Network-based performance indicators for football teams

Luca Pappalardo and Paolo Cintia

Department of Computer Science - University of Pisa

lpappalardo@di.unipi.it, paolo.cintia@isti.cnr.it

What is about?

Sports analytics has evolved in recent years in an amazing way, thanks to the sensing technologies that provide data streams extracted from every game. Despite the increasing wealth of data, there is not yet a consolidated repertoire of indicators for the various facets of team and players performance. Here, **we propose two data-driven approaches to measure the performance of football teams and football players**.

1   Team Performances evaluation

We describe each team passing style by two types of networks:

- a **player passing network** P, where nodes are players and weighted edges represent passes between players (Figure 1 left);
- a **zone passing network** Z, where nodes are zones of the pitch and weighted edges represent passes (performed by any player) from a zone to another (Figure 1 right).

From P and Z we extract the **H performance indicator**, the harmonic mean of the networks' mean degree and the networks' degree variance.
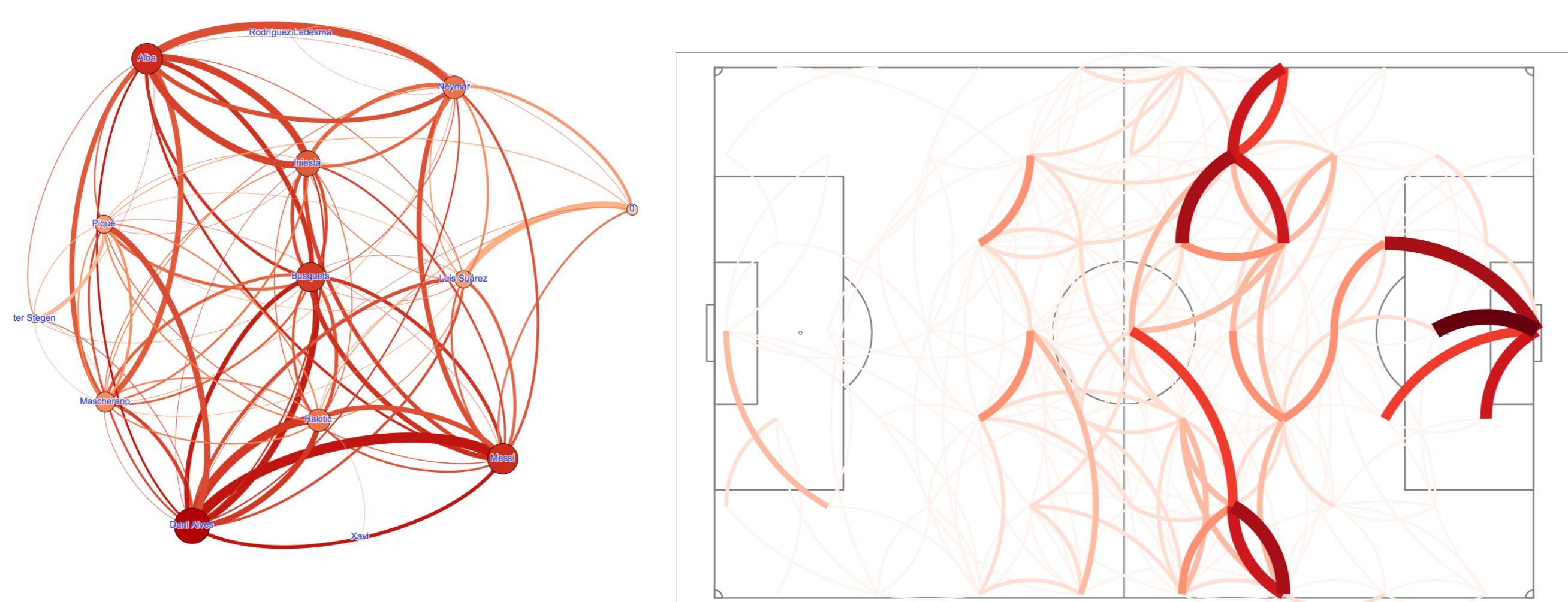

Figure 1. A player passing network (left) and a zone passing network extracted from a game of FC Barcelona in 2015.

Experiments.

- *Football Data*: all games in the Italian, Spanish, English and German leagues (almost 1500 games in season 2013/2014);
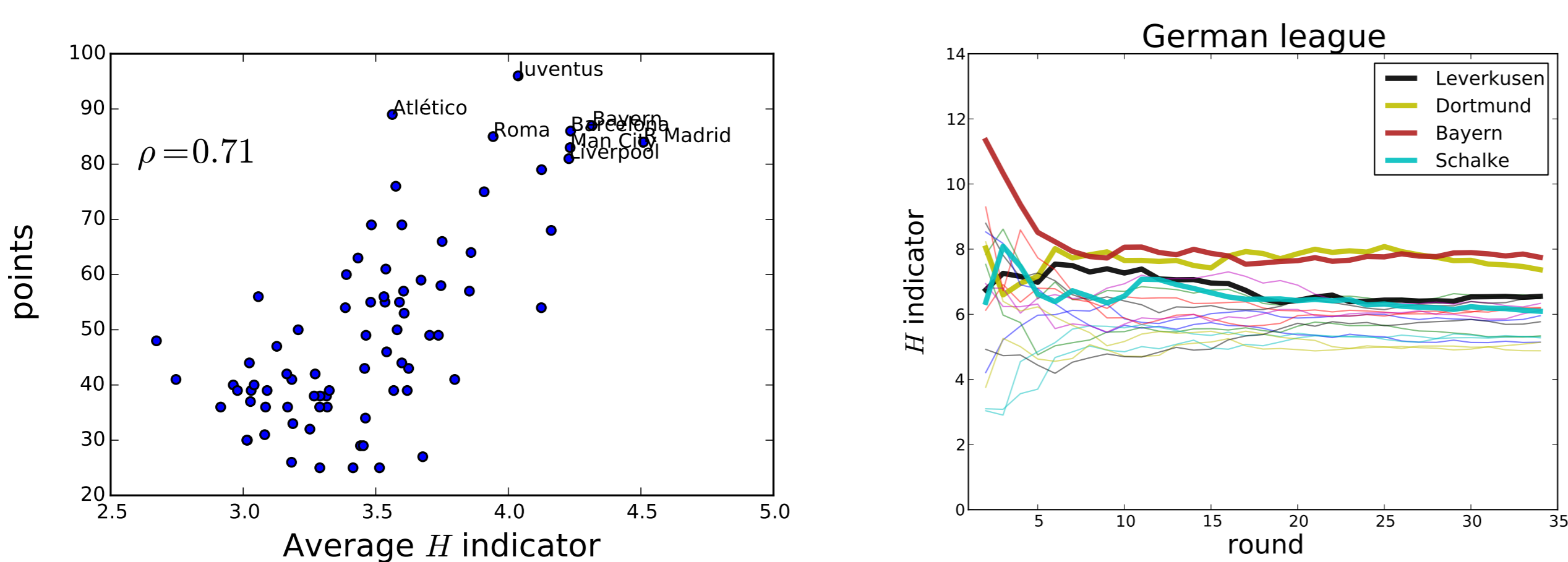- H indicator correlates with points and ranking (Figure 2).

Figure 2. (left) Average H indicator vs points. (right) Evolution of the H indicator in Bundesliga 2013/2014.

Simulation of tournaments.   We replace the outcome of each game by a synthetic outcome (win, loss or draw) based on the H indicator of each team:

- the simulated rankings are very close to the actual rankings (Figure 3);
- teams with high ranking error have extreme values of a defense/attack efficiency measure, the **Pezzali score** (Figure 2, right)
- a **"success zone"** emerges where the majority of the strongest European teams lie (Figure 2 right).

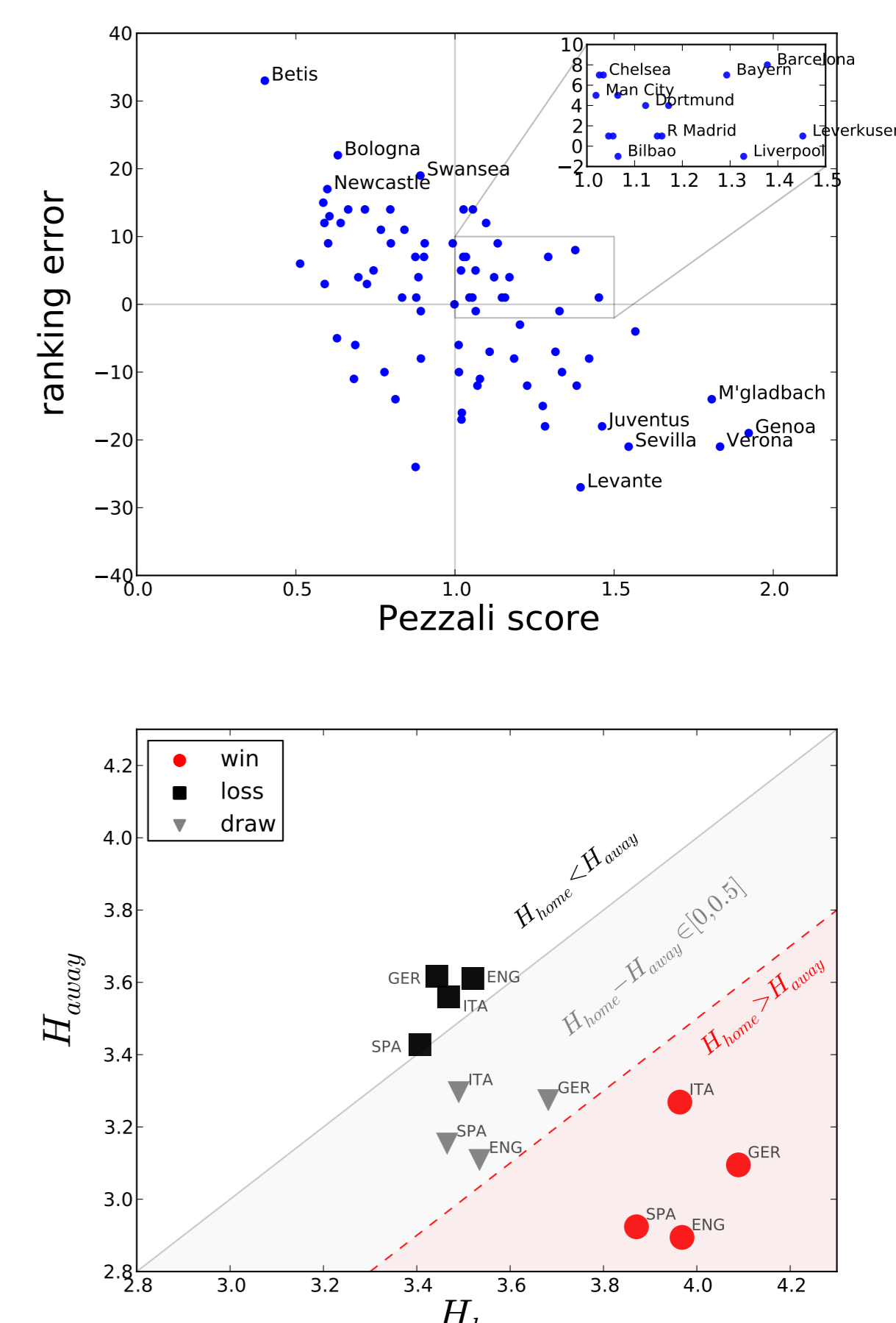| simulated ranking		real ranking	
Bayern	95	**Bayern**	90
Dortmund	75	Dortmund	71
Wolfsburg	62	Schalke	64
Leverkusen	59	Leverkusen	61
Augsburg	54	Wolfsburg	60
Hoffenheim	54	Mönchengladbach	55
Hannover	49	Mainz	53
Schalke	47	Augsburg	52
Hertha	43	Hoffenheim	44
Mönchengladbach	42	Hannover	42
Mainz	40	Hertha	41
Hamburg	40	Werder	39
Stuttgart	38	Freiburg	36
Frankfurt	34	Frankfurt	36
Nürnberg	29	Stuttgart	32
Braunschweig	26	Hamburg	27
Freiburg	24	Nürnberg	26
Werder	22	Braunschweig	25

Figure 3. Simulated vs real ranking for Bundesliga (left). Pezzali score vs ranking error (right top). Average H indicator of home and away teams (right bottom).

2   Player Performance evaluation

Algorithm.   Every player has a set of scores, each one indicating the quality he achieves on a given action a (tackle, dribbling, pass, shots, etc.) according to the quality of an opponent player in the counter-action $c(a)$ (dribbling, tackle, interception, goalkeeping, etc.).

The quality score $S_x^a(t)$ at time t of an action a performed by a player x is given by two factors:

- the ratio between the rate of success $p_y^{c(a)}(t)$ of opponent y on counter-action $c(a)$, and the rate of success $p_x^a(t)$ of player x on action a;
- the ratio between the historical scores of the players, i.e., the average of the scores obtained in previous events.

The two ratios are combined into the following equation to define the score $S_x^a(t)$ of player x on action a up to time t:

$$S_x^a(t) = \frac{p_y^{c(a)}(t)}{p_x^a(t)} * \frac{avg[S_y^{c(a)}(1), \ldots, S_y^{c(a)}(t-1)]}{avg[S_x^a(1), \ldots, S_x^a(t-1)]}. \quad (1)$$

The score $S_x^a(t)$ is updated every time player x succeeds in performing action a, hence defining a dynamic score:

- at the beginning of the season every player starts with the same set of scores $S_x^a(t) = 1$;
- the scores are updated during the season every time the player succeeds in performing action a.

Takeons			
Player x	**Score S_x^{takeon}**	**# takeons**	$p(takeon)_x$
Messi	162.21	174	0.55
Neymar	100.46	104	0.51
Orellana	96.96	88	0.37
Nolito	80.42	73	0.39
Gaël Kakuta	80.40	85	0.52
Lucas Vázquez	79.57	71	0.39
Alarcón Suárez	75.81	86	0.56
Wellington	69.46	75	0.55
Sergio García	68.94	62	0.36
Fede Cartabia	57.49	67	0.54

Table 1. Top-ten players on takeons at the end of La Liga 2014/2015.