

# Estimating individual contributions to team success in women's college volleyball

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RICE UNIVERSITY  
Sport Analytics

# Outline

## **Act 1: Estimating Point Win Probability**

*Technique: Markov Chain Model*

## **Act 2: Evaluating Individual Contributions**

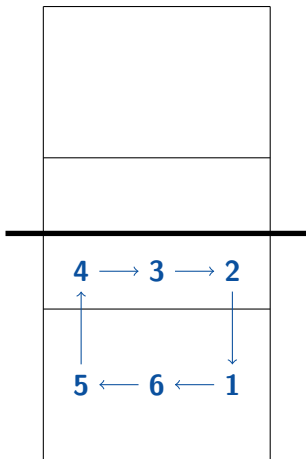
*Technique: Domain Knowledge*

## **Act 3: Adjusting for Strength of Schedule**

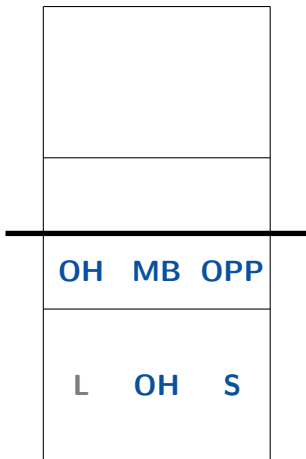
*Technique: Linear Mixed-Effect Models*

## **(Act 0: Introduction to Volleyball)**

# Introduction to Volleyball



# Introduction to Volleyball



## Setter (S)

*Setting*

## Outside Hitter (OH)

*Passing, Attacking*

## Middle Blocker (MB)

*Blocking, Attacking*

## Opposite Hitter (OPP)

*Blocking, Attacking*

## Libero (L)

*Passing*

# Existing metrics

- Standard metrics
  - Serving: Ace%, Error%
  - Receiving: Error%, Passer Rating
  - Digging: Digs / Set, Digs / Opportunity
  - Setting: Assists / Set
  - Attacking: Hitting Efficiency =  $(\text{Kills} - \text{Errors}) / \text{Attempts}$
  - Blocking: Blocks / Set
- State of the art
  - Fellingham (JQAS 2022): PAAPS
    - Similar to regularized adjusted plus-minus in basketball
  - Gordon (volleydork.com): Value Added above Expectation
    - Very similar to the present work

## **Act 1: Estimating Point Win Probability**

*Technique: Markov Chain Model*

## Example: First Point of 2022 National Championship

### Texas Louisville

Player	Skill	Eval	(X, Y)	Attack Code
Anna Deeber	Serve	-	(2.99, -0.13)	
Emma Halter	Reception	#	(0.93, 5.80)	
Saige K.-Torres	Set	#	(2.13, 3.13)	
Molly Phillips	Attack	-	(3.33, 3.20)	X6
Raquel Lazaro	Dig	+	(0.86, 4.98)	
Elena Scott	Set	#	(2.99, 1.65)	
Claire Chaussee	Attack	-	(0.63, 2.83)	V5
Kayla Caffey	Block	+	(3.26, 3.43)	
Phekran Kong	Dig	!	(0.89, 3.13)	
Raquel Lazaro	Set	#	(0.97, 2.61)	
Claire Chaussee	Attack	#	(0.67, 2.91)	X5

Evaluation Codes: # > + > ! > - > / > =

Dataset: 4,147 matches, 600K+ points, 5M+ contacts, ~6,000 players



## Markov Chain Model: Game State

*Definition:* A **volley** is a sequence of consecutive contacts by the same team

The game state on each contact is given by:

- Whether the team started the point by serving or receiving
- The sequence of contacts made during the current volley (including evaluation code *except* for contacts ending a volley)

Terminal states: (S, P) and (R, P)

*Example:* (S, D#)  $\rightarrow$  (S, D#S#)  $\rightarrow$  (S, D#S#A)  $\rightarrow$  (R, P)

## Example: First Point of 2022 National Championship

Player	Skill	Eval	State	P(Sideout)
Anna Deeber	Serve		(S, SV)	57%
Emma Halter	Reception	#	(R, R#)	63%
Saige K.-Torres	Set	#	(R, R#S#)	64%
Molly Phillips	Attack		(R, R#S#A)	64%
Raquel Lazaro	Dig	+	(S, D+)	49%
Elena Scott	Set	#	(S, D+S#)	47%
Claire Chaussee	Attack		(S, D+S#A)	47%
Kayla Caffey	Block	+	(R, B+)	56%
Phekran Kong	Dig	!	(S, D!)	51%
Raquel Lazaro	Set	#	(S, D!S#)	51%
Claire Chaussee	Attack		(S, D!S#A)	51%
<b>Point Louisville</b>				<b>0%</b>

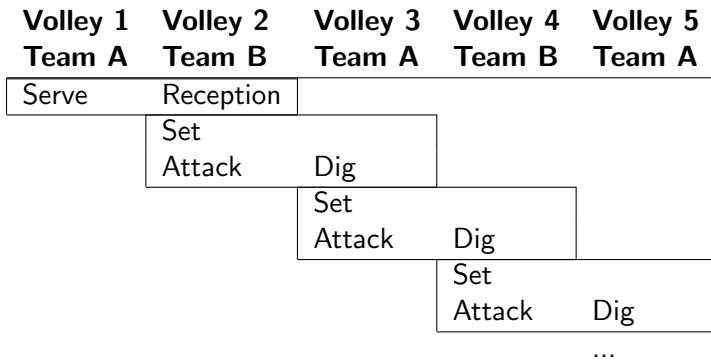
## **Act 2: Evaluating Individual Contributions**

*Technique: Domain Knowledge*

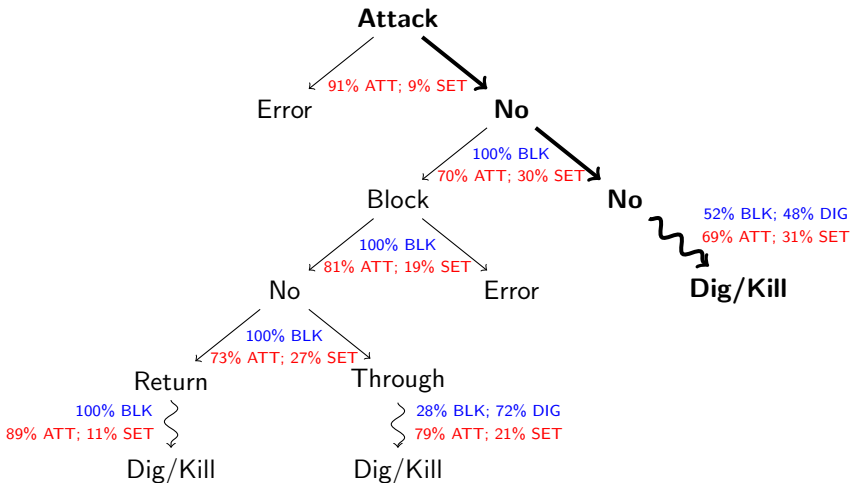
## How a Point Progresses

<b>Volley 1</b> <b>Team A</b>	<b>Volley 2</b> <b>Team B</b>	<b>Volley 3</b> <b>Team A</b>	<b>Volley 4</b> <b>Team B</b>	<b>Volley 5</b> <b>Team A</b>
Serve	Reception Set Attack	Dig Set Attack	Dig Set Attack	Dig ...

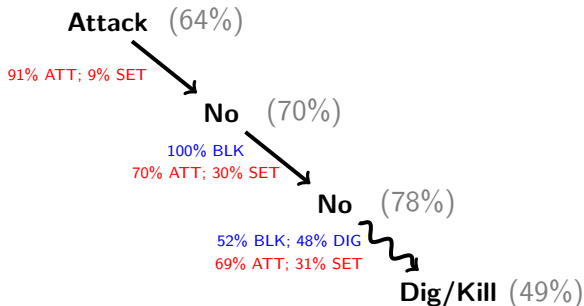
## How a Point Progresses



# Attack Outcome Tree



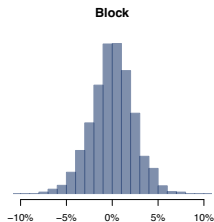
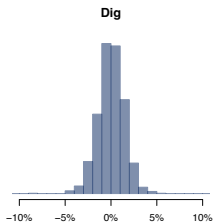
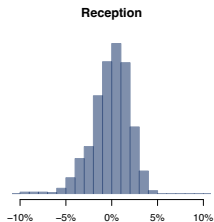
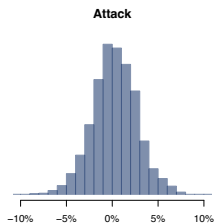
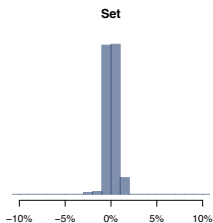
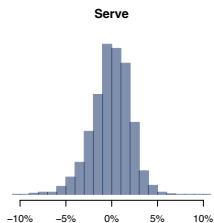
## Example: First Attack of 2022 National Championship



TOT	+6%	+8%	-29%	-15%	Standard Stats
ATT	+5%	+6%	-20%	-9%	1 attempt, 0 kills, 0 errors
SET	+1%	+2%	-9%	-6%	0 assists
BLK	—	-8%	+15%	+7%	—
DIG	—	—	+14%	+14%	1 opportunity, 1 dig

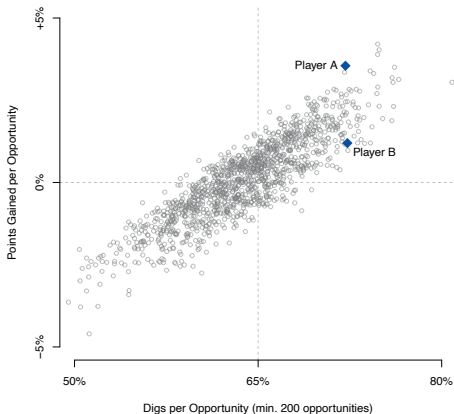
**Caution:** Blocker/digger assignment is a work in progress

# Distribution of Points Gained per Opportunity





## Standard vs. Advanced Metrics: Back Row Defense



### Player A:

72% digs per opportunity  
+3.6% PG per opportunity  
No block touch: 85%  
Perfect dig rate: 48%

### Player B:

72% digs per opportunity  
+1.2% PG per opportunity  
No block touch: 66%  
Perfect dig rate: 36%

**Caution:** Dig evaluation codes are biased against setters by design

## **Act 3: Adjusting for Strength of Schedule**

*Technique: Linear Mixed-Effect Models*

## Server vs. Receiver

$$\text{Exp. Points Gained} = \beta_{\text{Server}} + \delta_{\text{Receiver}} \quad (\text{good})$$

$$\text{Exp. Points Gained} = (\beta_{\text{Team}} + \beta_{\text{Server}}) + (\delta_{\text{Team}} + \delta_{\text{Receiver}}) \quad (\text{better})$$

$$\text{Exp. Points Gained} = (\beta_{\text{Conf}} + \beta_{\text{Team}} + \beta_{\text{Server}}) + (\delta_{\text{Conf}} + \delta_{\text{Team}} + \delta_{\text{Receiver}}) \quad (\text{best})$$

- Fit random-effects model using lme4 package in R

Server:

$$\text{Adj. Points Gained} \approx \text{Points Gained} - (\hat{\delta}_{\text{Conf}} + \hat{\delta}_{\text{Team}} + \hat{\delta}_{\text{Receiver}})$$

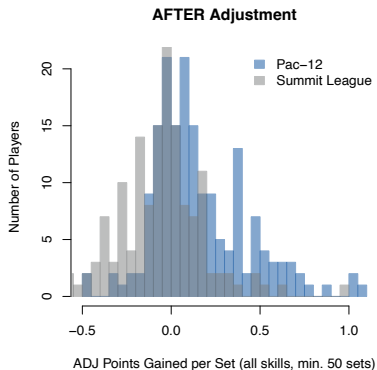
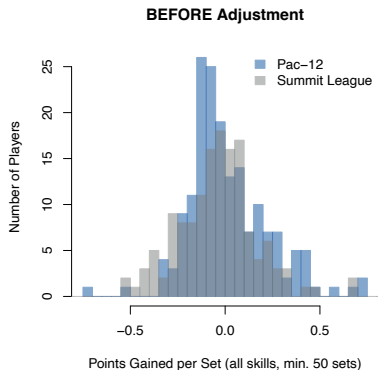
- Requires a de-biasing step
- Some generalization required for extension to other skills

## Results: Top 10 Conferences (all skills)

Conference	Avg SoS
Big Ten	+0.23
Pac-12	+0.23
SEC	+0.21
Big 12	+0.20
ACC	+0.15
West Coast	+0.09
American	+0.04
Big West	+0.04
Mountain West	+0.02
Mid-American	+0.01

SoS units: points gained per set

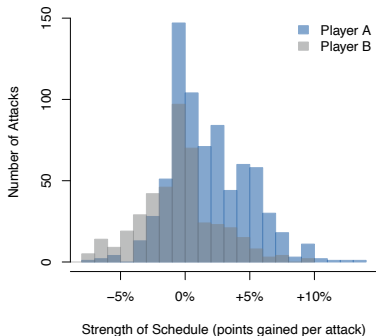
## Example: Conference Comparison (all skills)



- Separation between conferences is evident
- One elite player from the Summit League still stands out

**Caution:** Additive assumption is not literally true in real life

## Example: Teammate Comparison (outside hitters)



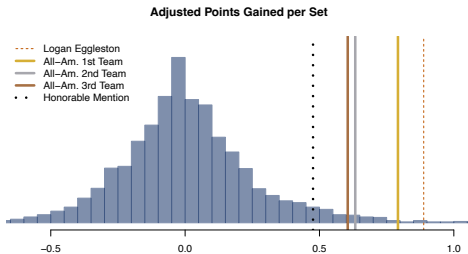
- Player A average SOS: +1.4% (PG per attack)
- Player B average SOS: -0.1% (PG per attack)

Toughest SoS: Player A vs. Nebraska, +13.0%  
Kaitlyn Hord blocking, Lexi Rodriguez digging

**Caution:** SoS depends on which zone the attacker hits

**(Act 4: Discussion)**

# Question: Where does Logan Eggleston rank?

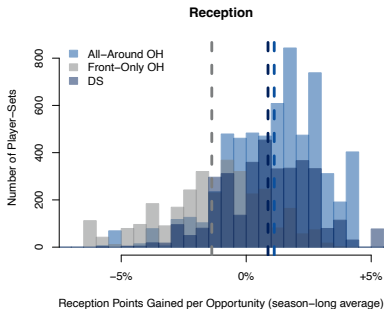


PLAYER	TEAM	CONF	POS	SETS		POINTS GAINED PER SET (ADJ)	SERVE PG*/S	PASS PG*/S	SET PG*/S	ATTACK PG*/S	BLOCK PG*/S
				PLAYED							
Brooke Nuneviller	Oregon	Pac-12	OH	122		<b>+1.09</b>	+0.07	+0.41	+0.00	+0.56	+0.04
Mckenna Melville	Central Florida	AAC	OH	104		<b>+1.09</b>	-0.14	+0.23	-0.00	+0.79	+0.22
Claire Hoffman	Washington	Pac-12	OH	112		<b>+1.04</b>	+0.13	+0.23	-0.00	+0.65	+0.02
Julia Bergmann	Georgia Tech	ACC	OH	86		<b>+1.03</b>	+0.09	+0.25	-0.01	+0.64	+0.06
Kendall Kipp	Stanford	Pac-12	OPP	117		<b>+1.02</b>	+0.03	-0.02	-0.00	+0.72	+0.29
Amber Igiede	Hawaii	Big West	MB	102		<b>+0.98</b>	+0.07	+0.04	+0.01	+0.47	+0.38
Elizabeth Juhnke	South Dakota	Summit	OH	113		<b>+0.96</b>	+0.01	-0.01	-0.00	+0.69	+0.26
Madi Kubik	Nebraska	Big Ten	OH	109		<b>+0.94</b>	+0.05	+0.42	-0.01	+0.44	+0.05
Asjia Oneal	Texas	Big 12	MB	87		<b>+0.93</b>	+0.05	+0.04	+0.00	+0.35	+0.50
Logan Eggleston	Texas	Big 12	OH	91		<b>+0.89</b>	+0.09	+0.05	+0.01	+0.70	+0.05



# Application: Defensive Specialist Strategy

- 63% of teams replace at least one OH with a DS in back row



## Reception PG per opportunity

All-Around OH: +1.1%

Front-Only OH: -1.4%

Defensive Specialist: +0.9%

Substitutable Opportunities:  
0.1 opportunities per point

- Example:* Point win probability 50% → 50.2%
  - Match win probability 50% → 52%

Pythagorean formula for volleyball:  $p^{10}/(p^{10} + (1 - p)^{10})$

## Limitations and Next Steps

- Improve blocker and digger assignments
- Correct bias for digs made by setter
- Reward good decision-making in strength of schedule
- Account for whether setter is back row or front row
- Leverage (X, Y) coordinate information

Thank You!