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Topological properties and dynamics of nets game shown by france and portugal in the final of european soccer cup 2016

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ABSTRACT

This paper explains some of the descriptive and organizational parameters underlying the theory of complex networks to understand how football team players interact, taking the pass as a reference. We analyze the offensive phase of the final of Euro 2016 football, which pitted France and Portugal teams. We used different strategies to determine the degree of interaction between the components of the analyzed teams. Specifically, we analyzed the effective number of passes and the number of peers with which each player is related; likewise, the geodesic distance and eccentricity. All within the basic descriptive parameters.
As organizational parameters, we consider the degree of centrality, levels of clustering and intermediation game values. Each of these parameters allows us to represent the play structure, examine the individual role of each player individually and understand the collective operation of the team. The results prove that the superiority in the different parameters within the game does not always guarantee a favorable marker.
Keywords: Complexity, Football, Passes, Organizational parameters, descriptive parameters.

INTRODUCTION

The methodological strategies used have undergone a significant change in recent years. They have also incorporated the non-linear analysis of information in the reports provided to the people who have to use it to improve and optimize the specific work of training or matches.

One of the progressing analysis strategies in recent years is the interpretation of the game from the perspective of complex systems and, especially, using complex networks. Complex networks described many systems in nature. Topologically, they are graphs adding dynamic characteristics, necessary to study applying specific mathematical algorithms.

Although the first structured analysis based on this methodology dates from the 70s (Gould & Gatrell, 1979), the most systematic application and with more different objectives is quite recent, when this last decade, it has joined the group of tools used by specialists although using different criteria in the study of specific matches, teams or tournaments (Cintia, Rinzivillo, & Pappalardo; Clemente et al., 2015; Cotta, Mora, Merelo, & Merelo-Molina, 2013; Duch, Waitzman, & Amaral, 2010; Gama, Couceiro, Dias, & Vaz, 2015; Grund, 2012; Onody & de Castro, 2004; Pena & Touchette, 2012; Sarangi & Unlu, 2010). Although the proposal of many quantitative measures of complex networks in recent years, not all are easy to understand, calculate and use in football analysis and, specifically, to evaluate a network of passes. The pass is a fundamental technical element when attacking in football. It is to control the game and look how to get the goal. Usually, the teams with most passes often have more chances of goal but there are important aspects to consider. Playing to pass the ball is within the reach of many but passing the ball with meaning is within the reach of very few teams. However, only if close to the area, there are high chances of getting a favorable option to get a goal. Near the opposing goal, we can search or cause the opponent's failure and have a chance

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to score. For these reasons, when it comes to studying football, the analysis of the passes network becomes important.

The objective of this paper is to analyze the football final of the European Soccer Cup 2016 of the National Teams from the perspective of networks, trying to explain the topology, dynamics and evolution both teams used in the game and trying to understand the reasons the final result is based.

METHOD

Sample

We started from the official reports published by UEFA (http://uefa.com/uefaeuro/) and by Wyscout (https://wyscout.com), and the viewing and discussion of the video of the game once the tournament was over. Specifically, the passes performed by each team and the game network they generate were used as a reference parameter. The values of the player he was substituted were added to carry out the analysis in the case of the substituted players.

Procedures

We will use two types of indicators or parameters for the quantitative analysis of the network: the basic descriptive parameters and the organizational parameters of the network. These indicators will be used individually or collectively according to the needs of the study.

Although individual, the descriptive parameters were used to evaluating the topological characteristics of the interconnection network (passes and receptions) and its spatial location. The starting parameter was always the number of nodes in the network (players). In each case, the weight (degree) of each player was determined, as well as the number and type of connections (intermediation and proximity) with other players and the distance that each player presents for the rest of the team´s components. The organizational parameters used were those of centrality (closeness, grouping or clustering, betweenness or intermediation and transitivity). The latter will be used to explain the dynamics of the game and its organization on the field.

Descriptive parameters

They are the simplest to evaluate since they are the number of connections of each player with their teammates in a unidirectional or bi-directional way. The density indicates the proportion of existing connections to the possible ones. In the case of soccer, they can be calculated in a simple way by dividing the number of existing relations (passes of a team) among all the possible ones (total of passes of the match or maximum value of the tournament). We also analyzed the density of passes of the team relating the total of triangulations in the totality of possible triangulations. We also divide the total number of passes a team or each player performs in each game by the total minutes of the game.

These parameters can be established from the gross interconnection values (higher value will indicate greater relationship) but they need more information to know the greater or lesser ease with these connections are generated. To know the length of the paths players use to connect, it was necessary to determine the distance between two nodes, the radius, the diameter and the average length.

In any case, the concept of distance should not be confused with length, defined in the networks as the average of the distances between all pairs of nodes. We will understand that the distance between two players is defined as the number of links of the shortest path connecting them. We must consider that the distance between players is calculated on the inverse value of the passes. That is, if i and j are two neighboring players, so for example, player i gives 30 passes to player j, the distance between i and j will be: dij=1/30. That is, the greater the number of passes between them, the closer two players are placed.

The diameter or the radius should not be confused with distance. Both values are born from the eccentricity (Ecc). The eccentricity of a node is the longest path (between the shortest) to another node in the network when the path is between two nodes and no node is visited more than once. Thus, it shows its link with the periphery. The nodes with less eccentricity are

more central and their value is determined by the following algorithm:

$$Ecc(i) = M_d of\ maximum\ (i);$$

Where M_d is the distance matrix.

As it happens with the concept of proximity, the eccentricity value represents measures of centrality (we will talk later), but inverse.

The diameter is defined as the shortest maximum path between any pair of players measured by the number of links traveled. In our case, it numerically shows the value of maximum eccentricity of the equipment and the lower its value, the greater communication skill of the players of a team. The value of the radius represents just the opposite value, that is, the minimum eccentricity.

The above-described concepts are recommended to be compared to each other for each game since they indicate different things and give specific and individualized information in each case.

Organizational Parameters

One of the main objectives of a network is to know the characteristics of the players´ behaviors within the group and, in this way, to be able to understand the game used in each match. This criterion can be evaluated based on what is known as centrality indexes (for players) or centralization (for the whole team). The concept of centrality is the position of the players in the passes network that the team builds and the concept of centralization is the structure of the network.

Centrality. The measure of centrality tries to capture how certain nodes are important for a given passes network and it informs us of the ability of each player to connect with the rest of his teammates. However, the centrality is not necessarily indicating a level of efficiency.

The most used parameter is the closeness of centrality, which provides a direct measure of how easy it is to reach a specific player of the team. The centrality of a node depends mainly on its distance to other nodes. It can be determined from the geodetic distances average that the player shows within the team. For this reason, centrality values usually correlate well with the number of passes and neighbors. The more a player passes the ball, the greater his value and the smaller his average distance to other players. Therefore, a player will show greater centrality if the maximum value or the sum of the distances are small. Thus, we must know the minimum distances between all the players by adding the paths between them to calculate the centrality. For this study, his value was determined by the following equation (Pena & Touchette, 2012):

$$C_i = \frac{1}{\sum_{j \neq i} d_{i,j} + \sum_{j \neq i} d_{j,i}}$$

Clustering. There is no consensus when determining how to calculate the clustering coefficient in sports modalities. In this work, we will use one of the most frequently proposal by Onnela et al., (2005). This procedure is based on the geometric average of the passes that each player performs with the teammates he most related during the game and, in turn, it includes the passes the neighbors perform among themselves:

$$c_i^c = \frac{1}{u_i(u_i - 1)} \sum_{j,k} \frac{\sqrt[3]{A_{i,j} A_{K,j} A_{k,i}}}{\max(A)}$$

Where $u_i = \sum_j \varepsilon_{i,j}$ is the number of passes perform by the player i, as the reference node.

An interesting parameter of clustering is the coefficient of assortativity. In this case, it is a value that shows the preference of the players of a team to join other similar players in some technical, tactical or positional characteristic. Numerically, it refers to the Pearson correlation coefficient of the degrees between two pairs of connected players. Positive values (assortative network) indicate that there is a correlation with similar weight (nodes with a lot of weight tend to link with very strong nodes), while a negative value (dissasortative network) indicates correlations between nodes of different degree

(nodes with little weight they are associated with low weight nodes).

$$Coefficient\ of\ assortativity = \frac{\sum_{jk} jk\ (e_j k - q_j\ Q_k)}{\sigma_q^2}$$

Another interesting parameter in this type of networks is known as effectiveness. From the point of view of the networks, we can evaluate it individually (Eff) or collectively (Ec). The Eff shows a grouping relationship with neighboring players and it represents the average value of the inverse of the shorter paths (geodetic) the players are connected. Consequently, the higher this value, the more efficient the player is since the distance (ease of interconnection) is small. Besides to the overall effectiveness level of the equipment, the Ec value also indicates the expansion capacity of the game network and it represents the inverse of the distance. Therefore, the lesser the distance, the more effective the team will be in interconnecting their players. The effectiveness is important because it refers to aspects related to the connectivity of the player in the network, which is not necessarily synonymous with effectiveness in the game, so we can find players who connect very little but are very important in the final behavior.

An interesting grouping value is offered by the transitivity factor. This parameter refers to the frequency of appearance of triangles (triangles to triples) that occur during the game. It indicates us as two players that are related to any other team, but at the same time they can also relate to each other. Consequently, it is a kind of a mean clustering value.

Intermediation. A different concept is the concept of intermediation (betweenness), which is how each player on the team interacts with the closest players (neighbors). The intermediation of a player is represented by the number of shortest paths directed between all the pairs of players with the reference player. It is a measure that favors the players who participate in the game by connecting peers and penalizes those who do not usually include support among team members in their game. From a tactical point of view, a team could look for intermediation scores that are not evenly distributed among all players. Concentrated meditation results indicate a high reliance on few players that are too important for the game, while low intermediation scores indicate a well-balanced step strategy. For their individual determination, the same criteria proposed by López-Peña & Tuchette (2012) were used:

$$C_B(i) = \frac{1}{90} \sum_{j \neq k \neq i} \frac{n_{jk}^i}{g_{jk}}$$

Transitivity was calculated for the global triangulation of each team. This type of grouping assigns greater weight to the players with the greater centrality of weight.

$$Transitivity = \frac{3\ x\ of\ triangles}{\begin{matrix} Number\ of\ triple\ connections \\ connected\ by\ vertices \end{matrix}}$$

DISCUSSION

Basic Descriptive Parameters

This match was characterized by the confrontation of two different styles. The French team made a clearly offensive game proposal, while the Portuguese team showed a more conservative game.

The way to the final also has significant differences in both teams. France arrives with six wins (favor-against goals: 13-4) and Portugal comes with four ties and two wins (favor-against goals: 8-5). Portugal needed three extra time to go to the final, which forces it to play 50 minutes more than the French team (Portugal: 628 minutes, France: 573 minutes). In the total of the tournament, both teams have a possession percentage (52%), but with different ways of treating the ball (Portugal: 3633 passes - 86% effectiveness - 4.78 passes/minute, France: 3519 passes - 88% effectiveness - 4.99 passes/minute). These values undergo modifications in the final game of the tournament.

In this match, France starts with a 1-4-2-3-1 scheme, in which the line of three midfielders is characterized by incorporating players with excellent mobility and ability to associate. This organization in the attack is enhanced by the

position and profile of a player such as Pogba who usually enlace easily with the most advanced players. They also used a striker as a reference to an offensive game (Giroud) with the intention of rying to fix the midfielder of Portugal. Their offensive capacity was reinforced by the presence of two full-back players with clear attacking vocation and two central defenders with a high creative capacity (381 passes performed) from the moment the team is in possession of the ball.

Portugal initially had a 1-4-3-3 scheme, with the variant to 1-4-4-2. They were possibly seeking to stop the combinative game that France usually showed in this tournament and giving offensive freedom to full-backs (Cristiano and Nani) to execute destabilizing offensive actions. However, an unexpected event causes a significant change in the organization of the team and the way of organizing the game. In complexity, this situation is especially interesting, provoking self-organizing phenomena with emergent capacity, necessary to interpret it in this work. Some facts of these characteristics show the dynamics of the game and, occasionally, generate surprising circumstances (goal, expulsion, injury, change of player, etc.) that alter that dynamic and the functional tendency they had.

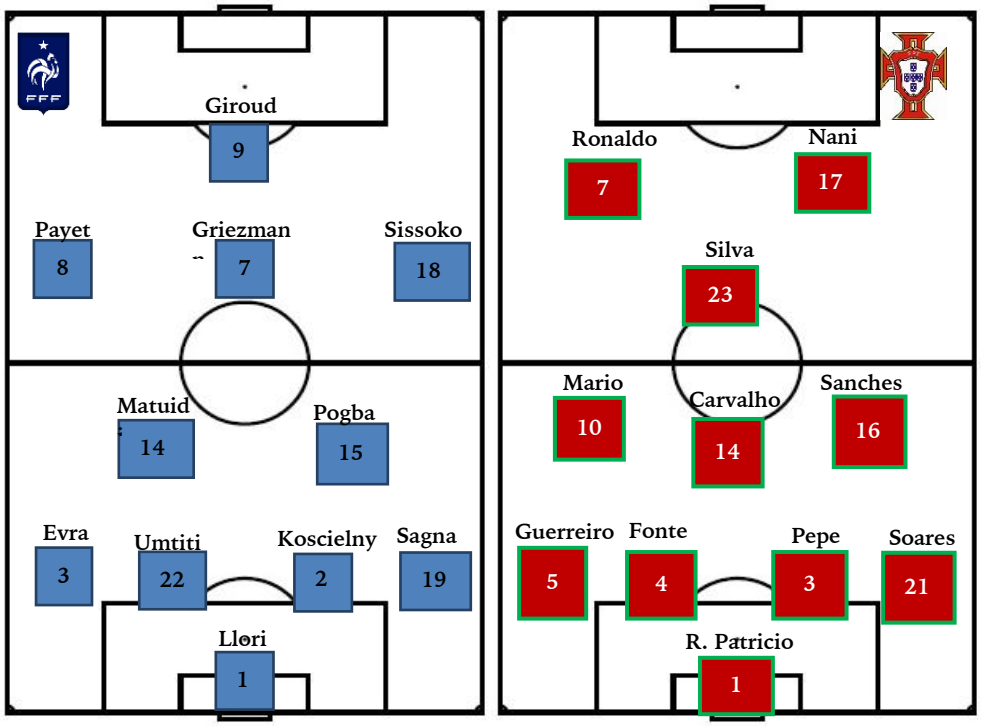

Figure 1. The game system presented by both teams at the beginning of the match.

In the 22nd minute of the first half, the Portuguese player of reference (Ronaldo) is injured and replaced four minutes later. The substitution of Cristiano Ronaldo in the first minutes was the triggering phenomenon that altered the organization and the dynamics of the game during the rest of the match changing (Figure 2) its initial tactical provision (1-4-1-4-1).

There is no a single mode of organization valid for all cases and it must be adapted to the environment in any circumstance. A large part of the organization processes can be understood as the constant attempt to resolve the tension between the environmental uncertainty and the organizational rationality. The relationship between organization and environment must be conceived as the result of multiple adjustments in which strategy, space and time management, and resources must be coherent and respond to the game situations. In theory, a rational organization should influence levels of uncertainty according to the phase of the game (defense or attack).

Figure 2. The game system presented by Portugal after replacing Cristiano Ronaldo

The number of effective passes performed by each player and the number of balls he receives is shown in Table 1. It also indicates the number of teammates (neighbors) he performs with this technical action. We must consider that the value of this parameter is a gross indicator of the offensive player participation.

Table 1

Number of neighbors and passes each player of both teams are linked.

	Portugal						France				
Player	Vo	Vi	Po	Pi	Tp	Player	Vo	Vi	Po	Pi	Tp
R. Patricio	8	7	36	19	55	Lloris	6	4	19	4	23
Soares	8	9	31	41	72	Sagna	8	9	48	44	92
Guerreiro	9	9	56	59	115	Evra	8	7	49	49	98
Pepe	10	9	42	34	76	Koscielny	8	9	85	76	161
Fonte	9	9	64	65	129	Umtiti	10	9	115	105	220
Carvalho	9	10	66	56	122	Pogba	10	9	105	97	202
Sanches	10	10	41	53	94	Matuidi	9	10	75	73	148
J. Mario	10	9	50	47	97	Sissoko	9	10	42	58	100
Silva	9	9	54	53	107	Payet	9	8	48	73	121
Ronaldo	9	10	27	33	60	Griezmann	9	9	45	47	92
Nani	9	9	29	36	65	Giroud	6	8	13	18	31

Note: Vo: neighboring players he passes the ball; Vi: neighboring players he receives the ball; Po: passes he performs; Pi: passes he receives; Tp: Total of actions (passes and receptions).

Neither the gross value of passes nor the centrality represents anything by themselves. They only indicate the weight of each player and the number of neighbors each player connects with the rest of his teammates, but it does not show the way the player interacts with each of its teammates. In this match, France has 20% more passes (710 passes vs. 575 passes), but no differences are detected in centrality, where the connectivity between players is similar in both teams except in the case of goalkeepers. Rui Patricio is a player with a good ball game with his feet manifested in the high level of centrality that, in part, is justified by the style of playing assumed

by Portugal, with more delayed positions during most of the match.

From a complexity point of view, it is more interesting to calculate the density of effective passes (644 passes vs. 496 passes). If we take the total of attempted passes as a reference, we see that the density of the gaming network created by France was clearly higher than Portugal (0.565 vs. 0.425). Something similar happens when the criteria used were the minutes of possession of each team´s ball (12.9 vs. 10.3) or the number of triangulations performed by each of them (11.7 vs. 9.0), indicating a greater associative capacity of the French team.

Beforehand, a greater collective control of the ball should allow a greater number of options for approaching the opposing area, greater shots on the goal and, if the effectiveness is high, there would be a greater number of goals achieved. On the contrary, a lower possession of the ball would mean running more behind the ball, higher levels of fatigue and consequently, less effectiveness in the passes (loss of technical quality) in the final parts of each time. However, this is not fulfilled, at least in part, especially in soccer criterion: win or lose. If we analyze the game in detail, we see that France plays more time in the rival area, having more possession of the ball, kicking more times to the goal (France: 18 total shots, 5 intercepted, 6 pitches out, Portugal: 9 total shots, 1 intercepted, 5 pitches out, 1 goal), but it is less efficient for the goal.

On an individual level, the density of French players also was the difference from their rivals. In the number of total actions, the average connectivity is equal in both teams (0.14 actions per player/total passes), but with great differences between some players of the team. The passes and receptions in which each player intervenes are considered as an action. In France, players like Umtiti (0.34), Pogba (0.31) or Koscielny (0.25) have high-density values compared to the best players of the rival team (Fonte: 0.26, Carvalho: 0.24, Guerreiro: 0.23). However, this parameter is insufficient if the minutes played by each player are not considered. In this sense, we see how the density of a player like Payet, who was substituted in the 58th minute, exceeds a high number of teammates (0.64 actions/minute) when related to time (actions/minute).

Another way to determine and assess the connectivity of each player is from the calculation of the geodesic distance of passes and receptions (Do and Di). For Portugal team, the lowest interconnection values belong to the players Fonte and Carvalho; that is, those players who need lesser teammates to intervene in the game. In contrast to these values, there are players like Ronaldo and Quaresma who need the previous participation of several teammates to intervene in the game. In the case of France, this situation of low interconnection occurs with Umtiti and Pogba; while Giroud presents similar values.

Table 2

Eccentricity and geodetic distance values are shown by both teams in the final of the Euro Cup 2016

	Portugal				France		
Player	Ecc	D_o	D_i	Player	Ecc	D_o	D_i
R. Patricio	0,356	1,99	2,68	Lloris	0,437	2,36	10,89
Soares	0,402	2,85	2,10	Sagna	1,000	2,46	1,82
Guerreiro	0,254	1,74	1,91	Evra	1,059	2,32	1,55
Pepe	0,292	2,02	2,49	Koscielny	1,000	2,11	1,49
Fonte	0,289	1,56	1,74	Umtiti	1,000	1,93	1,35
Carvalho	0,222	1,51	1,81	Pogba	1,000	1,99	1,33
Sanches	0,333	2,32	1,98	Matuidi	1,067	2,22	1,64
J. Mario	0,321	2.00	1,97	Sissoko	1,167	2,93	1,76
Silva	0,311	1,79	1,80	Payet	1,143	2,74	1,23
Ronaldo	0,411	2,96	2,62	Griezmann	1,167	2,92	1,81
Nani	0,393	2,73	2,38	Giroud	1,286	3,97	3,09
Mean	0.326	1.95	2.13	Mean	1.030	2.54	2.54
DT	0.392	0.62	0.51	DT	0.218	1.98	2.81

Note: Do is the percentage of the distance of passes performed; Di: is the percentage of the distance of passes received

For the collective analysis, we will use the distance and the average eccentricity, which are simple indicators that explain the connectivity (number and type) of each of the finalist teams. In the case of Portugal, the values of the distance between passes and receptions (defined as the length of the shortest trajectory between players and the matrix, giving us an idea about the capacity two players can interact in the network) do not show large differences between players. This does not happen with France, although in this case, we must consider the distortion value that Lloris causes. This value represents the maximum finite distance to the rest of the players. The value of eccentricity of this player is very high (10.89), which it seems logical if we consider the French team plays preferably attacking the opponent field.

At a collective level, it is interesting to analyze the radius and the diameter of the passes network of each set. The radius shows the minimum eccentricity of the players while the diameter shows the maximum eccentricity of the players. Comparing with physics, its value shows the characteristics of the orbit an object makes in space. If the orbit were circular, the diameter would be twice the radius, but when it is elliptical, that proportion logically changes, which is a usual situation when we apply the theory of networks to soccer.

The ratio between the diameter and the radius (Dm/R) shows how each team uses the field. The oscillations in both values of the distances the players show affect the surfaces of the game and this, in turn, affect the way in which the team plays. A high value indicates that the team has a more open game with the greater use of the game space, while a low value indicates the opposite, that is, the team closes and shortens the distance between its players. In soccer, the ratio between Dm/R almost always exceeds the theoretical maximum value (Dm/R>2). Although the playing field is longer than wide, the amplitude of the real game space is usually greater (35-40 meters) than its depth (30-35 meters). During the game, that surface moves from one side of the field to the other, varying its shape, position and surface depending on the circumstances of the game and the team that owns the ball (Castellano & Álvarez, 2013; Duarte et al., 2013). However, some authors suggest that, during the game, the teams tend to show a less regular and predictable behavior with the increase in variability in the organization and management of the space (Duarte et al., 2013).

Each game has its own peculiarities and values allowing evaluations between matches or teams. In the case of the analyzed match, the differences between teams are evident. France plays more openly than Portugal, concentrated in the midfield (France: Radio=0.437, Diameter=1.286, Ratio D/R = 2.943 - Portugal: Radio=0.222, Diameter=0.411, Ratio D/R=1.850).

The values that result in each case depend on how the players are in the field and how they interact with each other. The communication between neighboring players allows the team, as a whole, to coordinate and be correct in the field. In this sense, players do not have to control the position and direction of the movements of all teammates, or all their rivals, to read the game correctly and intervene properly in the game. Only the actions of neighboring players (peers or rivals) should be precisely controlled. If this is done correctly, the coordination of all team players will occur automatically. In large part this is the concept of self-organization, understanding it as the process in which some global form of order arises from the local interactions between the components of a system initially, more or less, ordered or disordered.

The team game, the organization, and occupation of the space are similar to the topology and functioning of any complex adaptive system. These systems constantly show emerging behaviors that try to adapt and make the system respond to the changing and specific needs of the environment. To be efficient, its elements (in our case, the players) behave according to previously established basic laws, usually given by the coach, and the ability of the players to self-organize. In soccer, this process is manifested differently. During a game, despite previously established criteria, players always self-organize according to the changes that occur in the environment

(game), the position of the ball and the score that exists at each moment of the game (won, losing or tying).

The organization and the uncertainty of the game must be based on the necessary position of an emerging order: spontaneous self-organization. But self-organized systems do not show emergent situations if the interactions of their components, locally or globally, do not present observable, evaluable and modifiable behaviors. For this to happen, it is necessary that there is a high level of automation of basic mechanisms, the understanding of the essence of the game, a high degree of interaction between players and the acceptance of the model by all the components. A clear example in this game is analyzed with the injury of Cristiano Ronaldo, where his replacement significantly modified the organization of the team and its form of playing.

Organizational parameters of the game network

The theory of networks provides parameters of centrality, clustering, and intermediation that helps to explain with enough precision how is the organizational dynamics of the game network.

Centrality

We can think that a player has greater centrality if he depends less on the rest to communicate with the rest of the team's components. In other words, he does not need many intermediate connections with his peers. From this point of view, a player has more centrality since he is independent. However, centrality is a value of participation but not of effectiveness. To complete this measure, it is convenient to also observe the values of intermediation and proximity. In our case, the values of centrality have a high correlation with the values of eccentricity. Especially total eccentricity (r=0.87) and pass (r=0.92) but not so much with the values of eccentricity in receptions (r=0.67)

Table 3
Centrality values

	Portugal				France		
Player	C_o * 100	C_i * 100	C_t * 100	Player	C_o * 100	C_o * 100	C_t * 100
R. Patricio	50,32	37,32	21,43	Lloris	42,36	09,18	07,55
Soares	35,04	47,61	20,18	Sagna	40,60	54,90	23,34
Guerreiro	57,61	52,38	27,44	Evra	43,06	64,48	25,82
Pepe	49,58	40,11	22,17	Koscielny	47,38	67,26	27,80
Fonte	64,18	57,38	30,29	Umtiti	51,84	74,27	30,53
Carvalho	66,07	55,21	30,08	Pogba	50,30	75,45	30,18
Sanches	43,02	50,53	23,24	Matuidi	45,03	60,93	25,89
J. Mario	50,01	50,86	25,22	Sissoko	34,14	56,91	21,34
Silva	55,78	55,68	27,86	Payet	36,53	81,29	25,21
Ronaldo	33,78	38,18	17,92	Giroud	25,22	32,39	14,18
Nani	36,64	42,10	19,59	Griezmann	34,22	55,11	21,11
Mean	49.28	47.94	24.13	Mean	40.97	57.47	22.30
DT	9.28	13.53	4.31	DT	17.50	23.21	6.90

Note: CP: passes centrality; CR: reception centrality; CT: total centrality.

Each team usually has several players that centralize the circulation of the ball in each subzone of the field. Teams using only one or two main strikers score fewer goals than teams that move the ball more evenly among all team members. A striker indicator in a complex network is given by the value (%) of centrality. The lower its value, the more efficient the game of the player or the team will be.

In the case of the Europe Cup 2016, there are no big global differences (Ct) but they highlight the existing differences when the passes and the receptions are compared separately. In this sense, France shows lower values but more distributed. On the other hand, Portugal centers the game on players like Carvalho and Fonte, players considered the main strikers of the game of Portugal. However, in both cases, in general, the

values are not statistically significant (Co: p <0.059, TE = 0.28, Ci: p <0.166, TE=0.24).

Clustering

In our case, three clustering indicators have been used (Table 4), showing similar results with high Pearson correlation coefficients among them (Wi vs WEff = 0.90, Wi vs Wv = 0.89), indicating the strength of the measure of clustering obtained.

Portugal presented strong offensive clustering in the middle of the field and in the right side of the field with four key players as strikers of these groups (Carvalho: 0.64, Silva: 0.54, Fonte: 0.53, Guerreiro: 0.51), who channeled the game towards the finishing area close to João Mario. Channeling the game on the right side was less frequent. The French team clustering was different in the way and the surface of the field used. Their offensive game was richer, with greater offensive options, strongly organized in the center of the field although important variants towards both sides. We can talk about a strongly interconnected central rectangle where Umtiti (0.35) and Koscielny (0.34) had the most backward zone, while Matuidi (0.36) and Pogba (0.37) were responsible for the circulation of the ball in the creation zone.

Such a tactical arrangement clearly shows the offensive sub-areas that most commonly generate both teams and the way in which players move and interconnect with each other. However, although everything is related to everything, the closest subspaces (clusters) are more related to each other than those more distant. Based on Waldo Tobler's law of geographical simplicity (first law of geography or the principle of spatial autocorrelation), Reggiani & Nijkamp, (2009) state that regardless of the spatial distribution used, each game subspace must always be related to all the spaces rest. They will achieve it through a specific organization (aggregate organization) sufficiently decentralized (subspaces and clustering) to optimize the game as a whole. Also, distant spaces can be related through preferential nodes in spatial networks similar to those configured in the field of play during the final analyzed.

In soccer as in any other team sport, players must adopt simple rules of the game knowing where to move, slowing down, accelerating, changing direction and using space intelligently for their own benefit and the team. This leads to the appearance or should appear, of areas with a high degree of concentration of links between a group of players. Such groupings vary in number and weight in each team, associating players with specific tactical functions that force an intense relationship between them. Each player has a greater affinity and contact with a certain number of partners than with others (either for technical reasons, such as tactics or purely spatial).

Finding the hub nodes of the game is useful to understand the behavior of multiple natural and/or accidental events generated by this type of networks. We must consider that the existence of more than one striker element makes the system more solid and less vulnerable to external attacks. The key to its functioning must be based, fundamentally, on the attention that each element shows about its neighbors and the understanding of its actions.

Table 4

Values of groupings showed by France and Portugal in the final of the Eurocup of 2016.

	Portugal				France		
Player	W_i	W_v	W_{Eff}	Player	W_i	W_v	W_{Eff}
R. Patricio	0,394	0,256	3,296	Lloris	0,229	0,107	3,501
Soares	0,363	0,152	3,966	Sagna	0,280	0,215	5,025
Guerreiro	0,510	0,382	5,022	Evra	0,287	0,228	5,859
Pepe	0,402	0,254	3,995	Koscielny	0,341	0,464	6,617
Fonte	0,530	0,440	5,270	Umtiti	0,354	0,536	7,599
Carvalho	0,644	0,406	5,559	Pogba	0,369	0,449	7,802
Sanches	0,415	0,268	4,741	Matuidi	0,357	0,317	6,883
J. Mario	0,450	0,314	4,563	Sissoko	0,237	0,154	5,280
Silva	0,548	0,340	5,304	Payet	0,265	0,181	6,425
Ronaldo	0,349	0,168	3,520	Griezmann	0,257	0,169	5,450
Nani	0,374	0,170	3,781	Giroud	0,136	0,035	3,007

Note: Wi, Wv y WEff: clustering coefficients.

Based on its associativity (associative coefficient), the global clustering capacity of a team can be established. Its value represents the Pearson's correlation coefficient of the degrees between two pairs of players who connect during the game. In this match, a negative associativity appears in both teams (Portugal: -0.0539, France: -0.1079). Positive values indicate a correlation between nodes with a similar degree, while a negative value indicates correlations of different degrees.

Game intermediation

In a way, soccer is often based on the triangulation of the game and the search and use of efficient pass lines between the players of a team. During the triangulation, the length of the sides changes constantly depending on the game situation to maintain pass lines without opposition or with a difficult interception by the rivals (Gyarmati, Kwak, & Rodriguez, 2014). This form of the game is based on intermediation. A player whose position is in the communication path between two others shows an important potential for control of communication among his peers. However, we must consider that, as suggested by Freeman & Freeman (1979), a player may be slightly connected to the rest of the team´s components (that is, low-degree centrality) and yet be an essential intermediation player in the relationships of two other components of the team. Therefore, they are players who can influence the group by filtering or distorting the circulation of the ball. In these cases, these players will also be in a better position to ensure the coordination of the game network. The intermediation coefficients used in the study practically tell us the same thing (r=0.98 and 0.94 for France and Portugal, respectively) and they explain with great precision what happened in the match (Table 5).

Table 5

Individual interconnection values of the players of the France and Portugal teams in the final of the Eurocup in 2016 using two criteria

	Portugal			France	
Player	B_1	B_2	Player	B_1	B_2
R. Patricio	7,76	27,72	Lloris	2,77	17,83
Soares	0,82	5,23	Sagna	4,27	19,37
Guerreiro	0,93	4,70	Evra	2,23	8,73
Pepe	1,38	11,27	Koscielny	1,12	9,37
Fonte	2,06	5,67	Umtiti	0,11	1,50
Carvalho	0	0	Pogba	0	0,53
Sanches	0	0	Matuidi	0,07	0,53
Joa Mario	0,79	3,20	Sissoko	1,77	11,57
Silva	0	2,17	Payet	0,20	1.00
Ronaldo	2,47	15,10	Griezmann	0,43	3,50
Nani	2,04	6,47	Giroud	6,58	31,77

The intermediation in Portugal was executed with a high precision in the center of the field by Calvalho, Sanches, and Silva, changing to players like Fonte and Guerreiro when the offensive game was moved to the left side and towards Cedric and Nani when the players were going to the right of the attack. In the case of France, the intermediation of the players is different, highlighting Pogba, Matuidi, and Umtiti. in these functions

The probability of two players neighboring a third player, being also neighbors of other team members may be more or less elevated depending on the spatial distribution of the players and the game system used. This quality of the game network could be estimated through transitivity. In this case, the transitivity value of the Portuguese team (0.226) was clearly higher than the French team (0.147), which indicates once again the greater location of the offensive Portuguese team against the greater dispersion and openness developed by the French team.

CONCLUSIONS

Compared to Portugal, the results reveal a clear superiority of France in most of the parameters analyzed. However, the final result of the match was favorable to the Portuguese team,

which shows that the dominance of the offensive game does not always translate into a favorable result.

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