Cartography M.Sc.

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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

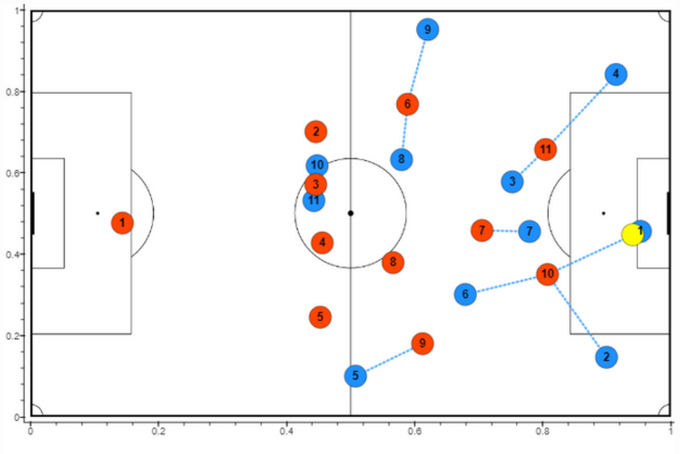
RQ1. *How effective are **geoprocessing tools** on football understanding in **users** with f**ootball knowledge** and **non-football knowledge**?*

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

Overview

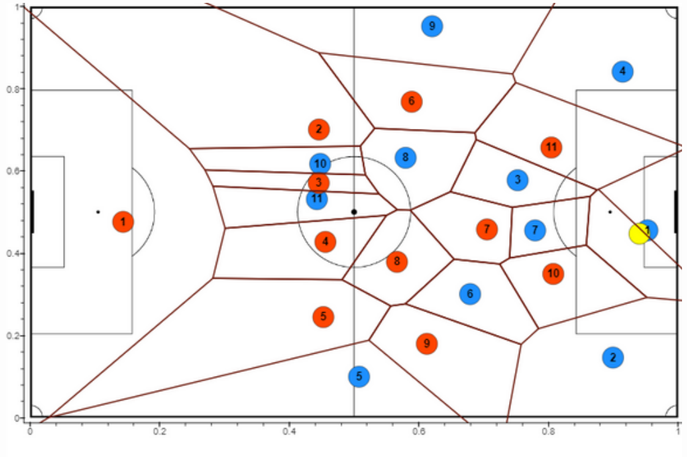
Visualizations enhanced with geoprocessing tools or **Geovisualizations** offer a powerful way to capture the dynamic nature of football games through spatiotemporal analysis and visualization (Andrienko et al., 2021; Kotzbek & Kainz, 2014).

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.



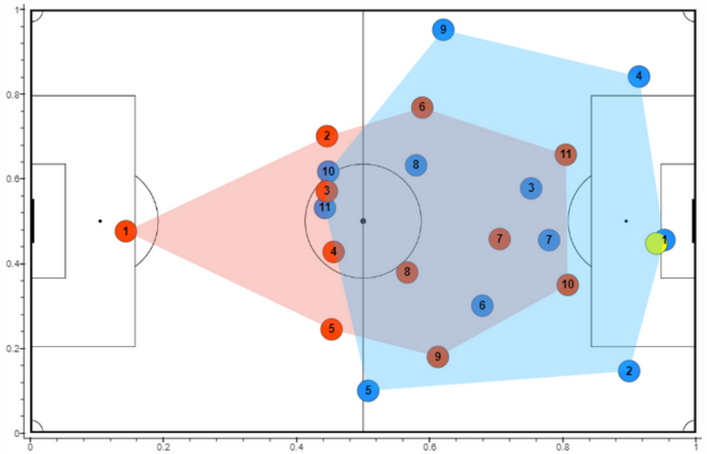
Nearest Distance calculation

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 *Online Survey*

Participants *(n=109)*

Materials *2x3 factorial design*

- *Factor #1: raw animation versus geoprocessing tool animation*
- *Factor #2: type of geovisualization: Nearest Distance, Voronoi, Convex Hull.*

Task Evaluation questionnaire (close-end questions) based on football knowledge parameters to evaluate the understanding football fundamentals.

Analysis

Football knowledge parameters:

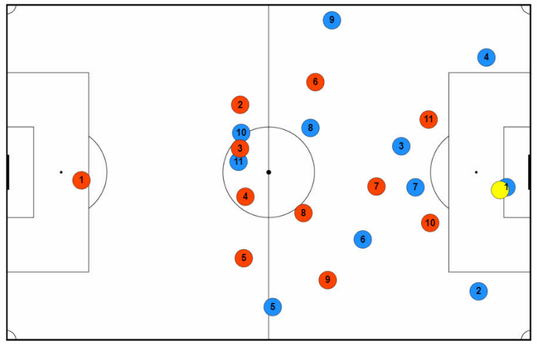
- Playing formation
- Attacker-defender distance
- Relative distance to intercept a shot
- Dominant region
- Distance between teammates
- Playing space

Usability measures:

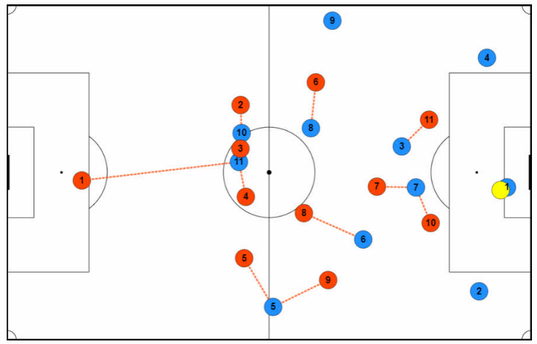
- Effectiveness: correct answers

Stimuli - Animations evaluated

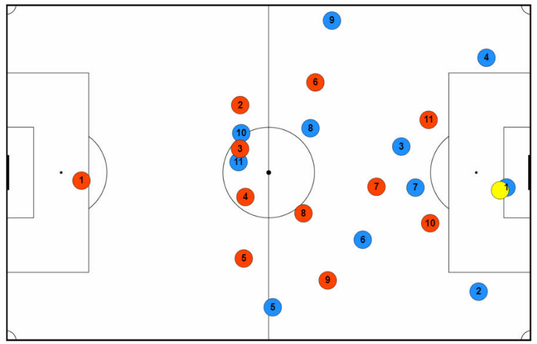
Raw animation



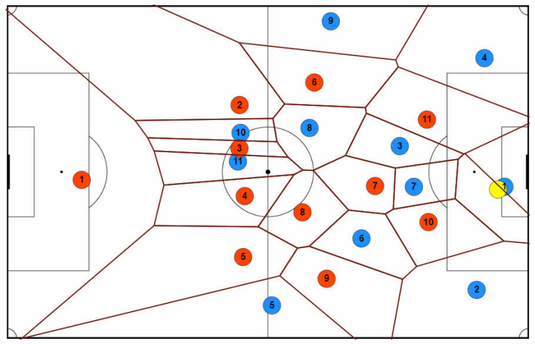
VS



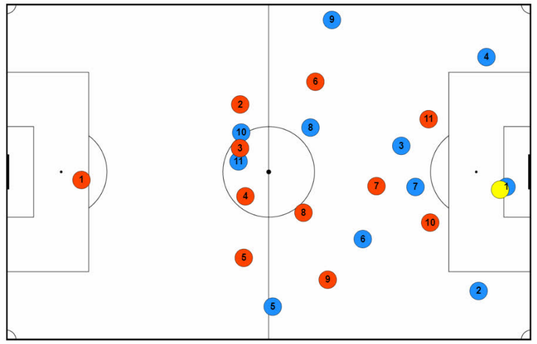
Nearest Distance calculation



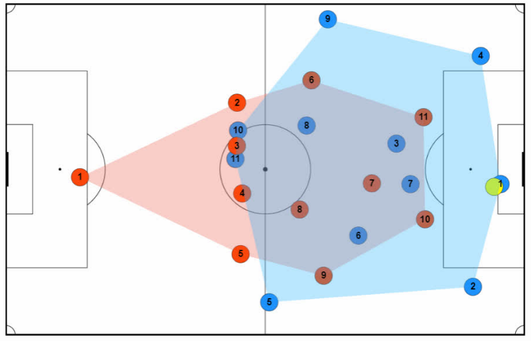
VS



Voronoi diagram



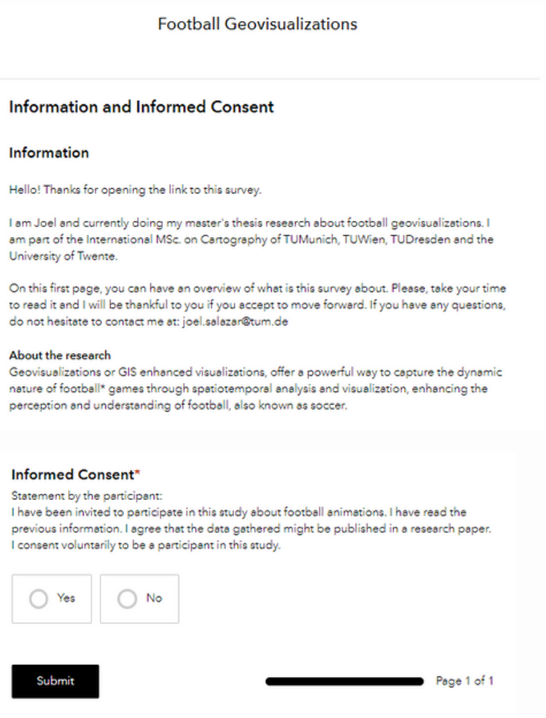
VS

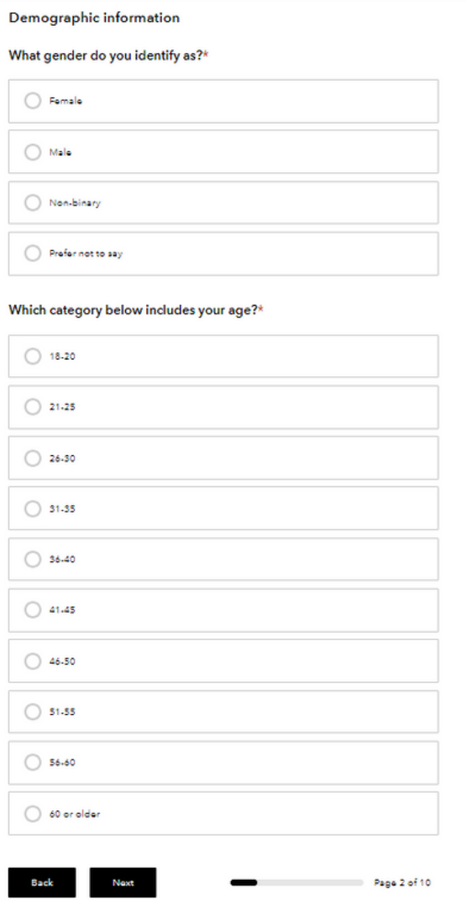


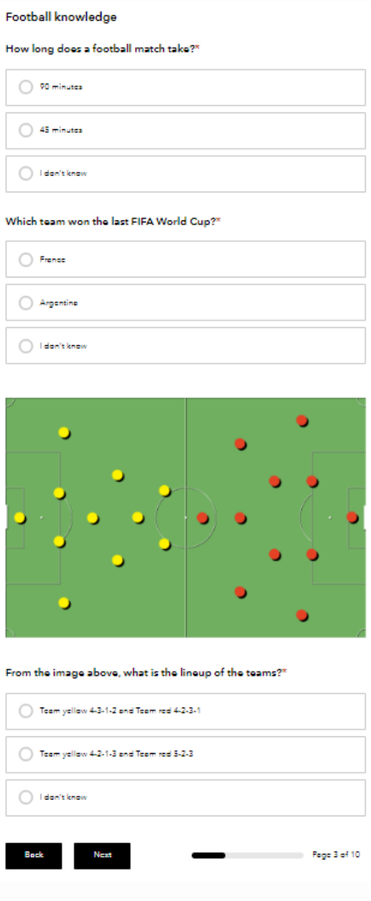
Convex Hull

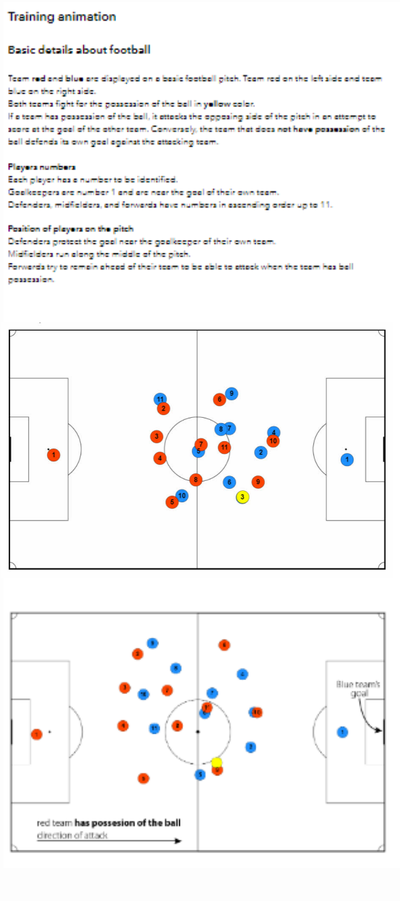
The football tracking dataset used for the animations is from Metrica Sports (https://github.com/metrica-sports/sample-data.git)

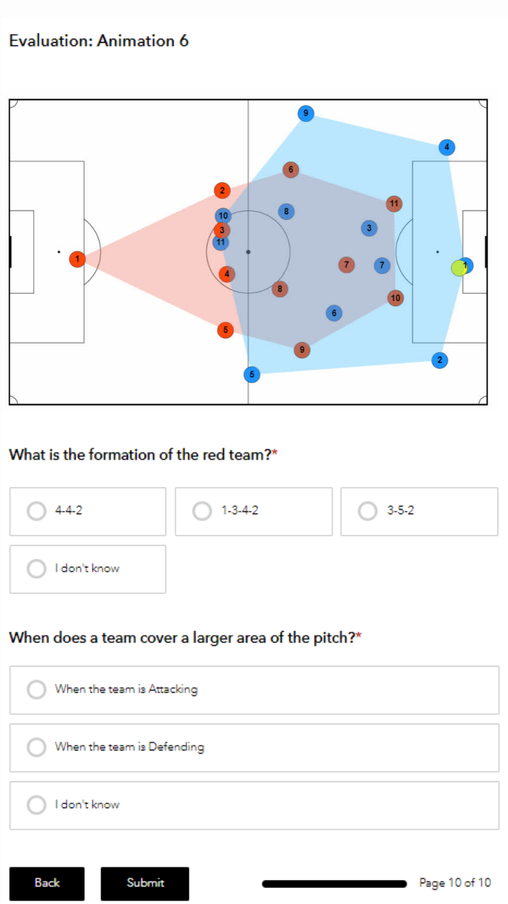
Survey structure











1 Informed consent

2 Demographic information

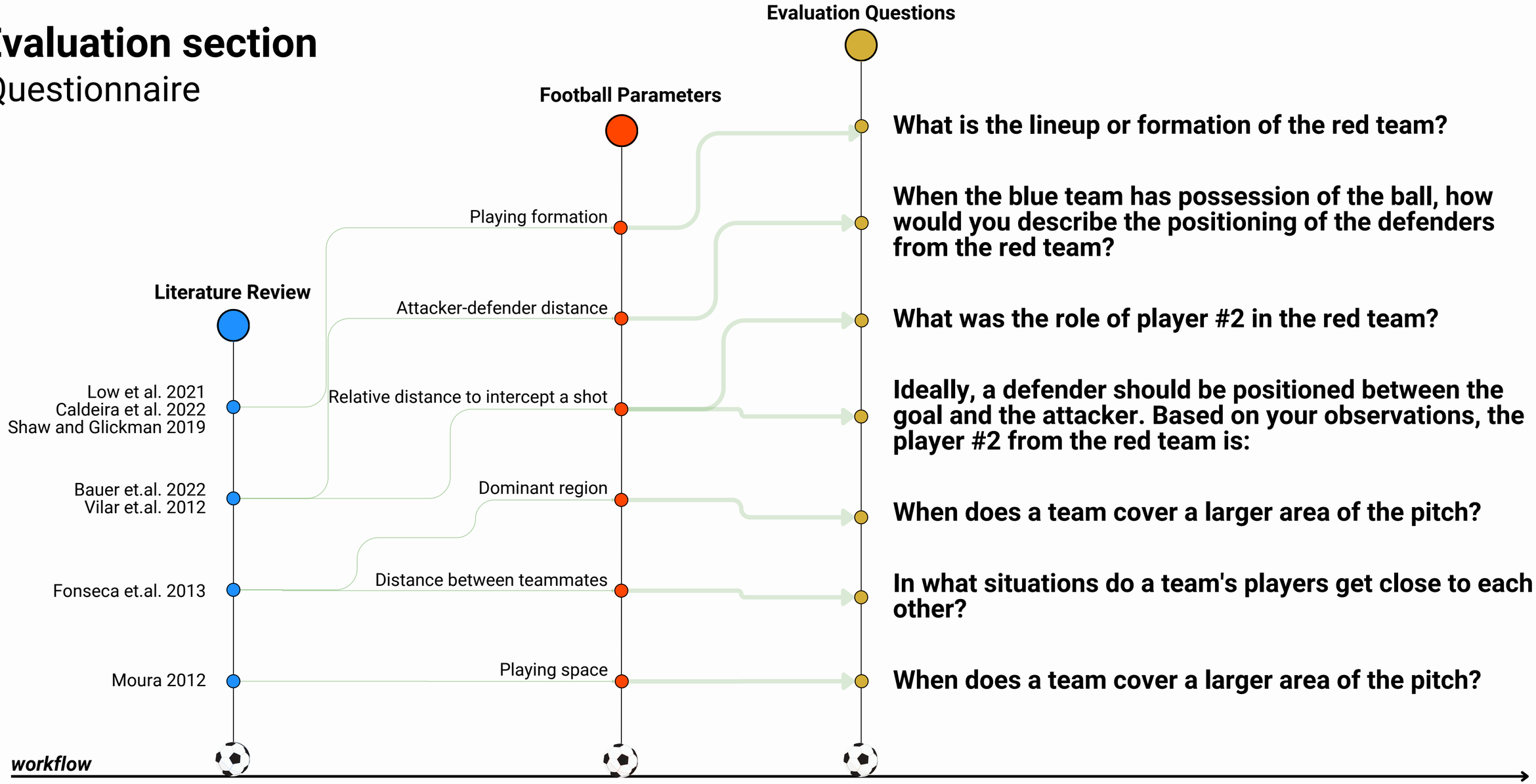
3 Football knowledge Information

4 Participant Training

5 Evaluation

Evaluation section

Questionnaire

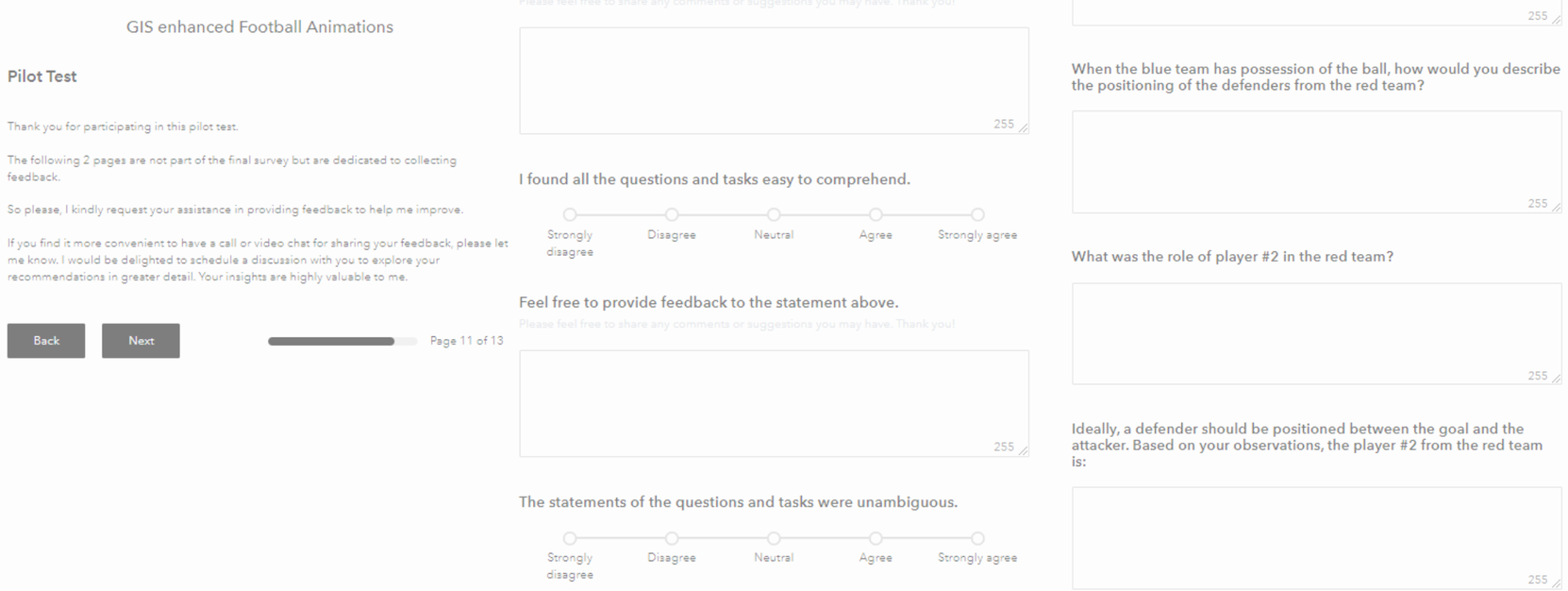


Pilot testing

1 Pilot test

Supervisor
TUDresden Writing center
Cartographer

Evaluation questionnaire
Training section
Grammar and clearness
Animations aesthetics

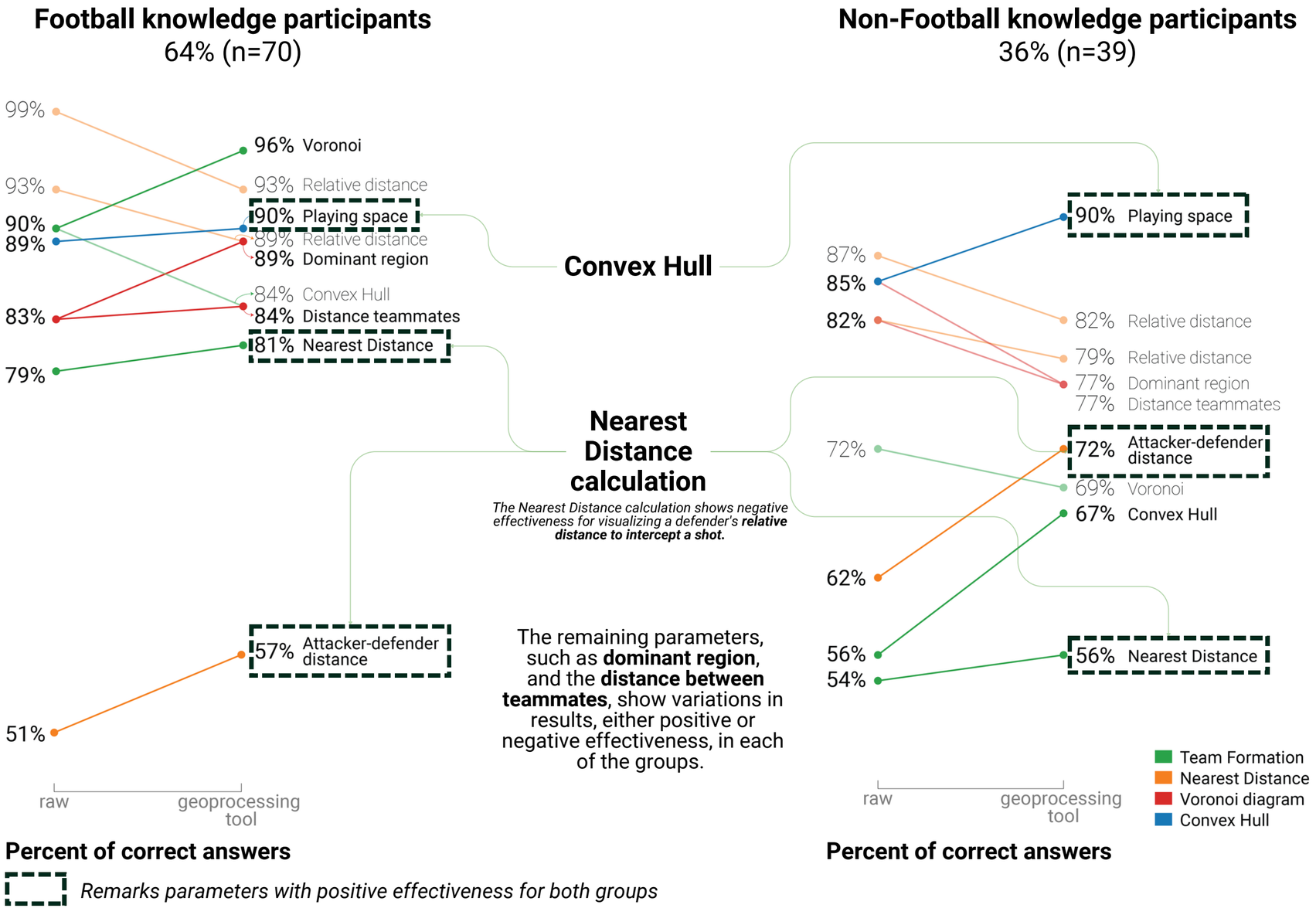


2 Pilot test

7 Cartography and Geomatic master students

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


Football knowledge participants
64% (n=70)
Non-Football knowledge participants
36% (n=39)
99%
93%
90%
89%
83%
79%
96% Voronoi
93% Relative distance
90% Playing space
89% Relative distance
89% Dominant region
84% Convex Hull
84% Distance teammates
81% Nearest Distance
57% Attacker-defender distance
51%
Convex Hull
Nearest Distance calculation
The Nearest Distance calculation shows negative effectiveness for visualizing a defender's relative distance to intercept a shot.
The remaining parameters, such as dominant region, and the distance between teammates, show variations in results, either positive or negative effectiveness, in each of the groups.
87%
85%
82%
90% Playing space
82% Relative distance
79% Relative distance
77% Dominant region
77% Distance teammates
72%
62%
56%
54%
72% Attacker-defender distance
69% Voronoi
67% Convex Hull
56% Nearest Distance
raw
geoprocessing tool
Team Formation
Nearest Distance
Voronoi diagram
Convex Hull
Percent of correct answers
Percent of correct answers
Remarks parameters with positive effectiveness for both groups

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 f**ootball 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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