



Contextual Analysis: Harnessing Pitch Network for Integrated Soccer Performance Evaluation



Changjing Zhou

School of Athletic Performance, Shanghai University of Sport

zhouchangjing01@sus.edu.cn

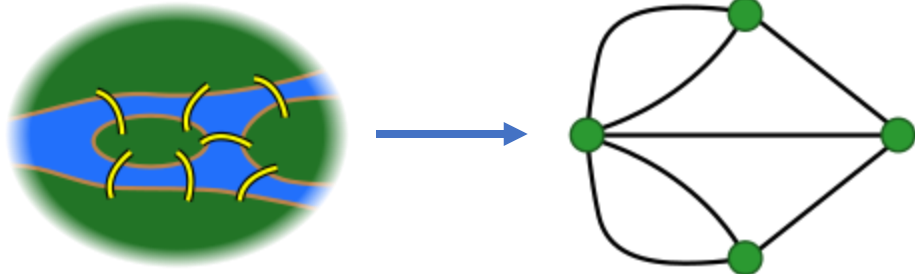
2024-8-12

The Historical Evolution from Social Network to Pitch Network



1736年

Euler, while solving the problem of the seven bridges of Königsberg, simultaneously pioneered graph theory and geometric topology, which laid the foundation for social network science."



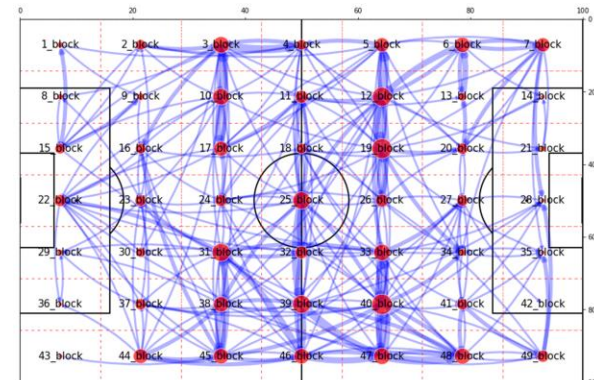
1890年末

Durkheim and Tönnies introduced the concept of social networks, which have since been applied across various disciplines including anthropology, biology, economics, and sociology.

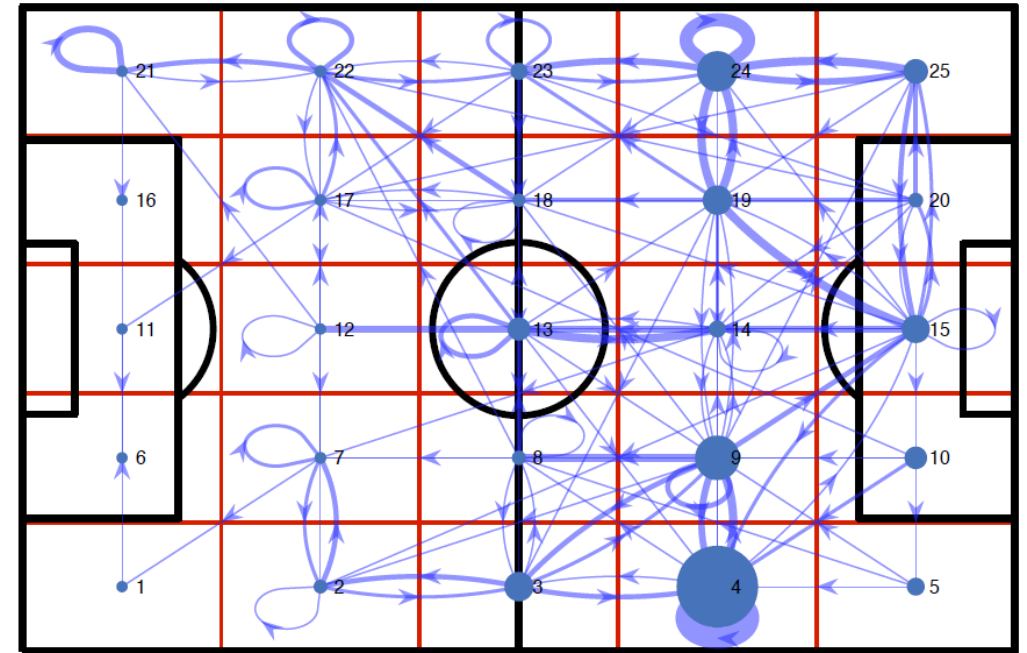
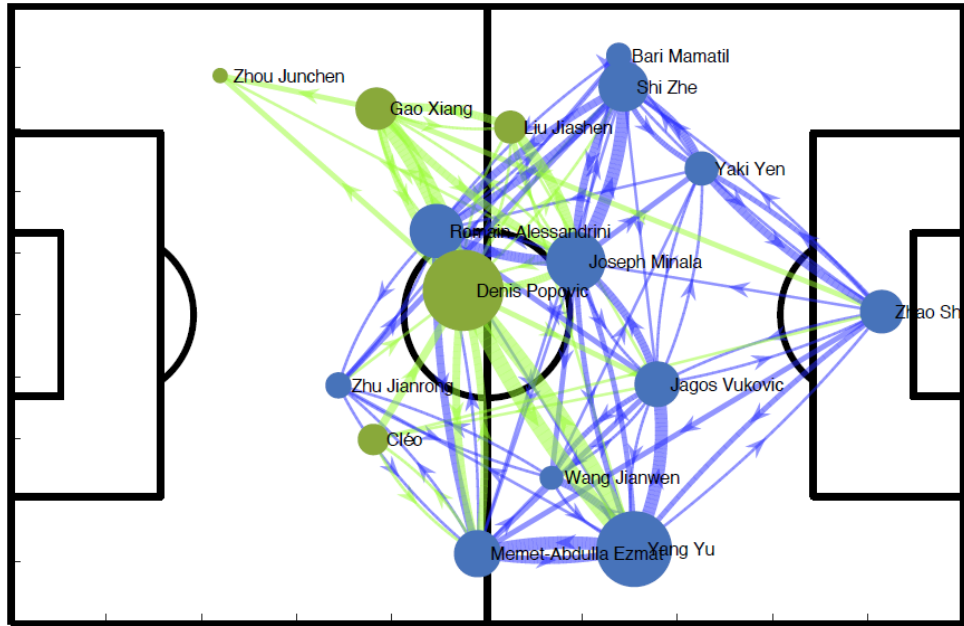


至今

Information networks, biological networks, pitch networks, and others have gradually evolved



Players passing network vs Pitch passing network



Players, who are the network's nodes, are placed at the average position of all their completed passes. Links account for the number of passes between pairs of players. Substitutes are highlighted in green

$n = p \times q$, $p = q = 5$, $n = 25$
 In this case, nodes are divisions of the pitch and links account for the number of passes between them.

Research aim



Investigating the influence of contextual factors (such as team quality, match outcomes, and match location) on the pitch passing network structure, including degree centrality, closeness centrality, and betweenness centrality.

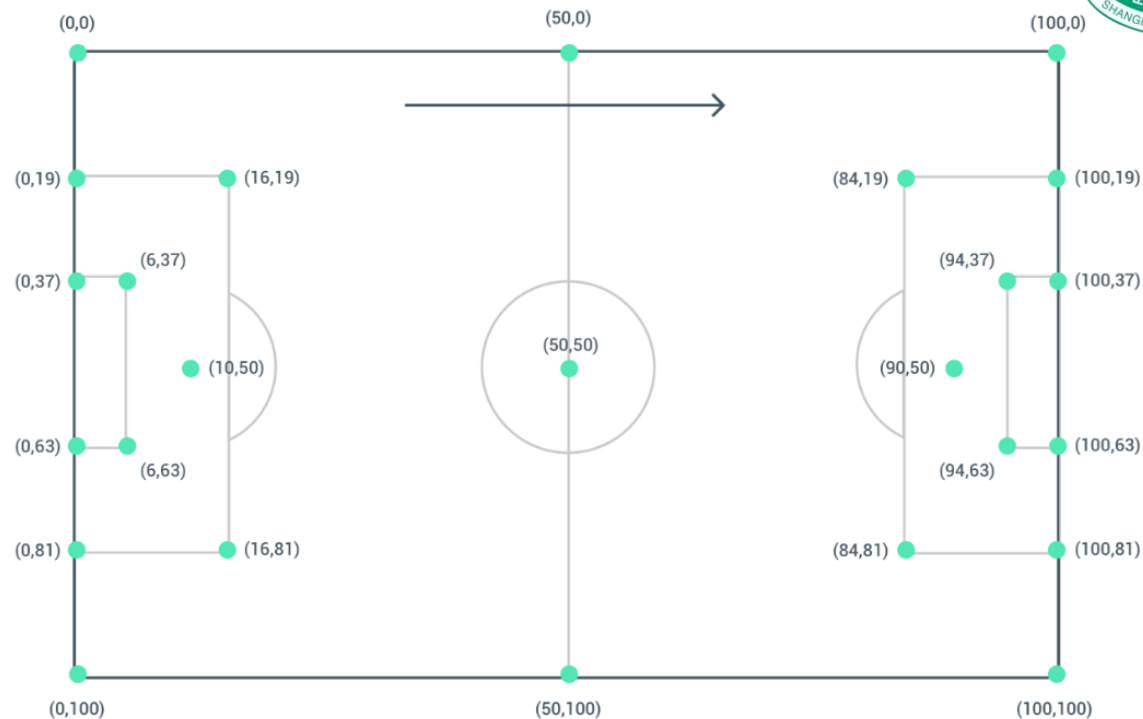
Verifying whether this new method and indicators can be used to identify specific tactics in football matches.

Database and Software

2017/2018 Season English Premier League



Wyscout English Premier League pitch coordinate system

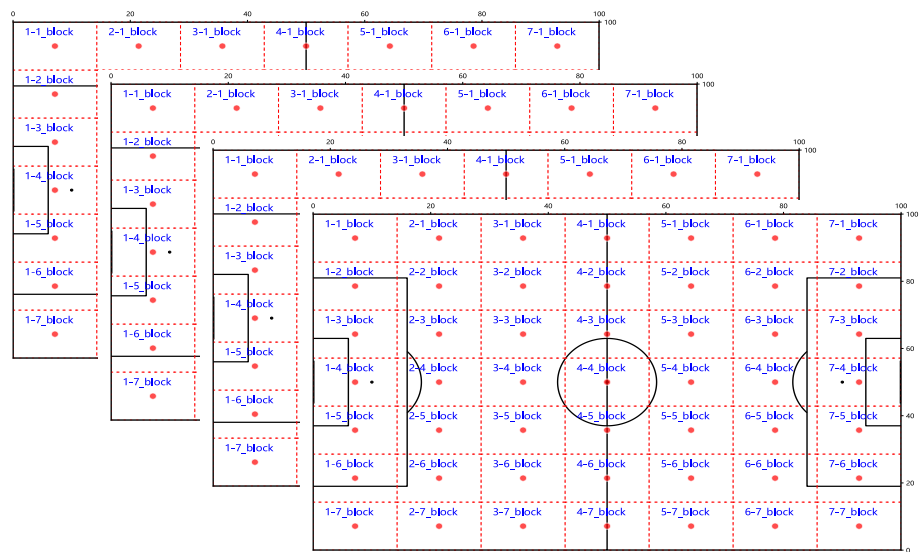


Wyscout English Premier League match pass data coordinates

index	event_id	event_type	result	period_id	timestamp	team_id	end_coordinates_x	end_coordinates_y	pass_type
0	177959171	PASS	COMPLETE	1	2.758649	1609	31	78	SIMPLE_PASS
1	177959172	PASS	COMPLETE	1	4.94685	1609	51	75	HIGH_PASS
...
1807	177961041	PASS	COMPLETE	2	2998.963701	1609	NaN	NaN	None
1808	177961042	PASS	COMPLETE	2	3006.647279	1609	100	100	None

Method for Constructing Pitch Networks

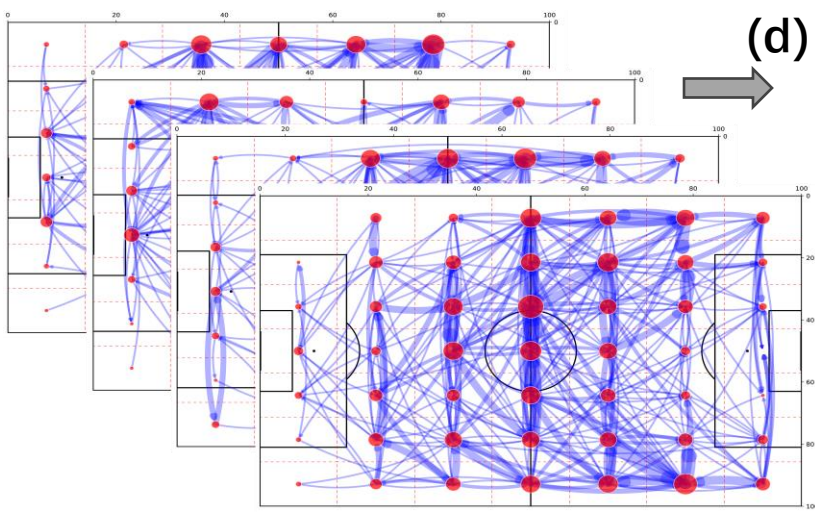
(a)



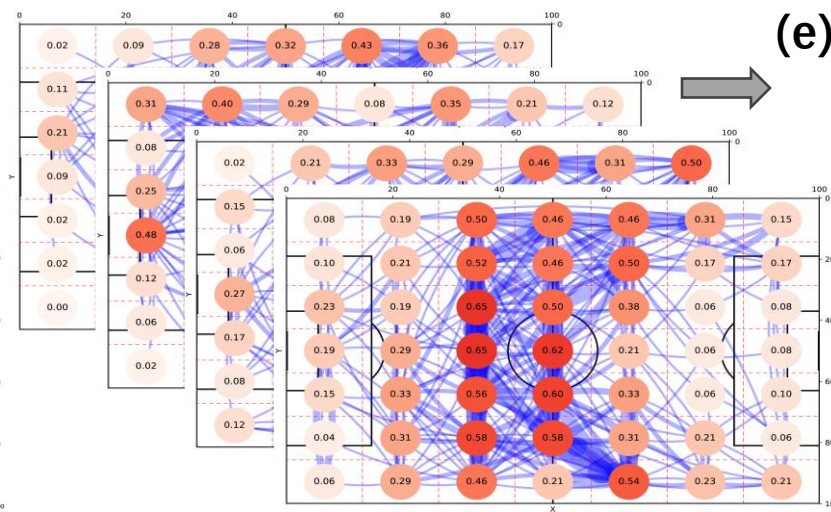
(b)

	1-1_block	1-2_block	1-2_block	...	7-5_block	7-6_block	7-7_block
1-1_block	1	1	2	...	3	1	4
1-2_block	1	2	5	...	1	1	2
1-3_block	0	1	2	...	1	1	1
...
7-5_block	3	6	2	...	2	5	1
7-6_block	6	2	1	...	2	3	4
7-7_block	1	0	1	...	3	1	5

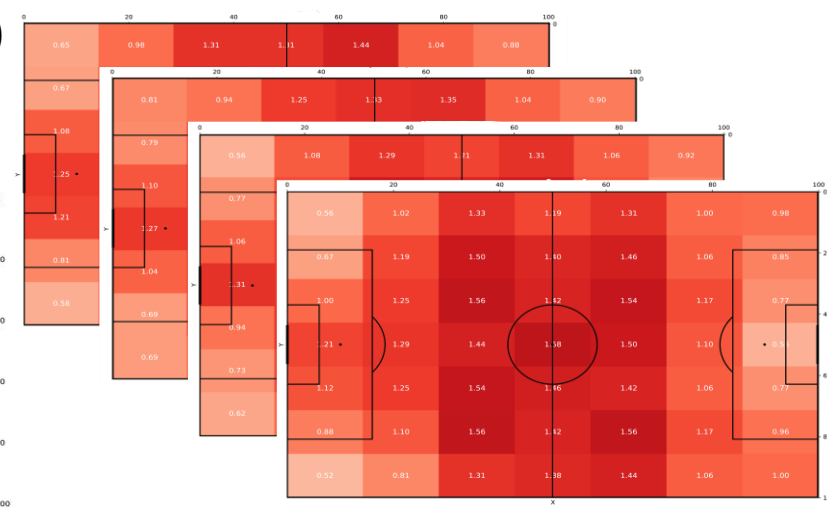
(c)



(d)



(e)





Variables and Statistical analysis

Degree Centrality

Degree centrality is a metric that measures the overall connectivity of passing interactions between blocks on the pitch. A high degree centrality value indicates that a block has more passing connections with other blocks, highlighting its critical position in the pitch-passing network.

Closeness centrality

Closeness centrality reflects the degree of closeness between blocks on the pitch. If a segment can easily interact with all other blocks, it is considered important in the network.

Betweenness Centrality

Betweenness centrality mainly identifies the bridge blocks that construct the pitch passing network. Simply put, it describes a node's influence over the shortest paths in the network and the potential traffic that the node may need to handle.

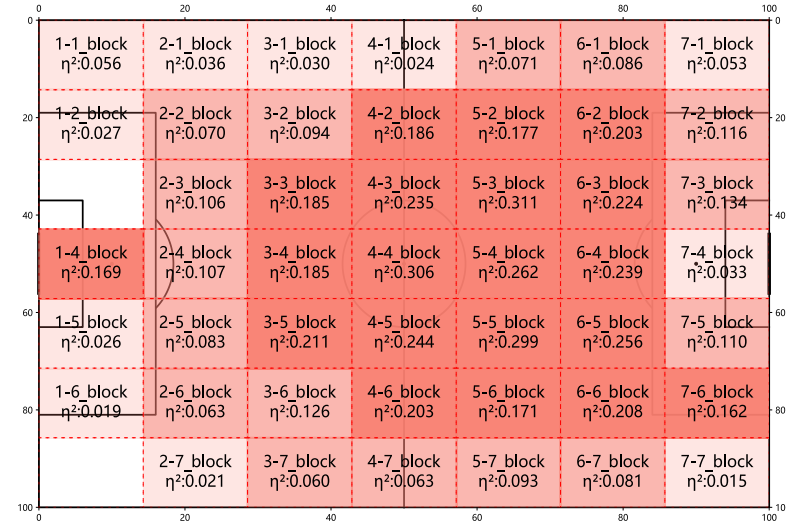
Non-parametric Mann-Whitney U test to evaluate the centrality results calculated for each subdivided block

Results

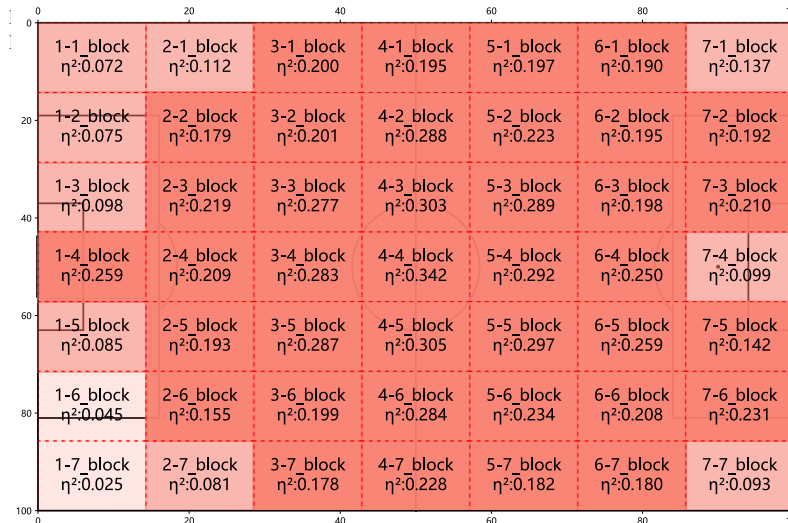


Team Quality (Strong vs Weak)

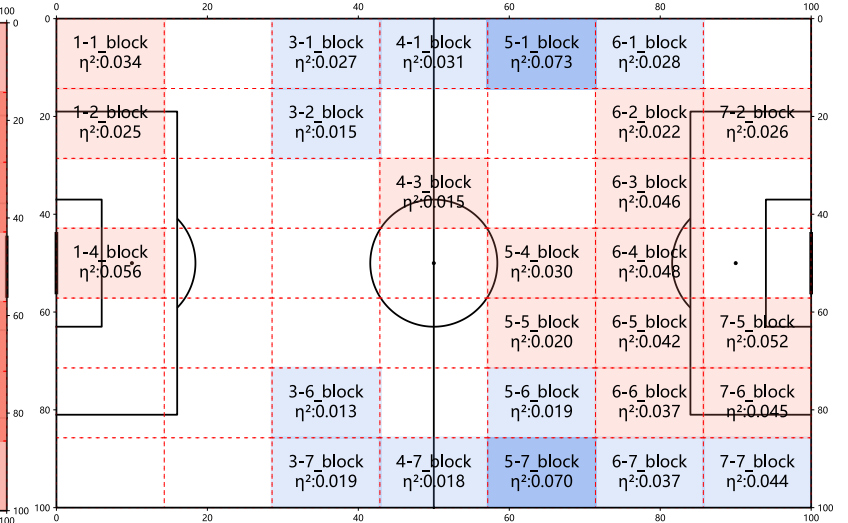
Attack Direction



Degree Centrality



Closeness centrality



Betweenness Centrality

Red: Strong > Weak

Blue: Weak > Strong

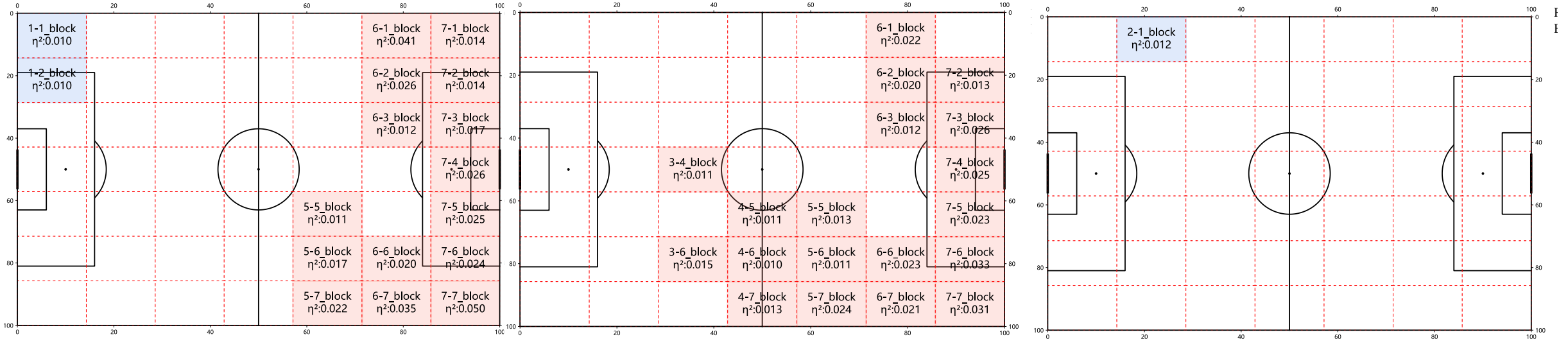
Large effect

Medium effect

Small effect

Match location (Home vs Away)

Attack Direction

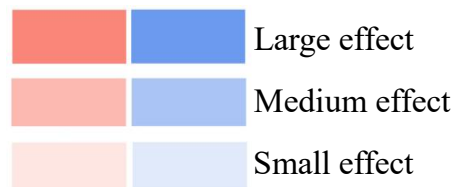


Degree Centrality

Closeness centrality

Betweenness Centrality

Red: Home > Away
 Blue: Away > Home



Conclusion



- 1. Strong Teams Dominate Central Zones:** Strong teams exhibit higher centrality in key areas, particularly near the opponent's goal, indicating superior ball distribution and control.
- 2. Tactical Superiority in Midfield:** Strong teams leverage the central and defensive midfield zones for tactical advantage, with higher betweenness centrality in the front middle area and near their own goal.
- 3. Weak Teams' Peripheral Play:** Weak teams show higher betweenness centrality in the midfield's side zones, suggesting a more peripheral approach to creating chances.
- 4. Home Advantage in Offensive Zones:** Home teams, regardless of strength, tend to have higher centrality values in offensive zones, likely due to the benefits of playing on familiar territory.



谢谢

Thanks