Analysis of Drivers of Football Match Outcomes with Data Mining:
A Benchmarking Study of Italian and Israeli Statistics

Ron S. Kenett
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With collaboration of Rony Lidor and Eyal Eliakim

Abstract

In recent years, the role of data and statistics in the world of professional sports in general, and specifically professional football, is becoming exceedingly significant. Thousands of data points, in hundreds of parameters and factors, are recorded for every top level match and can be used to consolidate outcome driving parameters and thresholds, along side finding parameters that characterize playing style, formations, teams, leagues and competitions. Carpita et al. (2014) apply several data science and machine learning tools to identify a relatively small set of factors that have a significant effect in determining match outcome. Specifically, they apply random forest algorithms and principal component analysis (PCA) for feature selection and parameter reduction. The original data set consisted of 482 variables from 4 seasons of Italian Serie A football and they generate match outcome probability predictions using different methods whose accuracy is compared. Specifically, they show that the amount of goal scoring opportunities, defensive actions near own goal, lost balls and crosses and attack success rate, are drivers of match outcome for the home team. Moreover, the amount of goal scoring opportunities, headers in own penalty area, general defensive actions, ball touches in midfield and more, were found to determine match outcome for the away team. Furthermore, the data was used to examine the similarities between different seasons of Italian top tier football.

Abstract

INSTAT data from Italian Series A and Israel Premier League (IPL) in 15/16 and 16/17

In this study, we expand the Italian study to similar data from the football league in Israel. This comparison provides a powerful benchmark evaluation with insights that can be further generalized. We model the relationship between outcomes of a football match (win, lose or draw) and a set of variables describing the game across time, by analyzing data from consecutive yearly championships in Israeli and Italian leagues. Differences and similarities are highlighted and interpreted. Characteristics of the two leagues are used to interpret the results.

An information quality (InfoQ) assessment of the work will be provided.

Agenda

- Analytics in sports: How and why
- The football benchmarking study: Series A and IPL
- Information quality assessment

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BDSports
Big Data Analytics in Sports

EDITORIAL

What Is the Role of Artificial Intelligence in Sports?

Vasant Dhar
Editor-in-Chief

I attended an interesting set of talks at the most recent KDD conference in Halifax, Canada, on the use of data-driven analytics in sports.[1,2] A couple of years ago, I supervised a student project with an NBA basketball team using box scores and other ancillary data that balance risk and reward—much like financial portfolios of assets selected to minimize their overall risk-to-return ratio. By "tactical," I mean actionable recommendations such as how to play against a specific adversary, possibly in real time.

Betting

Tennis rules | Sports Arbi

rebelbetting.com/faq/tennis-rules

RonLinks | Email link | בנק הפועלים – לקוח | Google | Sci-Hub: removing ba | LinkedIn | Facebook | News Ynet | Other bookmarks

RebelBetting

Pricing Blog Support

Tennis rules

The bookies have **different rules** on certain sports, where **tennis** matches are the most common sport to have different rules on. There are 4 different tennis rules on the market today, and they can be categorized as follows:

Ball Served

For the bet to stand, only one serve is required in the match. That means that if a player retires (due to an injury for example) at any time after the first serve, the bet stands with the bookies that have this rule on tennis.

1 Set Completed

For the bet to stand, at least one set needs to be completed in the match. That

Team Management

Select a club name to start the analysis

Over 150 clubs are available in the Premium Edition of Football Benchmark. Request access at the Data & Analytics page of footballbenchmark.com.

- Manchester United FC
- FC Bayern München

Currency

EUR | GBP | USD

FC Bayern München

Founded in: 1900

League titles: 27

Stadium name: Allianz Arena

Opened: 2005

Capacity (in 15/16): 75,000 seats

Social media (1st July 2017)

42.4 m | 4.9 m | 10.2 m | SUM 57.5 m

Seasons in Bundesliga I

	11/12	12/13	13/14	14/15	15/16
League position	2nd	1st	1st	1st	1st

Select a topic . . .

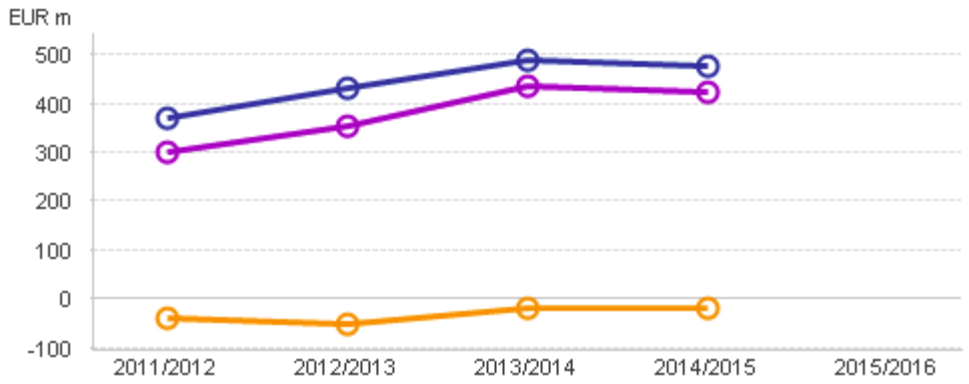
KEY FINANCIAL FIGURES | P&L and BALANCE SHEET | STADIUM and SQUAD | OTHER DATA

Overview

- Operating revenue (EUR)
- Operating expenses (EUR)
- Player trading (EUR)

CAGR between 2012 and 2016

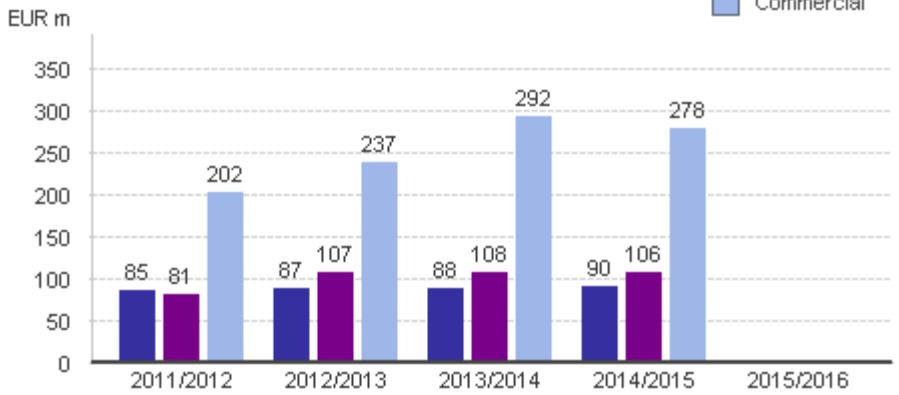
Op. revenue	Op. expenses
-	-



Revenue profile breakdown

Bar chart | % of total rev. | Table

- Matchday
- Broadcasting
- Commercial



Team Management

Select a club name to start the analysis

Over 150 clubs are available in the Premium Edition of Football Benchmark. Request access at the Data & Analytics page of footballbenchmark.com.

- Manchester United FC
- FC Bayern München

Currency

EUR | GBP | USD

Manchester United FC

Founded in: 1878
League titles: 20

Stadium name: Old Trafford
Opened: 1910
Capacity (in 15/16): 75,653 seats

Social media (1st July 2017)
73.7 m | 12.7 m
18.2 m | SUM 104.5 m

Seasons in Premier League

	11/12	12/13	13/14	14/15	15/16
League position	2nd	1st	7th	4th	5th

Select a topic . . .

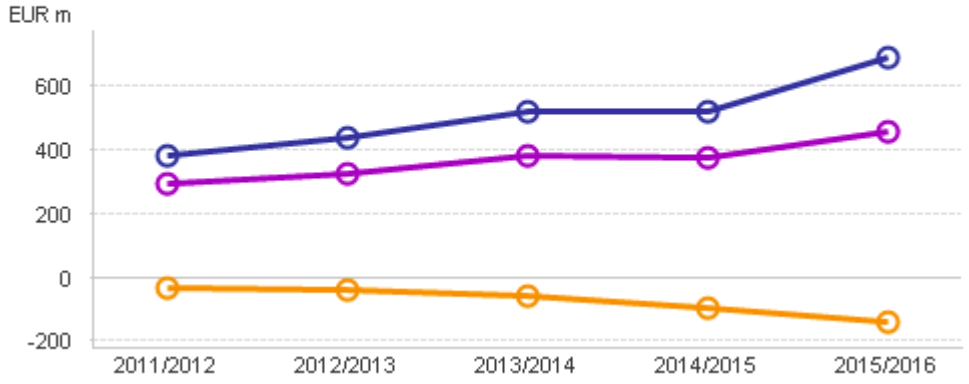
KEY FINANCIAL FIGURES | P&L and BALANCE SHEET | STADIUM and SQUAD | OTHER DATA

Overview

- Operating revenue (EUR)
- Operating expenses (EUR)
- Player trading (EUR)

CAGR between 2012 and 2016

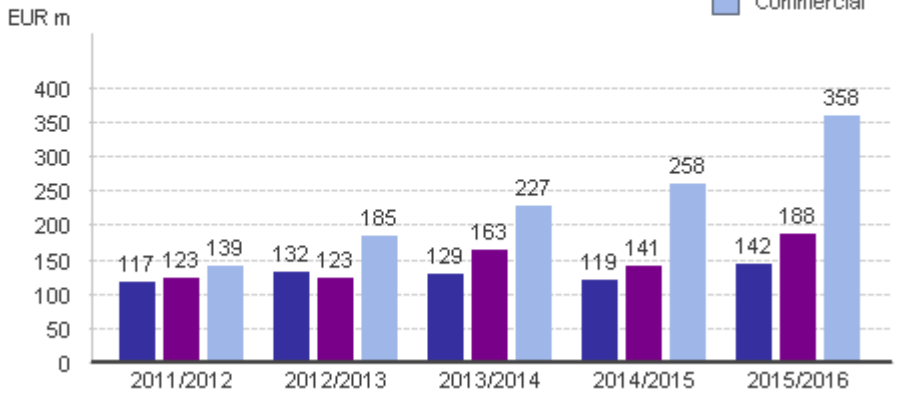
Op. revenue	Op. expenses
16.1%	11.8%



Revenue profile breakdown

Bar chart | % of total rev. | Table

- Matchday
- Broadcasting
- Commercial



Team Management

FC Bayern München - Profit and loss

Figures are in EUR million

	2011/2012	2012/2013	2013/2014	2014/2015
Total operating revenue	368.37	431.16	487.46	473.98
Total operating expenses (-)	301.47	352.00	435.64	422.32
Profit or loss before player tr...	**66.90**	**79.17**	**51.81**	**51.66**
Player trading balance	-38.03	-51.01	-19.12	-17.60
EBIT	**28.87**	**28.16**	**32.69**	**34.06**
Net interest receivable/payable	-10.17	-5.63	-6.75	-2.62
Net extraordinary income/expense	0.00	0.00	0.00	0.00
Pre-tax profit	**18.70**	**22.53**	**25.94**	**31.45**
Tax	-7.64	-8.51	-9.42	-7.62
Profit after tax	**11.06**	**14.02**	**16.52**	**23.83**

FC Bayern München - Balance sheet

Figures are in EUR million

	2011/2012	2012/2013	2013/2014	2014/2015
Total assets	**509.19**	**535.36**	**588.10**	**562.81**
Current assets	154.70	160.12	211.76	180.99
Cash and cash equivalents	114.44	114.07	149.01	101.45
Stock/Inventory	8.31	11.83	16.09	15.17
Debtors	22.41	20.36	39.45	57.46
Prepayments and accrued inc...	3.37	3.27	2.69	2.49
Other current assets	6.17	10.58	4.52	4.42
Fixed assets	354.50	375.24	376.34	381.82
Properties and facilities	254.47	245.28	236.24	229.24
Players' registrations	71.69	101.63	113.91	112.17
Other fixed assets	28.34	28.33	26.20	40.42
Total liabilities and equity	**509.19**	**535.36**	**588.10**	**562.81**
Current liabilities	138.43	156.50	158.50	152.83
of which: current loans and b...	4.51	4.51	4.51	0.00
Long-term liabilities	122.05	121.62	54.09	19.25
of which: long-term loans an...	113.93	109.42	29.91	0.00

Team Management

Manchester United FC - Profit and loss

Figures are in EUR million

	2011/2012	2012/2013	2013/2014	2014/2015
Total operating revenue	378.93	440.38	518.88	518.29
Total operating expenses (-)	292.05	325.72	379.67	377.26
Profit or loss before player tr...	**86.88**	**114.67**	**139.21**	**141.03**
Player trading balance	-33.80	-39.47	-57.86	-99.53
EBIT	**53.08**	**75.19**	**81.35**	**41.51**
Net interest receivable/payable	-58.60	-85.86	-32.84	-46.19
Net extraordinary income/expense	0.00	0.00	0.00	0.00
Pre-tax profit	**-5.52**	**-10.66**	**48.52**	**-4.68**
Tax	33.10	188.20	-19.97	3.50
Profit after tax	**27.58**	**177.54**	**28.55**	**-1.17**

Manchester United FC - Balance sheet

Figures are in EUR million

	2011/2012	2012/2013	2013/2014	2014/2015
Total assets	**1 173.96**	**1 304.61**	**1 516.79**	**1 829.62**
Current assets	183.73	190.52	238.91	336.70
Cash and cash equivalents	87.51	110.16	82.80	218.94
Stock/Inventory	0.00	0.00	0.00	0.00
Debtors	0.00	0.00	156.11	117.73
Prepayments and accrued inc...	0.00	0.00	0.00	0.00
Other current assets	96.22	80.35	0.00	0.04
Fixed assets	990.23	1 114.09	1 277.89	1 492.91
Properties and facilities	290.38	275.90	291.23	323.05
Players' registrations	139.31	139.93	255.24	334.76
Other fixed assets	560.54	698.26	731.42	835.10
Total liabilities and equity	**1 173.96**	**1 304.61**	**1 516.79**	**1 829.62**
Current liabilities	284.31	277.52	376.45	454.66
of which: current loans and b...	19.37	13.72	18.72	0.68
Long-term liabilities	598.25	504.51	518.20	703.15
of which: long-term loans an...	522.12	440.36	407.74	577.01

Team Management

Manchester United FC - Profit and loss

Figures are in EUR million

	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016
Total operating revenue	378.93	440.38	518.88	518.29	688.26
Total operating expenses (-)	292.05	325.72	379.67	377.26	456.80
Profit or loss before player tr...	**86.88**	**114.67**	**139.21**	**141.03**	**231.46**
Player trading balance	-33.80	-39.47	-57.86	-99.53	-139.34
EBIT	**53.08**	**75.19**	**81.35**	**41.51**	**92.12**
Net interest receivable/payable	-58.60	-85.86	-32.84	-46.19	-26.73
Net extraordinary income/expense	0.00	0.00	0.00	0.00	-0.17
Pre-tax profit	**-5.52**	**-10.66**	**48.52**	**-4.68**	**65.22**
Tax	33.10	188.20	-19.97	3.50	-16.64
Profit after tax	**27.58**	**177.54**	**28.55**	**-1.17**	**48.57**

Manchester United FC - Balance sheet

Figures are in EUR million

	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016
Total assets	**1 173.96**	**1 304.61**	**1 516.79**	**1 829.62**	**1 756.69**
Current assets	183.73	190.52	238.91	336.70	443.64
Cash and cash equivalents	87.51	110.16	82.80	218.94	277.31
Stock/Inventory	0.00	0.00	0.00	0.00	1.12
Debtors	0.00	0.00	156.11	117.73	120.38
Prepayments and accrued inc...	0.00	0.00	0.00	0.00	35.28
Other current assets	96.22	80.35	0.00	0.04	9.54
Fixed assets	990.23	1 114.09	1 277.89	1 492.91	1 313.05
Properties and facilities	290.38	275.90	291.23	323.05	273.35
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of which: long-term loans an...	522.12	440.36	407.74	577.01	586.24

Team Management

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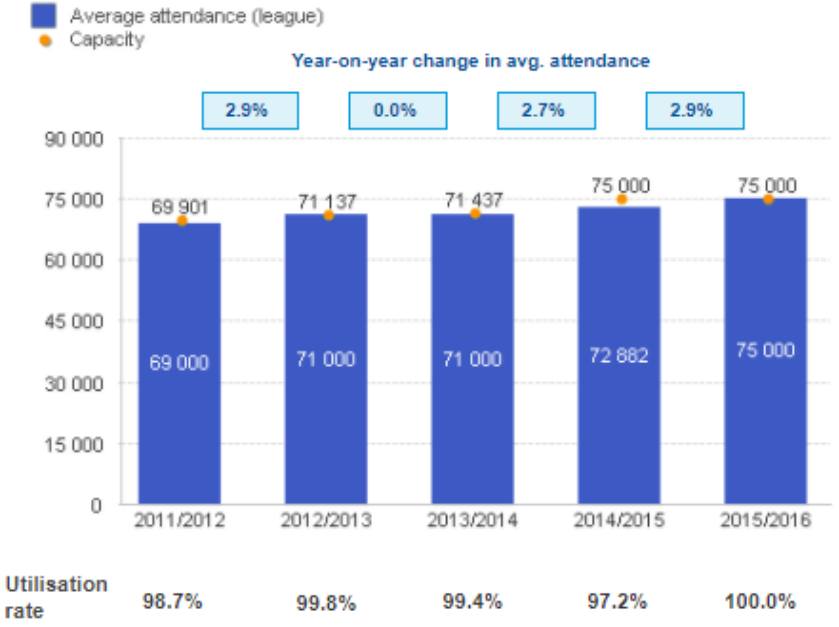
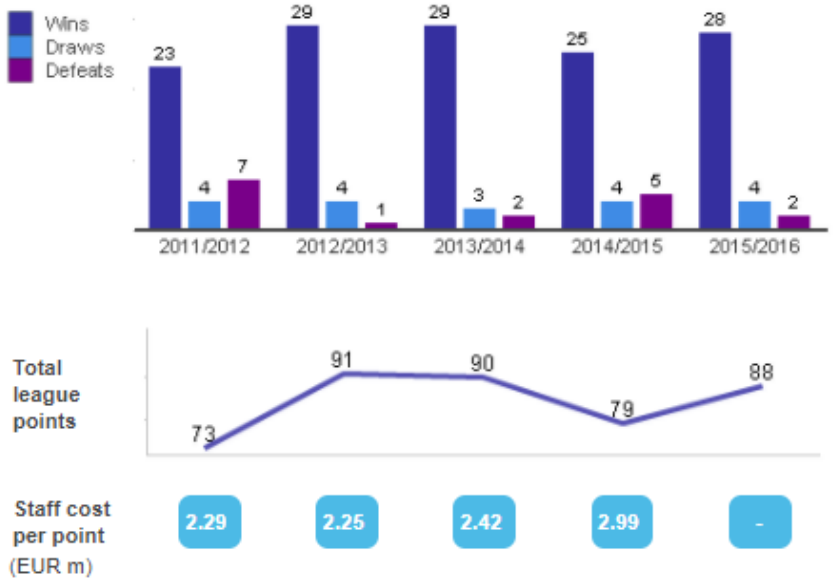
- Operating revenue
- Commercial revenue
- Operating expenses
- Profitability
- Balance sheet
- Squad value and player trading
- Social media
- Stadium

Average attendance at domestic league matches

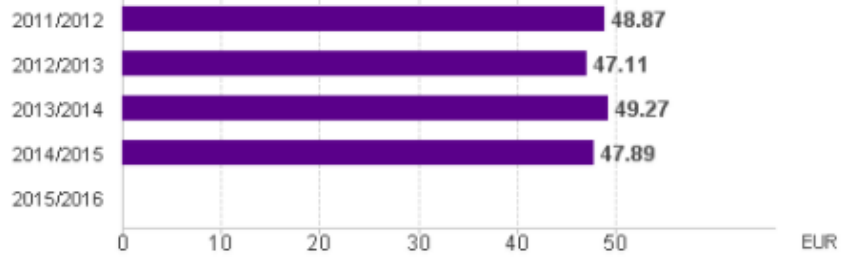


On-pitch performance of FC Bayern München

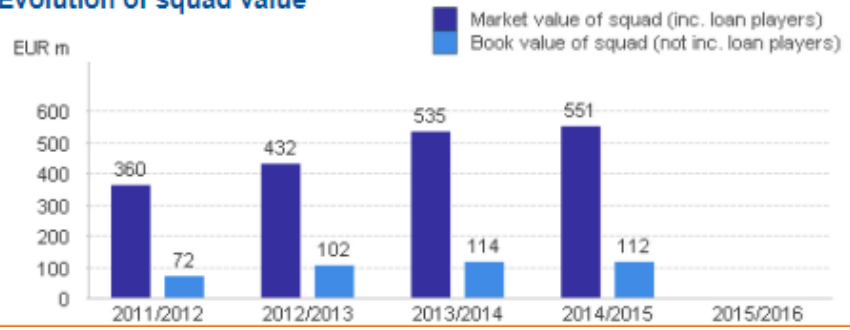


Revenue Per Event per Available Seat (RevPEPAS)

(All competitive fixtures)



Evolution of squad value



Team Management

Football Benchmark - Da | Football Benchmark - Da

Secure | https://www.footballbenchmark.com/data_analytics

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- Operating revenue
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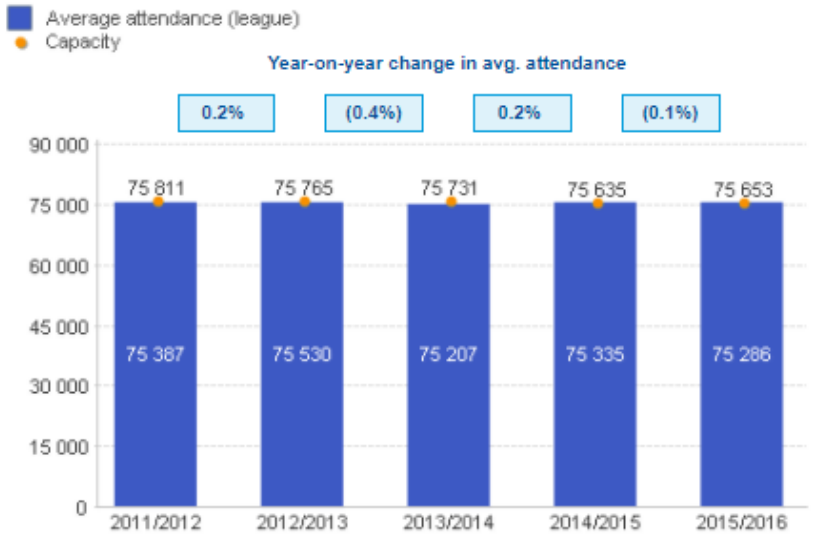
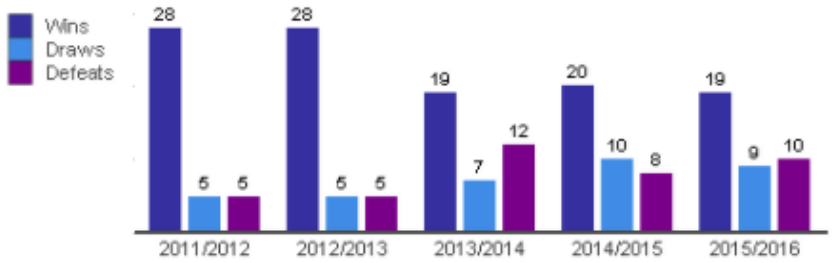
- Stadium

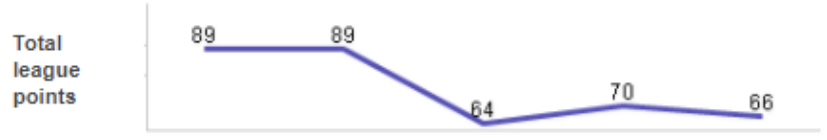
Average attendance at domestic league matches



Utilisation rate	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016
	99.4%	99.7%	99.3%	99.6%	99.5%

On-pitch performance of Manchester United FC

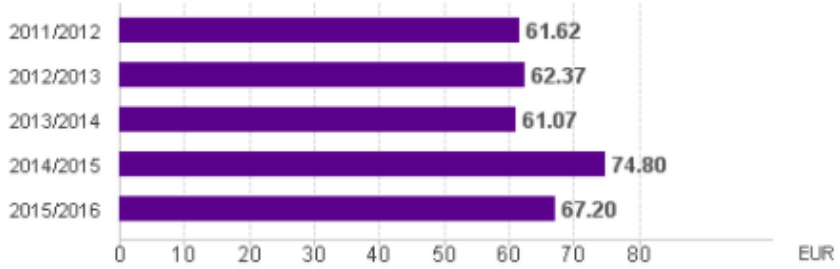




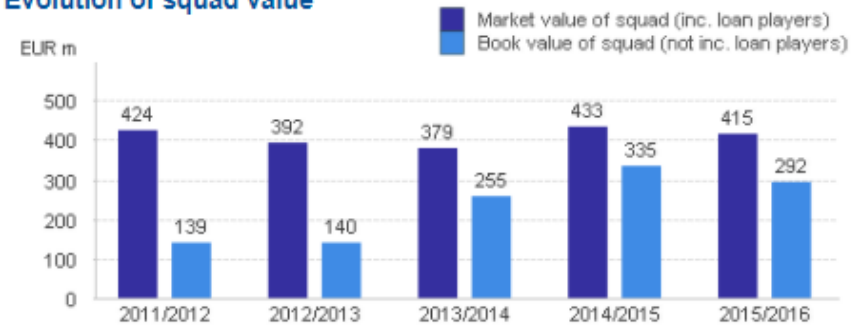
Staff cost per point (EUR m)	2011/2012	2012/2013	2013/2014	2014/2015	2015/2016
	2.15	2.49	4.11	3.80	4.87

Revenue Per Event per Available Seat (RevPEPAS)

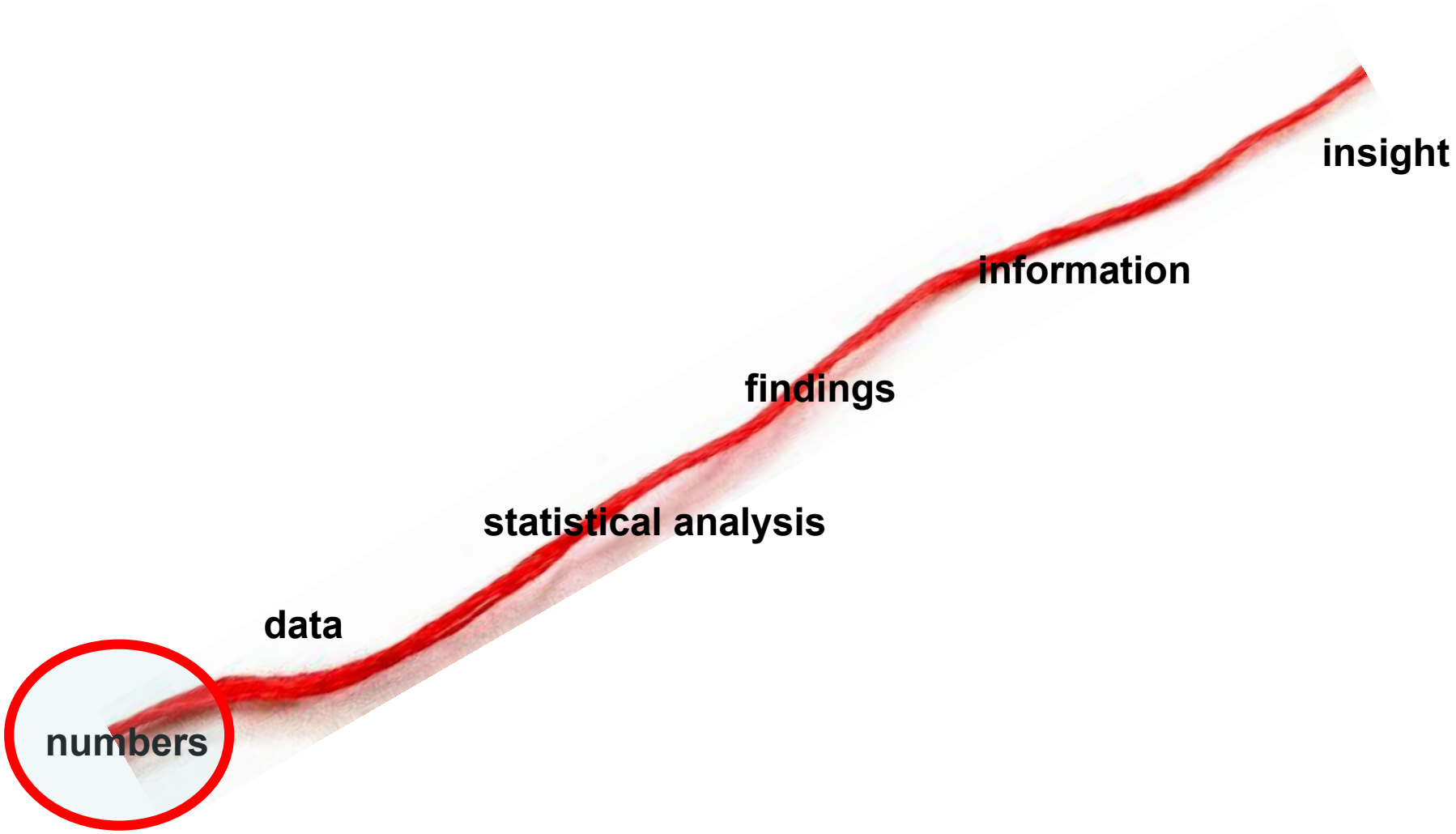
(All competitive fixtures)



Evolution of squad value



Game Management



Game Management

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QTQM
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Discovering the Drivers of Football Match Outcomes with Data Mining

Maurizio Carpita*, Marco Sandri, Anna Simonetto and Paola Zuccolotto

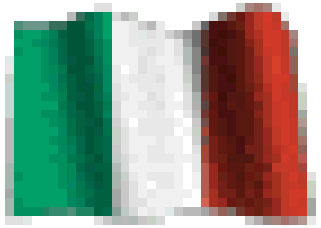
Department of Quantitative Methods, University of Brescia, Brescia, Italy
(*Received* January 2014, *accepted* May 2014)

Abstract: In this paper the relationship between the outcome of a football match (win, lose or draw) and a set of variables describing the game actions is investigated across time, by analyzing data from 4 consecutive yearly championships. The aim of the study is to discover the factors leading to win the match. More precisely, the goal is to select, from hundreds of covariates, those that most strongly affect the probability of winning a match, to recognize regularities across time by identifying the variables whose importance is confirmed in different analyses, and finally to construct a small number of composite indicators to be interpreted as drivers of match outcome. These tasks are carried out using the Random Forest machine learning algorithm, in order to select the most important variables, and Principal Component Analysis, in order to summarize them into a small number of drivers. Variable selection is performed using the novel approach developed by Sandri and Zuccolotto [33-34].

Indentifying the factors which mostly affect the probability of winning a match

Variable selection	Data reduction	Prediction
Random Forest Variable Importance Measures	Principal Component Analysis	Multinomial Logit Game strategy

Maurizio Carpita, Marco Sandri,
Anna Simonetto, Paola Zuccolotto
DMS StatLab – University of Brescia



Game Management

HOME TEAM

- shot.attack.home

ability to create opportunities to make shots on goal

- aerial.attack.home

aerial abilities (crosses and heading) when the team is on the attack

- defense.home

general defense abilities

AWAY TEAM

- midfield-defense.counterattack.away

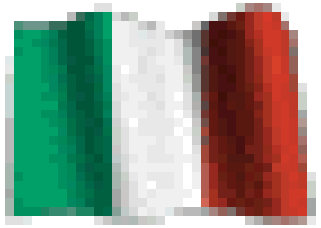
general defense abilities, long-range kicks and sudden counterattacks, with specific reference to actions in the midfield

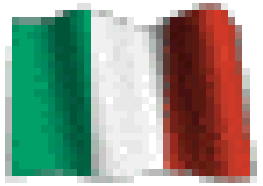
- shot.attack.away

ability to create opportunities to make shots on goal

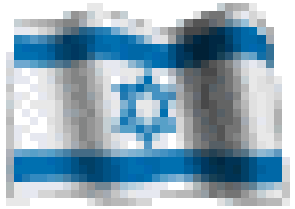
- area-defense.away

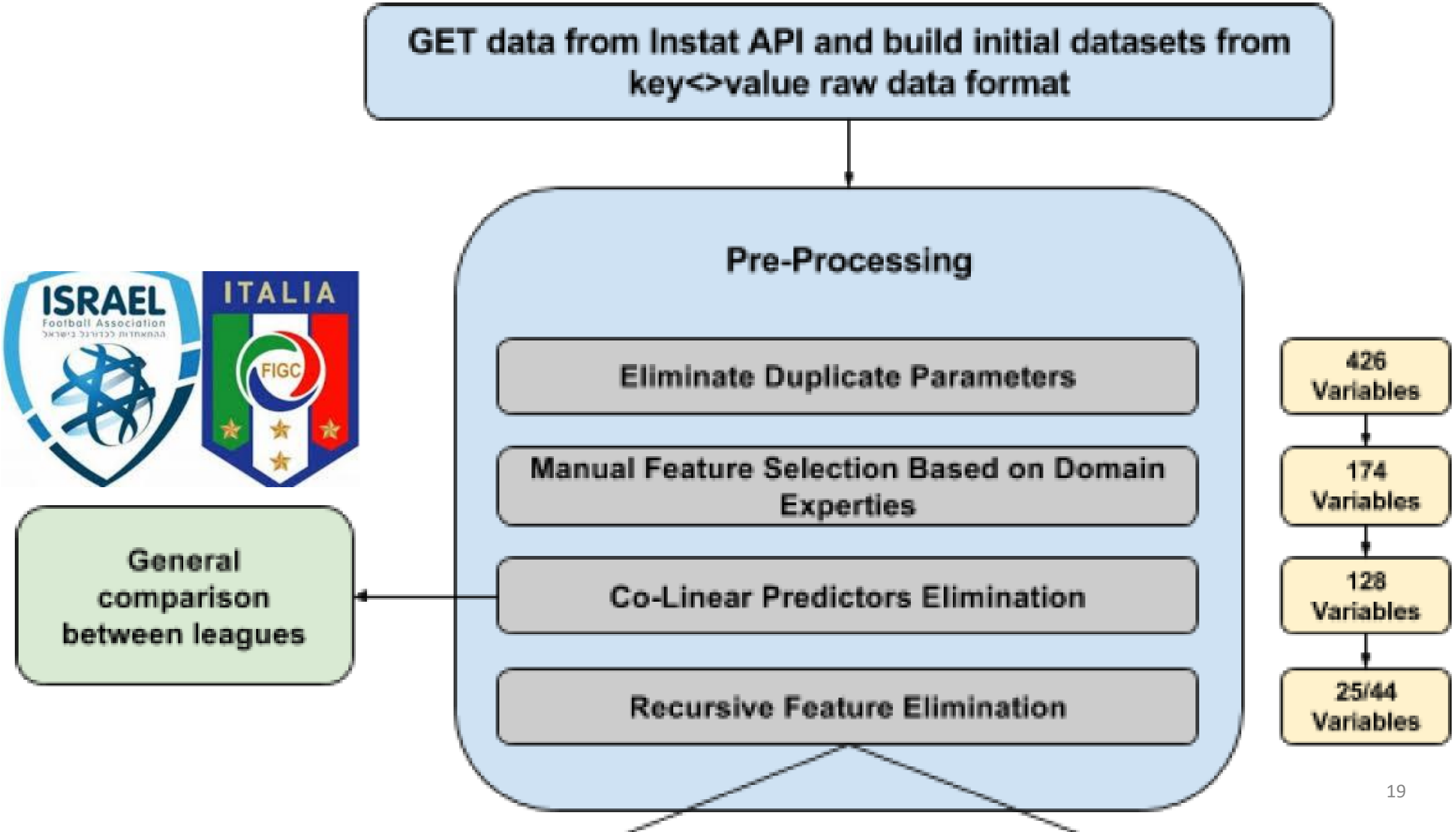
attitude to condense defense in the crucial penalty area

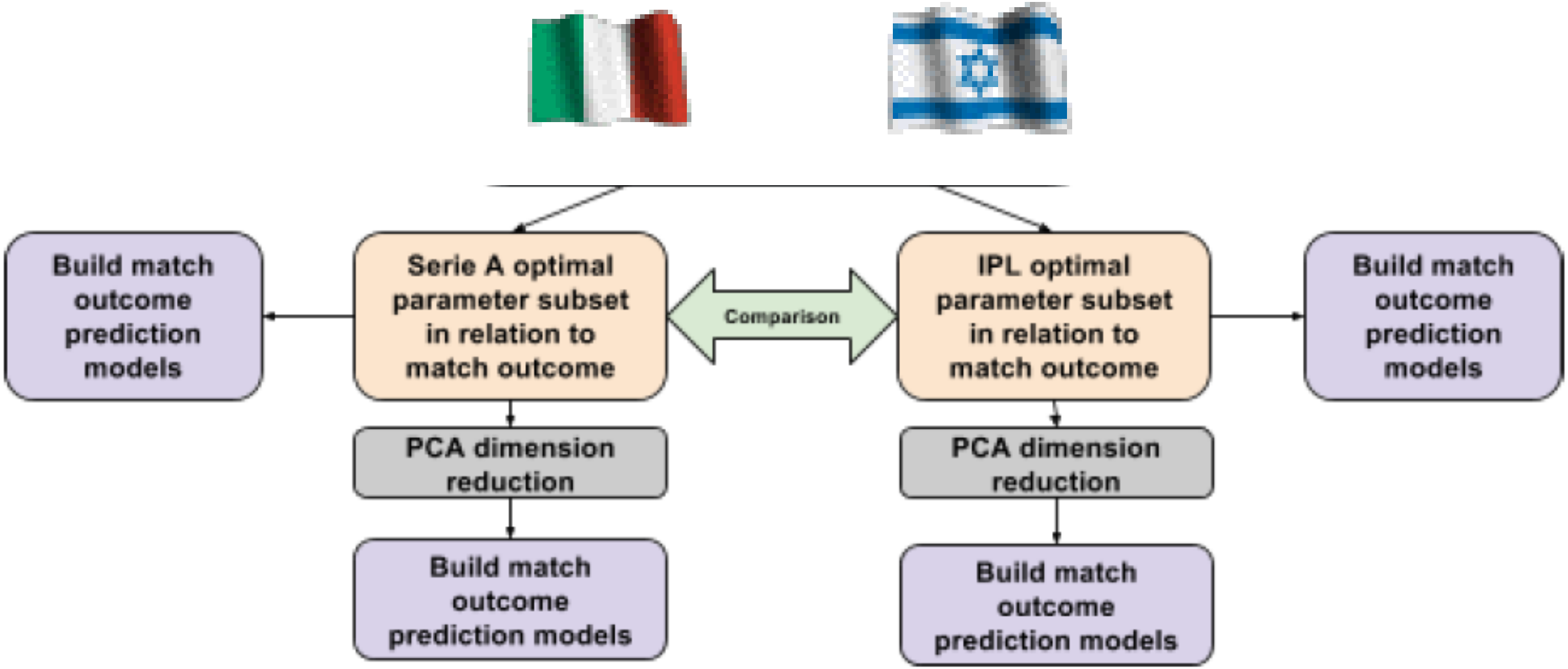




760 Serie A matches and 480 Israeli Premier League (IPL) matches .
The data was provided by Instat ltd.



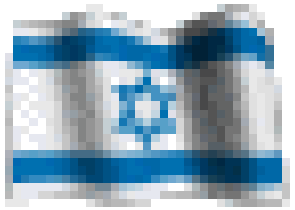

GET data from Instat API and build initial datasets from key<>value raw data format
Pre-Processing
Eliminate Duplicate Parameters
Manual Feature Selection Based on Domain Experties
Co-Linear Predictors Elimination
Recursive Feature Elimination
426 Variables
174 Variables
128 Variables
25/44 Variables
General comparison between leagues
ISRAEL
Football Association
ITALIA
FIGC


Build match outcome prediction models
Serie A optimal parameter subset in relation to match outcome
Comparison
IPL optimal parameter subset in relation to match outcome
Build match outcome prediction models
PCA dimension reduction
PCA dimension reduction
Build match outcome prediction models
Build match outcome prediction models

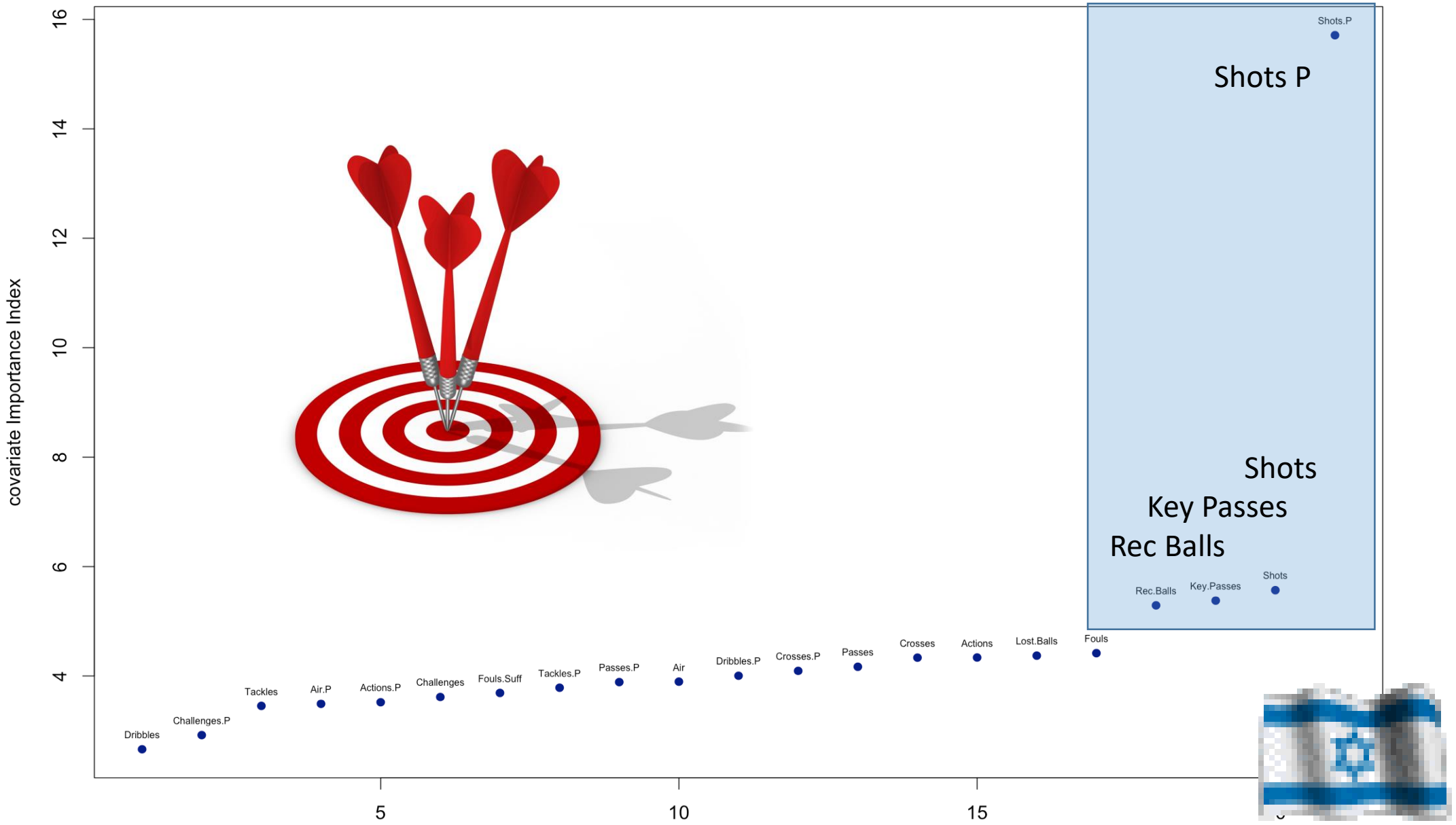
Random forest

- Shots to Post
- Shots
- Rec Balls
- Key passes

Outcome



Importance of Covariates
According to RandomForest Algorithm

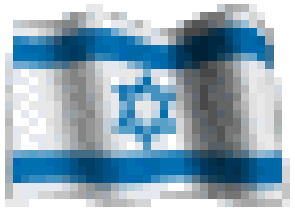


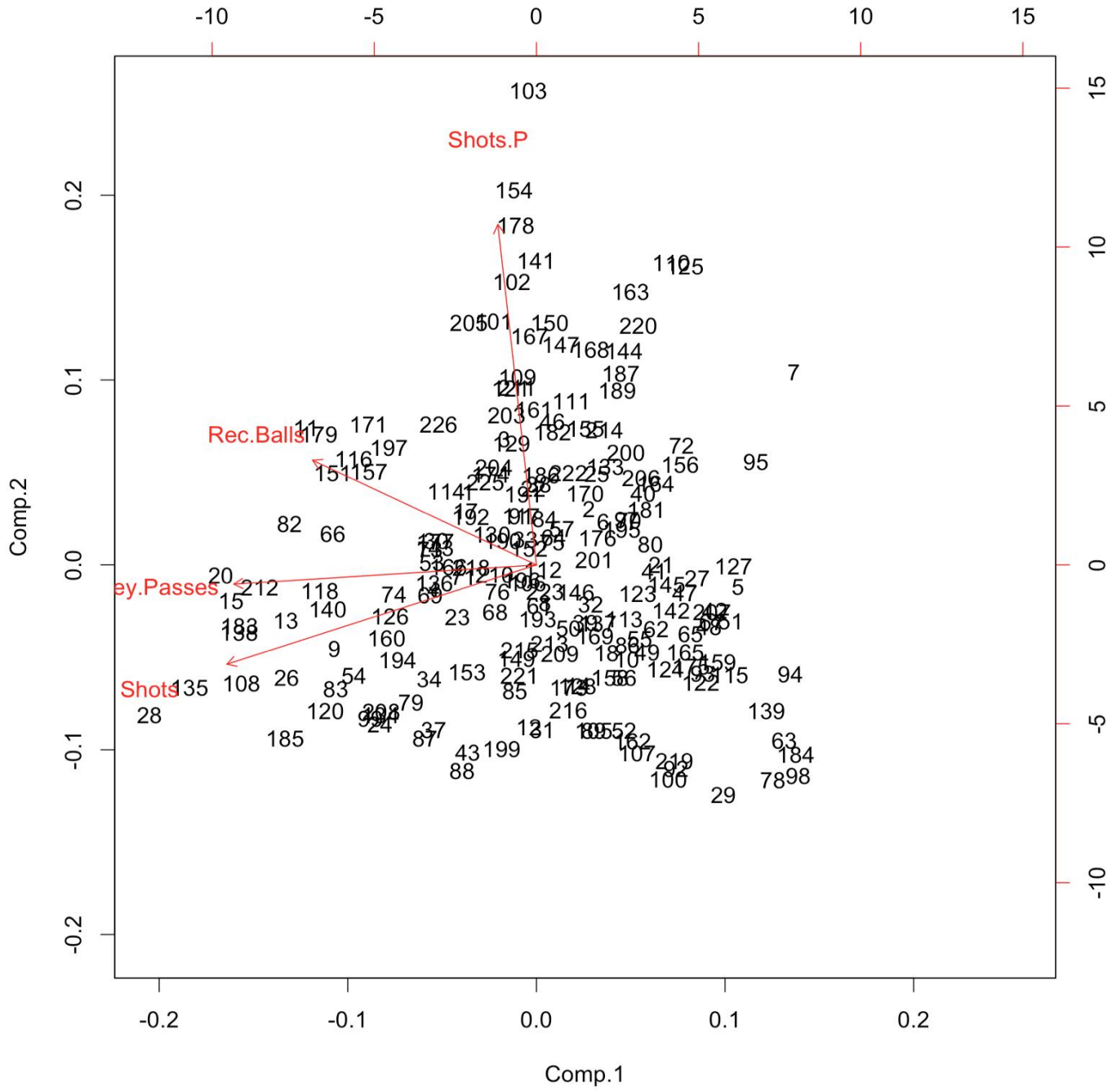
Importance of Components Table:

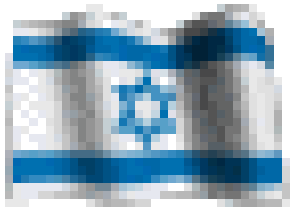
Comp 4	Comp 3	Comp 2	Comp 1	
0.631	0.883	1.027	1.329	Standard Deviation
0.099	0.195	0.264	0.442	Proportion of Variance
1	0.9	0.705	0.442	Cumulative Proportion

Loadings Table:

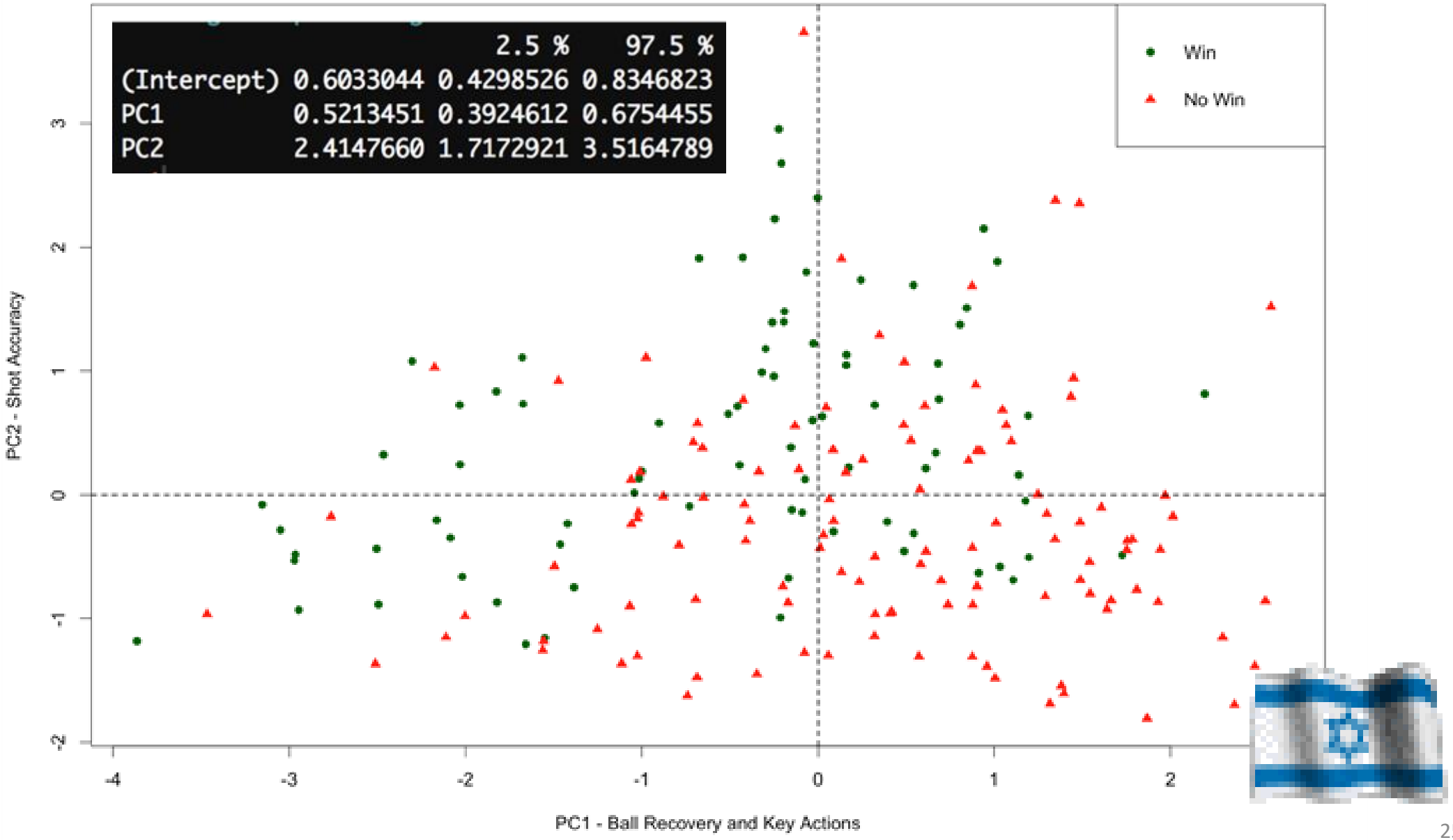
Comp 4	Comp 3	Comp 2	Comp 1	
-0.220	-0.316	0.919		Shots P
-0.715	-0.125	-0.268	-0.633	Shots
0.645	-0.445		-0.619	Key Passes
0.154	0.829	0.283	-0.458	Rec Balls



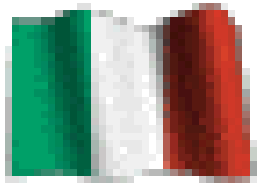

Shots.P
Rec.Balls
ey.Passes
Shots
Comp.1
Comp.2

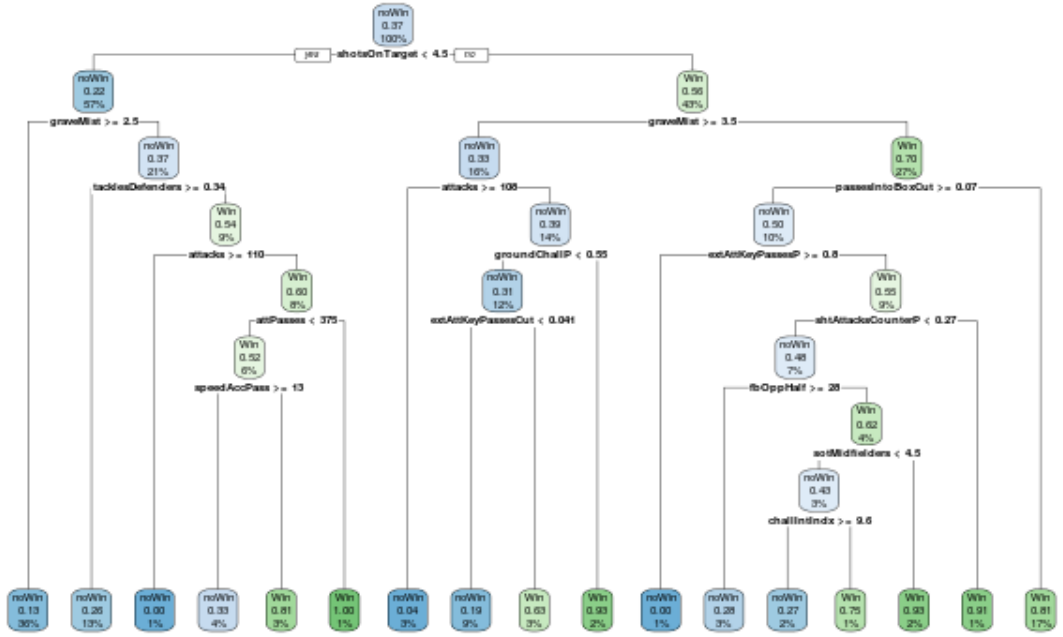


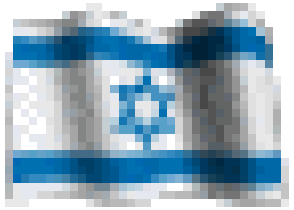
PCA

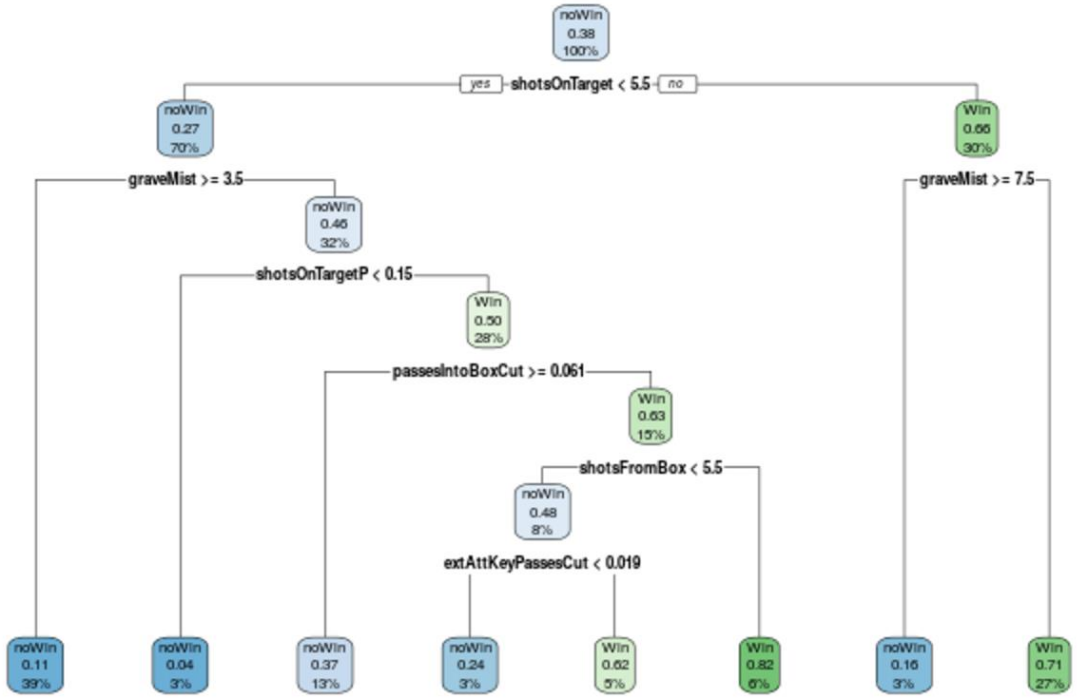


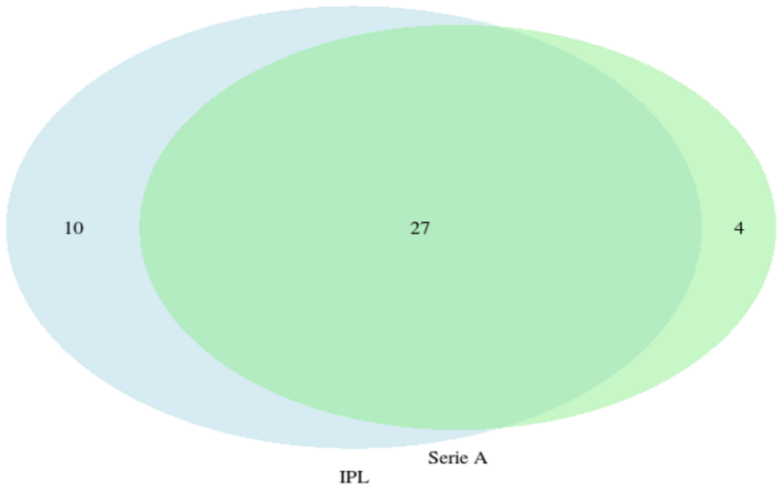
		2.5 %	97.5 %
(Intercept)	0.6033044	0.4298526	0.8346823
PC1	0.5213451	0.3924612	0.6754455
PC2	2.4147660	1.7172921	3.5164789

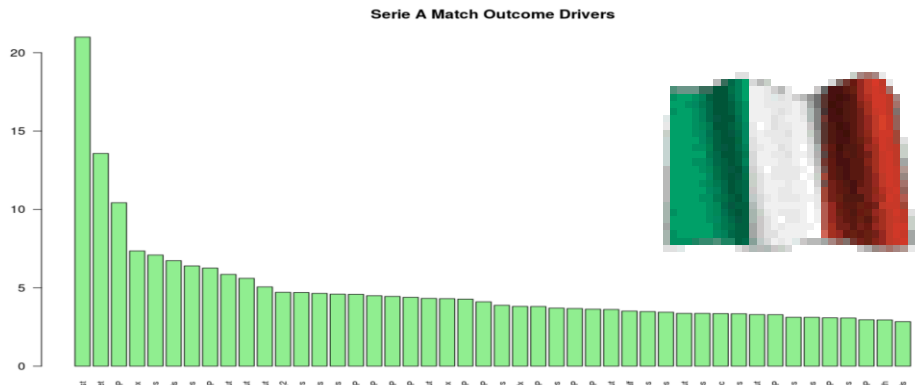


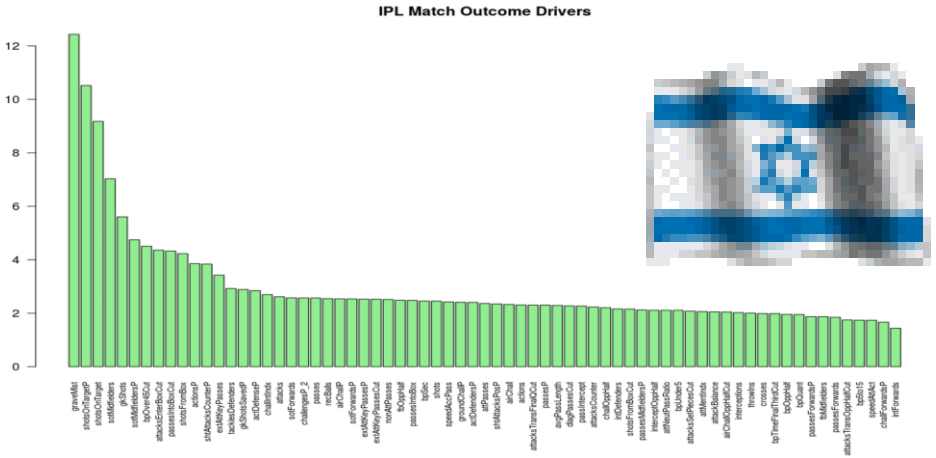

noWin
0.37
100%
yes
shotsOnTarget < 4.5
no
noWin
0.22
57%
Win
0.58
43%
graveMist >= 2.5
noWin
0.37
21%
graveMist >= 3.5
noWin
0.33
16%
Win
0.70
27%
tacklesDefenders >= 0.34
attacks >= 108
passesIntoBoxCut >= 0.07
Win
0.54
9%
noWin
0.39
14%
noWin
0.50
10%
attacks >= 110
groundChallP < 0.55
extAttKeyPassesP >= 0.8
Win
0.60
8%
noWin
0.31
12%
Win
0.55
9%
attPasses < 375
extAttKeyPassesCut < 0.041
shtAttacksCounterP < 0.27
Win
0.52
6%
noWin
0.48
7%
speedAccPass >= 13
fbOppHalf >= 28
Win
0.62
4%
setMidfielders < 4.5
noWin
0.43
3%
challIntIndx >= 9.6
noWin
0.13
36%
noWin
0.26
13%
noWin
0.00
1%
noWin
0.33
4%
Win
0.81
3%
Win
1.00
1%
noWin
0.04
3%
noWin
0.19
9%
Win
0.63
3%
Win
0.93
2%
noWin
0.00
1%
noWin
0.28
3%
noWin
0.27
2%
Win
0.75
1%
Win
0.93
2%
Win
0.91
1%
Win
0.81
17%




noWin
0.38
100%
yes
shotsOnTarget < 5.5
no
noWin
0.27
70%
Win
0.66
30%
graveMist >= 3.5
graveMist >= 7.5
noWin
0.46
32%
shotsOnTargetP < 0.15
Win
0.50
28%
passesIntoBoxCut >= 0.061
Win
0.63
15%
shotsFromBox < 5.5
noWin
0.48
8%
extAttKeyPassesCut < 0.019
noWin
0.11
39%
noWin
0.04
3%
noWin
0.37
13%
noWin
0.24
3%
Win
0.62
5%
Win
0.82
6%
noWin
0.16
3%
Win
0.71
27%







Mutual	Unique in IPL	Unique Serie A
grave mistakes	tackles by defenders	midfielders pass precision
shots on target	of shots saved by GK % from total amount of opponent's shots	pass precision
of shots on target from % total number of shots	precisoin of defensive actions	crosses
shots from the box	attacks	attacks entering the final quarter of the pitch
of shots on target by % midfielders	recovered balls	
of shots on target by % forwards	non attacking passes	
key passes	free ball pick ups in the opponent's half	
general precision	of ground challenges won %	
of passes into the box % from total number of passes	attacking passes	
of key passes from total % number of passes	air challenges	

The quality of ball movement in Serie A is improved in relation to the IPL with substantially higher amount of passes into the box, a higher absolute and relative amount of key passes, a higher percentage of short passes from total amount of passes, a shorter average pass length and a higher relative amount of attacks that last between 15 and 45 seconds.
Additionally, it seems that attack efficiency in Serie A is significantly better than in the IPL with higher absolute and relative amounts of shots from the box, attacks entering the box / final quarter of the pitch and time in possession in the final third of the pitch.
Furthermore, and maybe most importantly in an attacking perspective, the average speed of attacking actions and accurate passes are substantially higher in Serie A.

Significant differences were found in 54 out of 128 predictors, showing the vast differences in quality of performance between the leagues

Surprisingly, the amount of grave mistakes and lost balls in Serie A are higher than in the IPL

Major differences between the leagues are amongst defenders and forwards

Italian defenders are more focused on their main functionality - defensive duties

Italian forwards are also more defensively active than the Israeli ones

Future projects

- Study the effect of tactical discipline on match outcome and performance in key match outcome drivers. In a preliminary study we found a substantial positive correlation between tactical discipline and match outcome, using players' average location on the pitch.
- An exploratory study on passing network profiles and a team's offensive efficiency. The goal will be to find the optimal profile of a passing network (existence of pivots - yes/no? etc.) as an illustration of the best form of ball movement.
- Conditions that enable youth player integration in first teams and young player breakthroughs. Integration will be tested using playing minutes and position specific KPIs.

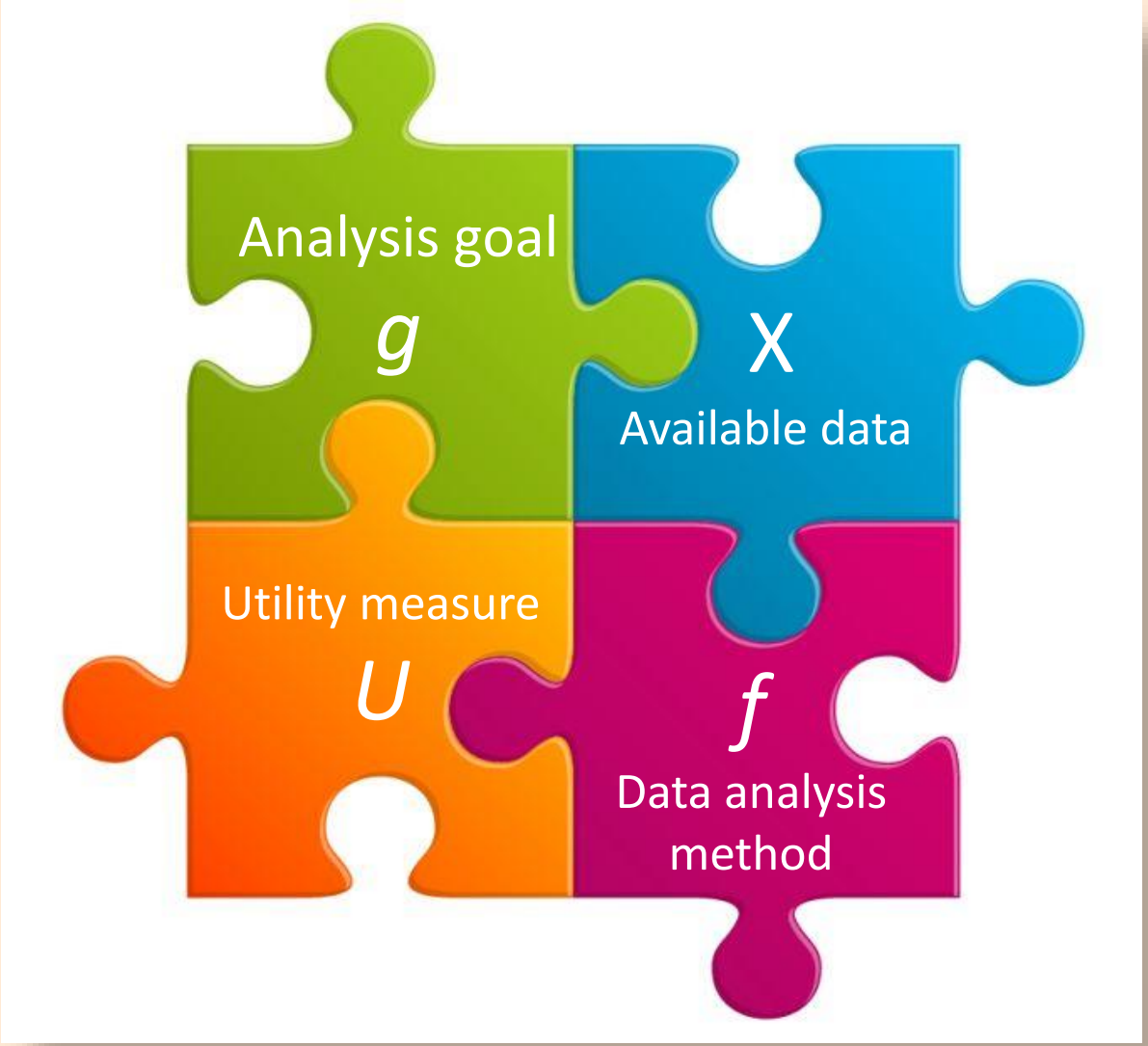
Information Quality (InfoQ)

The potential of a particular dataset,
to achieve a particular goal,
using a given empirical analysis method

g	**A specific analysis goal**
X	**The available dataset**
f	**An empirical analysis method**
U	**A utility measure**

$$InfoQ(f,X,g) = U(\, f(X|g)\,)$$

Kenett, R.S. and Shmueli , G. (2014) On Information Quality , *Journal of the Royal Statistical Society, Series A* (with discussion), Vol. 177, No. 1, pp. 3-38, 2014. http://ssrn.com/abstract=1464444.


Analysis goal
g
X
Available data
Utility measure
U
f
Data analysis
method

Domain goal

What, why, when, where, how

-> Analysis goal

Explain, predict, describe

Enumerative, analytic

Exploratory, confirmatory

Data Size and Dimension

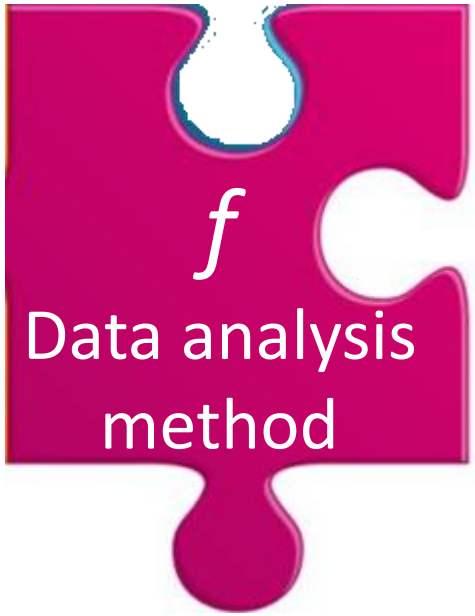
- # observations
- # variables

Data Source

- Primary, secondary
- Observational, experiment
- Single, multiple sources
- Collection instrument, protocol

Data Type

- Continuous, categorical, mix
- Structured, un-, semi-structured
- Cross-sectional, time series, panel, network, geographical



Statistical models and methods

- Parametric, semi-, non-parametric
- Classic, Bayesian

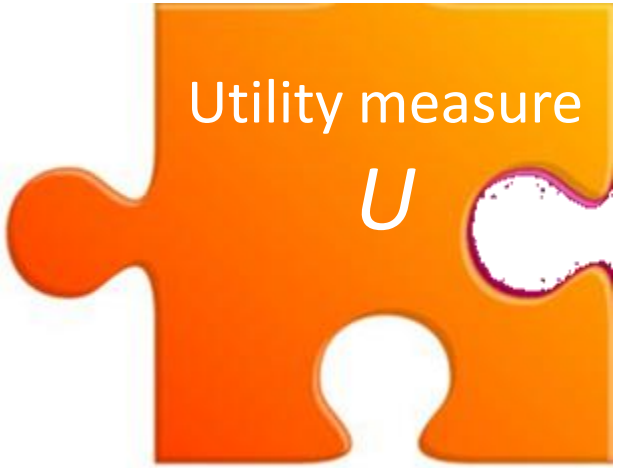
Data mining algorithms

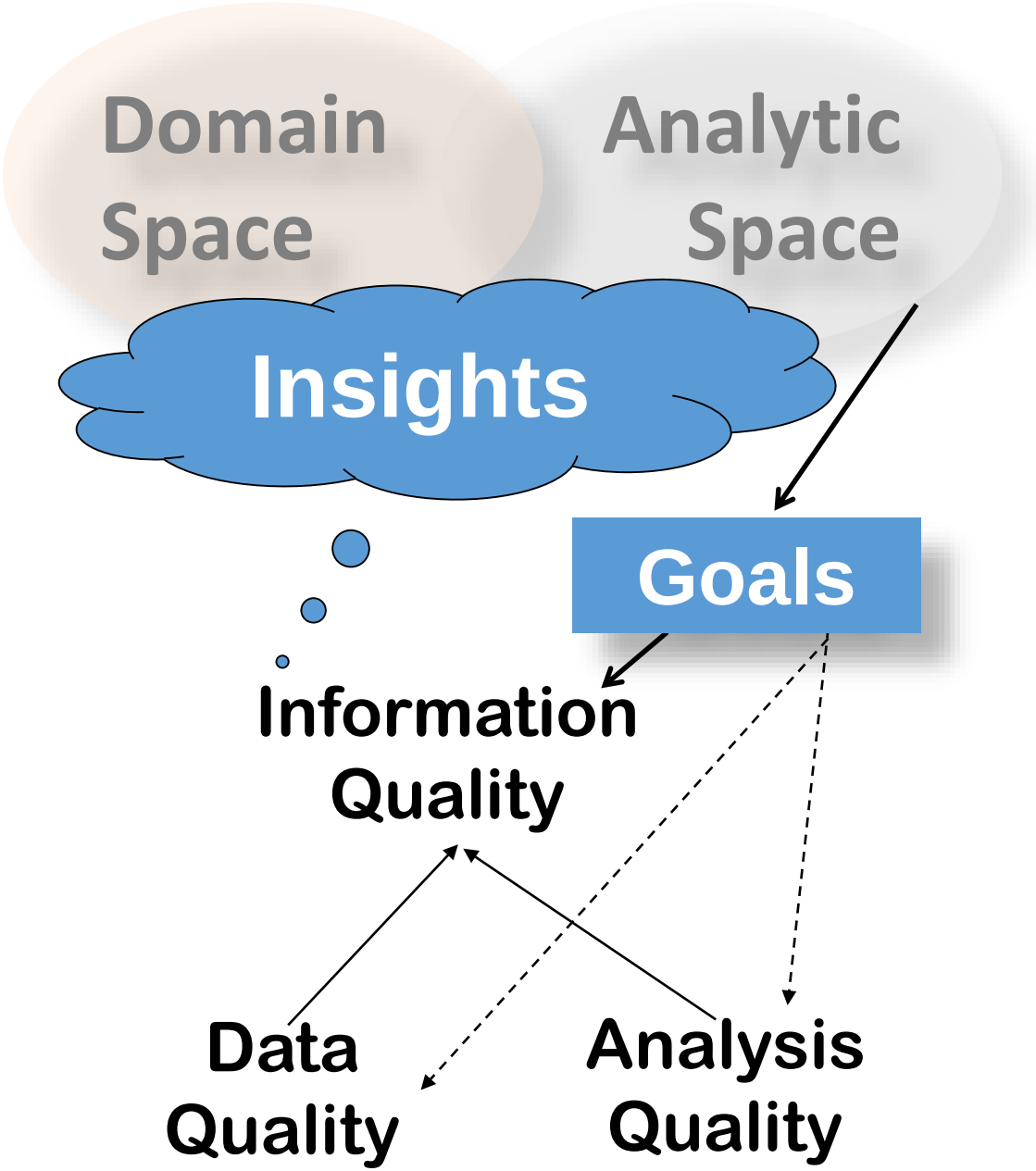
Graphical methods

Operations research methods

Domain goal -> Analysis goal

- Predictive accuracy, lift
- Goodness-of-fit
- Statistical power, statistical significance
- Strength-of-fit
- Expected costs, gains
- Bias reduction, bias-variance tradeoff



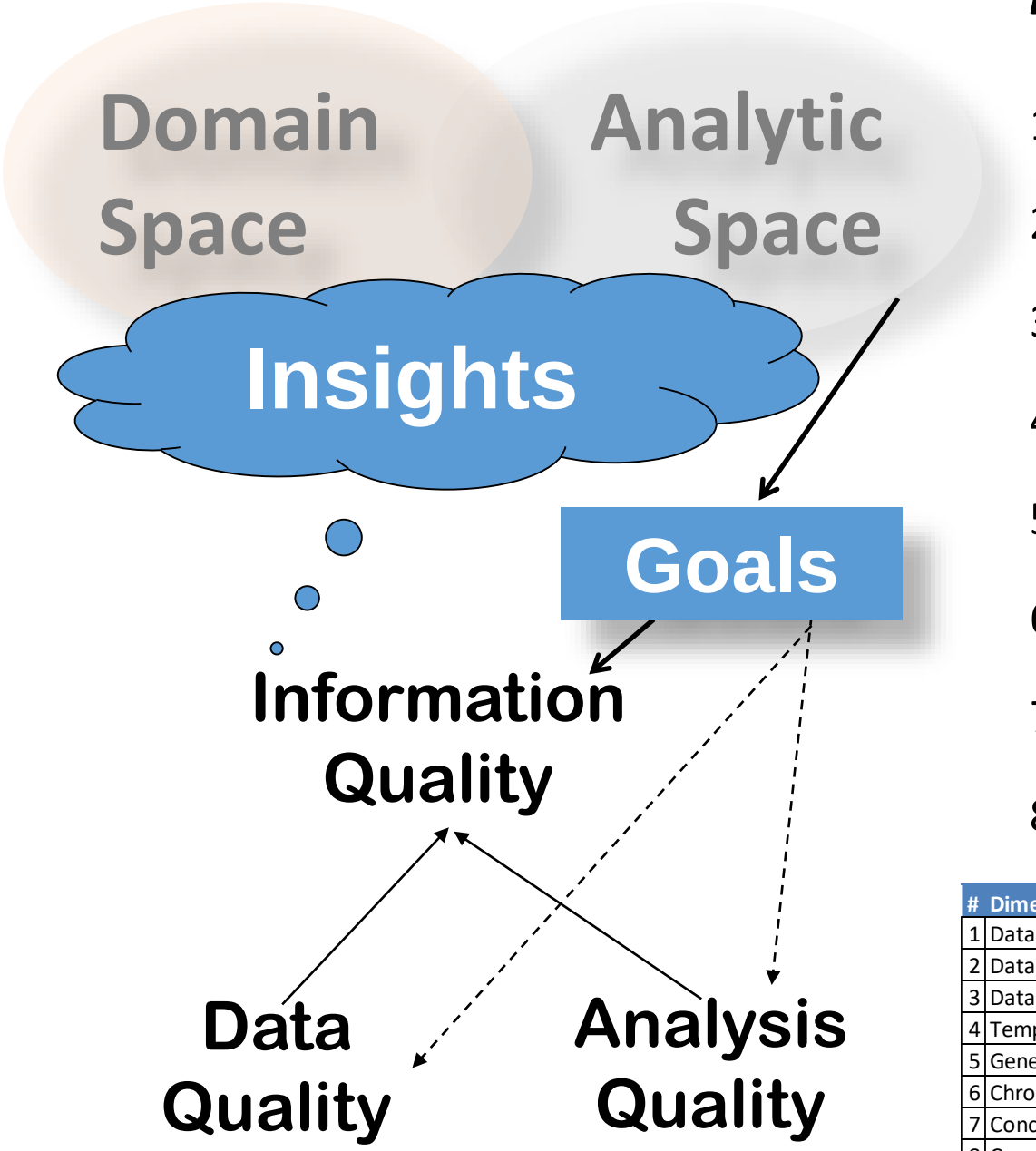


$$InfoQ(f,X,g) = U(f(X|g))$$

1. Data resolution
2. Data structure
3. Data integration
4. Temporal relevance
5. Chronology of data and goal
6. Generalizability
7. Operationalization
8. Communication

How

What



$$InfoQ(f,X,g) = U(f(X|g))$$

1. Data resolution
2. Data structure
3. Data integration
4. Temporal relevance
5. Chronology of data and goal
6. Generalizability
7. Operationalization
8. Communication

How

#	Dimension	Note	Value	Index
1	Data resolution		5	1.0000
2	Data structu			00
3	Data integrat			00
4	Temporal rel			00
5	Generalizabil			00
6	Chronology of data and goal		5	1.0000
7	Concept operationalization		2	0.2500
8	Communication		3	0.5000
	InfoQ Score = 0.68			

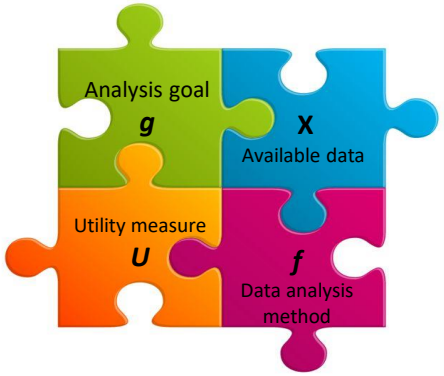
InfoQ=68%

KPA
Insights through analytics

BDSports
Big Data Analytics in Sports

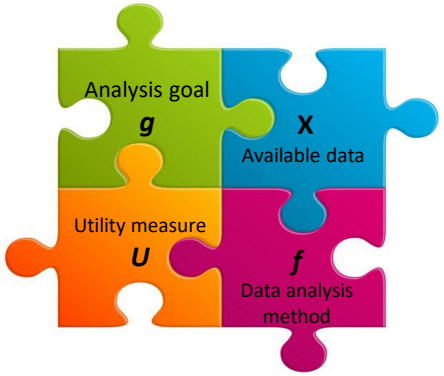
InfoQ assessment

Analysis of Drivers of Football Match Outcomes with Data Mining:
A Benchmarking Study of Italian and Israeli Statistics



g **A specific analysis goal**

Increase probability of winning by implementing winning strategies

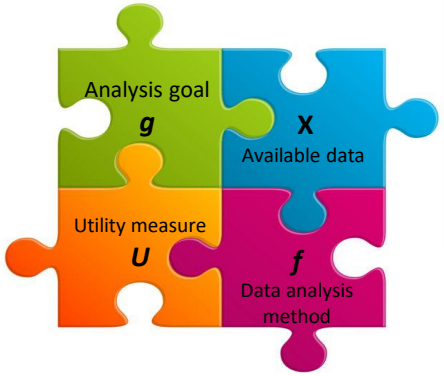


X The available dataset

760 Serie A matches and 480 Israeli Premier League (IPL) matches

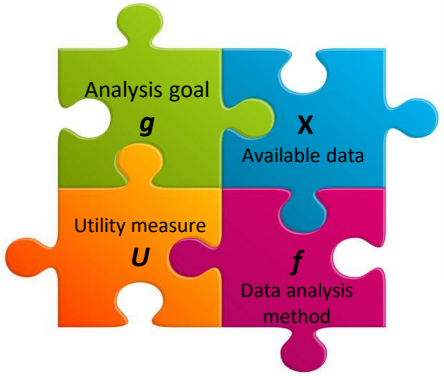
455 parameters per match

The data was provided by Instat ltd.



f **An empirical analysis method**

Random forests and other ML techniques

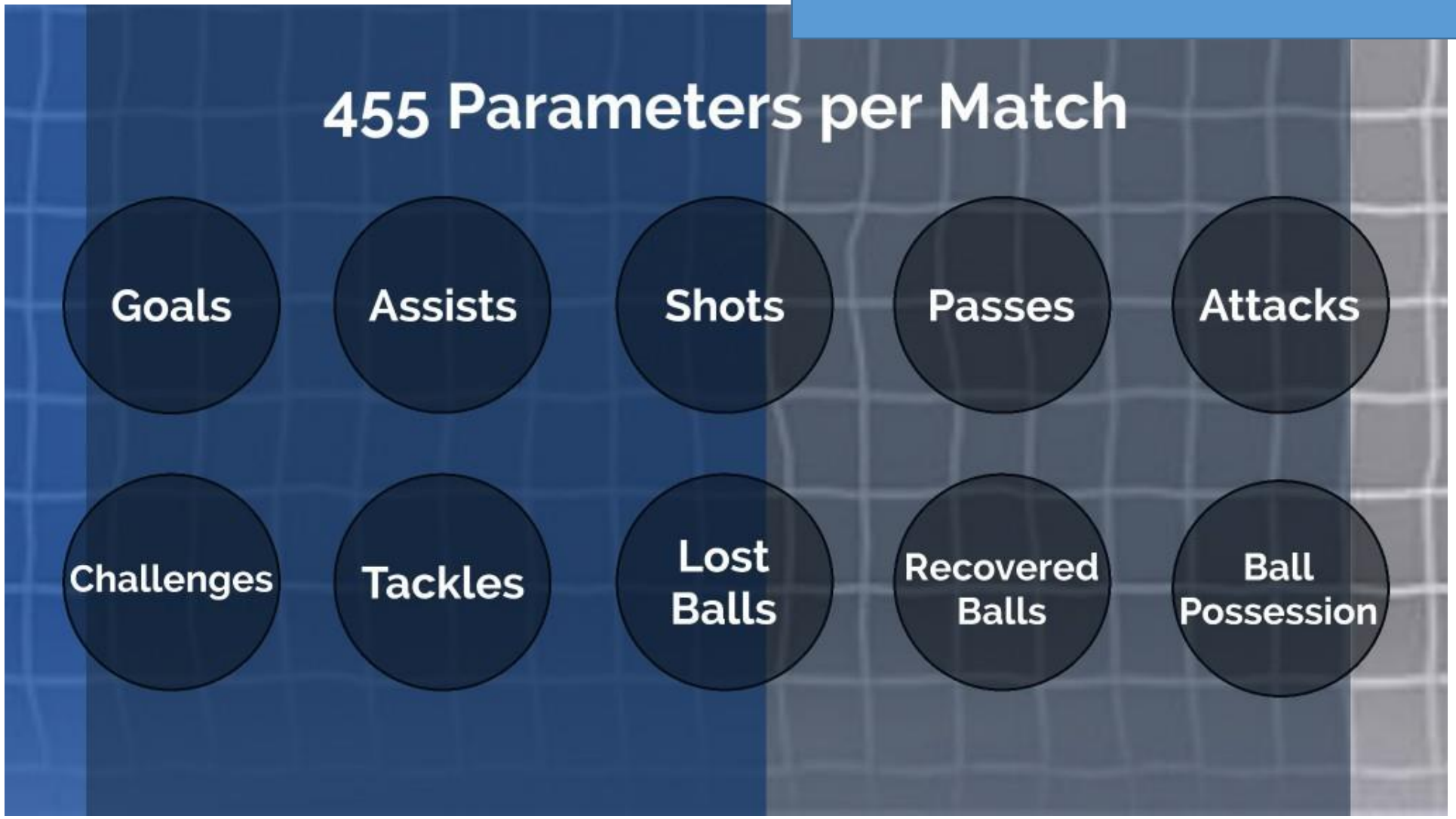


U **A utility measure**

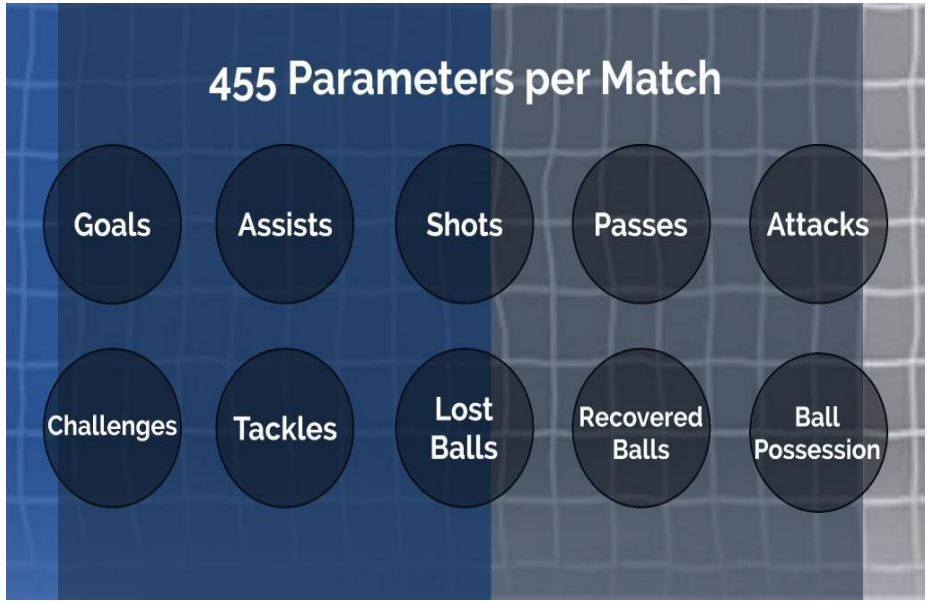
Improved game strategy

#1 Data Resolution

INSTAT data from Italian Series A and Israel Premier League (IPL) in 15/16 and 16/17



#2 Data Structure



Data from wearables

Crowd reaction

Physiological data

Blogs

#3 Data Integration

Match variables in Series A and IPL matches

#4 Temporal Relevance

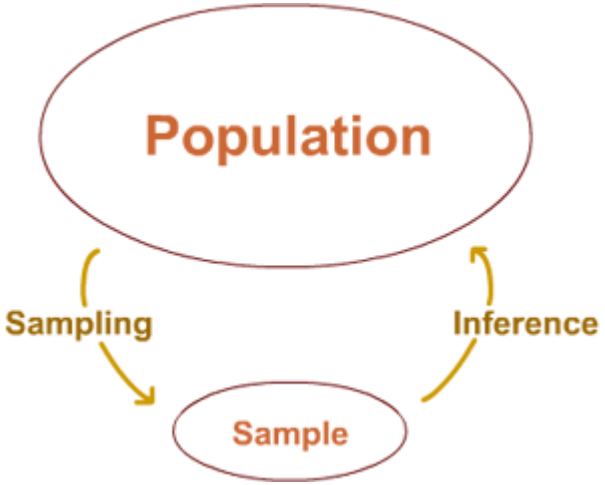
Apply analysis to 15/16 and 16/17 seasons

#5 Chronology of Data & Goal

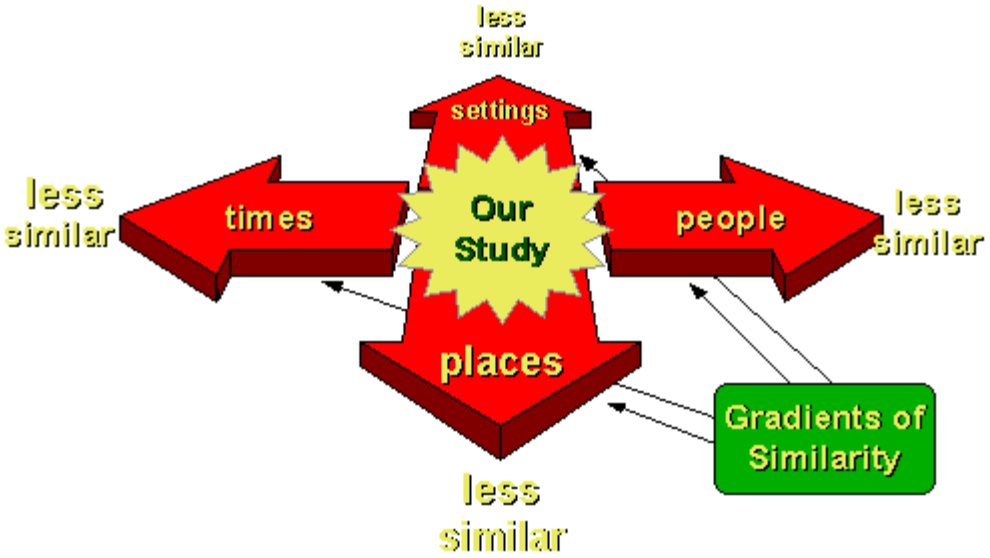
Off line (strategy) versus on ground (tactical) decisions

#6 Generalizability

Statistical generalizability



Scientific generalizability



#7 Operationalization

Off line (strategy) versus on ground (tactical) decisions:

- Who
- When
- Where
- How
- What

#8 Communication

Visualization Tools

Department of Economics and Management
University of Brescia

SEMINAR

"Sensor Analytics in basketball: analyzing spatio-temporal movements of players around the court"

Rodolfo Metulini
Università degli Studi di Brescia

Chair: Prof.ssa Paola Zuccolotto

March 15, 2017 – h. 11.00
Sala Biblioteca, S. Faustino building

Spatio-Temporal Movements in Team Sports: A Visualization approach using Motion Charts.

Rodolfo Metulini (1)

(1) *Department of Economics and Management, University of Brescia, Contrada Santa Chiara, 50, 25122 Brescia BS, Italy,*

rodolfo.metulini@unibs.it.

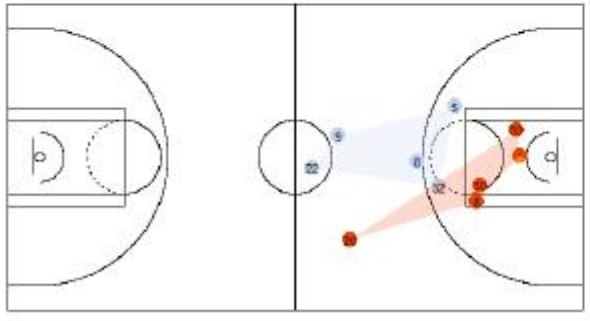
A tool to display data recorded by tracking systems producing spatio-temporal traces of player trajectories with high definition and frequency.
https://www.youtube.com/watch?v=aejyrDnqYVY

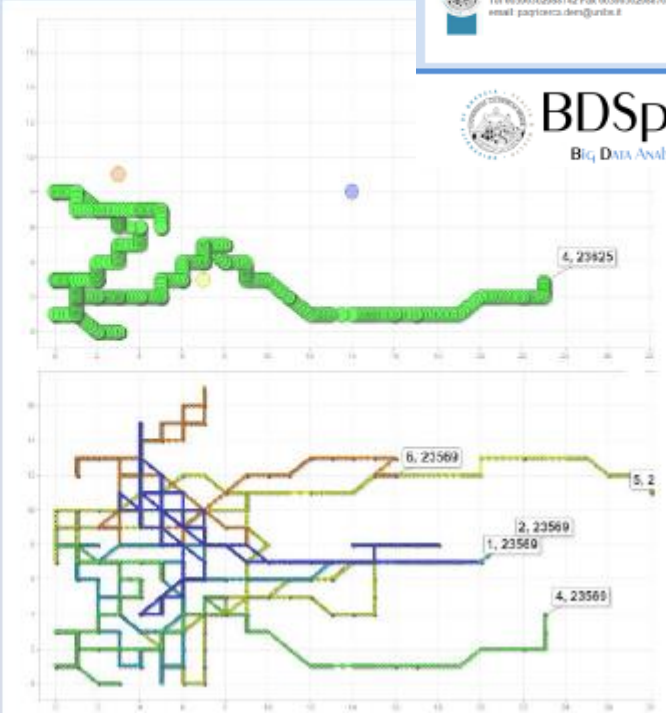
BDSports
Big Data Analytics in Sports

Marica Manisera
Paola Zuccolotto – University of Brescia, Italy

Visualization Tools

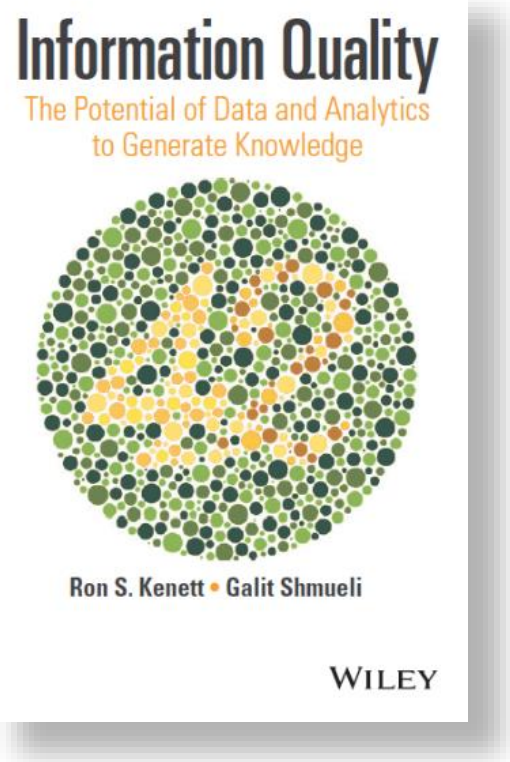
James P. Curley
Curley Social Neurobiology Lab website (Psychology Department and Center for Integrative Animal Behavior, Columbia University, New York City)





InfoQ at the Post-Data-Collection Stage

- Data Cleaning
- Preprocessing
- Reweighting
- Bias Adjustment
- Meta-Analysis
- Retrospective Experimental Design Analysis
- Censoring and Truncation



Kenett, R.S. and Shmueli , G. (2014) On Information Quality , *Journal of the Royal Statistical Society, Series A* (with discussion), Vol. 177, No. 1, pp. 3-38, 2014. http://ssrn.com/abstract=1464444.

BENNET STREET SW1
BLUE POSTS
UPSTAIRS BAR & DINING
BLUE POSTS
UPSTAIRS BAR & DINING
QUALITY FOOD AVAILABLE ALL

Questions?