



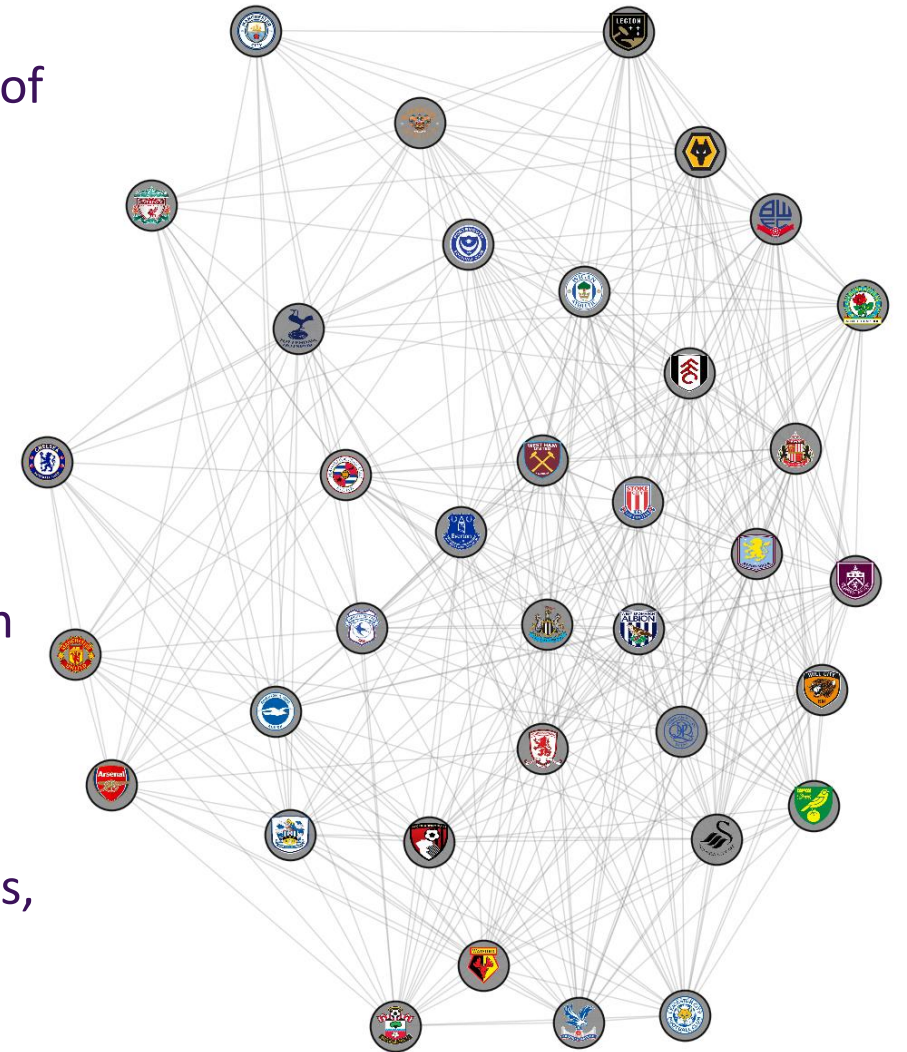
Network Science in Football

Unraveling Hidden Dynamics with Complex Networks

Marcello Russo

Network View of Football

- Football: More than just goals and points, it's a dynamic system of team interactions.
- Goal: Uncover hidden dynamics, strategies, and success factors beyond traditional statistics.
- Source: The dataset was found on Kaggle and contains data from the 2000 to the 2025.
- Key Data Points: Includes match dates, full-time/half-time results, goals, corners, shots, fouls, and cards.



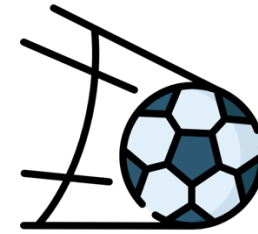
Teams and Interactions

- Nodes: Each Premier League team for that selected Season/s.
- Edges: Represent interactions between teams based on matches played.
- Edges carry detailed performance information from head-to-head encounters.

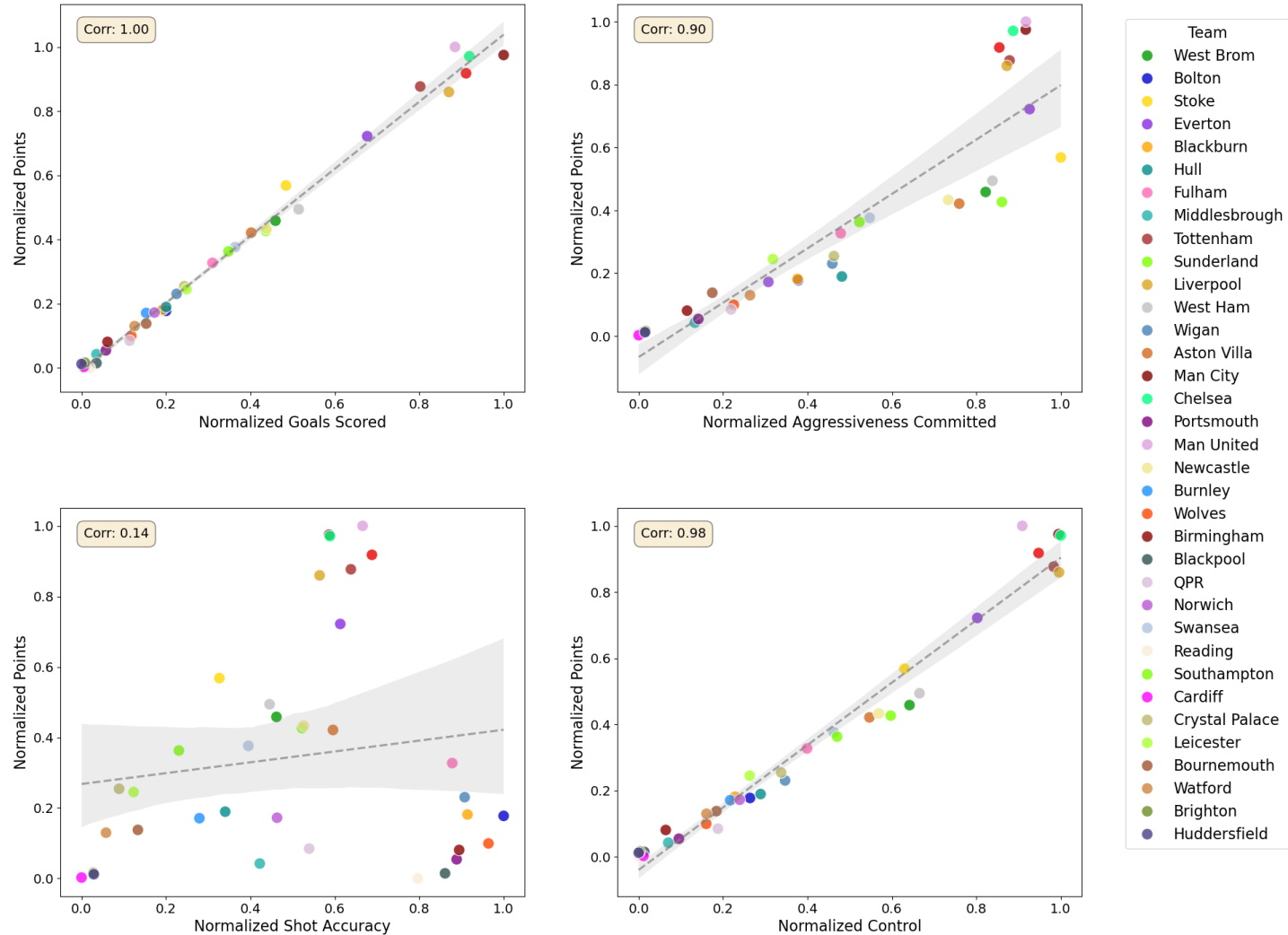


Teams and Interactions

- The study analyzes interactions based on three key metrics of differences:
 - Goals: Goal scored in matches.
 - Aggressiveness: Fouls, yellow/red cards.
 - Control: Shots, corners.
- Similarity between teams is achieved connecting those with minimal differences in these metrics during their games.

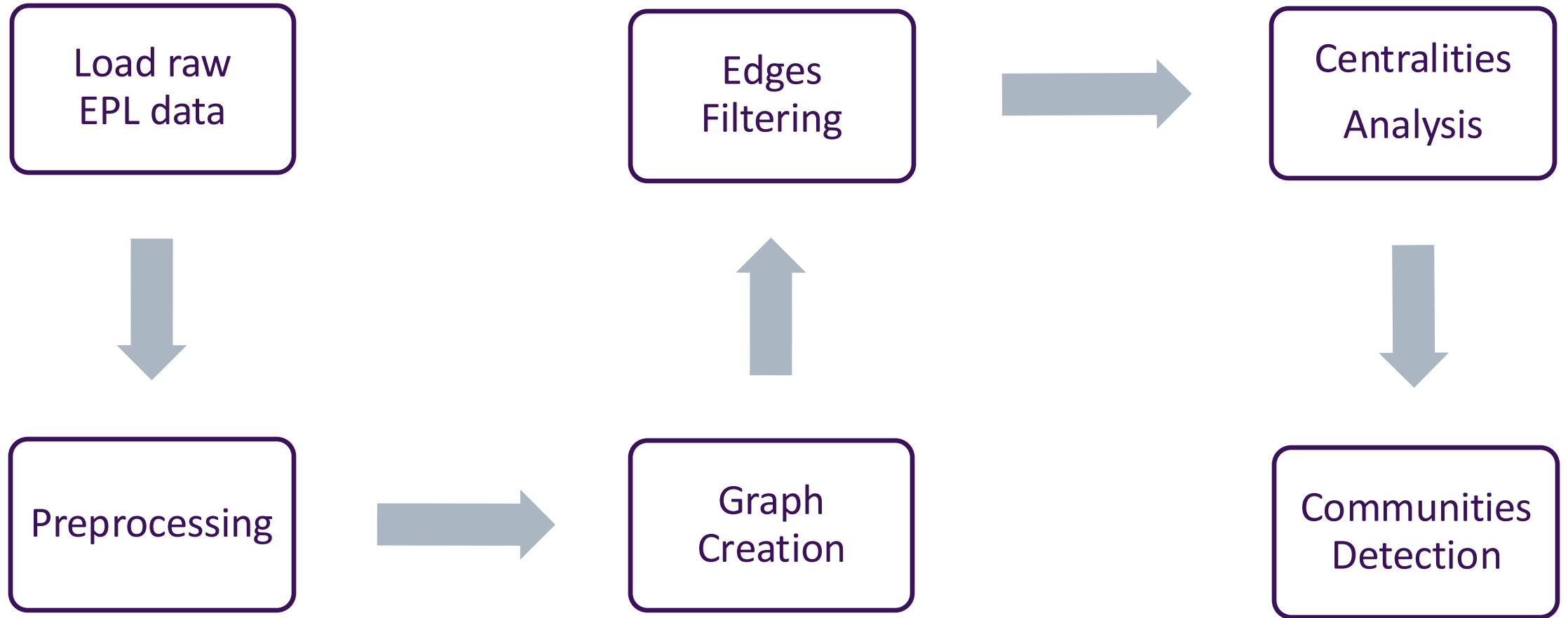


Teams and Interactions



Normalized Metrics vs Points (seasons from 2008/09 to 2017/2018)

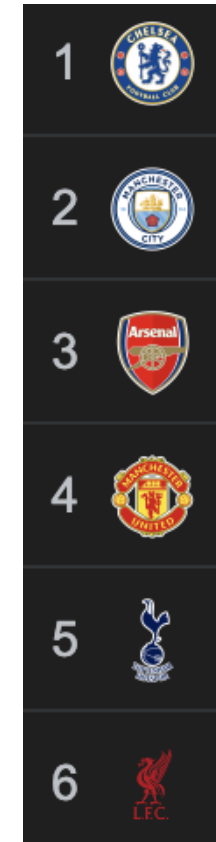
The Analysis Workflow



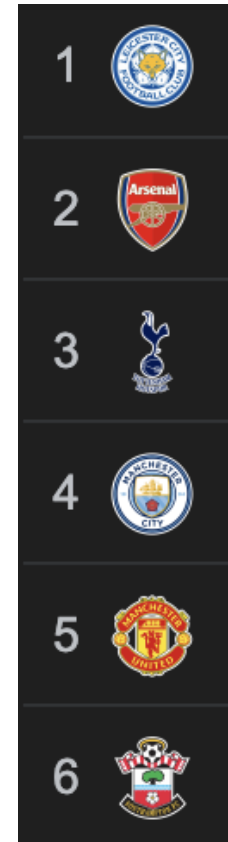
A Natural Experiment: 2014/15 vs 2015/16

- 2014/15 Season : Characterized by traditional *Big Six* dominance.
 - *Will dominant teams form cohesive network communities?*
- 2015/16 Season: Leicester City's unexpected title victory.
 - *How does such an anomaly alter established network dynamics?*
- This comparison reveals how performance shapes network structures and team centralities for that seasons.

2014/15



2015/16



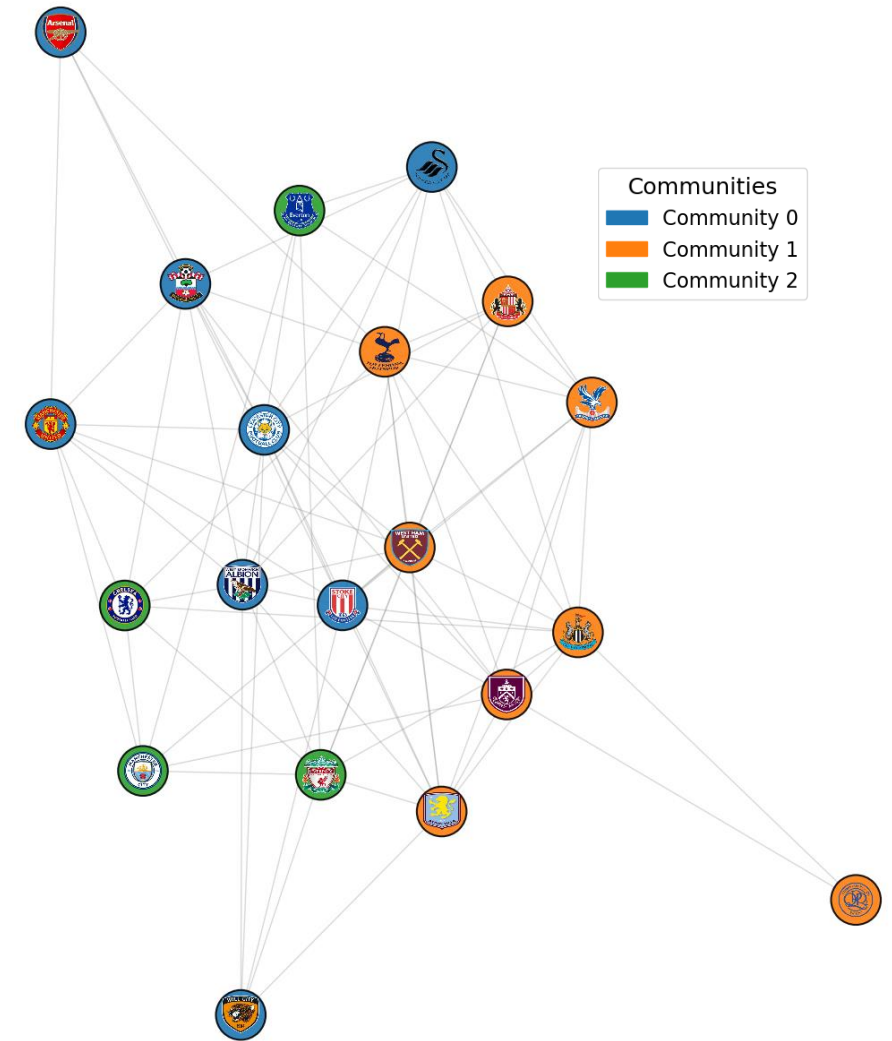
A Decade of Dynamics: 2008/09 - 2017/18

- Extended analysis over 10 seasons to:
 - Mitigate the impact of single-season anomalies;
 - Identify stable and enduring network patterns;
 - Understand how *similarity* in performance relates to success.
- This approach provides a more robust view of Premier League structural dynamics.

Single Seasons Insights

- Centrality and Correlations: *Goals* and *Control* centralities often correlate negatively with points.
- Community Dynamics: *Big Six* rarely form cohesive communities.

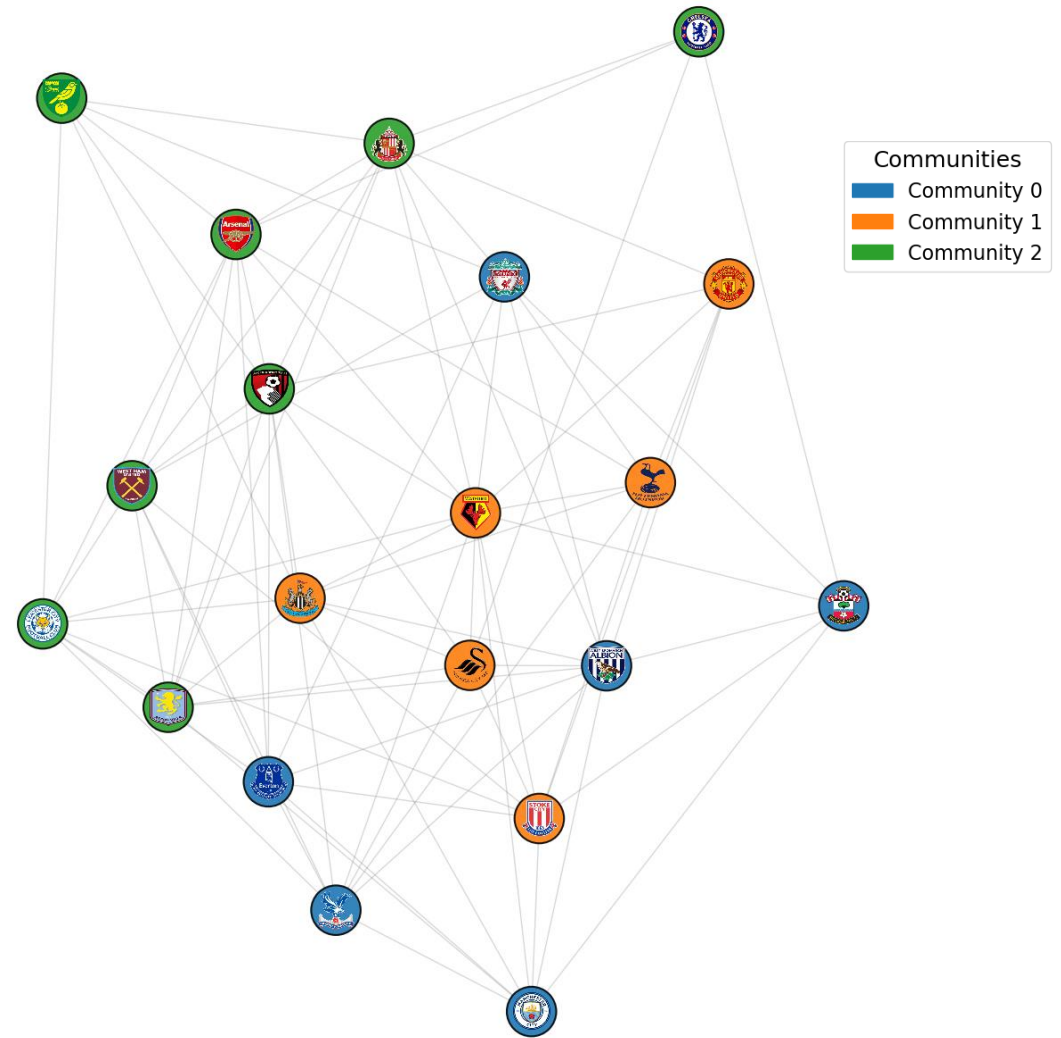
Centrality Measure	Goals	Aggressiveness	Control
Degree	Leicester (-0.11)	Sunderland (-0.37)	Newcastle (-0.52)
Strength	Leicester (-0.13)	Sunderland (-0.37)	Newcastle (-0.53)
Betweenness	Leicester (-0.16)	Southampton (0.08)	Crystal Palace (-0.31)
Closeness	Leicester (-0.06)	Liverpool (0.05)	Crystal Palace (-0.60)
Eigenvector	Leicester (-0.20)	Sunderland (-0.29)	Sunderland (-0.61)



Goal Similarity Network Communities 2014/15

Single Seasons Insights

- Leicester's Impact: *Aggressiveness* centrality shows strong correlation with points.
- This suggests an adaptable aggression style was key to their surprising success, distinguishing them from top clubs.



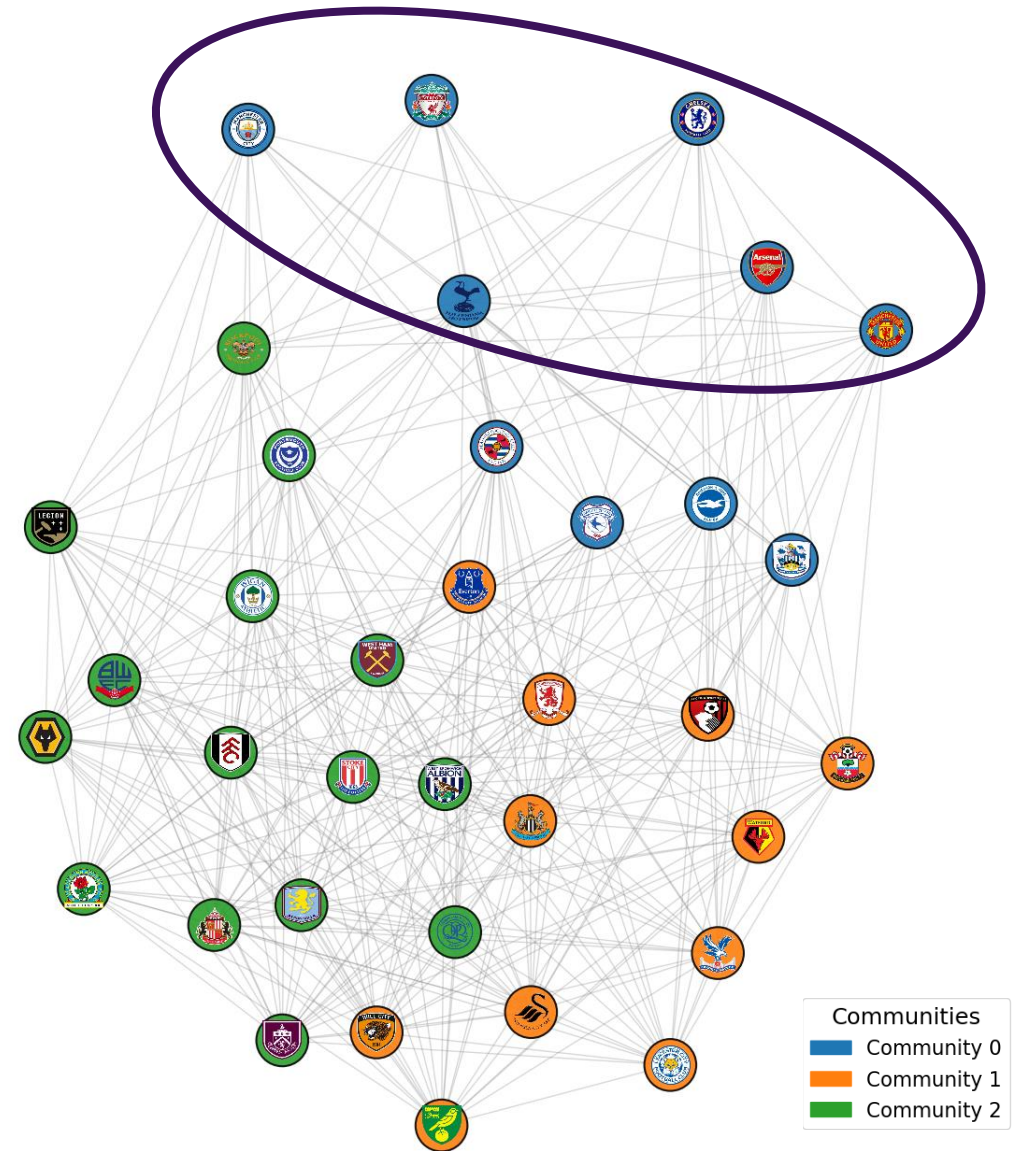
Aggressivity Similarity Network Communities 2015/16

Decade-Long Pattern

- Centrality and Correlations: centralities remain negatively correlated with points, but...

Centrality Measure	Goals	Aggressiveness	Control
Degree	Middlesbrough (-0.57)	Man City (0.39)	West Brom (-0.52)
Strength	Middlesbrough (-0.59)	Hull (0.35)	West Brom (-0.54)
Betweenness	Brighton (-0.34)	Arsenal (0.29)	Huddersfield (-0.26)
Closeness	Brighton (-0.66)	Newcastle (0.15)	Huddersfield (-0.67)
Eigenvector	Stoke (-0.58)	Hull (0.25)	West Brom (-0.53)

- Community Dynamics: A clear *Big Six* cluster emerges, indicating shared **offensive dominance**.



Control Similarity Network Communities 2008/09-2017/2018

Limitations and Future Horizons

- Current Limitations:
 - No data on possession in this dataset;
 - Season level data-aggregation;
 - Static network analysis;
 - Correlations identified, but not direct causality.
- Future work:
 - Dynamic network models;
 - Multi-layer networks (transfers, coaching changes);
 - Integration of advanced football **metrics**;
 - Cross-league comparative studies;
 - Development of predictive models for team performance.



Thanks for
your attention!

Any questions?

Marcello Russo