beta\|Y)$	$V(\beta\|Y)$	I_j
Overpass Attack	0.65062	0.00270	12.52568
3 point Float Serve	0.26774	0.00054	11.56483
3 point Jump Serve	0.18633	0.00040	9.35556
Back Attack	0.38659	0.00197	8.71921
2 point Dig	0.38268	0.00211	8.33366
Set Dump Attack	0.54814	0.00776	6.22122
3 point Dig	0.48367	0.00665	5.93223
2 point Float Serve	0.24707	0.00216	5.31146
1 point Float Serve	0.21983	0.00188	5.07389
2 point Jump Serve	0.16202	0.00122	4.64685
1 point Jump Serve	0.16242	0.00168	3.96645
Out of System Attack	0.26291	0.00974	2.66430

Men's National Team

Men

1. More practice time serving and receiving serve
2. Weight serving more and blocking less when evaluating talent
3. Pass and set further off the net
4. Better attacking outweighs better defense

BYU Women's Team

Women

1. Practice transition offense more
2. Float serve appears preferable to jump serve
3. Pass further off the net
4. Forget back row offense

Overall

1. Men's game and women's game are different.
    1. Men — Attack, Serve, Serve/Receive
    2. Women — Serve/Receive, Serve, Dig, Attack
2. Libero? Important for women, less so for men
3. Type of athlete. Can't coach size, but also can't coach quickness

General Application

Although we demonstrated for volleyball, idea is applicable to all sports

1. Golf – Drive for show, putt for dough
2. Basketball – assist, 3 pt. shot, 2 pt. shot, def. rebound, off. rebound
3. Football – most important position
4. Optimal line-up?