AGE OF PEAK PERFORMANCE AMONG SOCCER PLAYERS IN SWEDEN

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CONTENT

- Background
- Related work
- Research questions
- Data
- Method
 - Performance metrics
 - Mathematical model
- Results
- Conclusion

BACKGROUND

- In sports, the performance of athletes varies with age.
- At some point, athletes reach a peak in their performance.
 - When does this peak occur?
 - What happens before and after the peak?
- Knowledge of an athlete's performance trajectory can aid in e.g., player selection and decision-making.
- The peak age is dependent of the sport.
- Age-related biases are also present within sports.





RELATED WORK



BERTHELOT, G. ET AL.

The age-performance relationship in the general population and strategies to delay age related decline in performance. *Archives of Public Health* 77, 51 (2019).



BRADBURY, J.C.

Peak athletic performance and ageing: Evidence from baseball. *Journal of Sports Sciences* 27(6), 599–610 (2009)



BRANDER, J.A., ET AL.

Estimating the effects of age on NHL player performance. Journal of Quantitative Analysis in Sports 10(2), 241–259



DENDIR, S.

When do soccer players peak? A note. *Journal of Sports Analytics* 2(2), 89–105 (2016).



KALÉN, A., ET AL.

Are soccer players older now than before? Aging trends and market value in the last three decades of the UEFA Champions League. Frontiers in Psychology 10, 76 (2019).



OTERHALS, G., ET AL.

Age at nomination among soccer players nominated for major international individual awards: A better proxy for the age of peak individual soccer performance? *Frontiers in Psychology* 12(661523) (2021).

RESEARCH QUESTIONS

- What performance indicators are relevant for determining peak performance (in lower ranked leagues)?
- At which age do soccer players in Sweden reach their peak level of performance?
- When does the peak occur for different playing positions?



DATA: STRUCTURE

- Two datasets
 - Event data from the three highest tiers in Swedish soccer.
 Approx. ~1500 events/game.
 Supplied by Football Analytics Sweden AB
 - Event data used the *Soccer Player Action Description Language* (SPADL)
 - Player metadata.
 Retrieved from TransferMarkt



DATA: REPRESENTATION

SPADL attributes

Table 1: Attributes in the SPADL data representation.

Attribute	Description
Match id	Unique id of the match.
Action id	Unique id of the action within the match.
Period id	The id of the period/half.
Seconds	Time of the action.
Player id	The id of the player performing the action.
Team id	The team id of the player.
X start	X coordinate at the start of the action.
Y start	Y coordinate at the start of the action.
$X \mathrm{end}$	X coordinate at the end of the action.
$Y \mathrm{end}$	Y coordinate at the end of the action.
Action	The action being performed by the player.
Result	The result of the action.
Body part	The part of the body used to perform the action.

SPADL action types

Table 2: Action types in the SPADL representation.

Action type	Description	\mathbf{Result}
Bad touch	Player makes a bad touch and loses the ball.	Fail, Own goal ^a
Clearance	Player clearance.	Success
Cross	Cross into the box.	Success ^b , Fail, Offside
Crossed corner	Corner crossed into the box.	Success ^b , Fail
Crossed free kick	Free kick crossed into the penalty box.	Success ^b , Fail, Offside
Dribble	Player dribbles at least 3 meters with the ball.	Success
Foul	Foul.	Fail, Red card, Yellow card
Free kick shot	Direct free kick on goal.	Success ^c , Fail
Goal kick	Goal kick.	Success
Goalkeeper claim	Keeper catches a cross.	Success ^d , Fail
Goalkeeper pick-up	Keeper picks up the ball.	Success
Goalkeeper punch	Keeper punches the ball clear.	Success
Goalkeeper save	Keeper saves a shot on goal.	Success
Interception	Interception of the ball.	Success ^e , Fail
Pass	Normal pass in open play.	Success ^b , Fail, Offside
Penalty shot	Penalty shot.	Success ^c , Fail
Short corner	Short corner.	Success ^b , Fail
Short free kick	Short free kick.	Success ^b , Fail, Offside
Shot	Shot attempt not from penalty or free kick.	Success ^c , Fail
Tackle	Tackle on the ball.	Success ^e , Fail
Take-on	Attempt to dribble past opponent.	Success ^f , Fail
Throw-in	Throw-in.	Success ^b , Fail

^a Was originally the result of a shot but now is the result of a bad touch.

 $^{\rm b}$ Reaches teammate. $^{\rm c}$ Goal. $^{\rm d}$ Does not drop the ball. $^{\rm e}$ Regains possession. $^{\rm f}$ Keeps possession.

DATA: PLAYERS

- A total of 1693 players:
 - 317 forwards,
 - 419 midfielders,
 - 422 defenders,
 - 101 goalkeepers.
- Filtered players with < 450 minutes played in a season.
- Age was computed at June 1st each calendar year.





PERFORMANCE METRICS

- Player performance needs to be quantified.
- Historically, has been subjective but recently more objective metrics have been developed.
- A variety of metrics exist, e.g.
 - Expected goals (xG)
 - Expected threat (xT)
 - Valuing Actions by Estimating Probabilities (VAEP)
- Each metric has their pros and cons.

PERFORMANCE METRICS

XT

• Evaluates attacking prowess.



VAEP - DEFENSIVE

• Evaluates on-ball defensive contribution.



VAEP - SHOT ONLY

• Evaluates shooting/scoring ability.



PSXG-GA

• Evaluates goalkeeping ability.



VAEP - NON-SHOT OFFENSIVE

• Evaluates e.g. passing, crossing, dribbling etc.



COMBINED PERFORMANCE METRIC

- Standardize each metric to have mean zero and unit variance.
- Sum the respective metrics for the positions.

MODEL DEFINITION

$$y_{i} \sim \text{Normal}(\mu_{i}, \sigma_{i}), \quad i = 1, \dots, n_{p}$$
$$\mu_{i} = \alpha_{\mu, \text{player}[i]} + \beta_{\mu, \text{player}[i]} + s(\text{Age}_{i}, \tau_{\mu})$$
$$\sigma_{i} = \alpha_{\sigma} + s(\text{Age}_{i}, \tau_{\sigma})$$
$$\begin{bmatrix} \alpha_{\mu}, \text{player} \\ \beta_{\mu, \text{player}} \end{bmatrix} \sim \text{MVNormal} \left(\begin{bmatrix} \alpha_{\mu} \\ \beta_{\mu} \end{bmatrix}, \Sigma_{\mu} \right)$$
$$\Sigma_{\mu} = \begin{bmatrix} \nu_{\alpha_{\mu}} & 0 \\ 0 & \nu_{\beta_{\mu}} \end{bmatrix} \mathbf{R}_{\mu} \begin{bmatrix} \nu_{\alpha_{\mu}} & 0 \\ 0 & \nu_{\beta_{\mu}} \end{bmatrix}$$
$$(\alpha_{\mu}, \alpha_{\sigma}, \beta_{\mu}) \sim \text{Normal}(0, 1)$$
$$(\tau_{\mu}, \tau_{\sigma}) \sim \text{HalfCauchy}(0, 1)$$
$$\nu_{\alpha_{\mu}} \sim \text{HalfCauchy}(0, 0.5)$$
$$\nu_{\beta_{\mu}} \sim \text{HalfCauchy}(0, 0.1)$$
$$\mathbf{R}_{\mu} \sim \text{LKJcorr}(1)$$

Method

- Estimate a model per position *p*.
- Use a model that allows for individual and group-wise variation over age.
- Train a hierarchical Bayesian model with thin-plate splines.
 - Set weakly informative priors for α , β , and τ .
 - Prior for $\boldsymbol{\nu}$ was based on a belief of lower standard deviation.

RESULTS

POSTERIOR PREDICTIVE DISTRIBUTION



- Actual - Simulated

CONDITIONAL AGE EFFECT



SUMMARY STATISTICS

	Percentile			Mean	Std. Dev.
	25^{th}	50^{th}	75^{th}		
Forwards	23.0	24.6	27.2	25.1	3.25
Midfielders	22.9	25.8	27.4	25.4	3.15
Defenders	23.1	24.7	27.8	25.6	3.43
Goalkeepers	23.9	25.6	29.1	26.6	3.95

CONCLUSIONS



- Studied age-performance relationship of soccer players in Sweden.
- Players typically attain peak performance between ages 25 and 27.
- Peak age varies by position, with forwards peaking the earliest and goalkeepers the latest.
- Future work may utilize more finegrained player-role classification and relate results between different leagues.