Tennis Server Quality Metric

Aiwen Li, Amrita Balajee, Audrey Kuan

Contents

Motivation

- Existing research focuses extensively on match-level prediction (mostly ELO models)
- Basic serving statistics exist, but they tell an incomplete story of server dominance
- Room in the literature for an evaluation of servers in men’s and women’s tennis

Research Objectives

Group players by serve style: Clustering by serve speed, aces, location entropy, and modal serve location

Model serve outcomes: Using server statistics and clusters to predict point outcomes

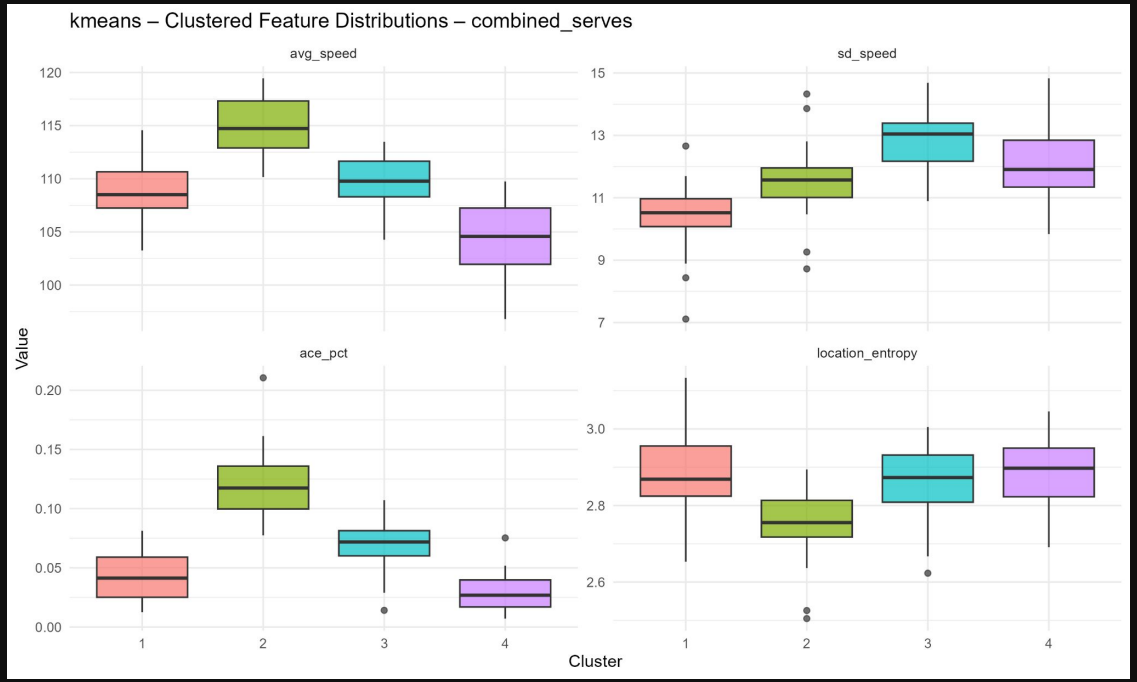
Construct server quality metrics: Creating numerical scores to evaluate servers.

Clustering

Modeling

Server Metrics

K-Means Clustering: Speed, Aces, Entropy



	cluster	avg_speed	sd_speed
1	1	108.960916920795	10.4145155732768
2	2	114.815266722397	11.5776122609671
3	3	109.746322772352	12.9167511071142
4	4	104.32923706341	12.0743616614806

	cluster	ace_pct	location_entropy
1	1	0.0433578436481444	2.872178922517
2	2	0.119837475337068	2.75073665561808
3	3	0.0706959470167434	2.86197448159623
4	4	0.0295168777819073	2.8866707644689

Data: Wimbledon Males, 2021-24, from Jeff Sackmann's point-by-point grand slam data

Server Quality Metrics

Results from Prediction Models

- General form of models: (*Win_pct* or *serve_efficiency*) ~ (*avg_speed + sd_speed + location_entropy + factor(modal_location) + factor(cluster) + interactions of cluster with all other variables*
- 3 models to predict win_pct or serve_efficiency: linear regression, random forest, and XGBoost
- Server metric = **scaled(prediction) + scaled(residual)**

Separate metrics using different data (Wimbledon/U.S. Open, males/females)
All metrics scaled to be between [-1, 1]

Server Quality Metrics

Weighted Average of Server Statistics

- Formula: Σ *[(Importance Score) * (player statistic)]*
- Player statistics: speed (average and sd), entropy, modal serve location (one-hot encoded)
- Importance scores from random forest model that predicts outcome variable (serve efficiency or win percentage)

Separate metrics using different data (Wimbledon/U.S. Open, males/females)
All metrics scaled to be between [-1, 1]

Server Quality Metrics

Weighted Elo

- Baseline metric: server's weighted Elo (wElo)
- Minimum wElo = 1500 in our datasets

Separate metrics using different data (Wimbledon/U.S. Open, males/females)
All metrics scaled to be between [-1, 1]

Outcomes for Prediction Models

Serve Efficiency

- Formula: *(# points won as server where rally count <= 3) / (total # points played as server)*
- How often a serve leads **rapidly** to a point win
- Might undervalue players with good serves who didn't win points quickly

(Point) Win Percentage

- Formula: *(# points won as server) / (total # points played as server)*
- How often a serve leads to a point win, regardless of rally count
- More confounded by other factors (e.g., opponent skill; other hits during rally)

Out-of-sample Predictive Performance

Serve Efficiency (Wimbledon males)

1	cor	p_value	rmse	avg_metric	n	Model
2	0.502909180219369	9.11273224652082e-05	0.98798057154534	-9.2886557031849e-18	55	performance_lm
3	0.524026062162999	4.02518734147486e-05	0.966767672442521	5.20417042793042e-18	55	performance_rf
4	0.521279498615177	4.49032935644374e-05	0.969552981810417	1.0857791938273e-17	55	performance_xgb
5	0.514238774755903	5.91794182818541e-05	0.976656749290078	1.18631430436687e-17	55	weighted_avg
6	0.0214043186327044	0.875575490603796	0.990804165032057	-1.85565751597868e-15	56	avg_welo

Metrics based on 2021-24 data; tested on serve efficiency from 2018-19 data

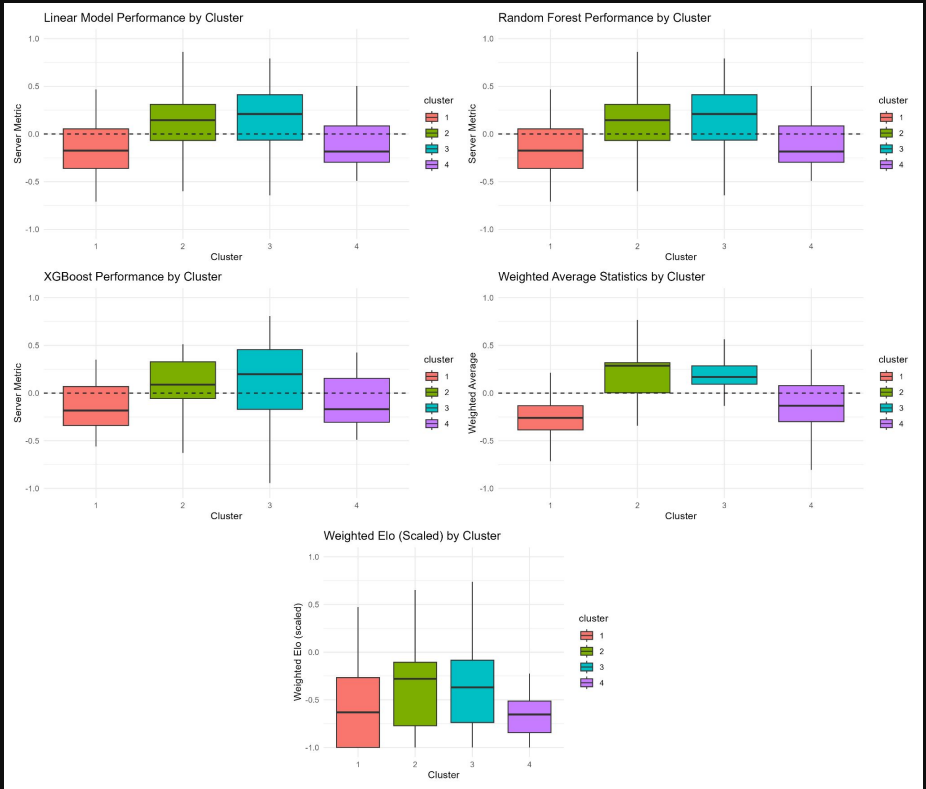
Out-of-sample Predictive Performance

Win Percentage (Wimbledon males)

1	cor	p_value	rmse	avg_metric	n	Model
2	0.309249505097055	0.0215953931066117	1.16463848038404	2.11517987468536e-17	55	performance_lm
3	0.298792693380145	0.0266984441446279	1.17342071130787	1.83895473028621e-17	55	performance_rf
4	0.311730967811898	0.0205136945428977	1.16254466562337	5.50183320619462e-18	55	performance_xgb
5	0.13516046428811	0.325175695971142	1.30316167877752	-1.93185114370144e-17	55	weighted_avg
6	0.284334647347935	0.0336846431777086	0.950126490239438	-1.85565751597868e-15	56	avg_welo

Metrics based on 2021-24 data; tested on win percentage from 2018-19 data

Distn of Server Quality Per Cluster



Server metrics based on win_pct prediction models for Wimbledon males data

Alexander Zverev

Serve Details

Average Serve Speed
119.448 mph

SD Serve Speed
11.783 mph

Ace Percentage
0.116

Location Entropy
2.833

Modal Serve Location
WC - DNCTL
(center; not close to line)

Cluster
2

Metrics (based on serve efficiency; scaled from [-1, 1])

RF performance metric	0.887
Weighted Stats	0.767
wElo (scaled)	-0.006

- Placed in “Powerhouse” server cluster
- Known for high speed, powerful serve

Future Work

- Adding serve spin and placement data to the metrics (if there is data)
- Ace percentage as an outcome variable
- Generate actionable insights for players (e.g., personalized training plan for certain serve styles and opponents)
- Server metric that updates live throughout a match