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# Skill Importance in Volleyball

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# Value

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- If we don't measure it, we can't value it. For example, offensive line.
- If we only measure one aspect, we may incorrectly value it. For example, left tackle, center.
- If we measure the wrong thing, we may over-value it. For example, quarterback – wide receiver, 40 yard dash.
- If we don't measure it, we can't model it. For example, skill importance, position importance.

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- 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

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- How do we determine what matters?
- Statistical model
- Parameter  $\beta_i$  associated with every skill
- Importance Score =  $\frac{E(\beta_i)}{\sqrt{V(\beta_i)}}$

# Men and Women

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The model relating the response to the skills and skill grades (skill scores) is the logistic model

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

for  $i = 1, \dots, 66$ .

*Note:* The  $\beta_j$  are interpreted as the effect of performing a skill at the noted level on the *Log Odds Ratio* of scoring a point.

To estimate predicted probabilities of scoring points we calculate the distribution of

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

where the Bayesian approach will provide a posterior distribution of  $\beta_{1i}$  for each of the skills.

# Women

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## Markov Process Model

We assumed that the sequences of events (serve-outcome, pass-set-attack- outcome, and dig-set-attack-outcome) were first-order Markov chains. We represented these sequences in a transition matrix where the elements of the matrix comprise the probability of moving from one state to another state (e.g., a four-point pass to a set 3–5 feet off the net).

The  $36 \times 36$  transition matrix contained the transitions for float serves, jump serves, passes, set distances off the net, attacks, digs, and possible outcomes. There were five different ratings for both float and jump serves, six ratings for passes, four ratings for sets, seven places for attacks (left, right, middle, back row, set dump, out of system, and over pass attack), six ratings for digs, and three outcomes of a rally (continuation, point for home team, point for visiting team).

# Women

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## Markov Process Model

We used Bayesian methods to estimate the transition probabilities. We assumed a multinomial likelihood

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

for each row,  $i = 1, \dots, m$ , of the count matrix, where  $k$  is the number of possible states that could occur in the next sequence of touches, and  $m$  is the number of states.  $\pi_{ij}$  represents the probability of moving from state  $i$  to state  $j$  in the transition probability matrix, and  $\sum_{j=1}^k \pi_{ij} = 1$ , for each  $i$ . We assumed the prior probability densities of each row were distributed as Dirichlet random variables

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

where  $\alpha_{ij}$  represents the expectation of how often we think the women's team moves from state  $i$  to state  $j$  relative to moving to a different state in the transition probability matrix.

# 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

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Table: Importance scores for the volleyball logistic regression analysis.

Skill	$E(\beta Y)$	$V(\beta Y)$	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

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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

# Results

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- 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?
- 3 Type of athlete

# Suggestions

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## Men

- 1 More practice time serving
- 2 More practice time receiving serve
- 3 Weight serving more and blocking less when evaluating talent
- 4 Pass and set further off the net
- 5 More and better attacking probably out weigh better defense

# Suggestions

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## 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

# Further Work

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- 1 Don't grade passing correctly
- 2 Need to grade serve independently of pass
- 3 Where does the best serve go?
- 4 Optimal line-up?