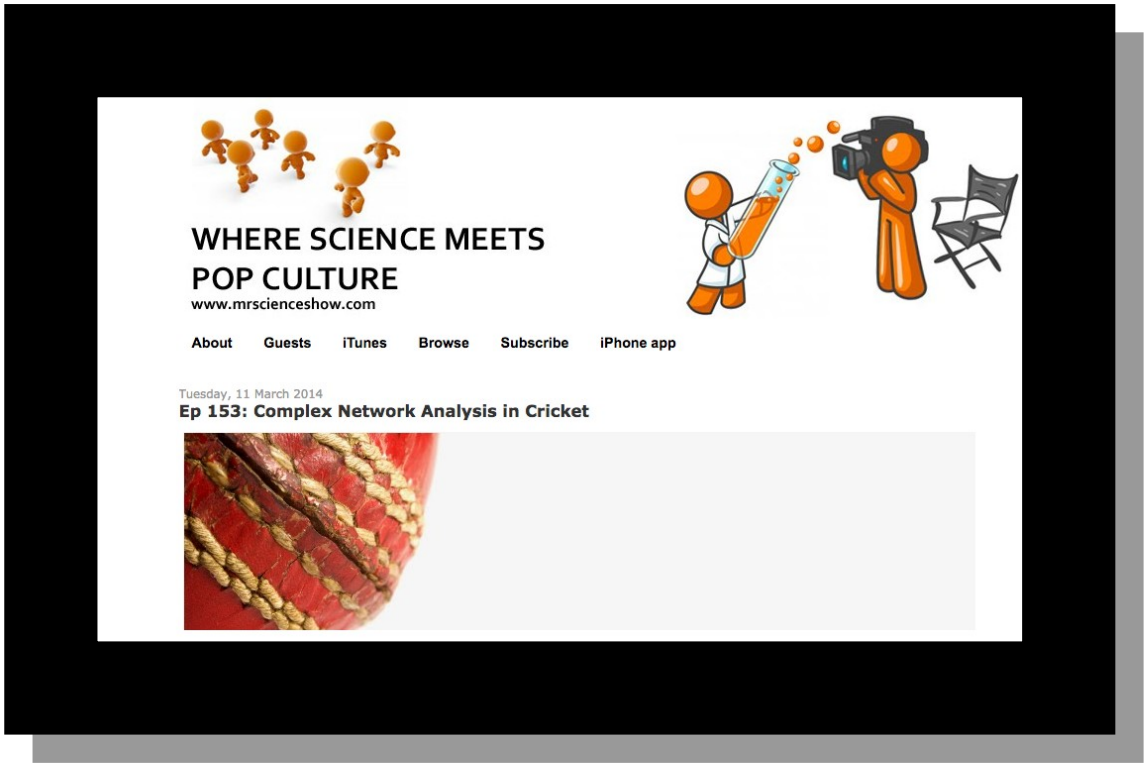
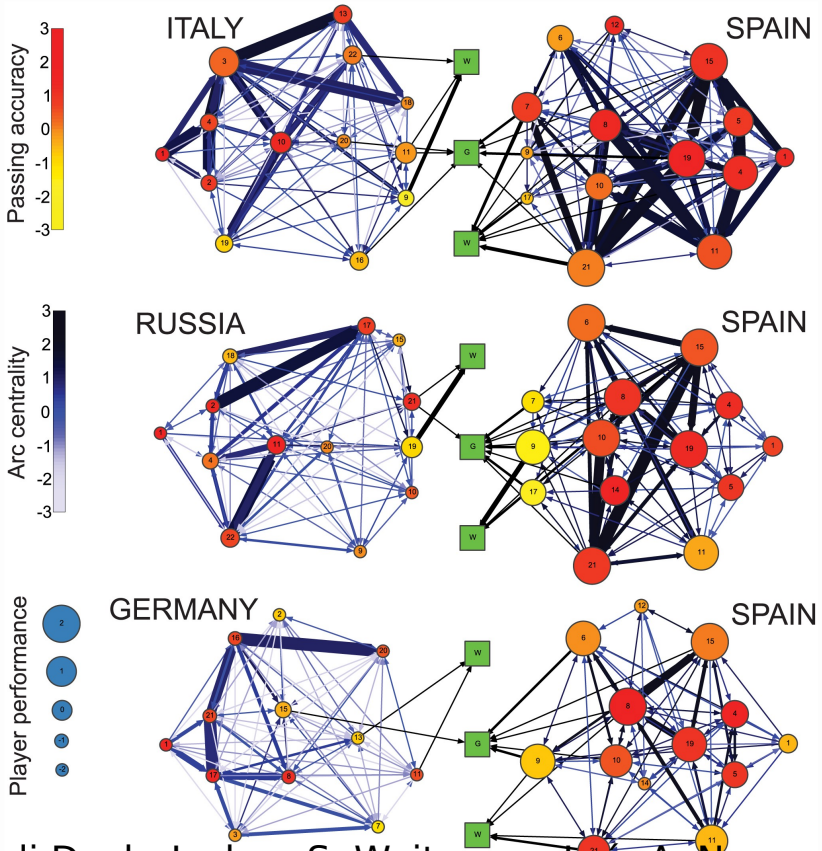
Network Analysis in Cricket

Leadership Network and Team performance



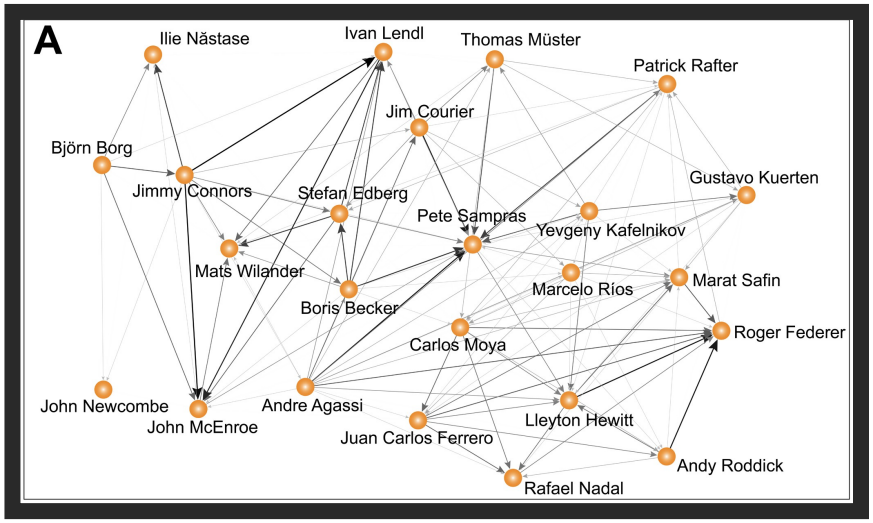
Satyam Mukherjee

Indian Institute of Management Udaipur



Jordi Duch, Joshua S. Waitzman, Luis A. Nunes Amaral,
PLoS ONE 2010

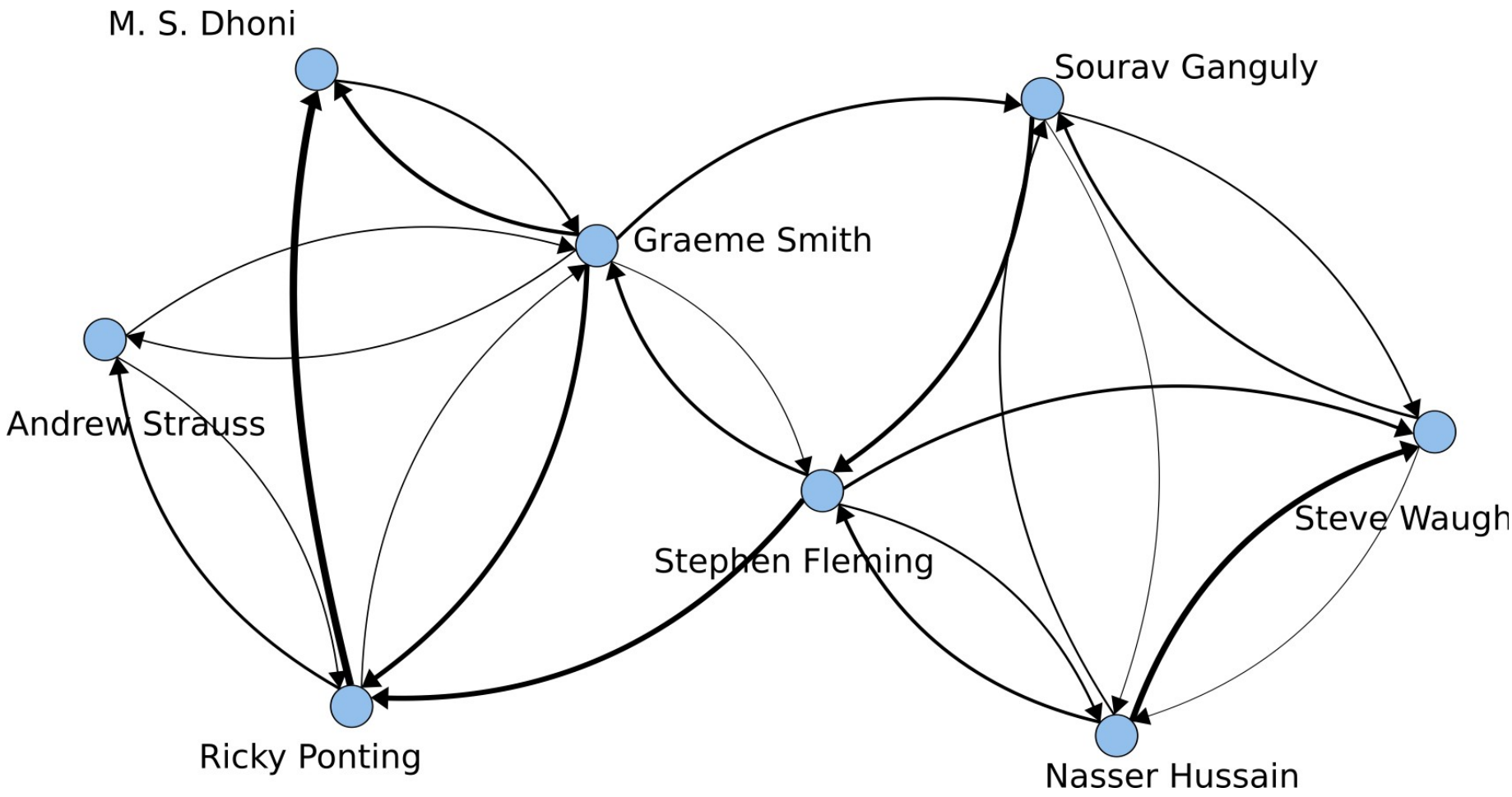
LYSIS & SPORTS



Filippo Radicchi, PLoS ONE 2011

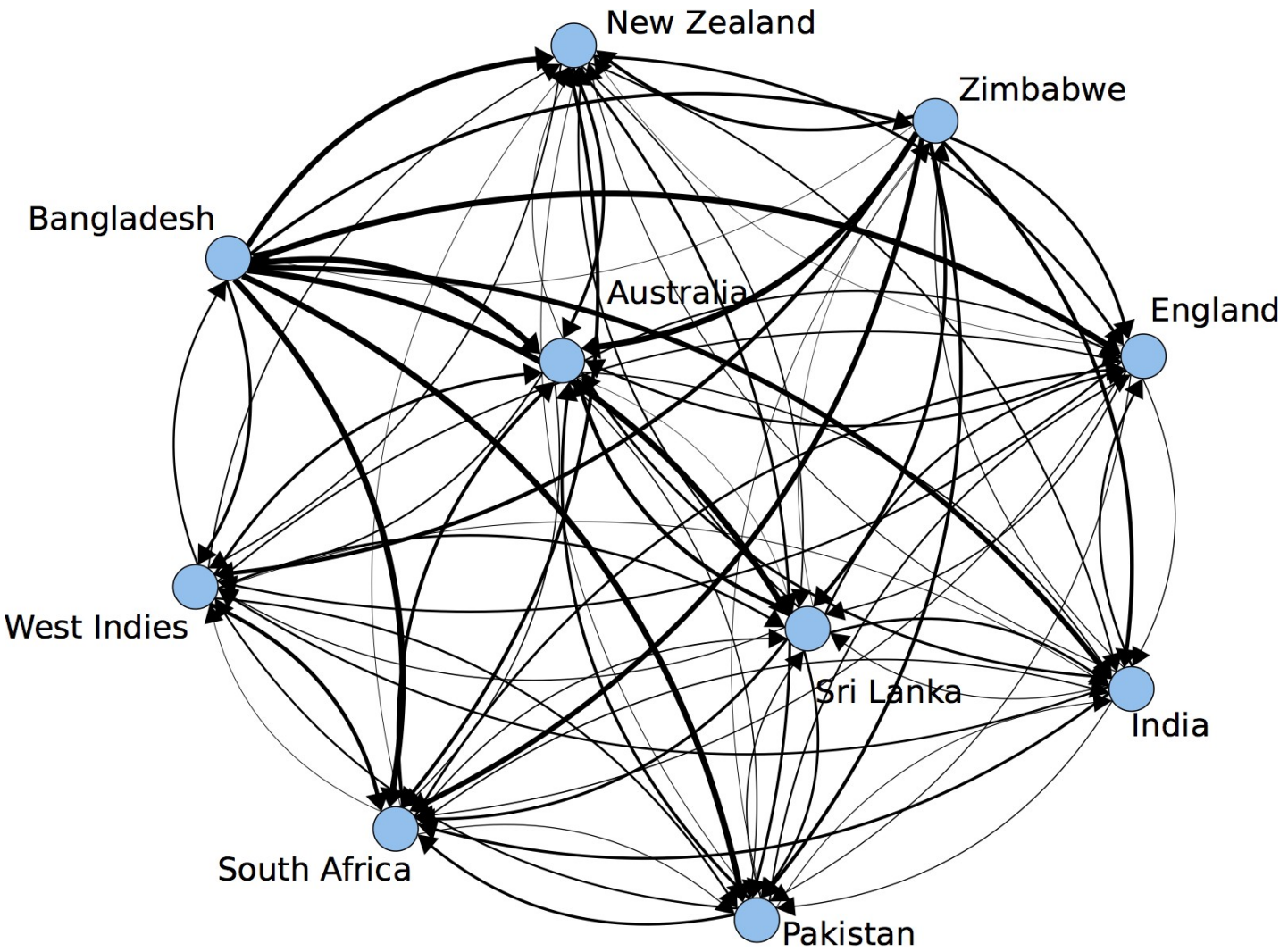
there a way to rank Cricketers?

NETWORK ANALYSIS in CRICKET: Skippers



fying the greatest team and captain – a complex network approach to Cricket matches
ica A 2012)

NETWORK ANALYSIS in CRICKET: Teams



fying the greatest team and captain – a complex network approach to Cricket matches
ica A 2012)

Ranking of Teams and Captains

In-strength

$$s_i^{in} = \sum_{j \neq i} w_{ji}$$

PageRank

$$p_i = (1 - q) \sum_j p_j \left(\frac{w_{ij}}{s_j^{out}} \right) + \frac{q}{N} + \frac{1 - q}{N} \sum_j \delta(s_j^{out})$$

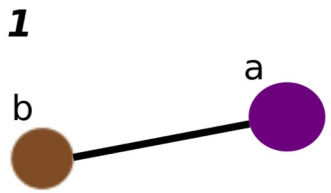
Most successful teams in the history of Test cricket (1877–2010). The teams are ranked according to the PageRank score of each team.

PageRank score	Rank	Team
0.170	1	Australia
0.141	2	South Africa
0.134	3	England
0.118	4	West Indies
0.104	5	Pakistan
0.103	6	India
0.093	7	Sri Lanka
0.076	8	New Zealand
0.030	9	Zimbabwe
0.027	10	Bangladesh

Top 20 captains in Test cricket (1877–2010). We also provide the nationality of the captain. The captains are ranked according to the PageRank score of each captain.

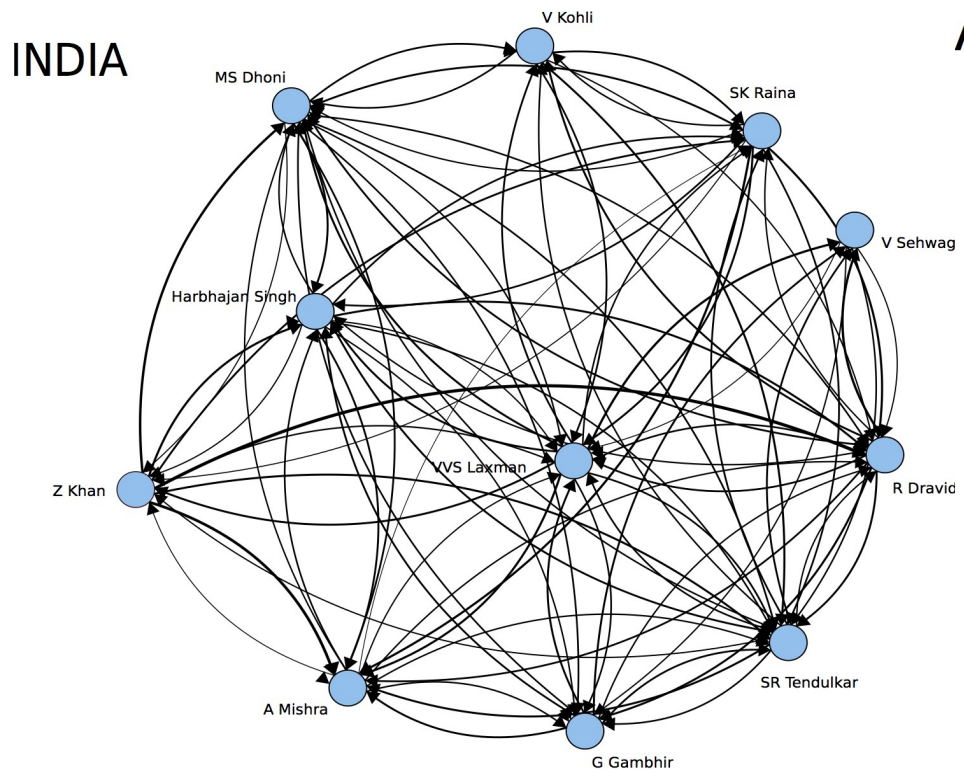
PageRank score	Rank	Captain	Country
0.02238	1	Steve Waugh	Australia
0.02105	2	Graeme Smith	South Africa
0.02002	3	Ricky Ponting	Australia
0.01995	4	Greg Chappell	Australia
0.01869	5	Richie Benaud	Australia
0.01587	6	Clive Lloyd	West Indies
0.01533	7	Ian Chappell	Australia
0.01474	8	Allan Border	Australia
0.01466	9	M. S. Dhoni	India
0.01394	10	Nasser Hussain	England
0.01352	11	Peter May	England
0.01303	12	Bill Woodfull	Australia
0.01224	13	Sir Vivian Richards	West Indies
0.01205	14	Sir Frank Worell	West Indies
0.01200	15	Sourav Ganguly	India
0.01153	16	Kim Hughes	Australia
0.01130	17	Ray Illingworth	England
0.01064	18	Geoff Howarth	New Zealand
0.01050	19	Andrew Strauss	England
0.01048	20	Stephen Fleming	New Zealand

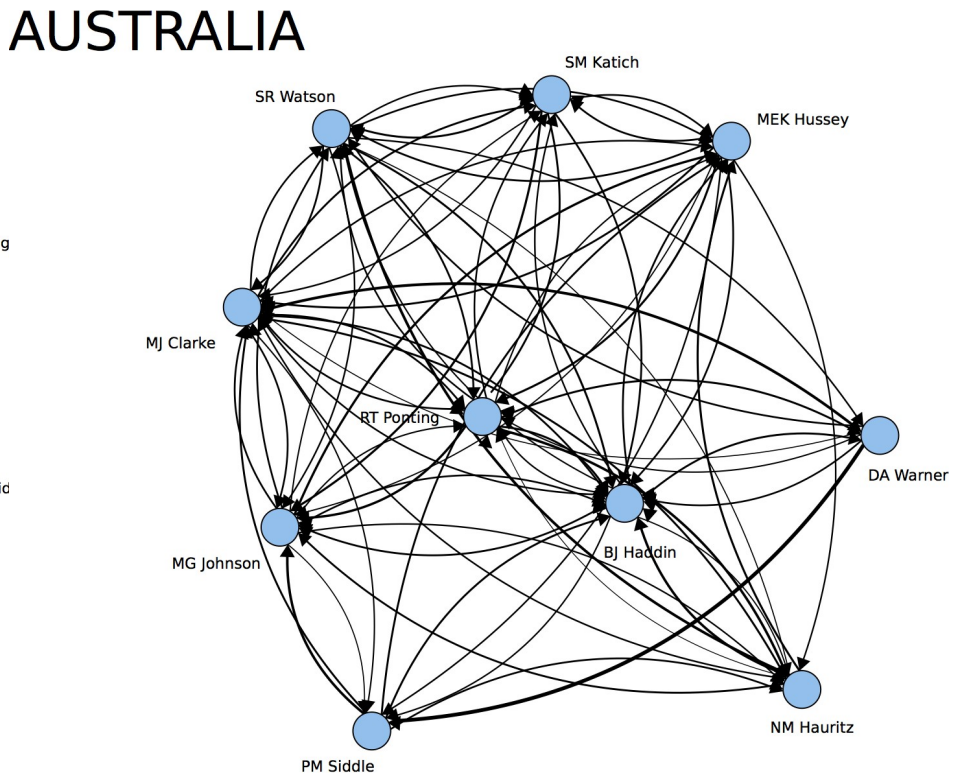
BATTING PARTNERSHIP NETWORK (BPN)



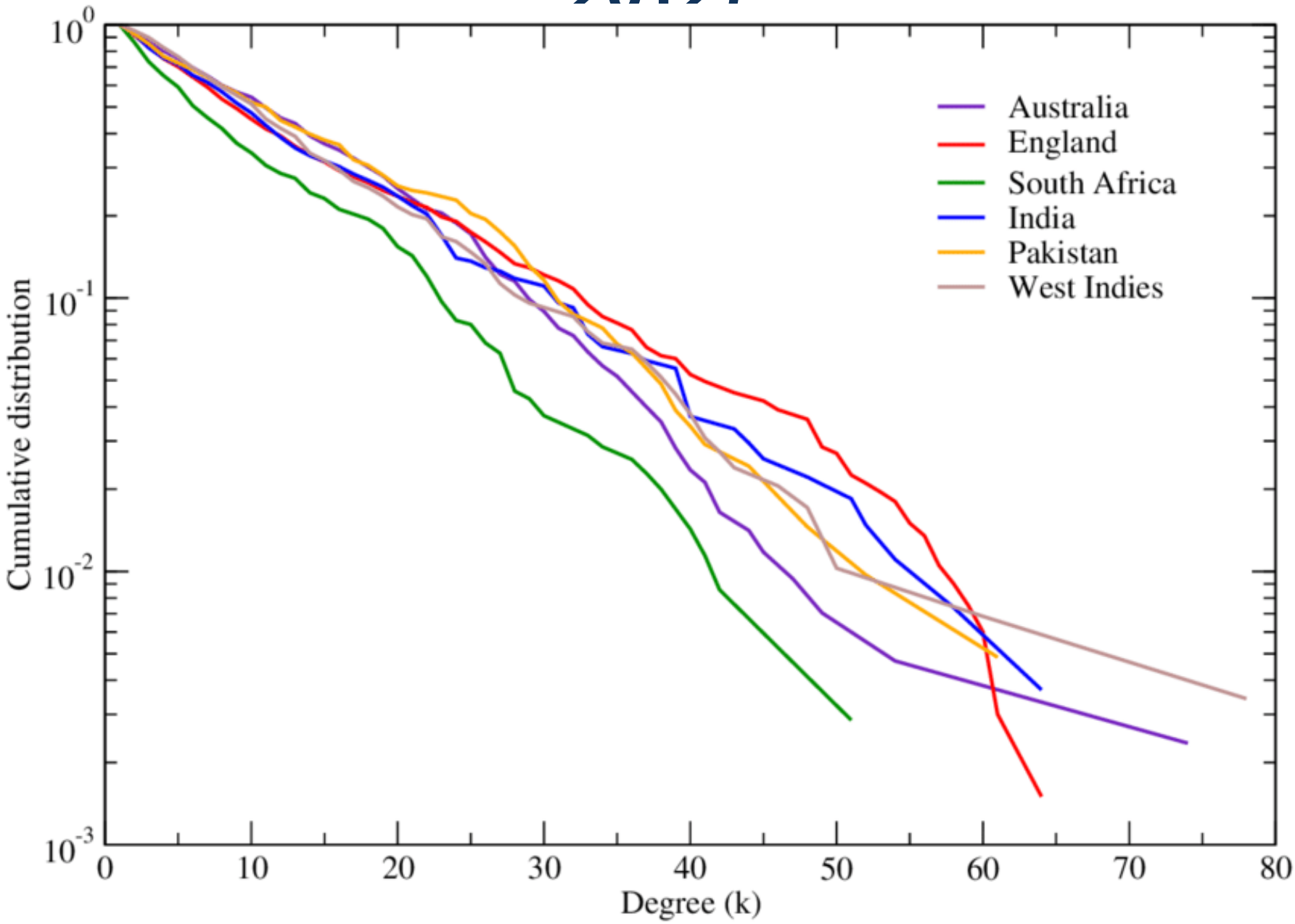
omplex Network Analysis in Cricket : Community structure, player's role and performance index
dvances in Complex Systems 2013

BPN of Australia and India in Test Cricket (2010 – 2012)





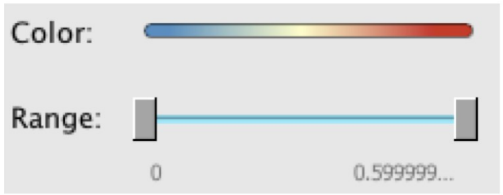
Degree Distribution Test Cricket (1877 – 2012)



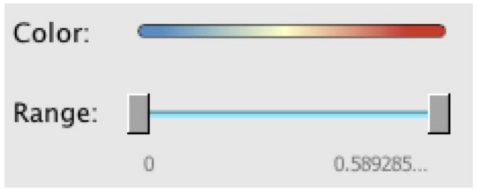
Visual summary of IPL 2014 Final

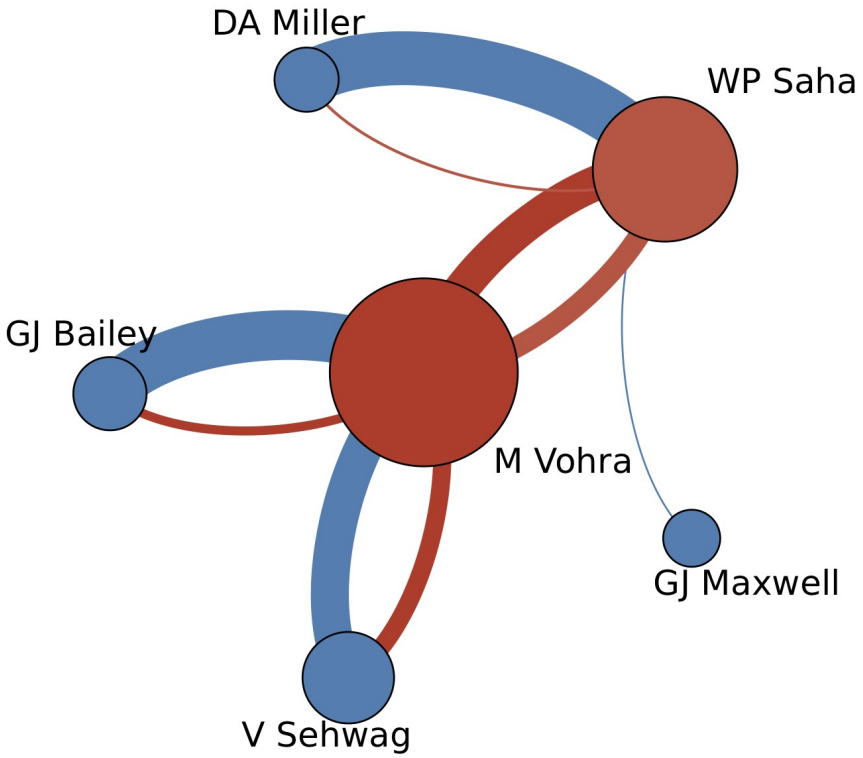
IPL 2014 Final

Betweenness centrality

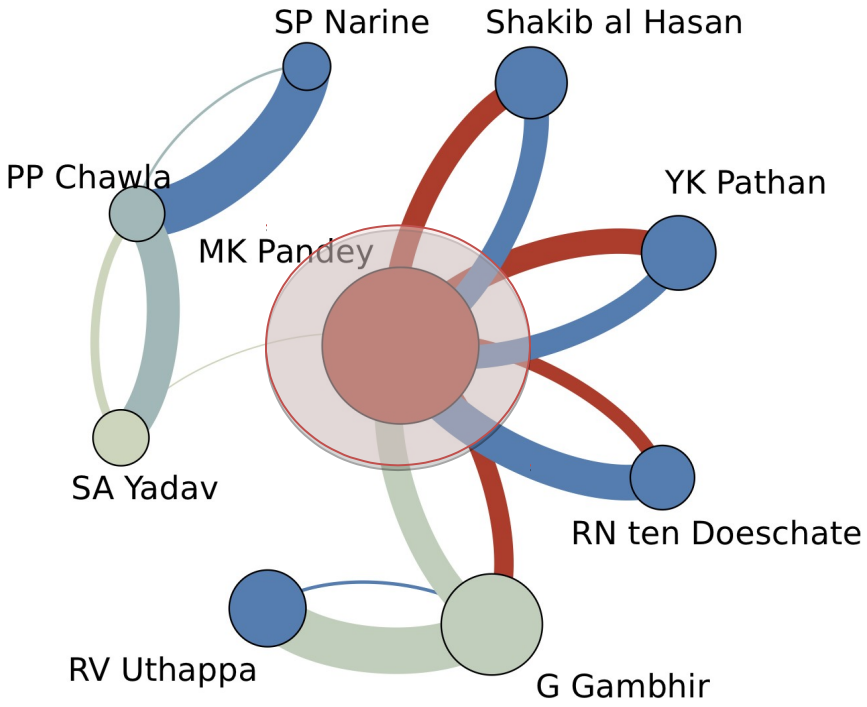


Betweenness centrality





Kings XI Punjab



Kolkata Knight Riders

Individual Performance & Man of the Match

Indian Premier League 2014

Match-Teams	PageRank	In-strength	Betweennes s	Closeness	Man of Match
Kolkata	YK Pathan	**JH Kallis**	**JH Kallis**	**JH Kallis**	**JH Kallis**
	SA Yadav	YK Pathan	YK Pathan	G Gambhir	
	JH Kallis	SA Yadav	Shakib Hasan	RV Uthappa	
Mumbai	AT Rayudu	AT Rayudu	AT Rayudu	KA Pollard	
	RG Sharma	AP Tare	KA Pollard	CM Gautam	
	AP Tare	KA Pollard	AP Tare	CJ Anderson	

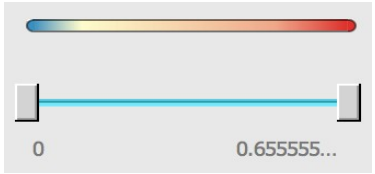
Match-Teams	PageRank	In-strength	Betweennes s	Closeness	Man of Match
Bangalore	PA Patel	PA Patel	V Kohli	V Kohli	YS Chahal
	V Kohli	V Kohli	PA Patel	PA Patel	
	NJ Maddinson	NJ Maddinson	Yuvraj Singh	Yuvraj Singh	
Delhi	M Vijay	M Vijay	M Vijay	M Vijay	
	JP Duminy	MK Tiwary	JP Duminy	JP Duminy	
	MK Tiwary	JP Duminy	MK Tiwary	KD Karthik	

Match-Teams	PageRank	In-strength	Betweennes s	Closeness	Man of Match
Punjab	**GJ Maxwell**	**GJ Maxwell**	**GJ Maxwell**	**GJ Maxwell**	**GJ Maxwell**
	DA Miller	DA Miller	DA Miller	DA Miller	
	CA Pujara	V Sehwag	CA Pujara	CA Pujara	
Chennai	DR Smith	MS Dhoni	SK Raina	SK Raina	
	MS Dhoni	DR Smith	MS Dhoni	MS Dhoni	
	SK Raina	SK Raina	DR Smith	DR Smith	

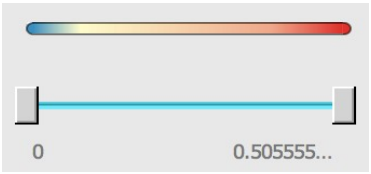
Leadership in Cricket Matches

A captain must make every decision before he knows what its effect will be, and he must carry the full responsibility, not whether his decision will be right or wrong, but success.

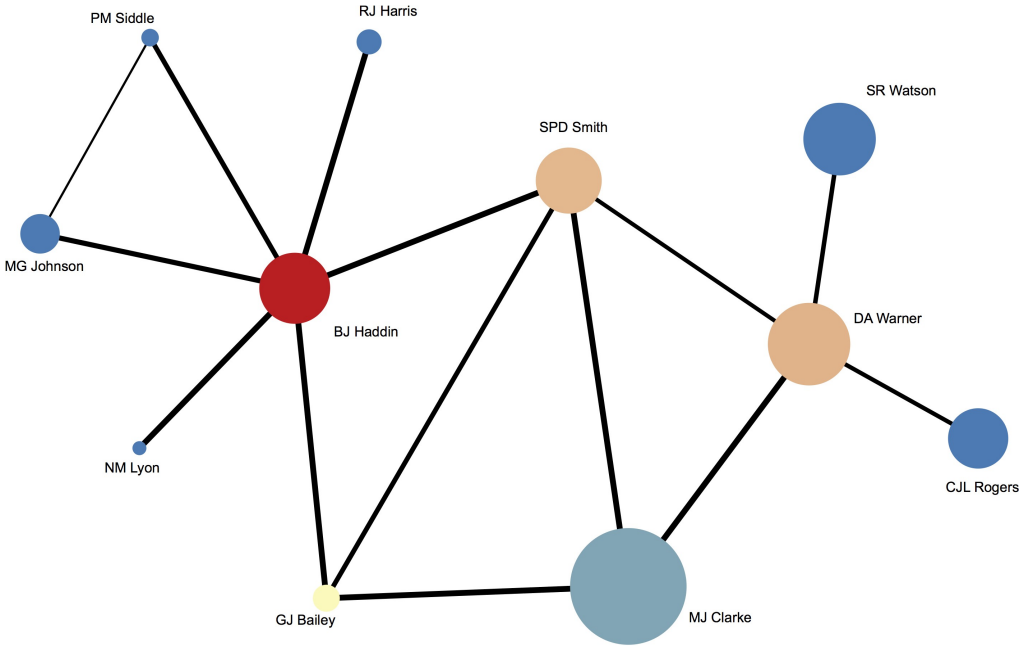
Ashes 2013/2014 1st Test match

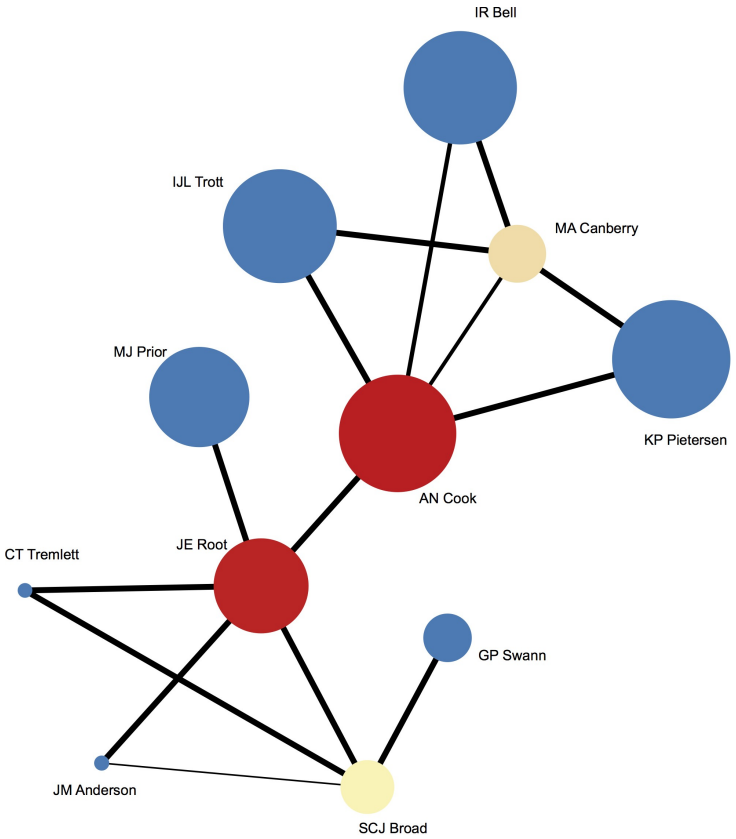


Betweenness centrality



Betweenness centrality



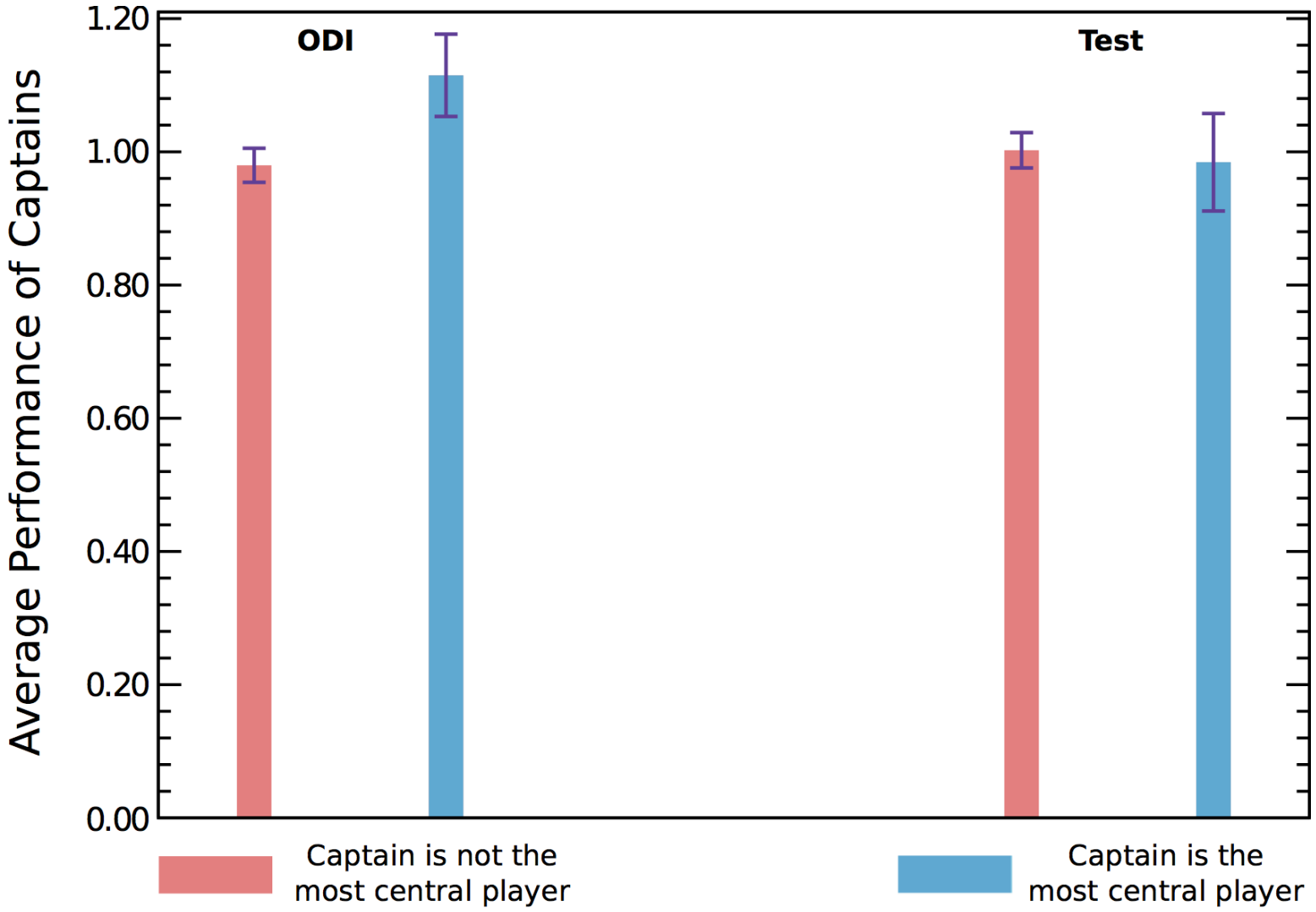


Australia

England

Performance of Cricket Captains

Loss, score = 0 Draw or Tie, Score = 1 Win, score = 2



Non-parametric Approach

$$CI = p \pm 1.96\sqrt{\frac{p(1-p)}{M}}$$

Binomial Confidence Interval (BCI) using the Normal Approximation Method (Wallis, 2013).

We estimate the number of wins when the captain is the player with highest centrality as well as number of wins when the captain is not the player with highest centrality

In ODI cricket, out of 891 matches, 459 resulted in win when the captain is the player with highest centrality, with the 95% BCI falling between 48.2% and 54.8%.

Captain is not the player with highest centrality, we observe that the 95% BCI falls between 43.8% and 46.6% (2293 wins out of 5067 matches)

Centralized leadership is more successful than de-centralized leadership?

Test cricket: No significant difference between success under centralized leadership or de-centralized leadership - the 95% BCI falling between 61.5% and 69.8% for centralized leadership (338 wins and draws out of 514 matches) and between 65.6% and 68.7% for de-centralized leadership (2360 wins and draws out of 3512 matches)

Modeling and Regression Evidence

$$\Pr(W_i) = f\left(\beta_1 C(i) + \beta_2 S_b(i) + \beta_3 S_p(i) + \sum_t \gamma_t Team_{ti} + \sum_y \gamma_y Year_{yi} + \sum_p \gamma_p Pos_{pi}\right)$$

- win-loss variable of captain

) - Indicator variable for centrality of a captain

S_p) -Takes value *1* if batting avg (ICC points) is above the median; *0* otherwise

work decentralization: variance of centrality

$$\omega = \frac{\sum_{i=1}^{N}(k_{max} - k(i))}{(N-1)(N-2)}$$

Meindl, Mayo, & Pastor (2003)

$$\delta r_{12}(i) = A_0 + A_1 \delta \omega_{12}(i) + A_2 \delta C_{12}^{v}(i) + A_3 \delta B_{12}^{Avg}(i) + A_4 \sum_g \gamma_g Ground_{gi} + A_5 \sum_y \gamma_y Year_{yi}$$

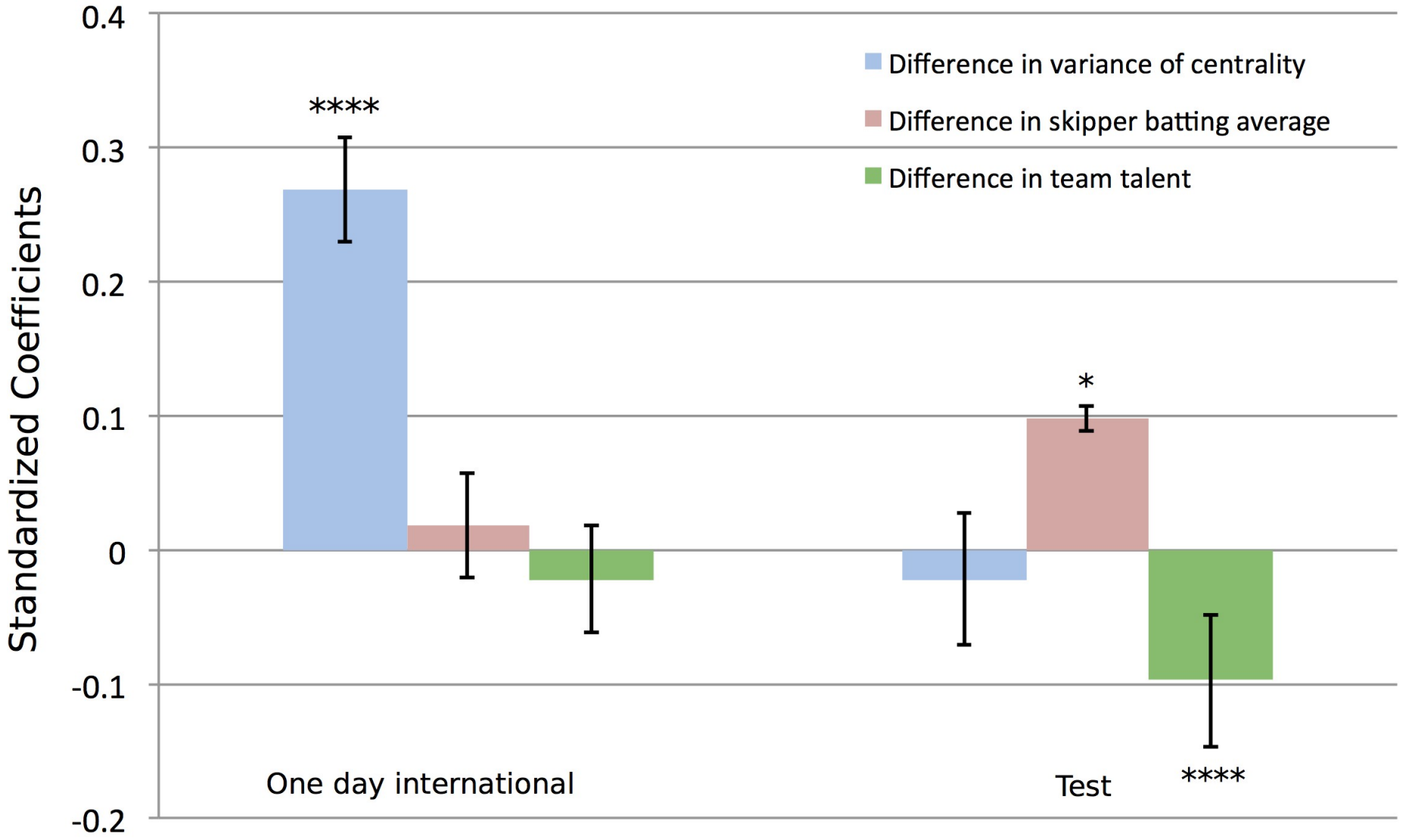
Logistic and OLS Regression

	ODI (1971 – 2013)		Test (1877 - 2013)	
C	0.251** (0.072)	0.262** (0.085)	-0.064 (0.099)	-0.014 (0.114)
S_b		-0.039 (0.068)		0.719 (0.594)
S_p		0.006*** (0.0004)		0.005*** (0.0006)
Fixed effects				
Team		Y		Y
Year		Y		Y
Batting position		Y		Y
Prob>chi-sq	0.0006	< 0.00001	0.517	< 0.00001
# Obs.	5936		4026	

	ODI (1971 – 2013)		Test (1877 - 2013)	
$\delta\omega_{12}$	1.066*** (0.073)	1.099*** (0.084)	-0.046 (0.097)	-0.015 (0.099)
δB_{12}^{Avg}		0.0004 (0.0006)		0.002** (0.001)
δC_{12}^{v}		-0.241 (0.231)		-0.530** (0.137)
Fixed effects				
Team		Y		Y
Year		Y		Y
Ground		Y		Y
R^2	0.08	0.106	0.0002	0.048
# Obs.	3420		1979	

***$p < 0.001$, **$p < 0.01$

Standardized Coefficients



dership network and team performance in interactive contests,
ial Networks 47 (2016) 85-92

Prior Shared Success Predicts Victory in Team Competitions

nature human behaviour

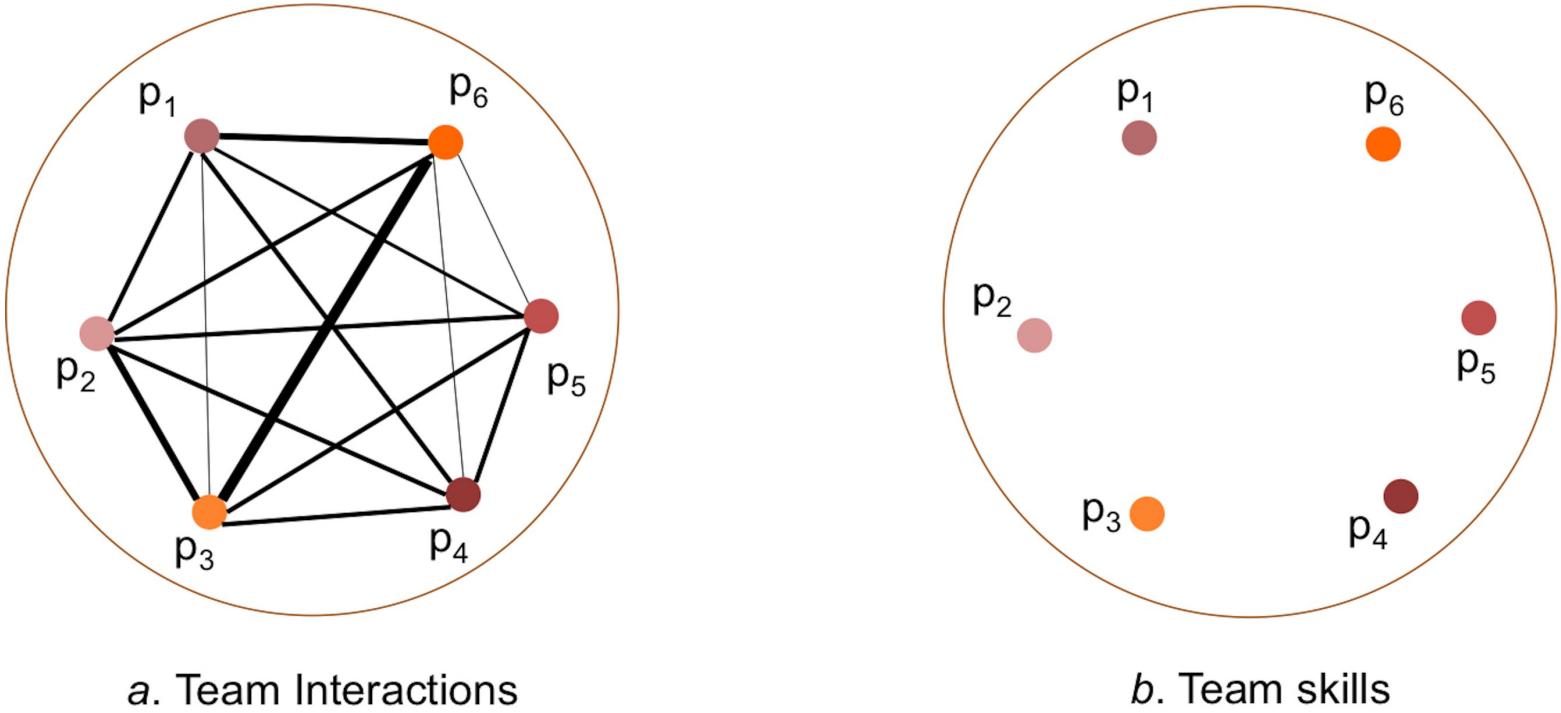
LETTERS

https://doi.org/10.1038/s41562-018-0460-y

Prior shared success predicts victory in team competitions

Satyam Mukherjee[1,2,3*], Yun Huang[4], Julia Neidhardt[5], Brian Uzzi[1,2] and Noshir Contractor[1,2,4,6]

Team Interactions and Team Skills



a. Team Interactions

b. Team skills

ks represent the **successful prior repeated interactions** among the players.
of a link being proportional to the number of such interactions.
eam member possesses **individual attributes like skills**. The color of the nod
ual skills of every player. Team skill is measured as the average of individual ski
ger teams having a higher average.

Predicting Winning Team

	NBA 2013-2014		EPL 2013-2014		IPL 2013		MLB 2013		Dota2	
Ind. Var.										
δS		0.126*** (0.029)		0.078*** (0.022)		0.111** (0.036)		0.083 *** (0.007)		1.401*** (0.176)
Control variables										
δC_1	0.862 (0.668)	0.401 (0.664)	0.185* (0.088)	0.231** (0.086)	0.0001 (0.008)	-0.005 (0.008)	0.112 (0.103)	0.068 (0.099)	-4.102*** (0.678)	-4.057*** (0.671)
δC_2	0.270 (0.477)	0.470 (0.467)	0.066 (0.067)	0.088 (0.065)	0.344 (0.327)	0.325 (0.326)	-0.078 (1.00)	-0.891 (0.983)	2.182*** (0.605)	1.144 (0.615)
δC_3	0.477 (1.325)	1.223 (1.319)	-1.158 (0.611)	-1.358* (0.597)	NA	NA	NA	NA	NA	NA
Team Fixed Effects	Y	Y	Y	Y	Y	Y	Y	Y	N	N
R^2	0.244	0.256	0.284	0.310	0.269	0.425	0.064	0.105	0.009	0.023
Prob > F	<0.0001	<0.0001	<0.0001	<0.0001	0.021	0.0001	<0.0001	<0.0001	<0.0001	<0.0001
BIC	10648	10635	1660	1652	336	322	14270	14167	40507	40453
N_{obs}	1315	1315	380	380	74	74	2422	2422	4357	4357

Conclusions

- These studies advance our understanding of Sports teams from a network perspective.
- The odds for winning a one day international match under centralized leadership is 30% higher than the odds for winning under de-centralized leadership.
- No evidence that distributed leadership is associated with higher team performance
- Depending on the level of competitiveness, centralized leadership is positively related with team performance.
- In elite-league competitions, where all competing teams have highly skilled players in their sides, the difference in skills is possibly not a consistent differentiator for a team's success.
- We demonstrate the competitive advantage derived by a team, based on the prior shared success among team members.
- Selecting players who have teamed up together successfully in the past increases a team's odds of winning a competition.
- Our empirical evidence transcends the idiosyncratic characteristics of basketball, baseball, soccer, cricket, or online games.
- Rather than solely focusing on people's skills, company CEOs, sports coaches, and

Media Highlights

Ranking cricket captains

Leaderboard

THERE is a certain type of sporting conversation, usually begun in a pub after the third pint of beer, that begins with the phrase "who was the greatest...ever?" Such discussions have the benefit of being both hypothetical and intractable, making them perfect for filling the long hours between that third pint and last orders at the bar.

Game theory ›
Jul 6th 2012 | by B.R.

GAME THEORY

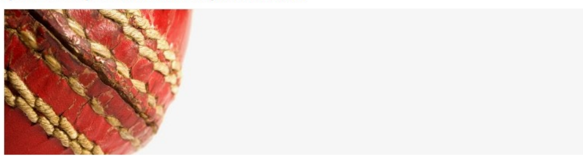
Steve Waugh is the best Test skipper because of the quality of his wins, says a scientist who has devised a new algorithm to measure success

JAYANTH KODKANI
TIMES NEWS NETWORK

The ICC ranking scheme is opaque. The methodology is not available anywhere and ranking is based on points. Such points are prone to bias
Satyam Mukherjee | Scientist & cricket buff

Tuesday, 11 March 2014

Ep 153: Complex Network Analysis in Cricket



Complex network analysis is an area of network science and part of graph theory that can be used to rank things, one of the most famous examples of which is the Google PageRank algorithm. But it can also be applied to sport. Cricket is a sport in which it is difficult to rank teams (there are three forms of the game, the various countries do not play each other very often etc.), whilst it is notoriously difficult to rank individual players (for how the ICC do it, see Ep 107: Ranking Cricketers).

Satyam Mukherjee at Northwestern University became a bit famous when The economist picked up his work (more famous than when we picked it up!) and he has published extensively on complex network analysis as applied to cricket rankings. I had a very interesting chat with Satyam about his various works concerning the evaluation of cricket strategy, leadership, team and individual performance, and the papers we discuss in the podcast are listed below. One of the more interesting findings was that left-handed captains and batsmen are generally ranked higher than their right-handed counterparts, whilst this is not true for left-handed bowlers.

Tune in to this episode here:

From Farokh Engineer

THE COPERNICAN

After-math of the Ashes

Vasudevan Mukunth

SEPTEMBER 08, 2013 20:52 IST
UPDATED: JUNE 02, 2016 10:28 IST

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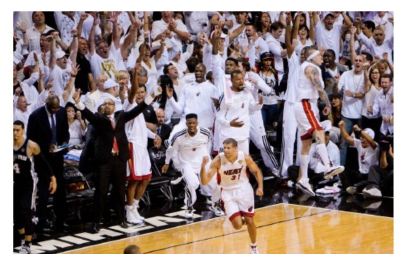
https://www.wsj.com/articles/the-key-to-building-a-successful-team-11550862585

BUSINESS | JOURNAL REPORTS: LEADERSHIP

The Key to Building a Successful Team

Researchers found that if a group has worked together effectively in the past, it can be more important than their individual skills



Pro sports leagues—and a multiplayer online game—may hold lessons in team-building for the business world.
PHOTO: NOAH GRAHAM/NBAE/GETTY IMAGES

By Lisa Ward
Feb. 22, 2019 2:09 p.m. ET