MathSport International

- Volleyball
- Method of analysis
- Data
- Results
- Conclusions

Complex 1 in male volleyball as a Markov chain

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- Structure of the game: Hierarchical
- Scoring patterns and possible outcomes

- Win the rally (+)
- Lose the rally (-)
- Continuation of the rally with the ball on opponent's side (C)

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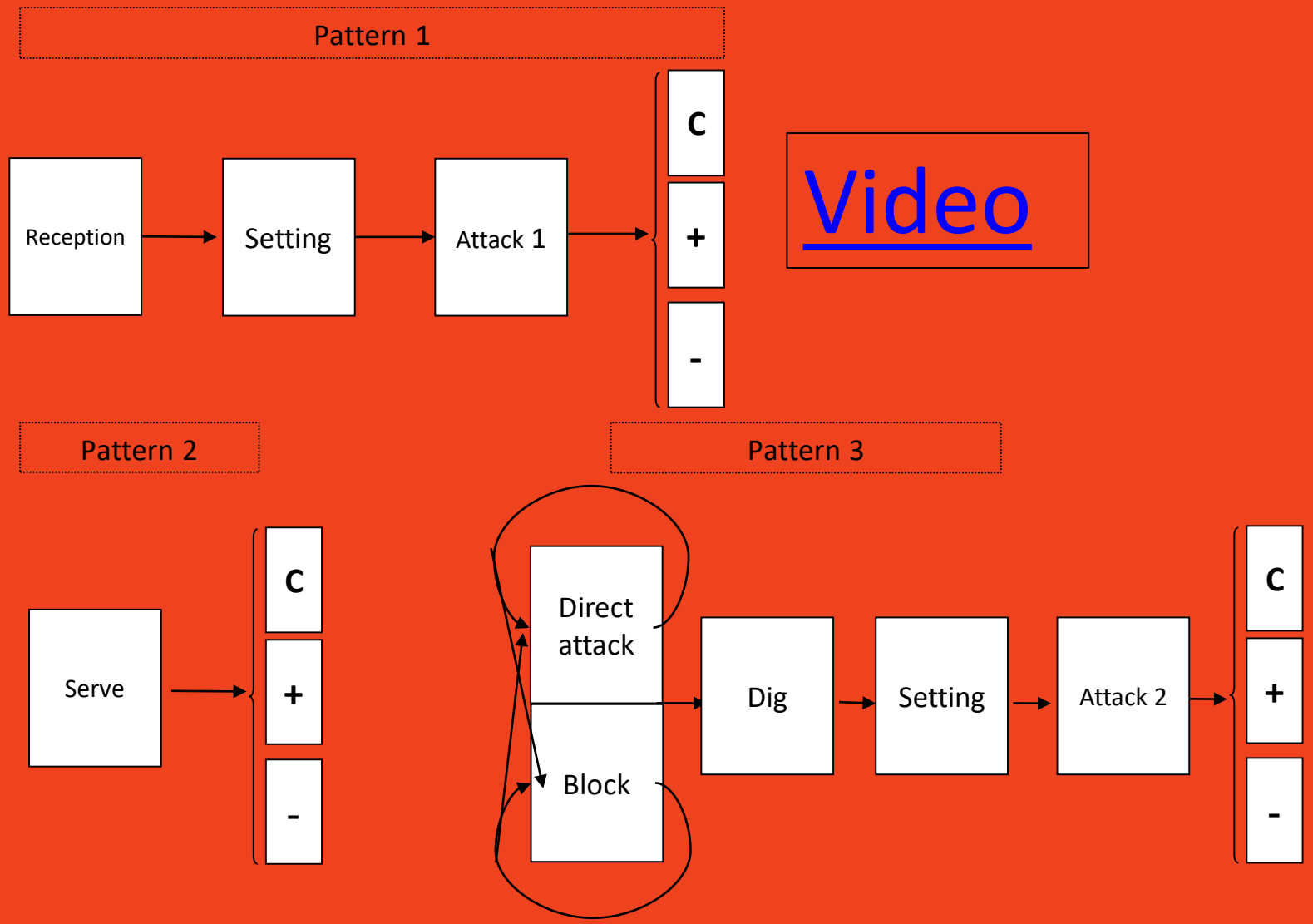

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- Pattern 1 is the necessary condition to claim the victory because winning a point when receiving the ball is easier than winning a point when serving.
- The performance in one skill depends on the performance in the previous one.
- Receiving well is a guarantee for a winning attack (coaches belief)

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Skill	Pass in Jump=	Pass in Jump/	Pass in Jump-	Pass in Jump!	Pass in Jump+	Pass in Jump#	Pass in Float=	Pas sin Float/	Pass in Float-	Pas sin Float!	Pass in Float+	Pass in Float#	Attack 1 LS quick	Attack 1 LS high	Attack 1 FRS quick	Attack 1 FRS high	Attack 1BRS quick	Attack 1BRS high	Attack 1 MF quick	Attack 1 MB quick	Attack 1 MB high	Attack 1 STR TIP	Attack 1 out of system	Set error1	Continue	Point +	Point -
Passin Jump=																											
Passin Jump/																											
Passin Jump-																											
Passin Jump!																											
Passin Jump+																											
Passin Jump#																											
Passin Float=																											
Passin Float/																											
Passin Float-																											
Passin Float!																											
Passin Float+																											
Passin Float#																											
Attack 1 LS quick																											
Attack 1 LS high																											
Attack 1 FRS quick																											
Attack 1 FRS high																											
Attack 1BRS quick																											
Attack 1BRS high																											
Attack 1 MF quick																											
Attack 1 MB quick																											
Attack 1 MB high																											
Attack 1 STR TIP																											
Attack 1 out of system																											
Set error1																											

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- P_i is the probability for a skill to end up in a point after two subsequent game moves

$$P_i = P(Y_{t+1} = \text{point}^+ \mid Y_t = S_i) + \sum_{\substack{k=1 \\ k \neq i}}^{n} P(Y_{t+2} = \text{point}^+ \mid Y_{t+1} = S_k) P(Y_{t+1} = S_k \mid Y_t = S_i)$$

$$P(Y_{t+1} = \text{point}^+ \mid Y_t = S_i) \qquad P(Y_{t+1} = S_k \mid Y_t = S_i)$$

- 1st assumption: Pattern 1 is first order Markov chain.
- 2nd assumption: Scoring for each skill is i.i.d.

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- Simple multinomial model to estimate transition & success probabilities π_{ik}

$$\pi_{ik} = P(Y_{t+1} = S_k \mid Y_t = S_i)$$

- For each skill we assume multinomial likelihood

$$f(y_{i1},\ldots,y_{i,n},y_{i,n+1},y_{i,n+2} \mid \pi_{i1},\ldots,\pi_{i,n},\pi_{i,n+1},\pi_{i,n+2}) \propto \prod_{k\in M_i} \pi_{ik}^{y_{ik}}$$

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- We use a conjugate Dirichlet prior distribution of the type

$$f(\Pi_i \mid A_i) \propto \prod_{k \in M_i} \pi_{ik}^{a_{ik}-1}$$

- Given that the interest was in what the data suggest on the relationship between different states of the sequence, a minimally informative distribution is assumed.
- All success probabilities were calculated using a Monte Carlo scheme of 10.000 iterations.

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- Importance score (I_i). Measure of impact & uncertainty for a skill proposed by Fellingham & Reese (2004).

$$I_i = \frac{E(P_i \mid y)}{\sqrt{V(P_i \mid y)}}$$

→ Posterior mean

→ Standard deviation

- Adv: I_i incorporates the impact and the uncertainty of a specific skill
- Disadv: When comparing importance scores across teams, only the ordering should be compared.

•New proposed measure: **Q**uantile **M**id range **R**atio

• 90% *QMR*= $\frac{M - Q_{0,05}}{Q_{0,95} - M}$

•Values >1.2 can help to identify skills with negative skewness but a lower importance index that still might have high success probabilities

- 3 world champions in relevant championships
  - Youth 2013(U19): Russia
  - Juniors 2013 (U21): Russia
  - Men 2014: Poland.
- Recorded and analyzed all actions of scoring pattern 1 of the selected team.
- Pass (vs jump float & vs jump spin serve) rated from 1-6 levels fully detailed. Validity of the scale and reliability of data recording.
- Setting rating based on location (8) and tempo(2).
- Computer Software: Data Volley system. Improve of worksheet (www.dataproject.com/Volleyball).

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Level (Symbol)	Level brief description	Video
excellent 6(#)	The ball was passed accurately with suitable height, speed and parabolic trajectory in the target area (3m-4m from the right sideline and about 30-50 cm from the net or over 30-50 cm over the net if setter has the ability to jump setting). The setter could have all the options (location & type) for a set from the sidelines and the central lane without any adjustments in his approach to the ball.	
5(+)	The ball was passed either away (1m. behind or 2m. in front of the target area), or travelled higher, or lower (setter's shoulder level). The setter could have all the options for attack (location & type) from the sidelines and the central lane with adjustments in his approach to the ball.	
4(!)	The ball was passed with either 3m away from the net or near the sidelines or to the top of the net. The setter could have two options for attack only from the sidelines.	
3(-)	The ball was passed with very poor parabolic trajectory or near the sidelines, end line or outside of the court. The setter could have just one mandatory option for attack or the setter could not approach the ball and another player sets the ball mandatory.	
2(/)	The ball was passed directly to the serving team court. No option for attack for the receiving team.	
error 1(=)	The ball hit the floor directly or after touched by a receiver. The rally was ended after 1st or 2nd contact.	

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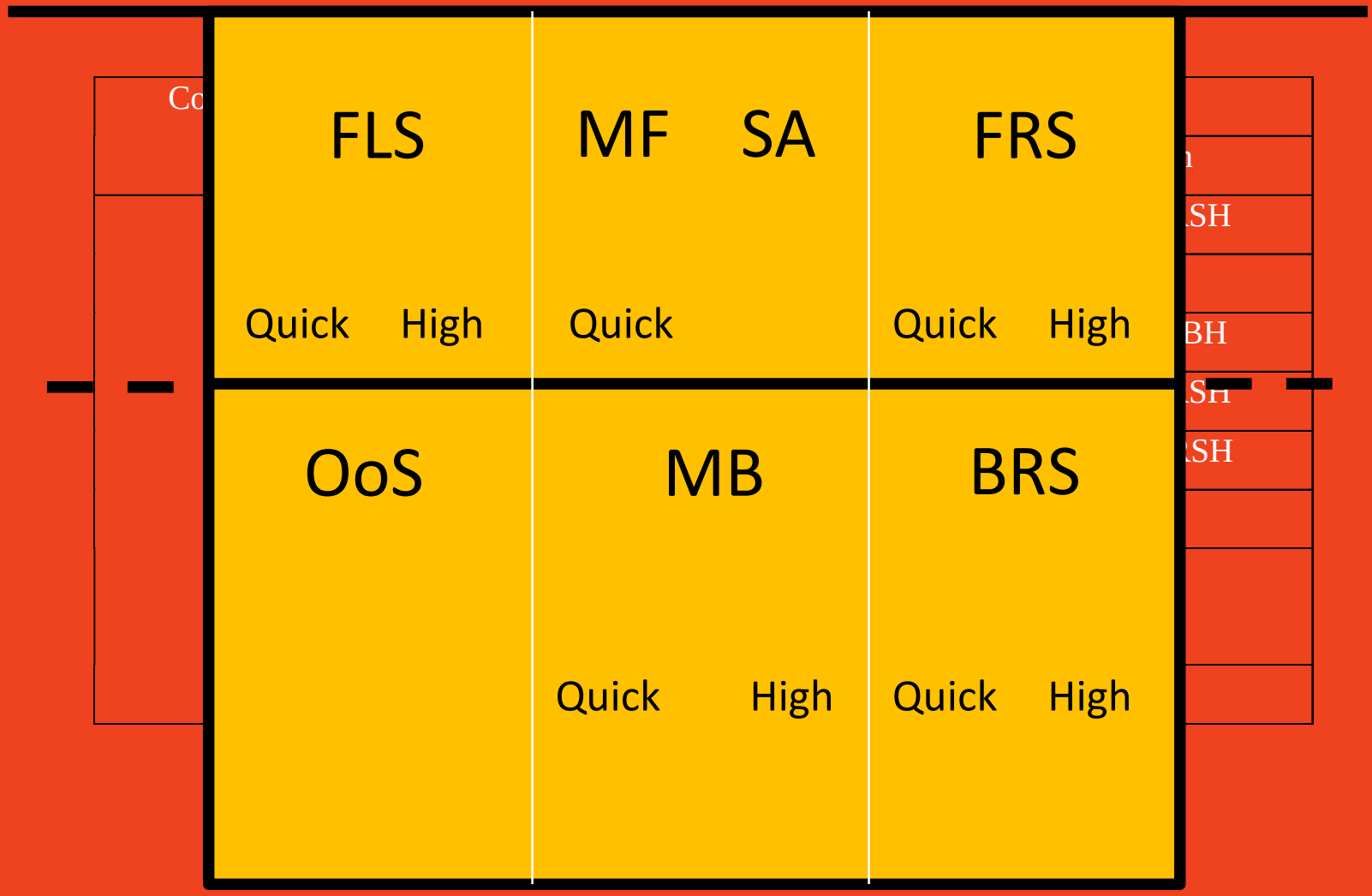

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Skills (S_i)	Skills (sub)	Men	U21	U19	*Posterior differences**
Pass in Jump Spin	2(/)	0.274 (±0.058)	0.266 (±0.053)	0.454 (±0.124)	*Men,U21<U19*
	3(-)	0.308 (±0.038)	0.337 (±0.055)	0.307 (±0.090)	
>50%	4(!)	0.548 (±0.022)	0.515 (±0.033)	0.631 (±0.045)	*Men<U19, U21<<U19*
	5(+)	0.593 (±0.022)	0.548 (±0.029)	0.605 (±0.045)	
	6(#)	0.589 (±0.0212)	0.545 (±0.032)	0.565 (±0.048)	
Pass in Jump Float	2(/)	0.256 (±0.046)	0.188 (±0.069)	0.281 (±0.049)	
	3(-)	0.325 (±0.039)	0.304 (±0.052)	0.412 (±0.079)	
>50%	4(!)	0.539 (±0.024)	0.513 (±0.031)	0.603 (±0.035)	*Men<U19, U21<<U19*
	5(+)	0.581 (±0.022)	0.563 (±0.027)	0.616 (±0.031)	
	6(#)	0.569 (±0.022)	0.558 (±0.026)	0.629 (±0.030)	*Men<U19,U21<<U19*

* *Inequalities indicate important differences between age categories: Age category A has lower success rates than age category B with posterior probability less than 0.01 ("A<<<B"), between 0.01 and 0.05 ("A<<B"), between 0.05 and 0.10("A<B").*

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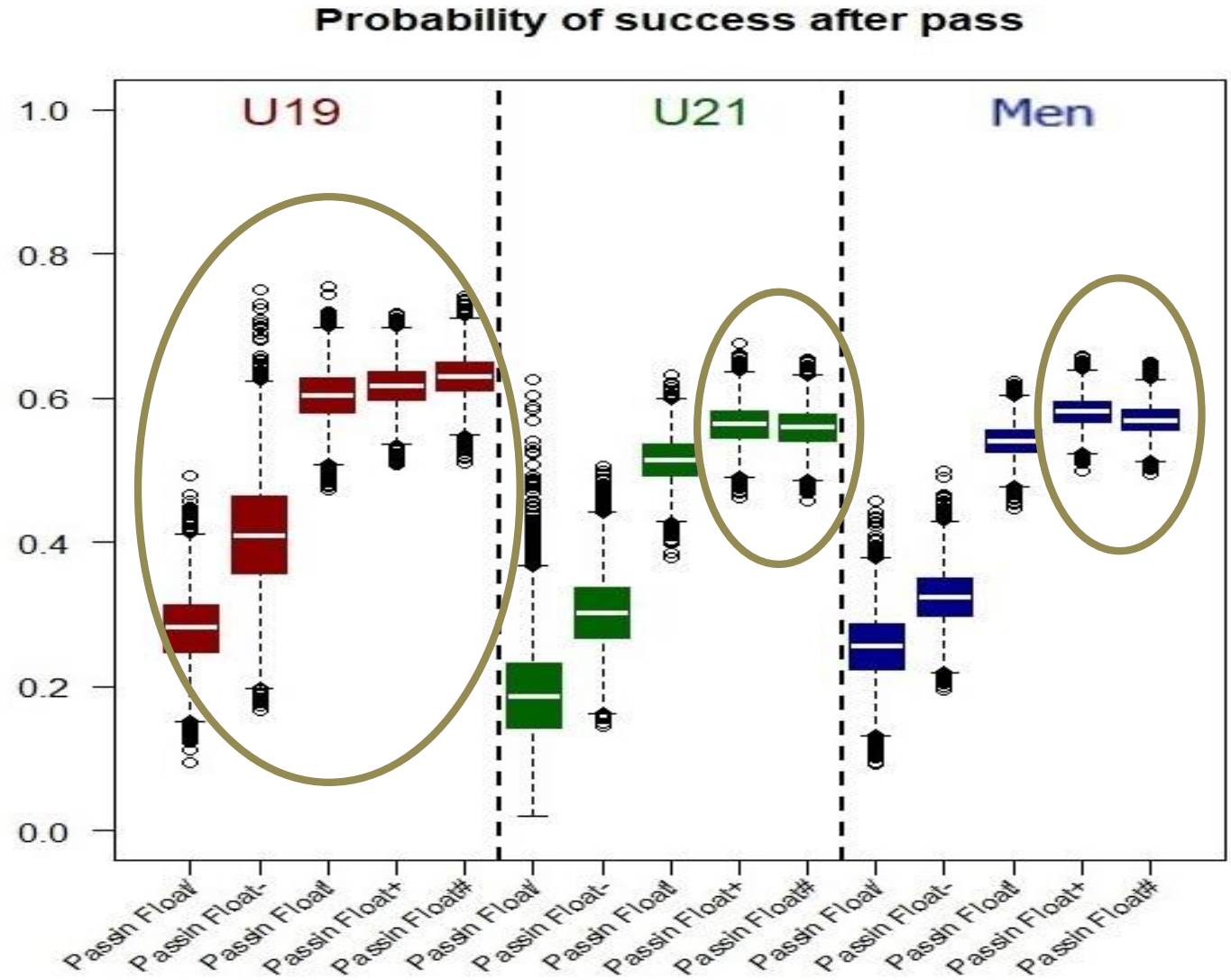

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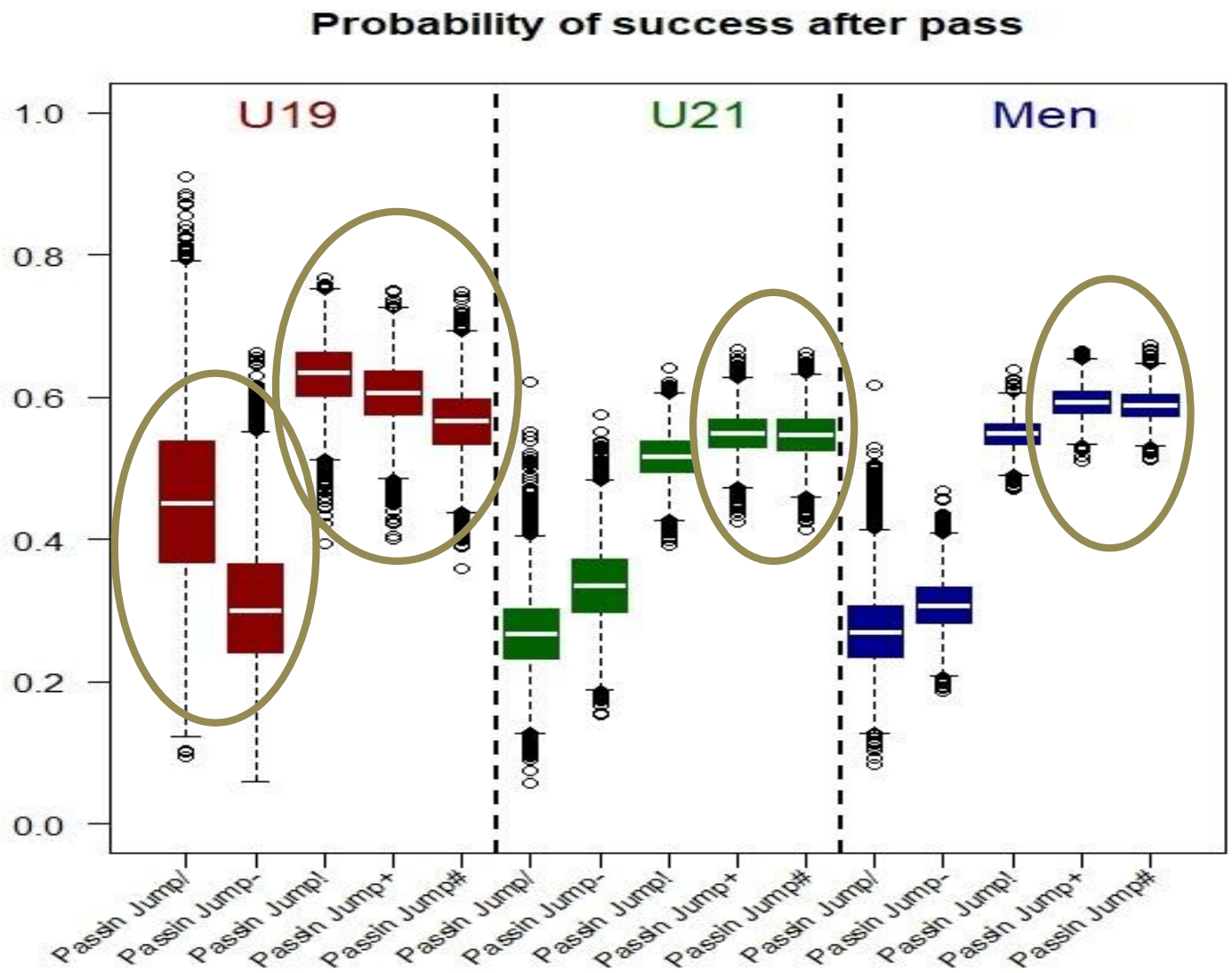

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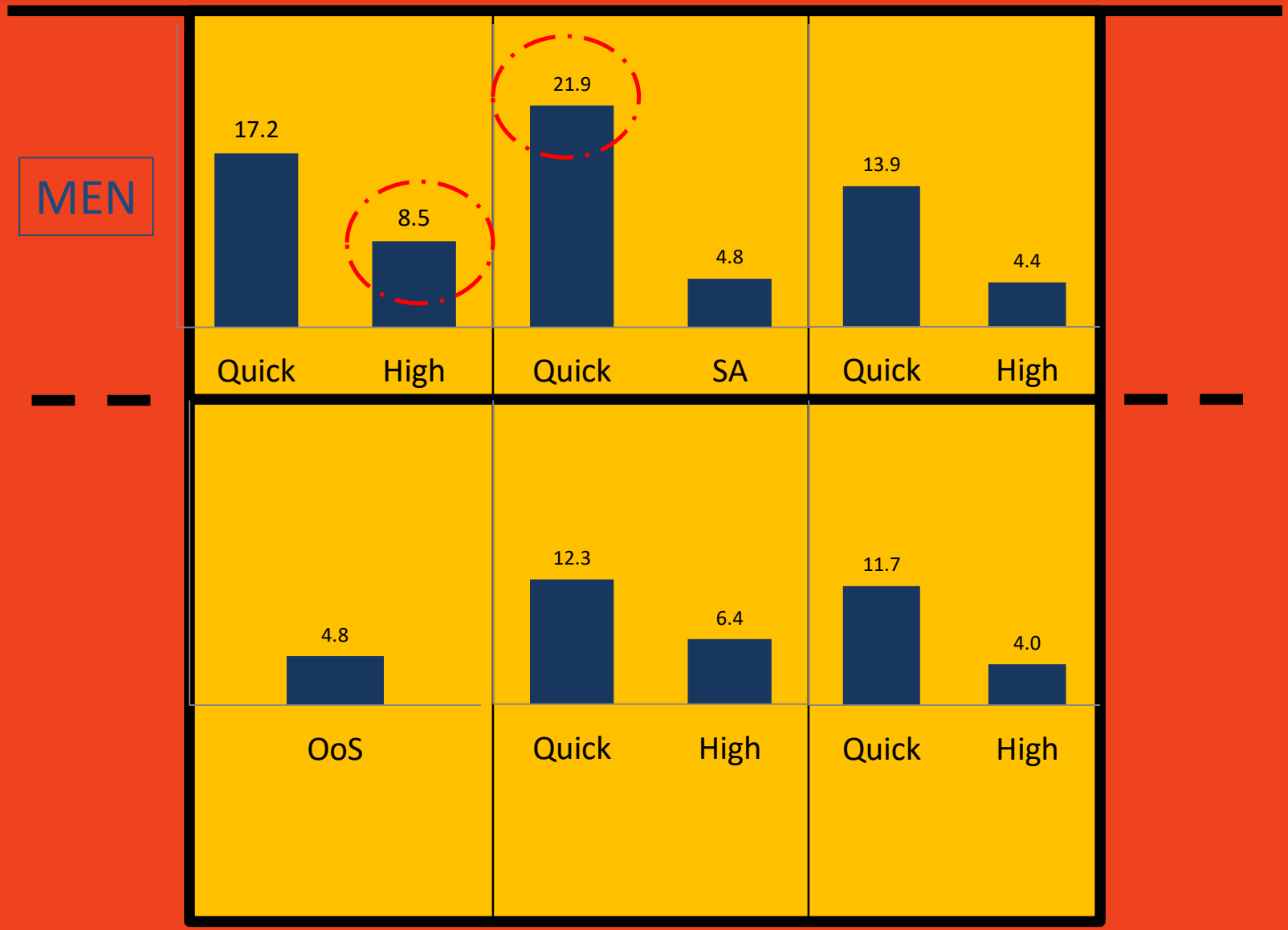

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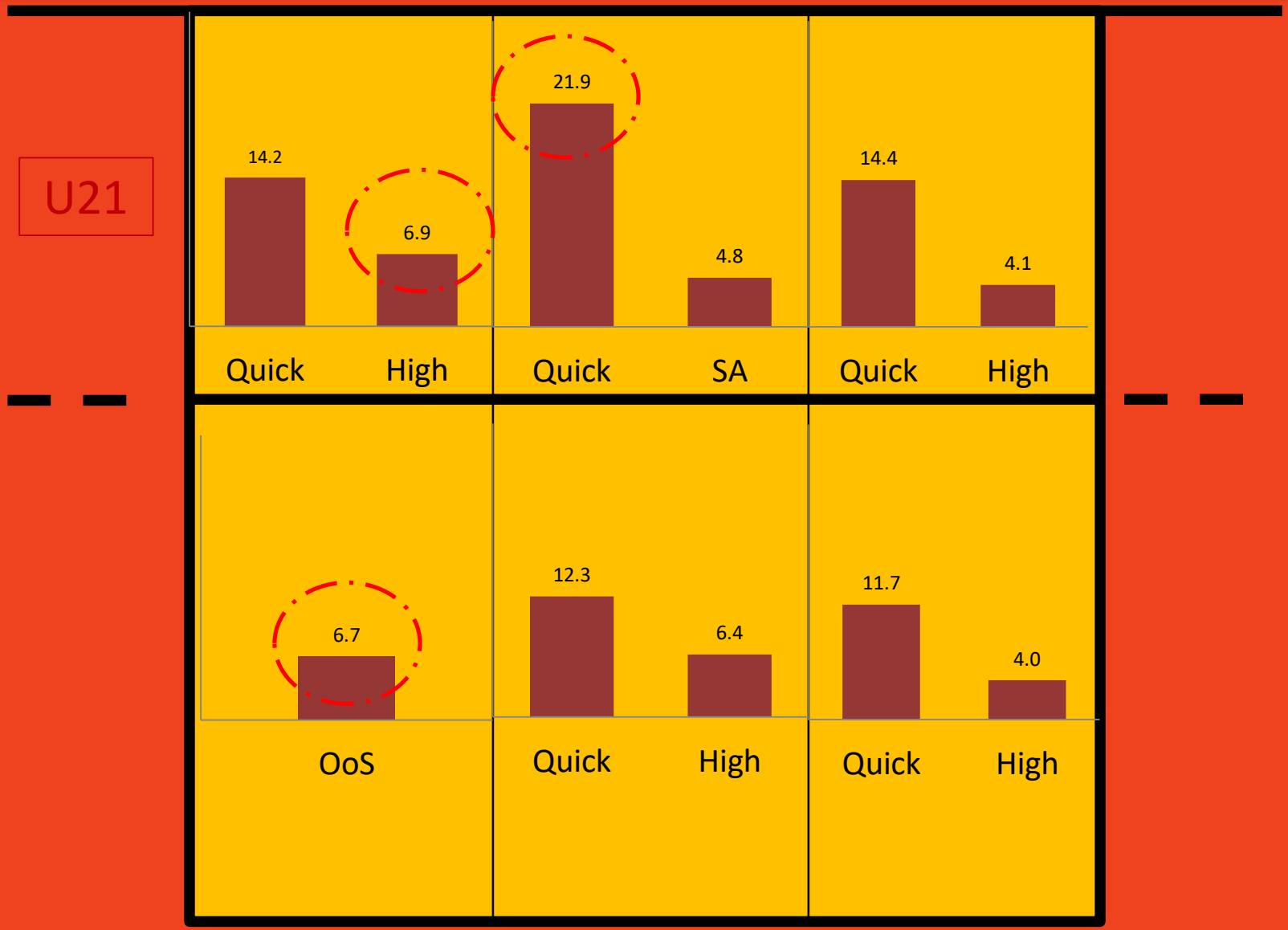

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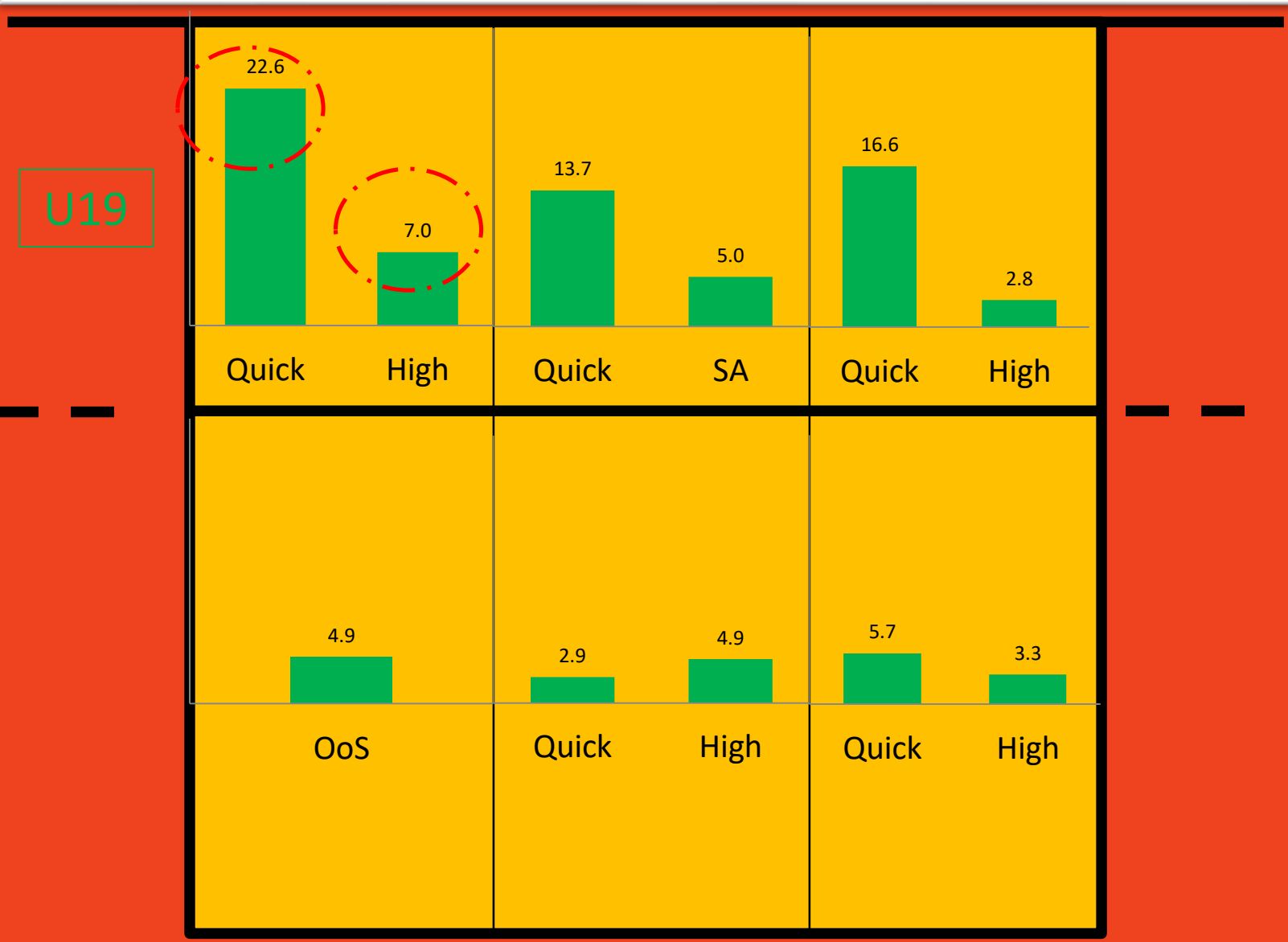

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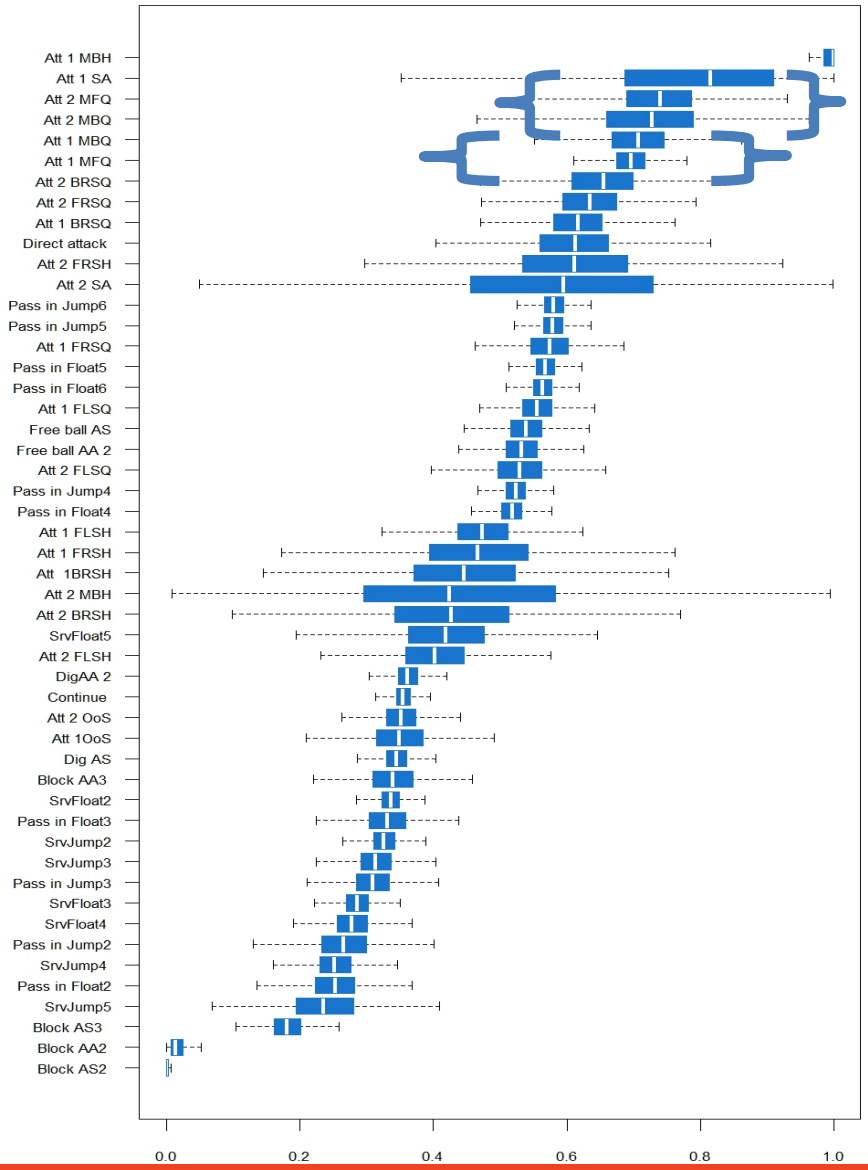
Skill	Importance score	Success Probability	QMR
Pass in Float 5	(1) 27.6	0.581	
Pass in Jump 6	(2) 27.4	0.589	
Pass in Float 6	(3) 27.2	0.569	
Pass in Jump 5	(4) 27.0	0.593	
Pass in Jump 4	(5) 24.9	0.548	
Pass in Float 4	(6) 22.8	0.539	
Attack 1 MF quick	(7)21.9	0.704	
Attack 1 LS quick	(9) 17.2	0.557	
.....			
Attack 1 STR	(41) 4.8	0.722	2.093



Reception

- The penalty for overpass (2nd level pass) is higher compared to this for a 3rd level pass
- The pass level 6 does not present higher prob compared to 5th level
  - The target area of the pass on the net must be more conservative

Reception

- Large discrepancy from 2nd, 3rd level in relation to 4th, 5th,6th level of pass
  - Prob of success is not increasable as the evaluation grade gets higher
  - Change of rating system
  - No fixed intervals between levels of scale
  - Use of mean and sd for evaluation of teams/players maybe is groundless.

Setting/Attack 1

- Quick tempo is more important than slow tempo.
  - Quick tempo of attack of zone 3 and slow tempo of attack of zone 4 are more important choices for Men and U21.
  - For U19 zone 4 is the most important for quick and slow tempo of attack.
- Setter has to attack during 2nd touch of the ball

Complex 1 Contradiction

The target area of the pass on the net must be more conservative

$\neq$

Setter has to attack during 2nd touch of the ball

Thank you for your attention!