



User evaluation of the effectiveness of geoprocessing tools for football data visualization

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Research Identification

Objectives

*To evaluate the effectiveness of three geoprocessing tools (**Nearest Distance calculation, Voronoi diagram, and Convex Hull**) for visualizing football tracking data.*

To generate three geovisualizations based on open football tracking data using the geoprocessing tools considered.

To design a user experiment to evaluate the effectiveness of the geovisualizations within football and non-football knowledge users.

To find football data analysis parameters to link previous research with the effectiveness evaluation.

Research Questions

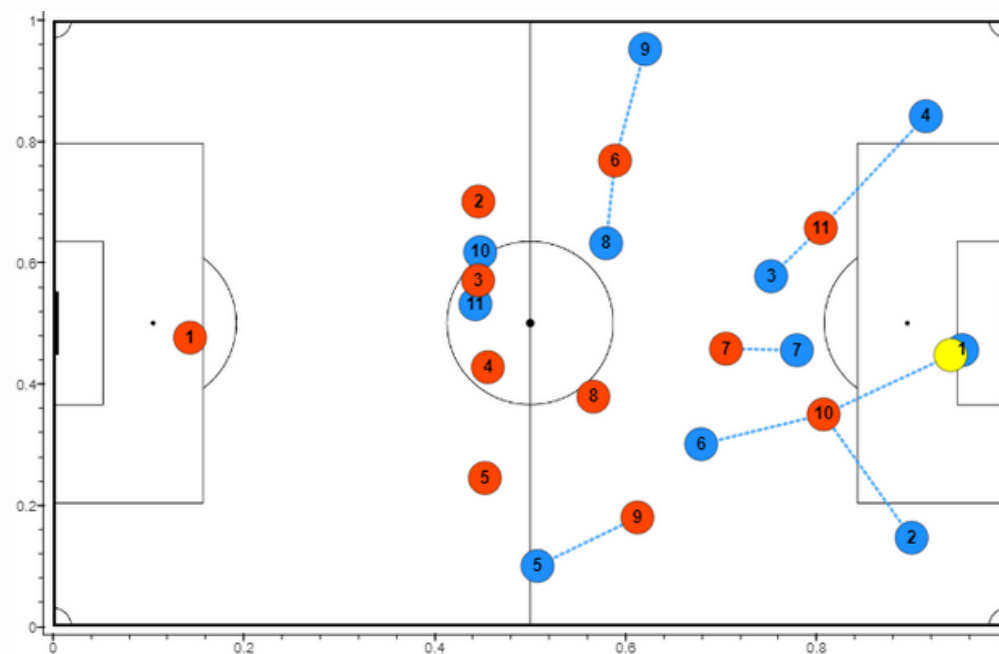
RQ1. *How effective are **geoprocessing tools** on football understanding in **users** with **football knowledge** and **non-football knowledge**?*

RQ2. *Which parameters of football data analysis can be considered to evaluate the three geoprocessing tools?*

Overview

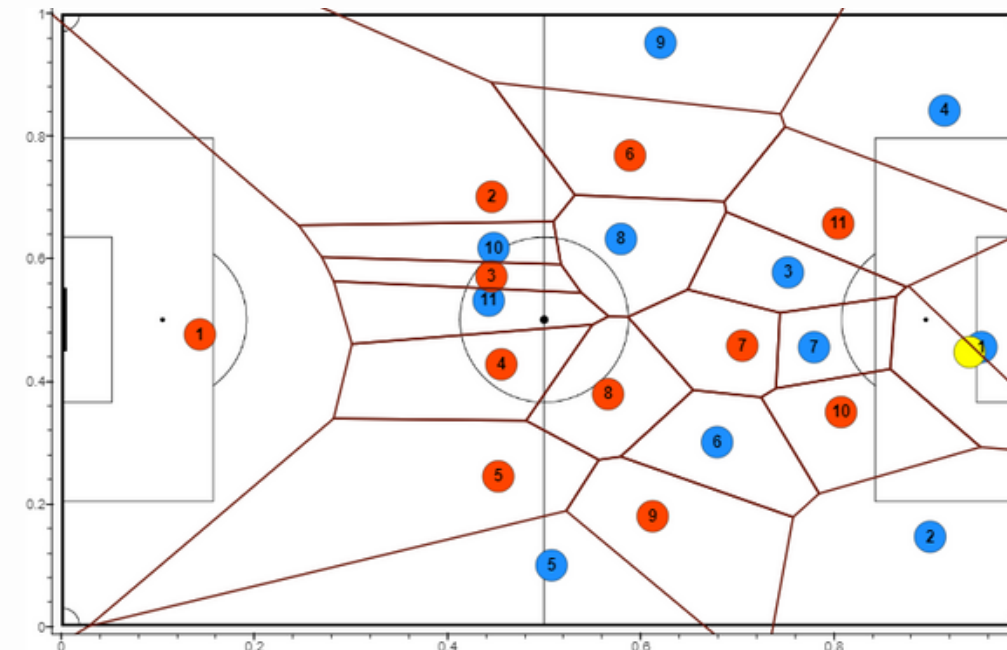
Visualizations enhanced with geoprocessing tools or **Geovisualizations** offer a powerful way to capture the dynamic nature of football games through spatiotemporal analysis and visualization (Andrienko et al., 2021; Kotzbek & Kainz, 2014).

Post-match football analysts try to understand spatial point patterns during a game with the help of geoprocessing tools. Researchers use tools such as Nearest Distance calculation, Voronoi diagram, and Convex Hull for data analysis rather than visualization.



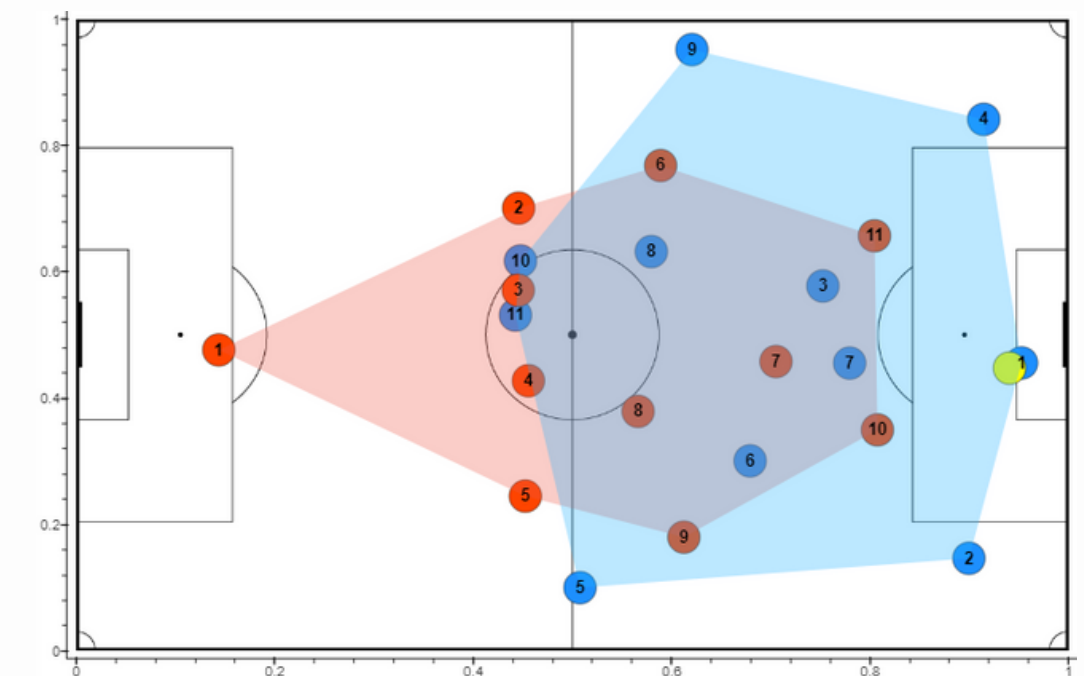
Nearest Distance calculation

The tool considers the nearest distance from each of the defending team players to the attacking team players and displays a dotted line from the defending team player to the nearest attacking player



Voronoi diagram

The Voronoi diagram generates cells that are considered dominant regions for each player.



Convex Hull

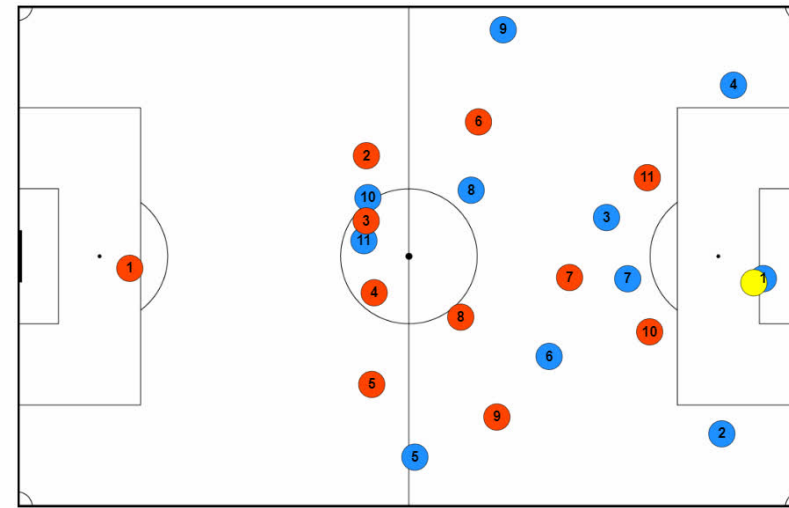
The polygons are constructed based on the outer players of each team; the position of the ball is avoided for this animation.

Methodology

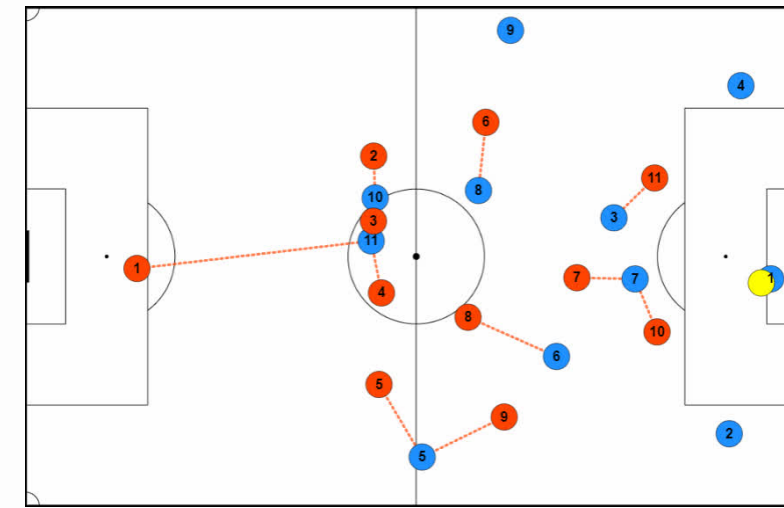
Method	<i>Online Survey</i>	
Participants	<i>(n=109)</i>	
Materials	<i>2x3 factorial design</i> <ul style="list-style-type: none">• <i>Factor #1: raw animation versus geoprocessing tool animation</i>• <i>Factor #2: type of geovisualization: Nearest Distance, Voronoi, Convex Hull.</i>	
Task	Evaluation questionnaire (close-end questions) based on football knowledge parameters to evaluate the understanding football fundamentals.	
Analysis	<i>Football knowledge parameters:</i> <ul style="list-style-type: none">• Playing formation• Attacker-defender distance• Relative distance to intercept a shot• Dominant region• Distance between teammates• Playing space	<i>Usability measures:</i> <ul style="list-style-type: none">• Effectiveness: correct answers

Stimuli - Animations evaluated

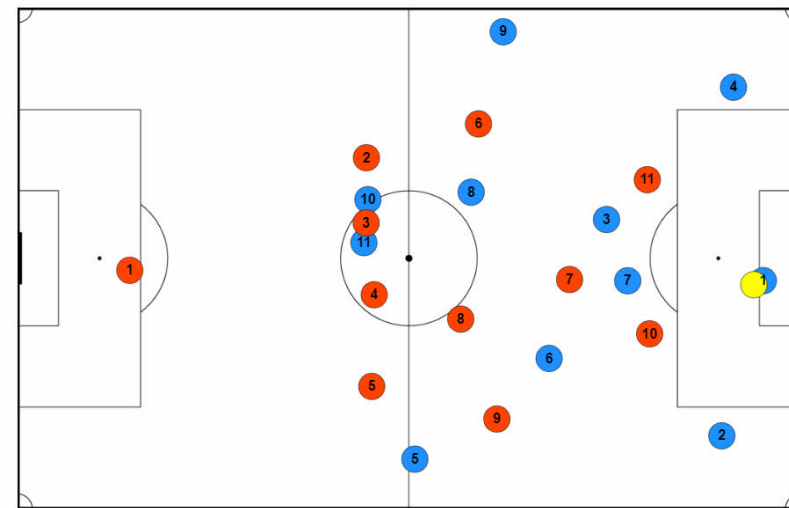
**Raw
animation**



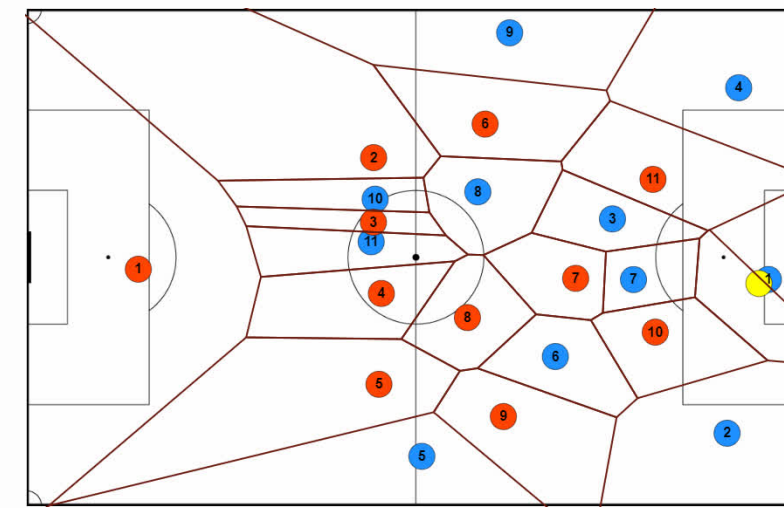
VS



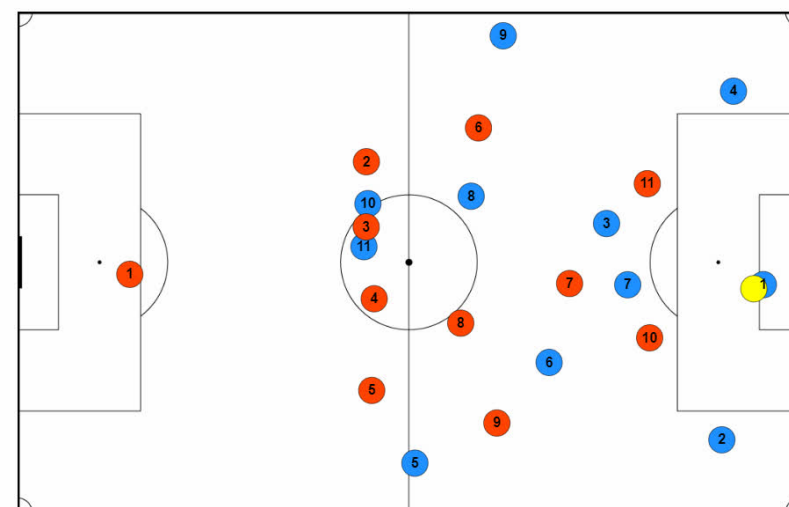
Nearest Distance calculation



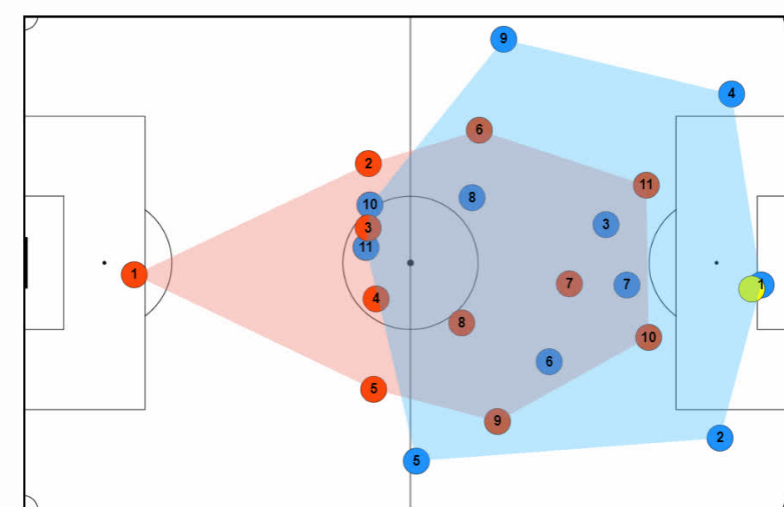
VS



Voronoi diagram



VS



Convex Hull

The football tracking dataset used for the animations is from Metrica Sports (<https://github.com/metrica-sports/sample-data.git>)

Survey structure

Football Geovisualizations

Information and Informed Consent

Information

Hello! Thanks for opening the link to this survey.

I am Joel and currently doing my master's thesis research about football geovisualizations. I am part of the International MSc. on Cartography of TUMunich, TUWien, TUDresden and the University of Twente.

On this first page, you can have an overview of what is this survey about. Please, take your time to read it and I will be thankful to you if you accept to move forward. If you have any questions, do not hesitate to contact me at: joel.saez@tum.de

About the research

Geovisualizations or GIS enhanced visualizations, offer a powerful way to capture the dynamic nature of football* games through spatiotemporal analysis and visualization, enhancing the perception and understanding of football, also known as soccer.

Informed Consent*

Statement by the participant:

I have been invited to participate in this study about football animations. I have read the previous information. I agree that the data gathered might be published in a research paper. I consent voluntarily to be a participant in this study.

Yes

No

Submit

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Demographic information

What gender do you identify as?*

Female

Male

Non-binary

Prefer not to say

Which category below includes your age?*

18-20

21-25

26-30

31-35

36-40

41-45

46-50

51-55

56-60

60 or older

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Football knowledge

How long does a football match take?*

90 minutes

45 minutes

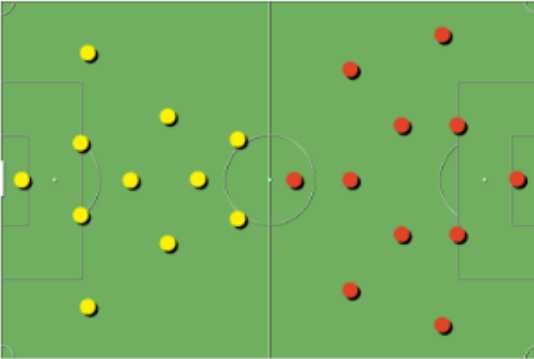
I don't know

Which team won the last FIFA World Cup?*

France

Argentina

I don't know



From the image above, what is the lineup of the teams?*

Team yellow 4-3-1-2 and Team red 4-2-3-1

Team yellow 4-2-1-3 and Team red 5-2-3

I don't know

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Training animation

Basic details about football

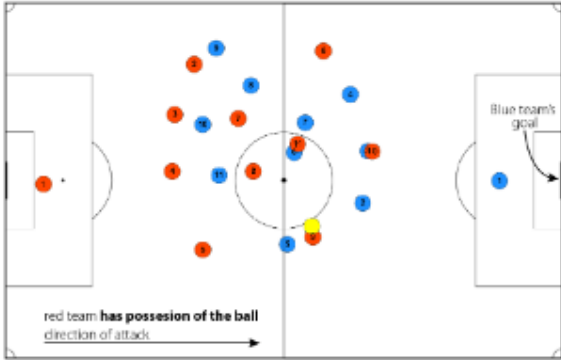
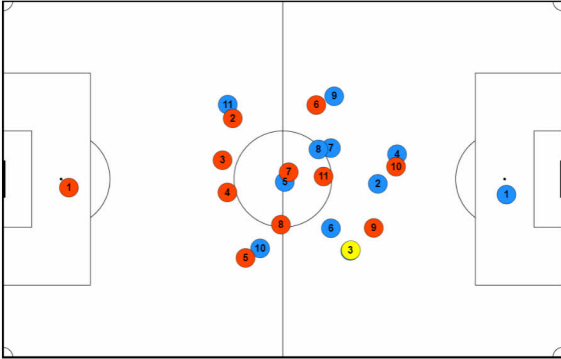
Team red and blue are displayed on a basic football pitch. Team red on the left side and team blue on the right side.
Both teams fight for the possession of the ball in yellow color.
If a team has possession of the ball, it attacks the opposing side of the pitch in an attempt to score at the goal of the other team. Conversely, the team that does not have possession of the ball defends its own goal against the attacking team.

Players numbers

Each player has a number to be identified.
Goalkeepers are number 1 and are near the goal of their own team.
Defenders, midfielders, and forwards have numbers in ascending order up to 11.

Position of players on the pitch

Defenders protect the goal near the goalkeeper of their own team.
Midfielders run along the middle of the pitch.
Forwards try to remain ahead of their team to be able to attack when the team has ball possession.



Evaluation: Animation 6



What is the formation of the red team?*

4-4-2

1-3-4-2

3-5-2

I don't know

When does a team cover a larger area of the pitch?*

When the team is Attacking

When the team is Defending

I don't know

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Submit

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1 Informed consent

2 Demographic information

3 Football knowledge Information

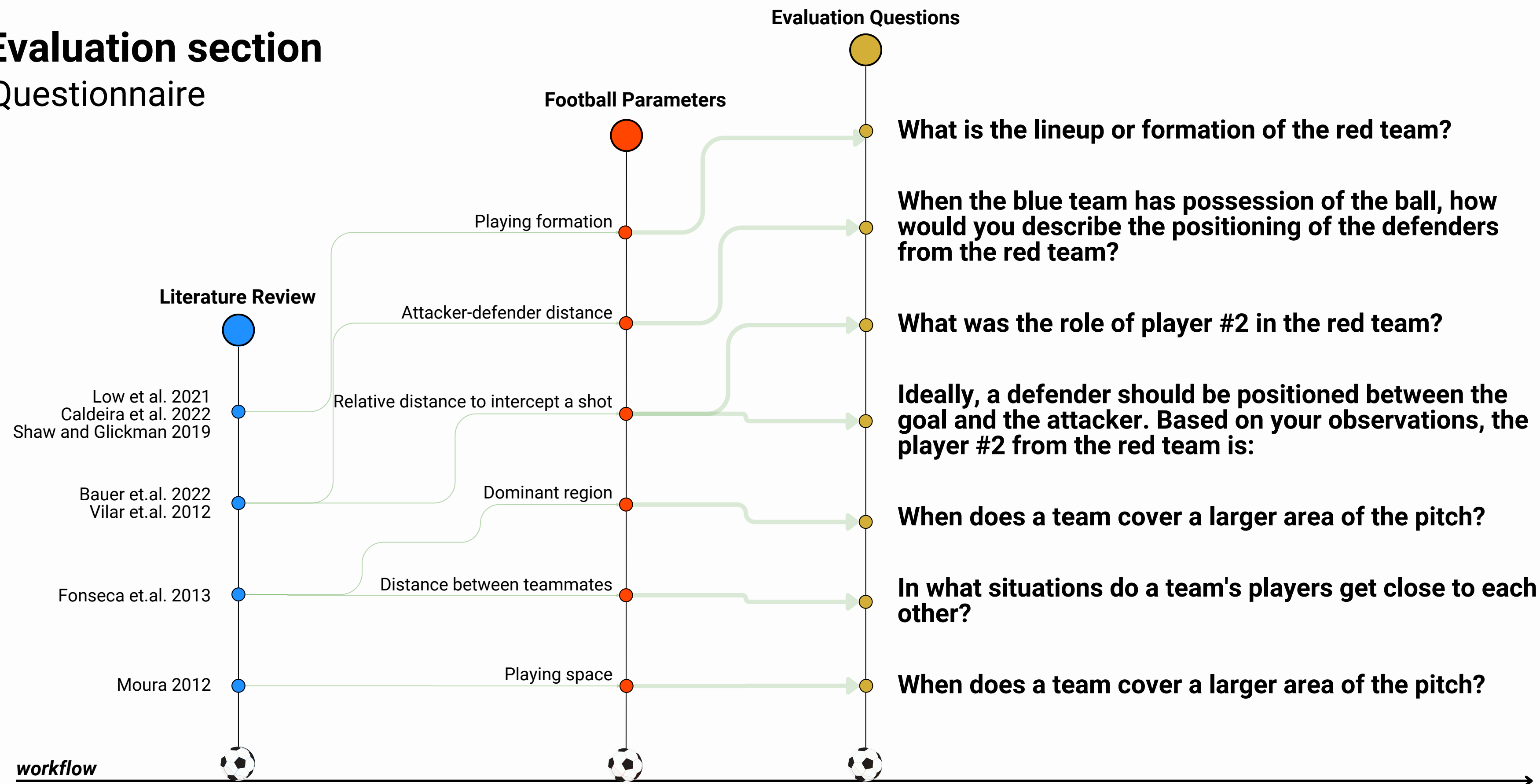
4 Participant Training

5 Evaluation

6 User evaluation of the effectiveness of geoprocessing tools for football data visualization

Evaluation section

Questionnaire



Pilot testing

1 Pilot test

Supervisor
TUDresden Writing center
Cartographer

Evaluation questionnaire
Training section
Grammar and clearness
Animations aesthetics

2 Pilot test

7 Cartography and Geomatic
master students

GIS enhanced Football Animations

Please feel free to share any comments or suggestions you may have. Thank you!

Pilot Test

Thank you for participating in this pilot test.

The following 2 pages are not part of the final survey but are dedicated to collecting feedback.

So please, I kindly request your assistance in providing feedback to help me improve.

If you find it more convenient to have a call or video chat for sharing your feedback, please let me know. I would be delighted to schedule a discussion with you to explore your recommendations in greater detail. Your insights are highly valuable to me.

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I found all the questions and tasks easy to comprehend.

Strongly disagree Disagree Neutral Agree Strongly agree

Feel free to provide feedback to the statement above.

Please feel free to share any comments or suggestions you may have. Thank you!

The statements of the questions and tasks were unambiguous.

Strongly disagree Disagree Neutral Agree Strongly agree

255

When the blue team has possession of the ball, how would you describe the positioning of the defenders from the red team?

255

What was the role of player #2 in the red team?

255

Ideally, a defender should be positioned between the goal and the attacker. Based on your observations, the player #2 from the red team is:

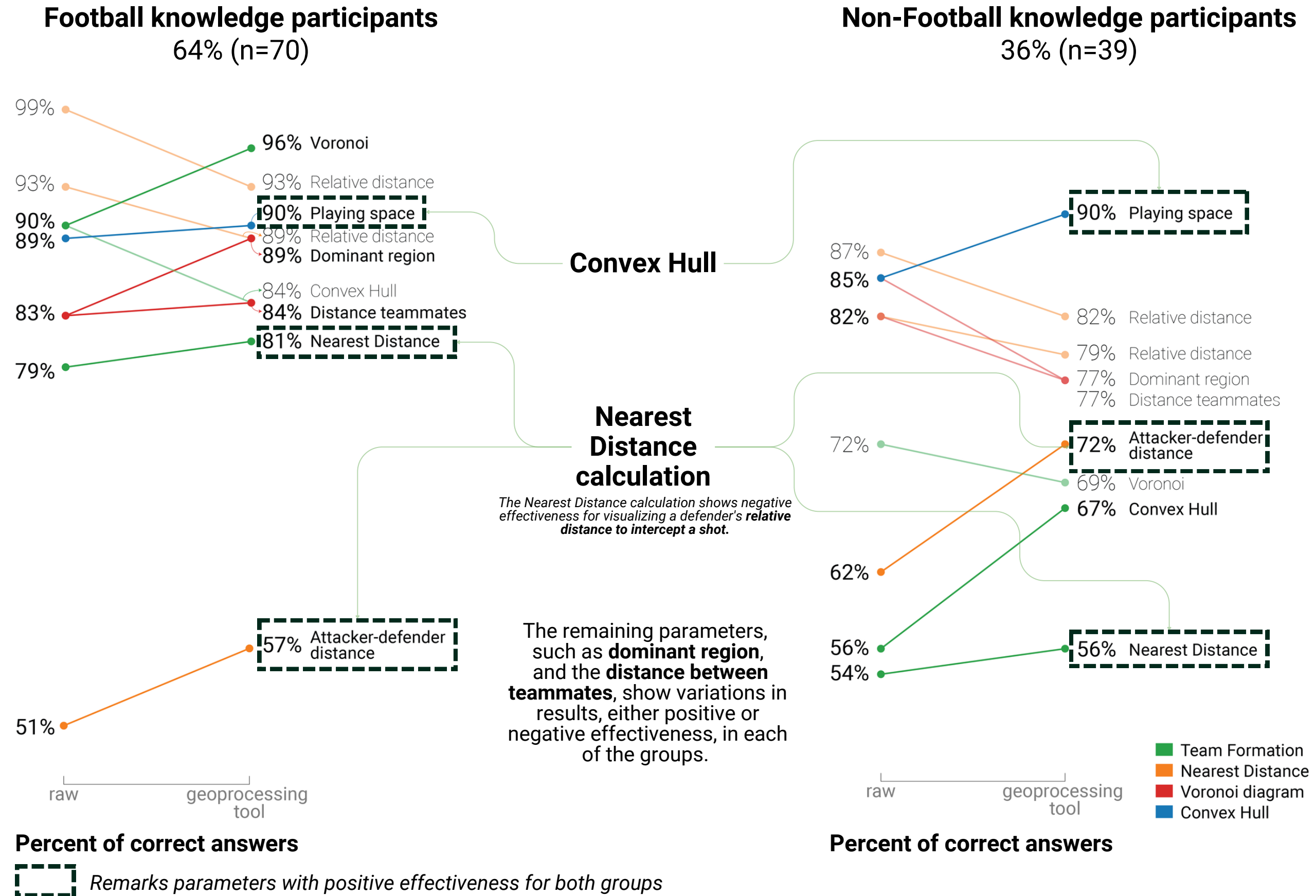
255

Parameters

Statements

- Lack of context → The training information provided sufficient context for me to understand the tasks to solve.
- Clearness →
 - I found all the questions and tasks easy to comprehend.
 - The statements of the questions and tasks were unambiguous.
- Wording → The training section included all the football terms used in the questionnaire.
- Animation design →
 - I can clearly differentiate between the teams through the selected colors for the animation.
 - I was able to easily identify the ball in the animation.
 - The animation speed was appropriate, allowing me to answer the questions and solve the tasks effectively.

Results



Conclusion

RQ2. Which parameters of football data analysis can be considered to evaluate the three geoprocessing tools?

From the literature review, I selected six parameters that researchers use for tactic analysis in football. Based on these parameters, I evaluated the three geoprocessing tools.

RQ1. How effective are **geoprocessing tools** on football understanding in **users** with **football knowledge** and **non-football knowledge**?

Results show differences between knowledge groups when visualizing football tracking data with different geoprocessing tools.

Each geoprocessing tool analyzed proved effective for specific football tactic parameters and a specific knowledge group.

When considering using a geoprocessing tool for visualizing football data, it is necessary to consider the football tactic parameter that aims to be shown.

Further implementations can explore a user interface to provide users with more interaction and pseudo-manipulation of data.

These results close the gap between cartography and football data analysis and serve as a reference for further cartographic visualization research.

Thanks

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