MathSport ASIA

XLRI Xavier School of Management

For the greater good

MathSport ASIA

Conference Venue

XLRI Xavier School of Management
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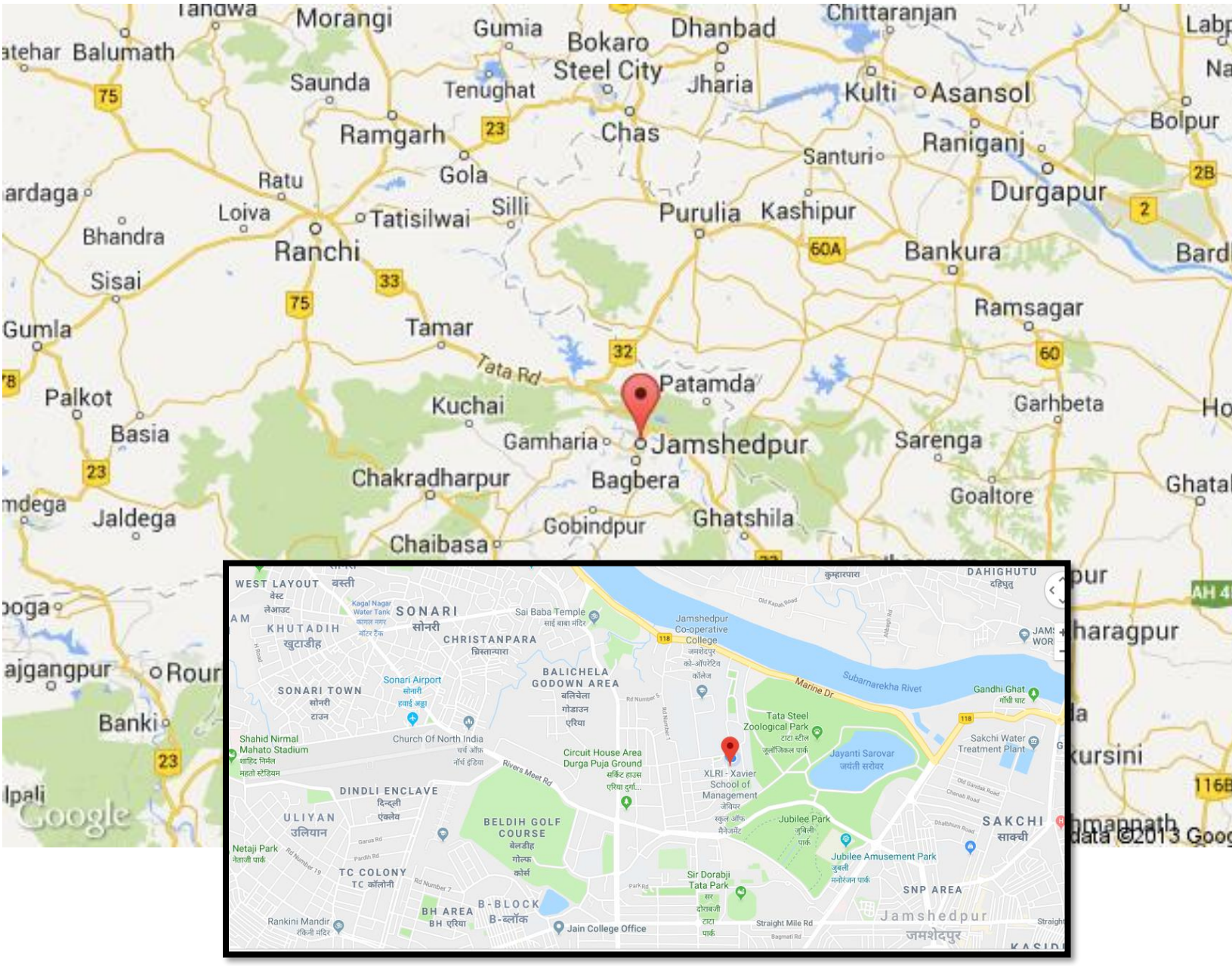

Contents

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CONFERENCE TOPICS

- Mathematical Models in Sports
- Performance Measures and Models
- Optimization in Sports
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- Competitive Strategy
- Game Theoretical Models
- Optimal Tournament Design and Scheduling
- Decision Support Systems
- Analysis of Rules and Adjudication
- Econometric Modeling of Sports
- Analysis of Sporting Technologies
- Mathematics Education and Sport
- Computationally Intensive Methods
- Financial Valuation in Sports
- E-sports (gaming)
- Betting and Sports

Local Organizing Committee

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MathSport Asia

Asia, the largest and most populous continent on Earth, has a long tradition of sports. Traditional Asian Sports like wrestling and archery survive even today in forms unchanged over centuries. The globalization of sport has brought new sports, coaching techniques and methods to the continent.

MathSport Asia is a group of academicians and sports professionals interested in the promotion and development of the application of mathematics, statistics and data analysis to sports management, sports performance analysis and management and sports coaching and training, in Asia.

MathSport Asia seeks to play the role of a catalyst in encouraging the use of Mathematical and Statistical Analysis in Sports in Asia by organizing Conferences and Workshops, by encouraging research in the area and facilitating its dissemination. MathSport Asia will also seek to promote the teaching of mathematics and statistics using sports.

In this endeavour, MathSport Asia will seek to bring together various stakeholders: academicians, sportspeople, sports bodies, industry, sports academies, sports leagues and the government.

MathSport Asia seeks to complement the work done by two related groups, MathSport International and ANZIAM MathSport. While MathSport International has been organizing biennial conferences in Europe since 2007, ANZIAM MathSport has been organizing biennial conferences in Australia/ New Zealand since 1992.

About the Conference: MathSport Asia, 2018

MathSport Asia 2018, the inaugural conference, of MathSport Asia is being held from December 10 to 12 2018, at XLRI Xavier School of Management, Jamshedpur, India.

It is the inaugural conference of a series of biennial conferences that will be held across Asia, under the aegis of MathSport Asia, a group of academicians and practitioners interested in the promotion and development of the application of mathematics, statistics and computing in sports in Asia.

In spite of being the first conference of its type the response received was overwhelming. We received as many as 80 papers out of which 63 papers are selected for presentation. 124 researchers have shown interest to present their work in the technical sessions.

Leading research in the field of sports analytics namely, Prof. Tim Swartz of Simon Fraser University, Canada; Prof. Steven Stern of Bond University, Australia; Prof. Dries Goossens of Ghent University, Belgium and Prof. Nobuyoshi Hirotsu of Juntendo University, Japan will be delivering the Plenary talks.

The conference shall also have practitioners from the field of sports analysis like Mr. Ramakrishnan, S from Sportsmechanics India Pvt Ltd, Mr. Gaurav Khilari from Jamshedpur Football Club and Mr. Amit Kini from Sportzinteractive as speakers.

About the Host Institution

XLRI – Xavier School of Management, Jamshedpur is the host institution for the inaugural conference in 2018. XLRI is a management school founded in 1949 by the Society of Jesus (Jesuits) at Jamshedpur, Jharkhand, India. XLRI began by offering courses for management and trade unions in 1949 before setting up a two-year, full-time program in industrial welfare in 1953. In 1955 it took on the name Xavier Labor Relations Institute, and became India's oldest business management school. The campus are is 40 acres.

Some of the academic programs XLRI Jamshedpur offers are Post Graduate Diploma in Management (PGDM), Fellow Programme in Management (FPM), Executive Fellow Programme in Management (Exec-FPM), Executive Development in Human Resource Management (EDHRM), Post Graduate Certificate in Business Management (PGCBM), Post Graduate Certificate in Human Resource Management (PGCHRM), Management Development Programmes etc.

XLRI is ranked tenth among management schools in India by the National Institutional Ranking Framework (NIRF) in 2018,fourth by *Business Today*'s "India's best B-schools 2016"[5] and third in India by *Outlook India*'s "Top 100 Management Schools" of 2016.

XLRI has 81 regular and 27 visiting faculty members and a residential student strength of around 1000.

elines for Session Chairs and Presenters

Conference Schedule

Day 1: December 10th, 2018

Inauguration	:	**8:30 am to 9:00 am**
Plenary Session 1	:	**9:00 am to 9:45 am** ***"Sports Analytics: Reflections Based on 20+ years of Work, and Experiences"*** ***Speaker:*** Tim Swartz, Professor, Department of Statistics & Actuarial Science, Simon Fraser University, Canada
Technical Session 1A Learning Centre 2, Lecture Hall 32, 35	:	**10 am to 11:30 am** Research Paper Presentations & Discussions
Technical Session 1B Learning Centre 2, Lecture Hall 32, 35	:	**12 noon to 1:30 pm** Research Paper Presentations & Discussions
Lunch	:	**1:30 pm to 2:30 pm;** International Centre Dining Hall
Plenary Session 2	:	**2:30 pm to 3:15 pm;** Learning Centre 2, Lecture Hall 33 ***"Rain Rules in Modern Limited Overs Cricket: The Duckworth-Lewis-Stern Method in Context"*** ***Speaker:*** Steven Stern, Professor of Data Science, Bond Business School, Bond University, Australia.
Technical Session 1C Learning Centre 2, Lecture Hall 32, 35	:	**3:30 pm to 5:00 pm** Research Paper Presentations & Discussions
Sports Live Practitioners' Sessions	:	**5 pm to 6:00 pm;** Learning Centre 2, Lecture Hall 33 **Presentation by High Performance Centre (HPC), Tata Steel** ***Speaker*:** Amey Kolekar, High Performance Centre **"Video Analysis Support for Soccer"** ***Speaker:*** Gaurav Khilari: Analyst, Jamshedpur Football Club
Social Events	:	**6:30 pm to 8:00 pm** Visit to HPC & JRD Stadium: 6:30pm to 8:00pm
Dinner	:	**8:00 pm to 9:30 pm;** International Centre Dining Hall Director's Dinner: Hosted by Director, XLRI

Conference Schedule cont...

Day 2: December 11th, 2018

Plenary Session 3	:	**9:00 am to 9:45 am;** Learning Centre 2, Lecture Hall 33 ***"Optimization of Sports League Scheduling: Experiences from a Decade of Scheduling the Belgian Soccer League"*** ***Speaker:*** Dries Goossens, Professor, Faculty of Economics and Business Administration, Ghent University, Belgium
Technical Session 2A Learning Centre 2, Lecture Hall 32, 35	:	**10 am to 11:30 am** Research Paper Presentations & Discussions
Technical Session 2B Learning Centre 2, Lecture Hall 32, 35	:	**12 noon to 1:30 pm** Research Paper Presentations & Discussions
Lunch		**1:30 pm to 2:30 pm;** International Centre Dining Hall
Plenary Session 4	:	**2:30 pm to 3:15 pm;** Learning Centre 2, Lecture Hall 33 ***"Game Theoretic Modelling in Sports"*** ***Speaker:*** Nobuyoshi Hirotsu, Professor, Graduate School of Health and Sports Science, Juntendo University, Japan
Technical Session 2C Learning Centre 2, Lecture Hall 32, 35	:	**3:30 pm to 5:00 pm** Research Paper Presentations & Discussions
Sports Live Practitioners' Sessions	:	**5:00 pm to 6:00 pm;** Learning Centre 2, Lecture Hall 33 **"Birth and Growth of Sports Technology and Analytics in India"** ***Speaker:*** Ramakrishnan, S (Ramky): CEO, Sportsmechanics India Pvt Ltd **"Fan Engagement Through Data and Technology"** ***Speaker:*** Amit Kini: Senior Manager, Data & Analytics, Sportzinteractive
Social Events		Demonstration: Sekkor, an indigenous tribal game of Jharkhand
Dinner	:	**8:00 pm to 9:30 pm;** International Centre Dining Hall

Conference Schedule cont...

Day 3: December 12th 2018

Plenary Session 5	:	**9:00 am to 9:45 am;** Learning Centre 2, Lecture Hall 33 ***"Sports, Analysis & Numbers: A Practitioner's Perspective"*** ***Speaker:*** Kokum Weeratunga, Data Scientist, Game Insight Group, (GIG)Victoria University, Australia and Tennis Australia
Technical Session 3A Learning Centre 2, Lecture Hall 32, 35	:	**10 am to 11:30 am** Research Paper Presentations & Discussions
Technical Session 3B Learning Centre 2, Lecture Hall 32, 35	:	**12 noon to 1:30 pm** Research Paper Presentations & Discussions
Lunch	:	**1:30 pm to 2:30 pm;** International Centre Dining Hall
Technical Session 3C Learning Centre 2, Lecture Hall 32, 35	:	**2:30 pm to 4:00 pm** Research Paper Presentations & Discussions
Concluding Session	:	**4:30 pm to 5:00 pm**
Social Events		**7:30 pm to 9:30 pm** Indian Super League Soccer Match: Jamshedpur FC vs Delhi Dynamos, JRD Tata Sports Complex

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Schedule of Technical Sessions

DAY 1 : DECEMBER 10, 2018 (Monday)

Technical Session 1A : 10 am to 11:30 am

Parallel Session :: 1

Session Chair : Sanjeev Tripathi , IIM Indore Venue : Learning Center 2, Lecture Hall 32

Presenters	Affiliation	Title of the Work
Sanjeev Tripathi	Indian Institute of Management Indore	Driving success at Olympics
Guillermo Durán, **Mario Guajardo** and Gonzalo Zamorano	NHH Norwegian School of Economics	More than the Coca-Cola formula: Scheduling the Argentina's Football Superliga
Aman Sinha, Rohit Agarwal, Utkarsh Bairolia and Vishal Sourav	Indian Institute Of Technology(ISM) Dhanbad	Competitive Balance in Football Leagues: Domestic vs International

Parallel Session :: 2

Session Chair: TVS Vijayaraghavan, XLRI Venue : Learning Center 2, Lecture Hall 35

Presenters	Affiliation	Title of the Work
Bikramjit Ray Chaudhuri and **Diptarag Ray Chaudhuri**	Hiranandani Foundation School	Big data analysis using small data in sports – identifying best tennis player of all times
Dmitry Dagaev and **Akash Adhikari**	Indian Institute Of Technology(ISM) Dhanbad	Mistakes Provoke Further Mistakes: Evidence from Chess
Reema Aswani, **Purva Grover**, Arpan Kar and Vigneswara Ilavarasan	Indian Institute of Technology Delhi	Understanding Deviation in User Preferences: Insights from Twitter Analytics

Schedule of Technical Sessions cont...

DAY 1 : DECEMBER 10, 2018 (Monday)

Technical Session 1B : 12 noon to 1:30 pm

Parallel Session :: 1

Session Chair: Arun Kumar Paul, XIMB Venue : Learning Center 2, Lecture Hall 32

Presenters	Affiliation	Title of the Work
Bhaskar Basu and Arun Kumar Paul	XIMB	Evaluating Service Quality Models in Spectator Sports through Fan satisfaction: Evidence from India
Subhasis Sen, Kannan Rajagopal and Shantanu Prasad	Symbiosis International Pune	Understanding Determinants of Attendance Behaviour in Sporting Events
Arth Shah and Phil Scarf	Indian Institute of Technology Madras	A Blackbox for White Ball Cricket: Optimal Run-Chasing Strategy

Parallel Session :: 2

Session Chair: Supriyo De, XLRI Venue : Learning Center 2, Lecture Hall 35

Presenters	Affiliation	Title of the Work
Ayush Tiwari and Yannick Marchand	Dalhousie University Canada	Predicting the Career Path of Professional Soccer Players
Abhishek Chakraborty	XLRI Jamshedpur	Analyzing the competitiveness of European Football Leagues through Social Networking
Jimut Bahan Chakrabarty and Prashant Premkumar	Indian Institute of Management Kozhikode	Ranking using Factor Scores in T20 Cricket
Purva Grover and Arpan Kumar Kar	Indian Institute of Technology Delhi	Framing the Positive or Negative Reputation in Sports – Inputs from Governing Bodies using Social Media Analytics

Schedule of Technical Sessions cont...

DAY 1 : DECEMBER 10, 2018 (Monday)

Technical Session 1C : 3:30 pm to 5 pm

Parallel Session :: 1

Session Chair: Subhahrata Das, IIMB Venue : Learning Center 2, Lecture Hall 32

Presenters	Affiliation	Title of the Work
Divya Aggarwal	XLRI Jamshedpur	Are Better Predictions Related to Better than Average Effect
Harsh Kumar Mohanka, Shubham Gaurav and Himanshu Bhadani	Indian Institute Of Technology(ISM) Dhanbad	Decision model for Club Transfer of Football Players
Shubhabrata Das	Indian Institute of Management Bangalore	Upset Index of a tournament

Parallel Session :: 2

Session Chair: Dries Goossens , Ghent University Venue : Learning Center 2, Lecture Hall 35

Presenters	Affiliation	Title of the Work
Aravind R and Joshy Joseph	Indian Institute of Management Kozhikode	Winning the Brand Loyalty Cup: The Psychological Play of Symbol-related Brand Elements of Football Clubs
Anay Rennie, Parardha Kumar and Aakar Dwivedi	Deloitte USI	Self-improvement Artificial intelligence tool for Football players
Shubham Krishna, **Krishna Singh** and Rishikesh Parma	Samsung Research and Development Bangalore	Advancement in Batting and Bowling strengths and their influence on match outcome
David Van Bulck, Dries Goossens,	Ghent University, Belgium	RobinX: an XML-driven classification for round-robin sports timetabling

Jörn Schönberger, Mario Guajardo		

Schedule of Technical Sessions cont...

DAY 2 : DECEMBER 11, 2018 (Tuesday)

Technical Session 2A : 10 am to 11:30 am

Parallel Session :: 1

Session Chair: V Jayadevan, Vidya Academy — Venue : Learning Center 2, Lecture Hall 32

Presenters	Affiliation	Title of the Work
V Jayadevan	Vidya Academy of Science and Technology Thrissur, Kerala	Setting target scores of better acceptability in interrupted limited over cricket matches by introducing a concept "the makeup factor".
Giridhar Kamath, Simon George and Shirshendu Ganguli	Manipal Academy of Higher Education	Relationship between event-sponsor fit and attitude towards sponsors: A study on IPL team sponsorships
Makoto Kiuchi and Nobuyoshi Hirotsu	Juntendo University	Selection of Players Considering the Characteristics of Japan Team in the Super Rugby by Using Data Envelopment Analysis.
Subhasree Mukherjee and Deepak Dhayanithy	Indian Institute of Management Kozhikode	Emergent relational structures of knowledge resource mobility: an ERGM analysis of professional soccer player transfers

Parallel Session :: 2

Session Chair: Sumit Sarkar, XLRI — Venue : Learning Center 2, Lecture Hall 35

Presenters	Affiliation	Title of the Work
Subhasis Ray	IISWBM Calcutta University	An analytic approach towards assessing the effect of twenty over cricket match on test cricket with special focus on India's performance
Rishabh Saraf and Dries Goossens	Indian Institute of Technology (ISM) Dhanbad	Is there a home advantage in professional road cycling?
Dibyojyoti Bhattacharjee and	Assam University	Application of Zero Inflated Poisson distribution to predict the Performance of Wicket Keepers in

Deepjyoti Choudhury		Cricket: A Study Based on Last Five IPL Seasons

Schedule of Technical Sessions cont...

DAY 2 : DECEMBER 11, 2018 (Tuesday)

Technical Session 2B : 12 noon to 1:30 pm

Parallel Session :: 1

Session Chair: Bhaskar Basu, XIMB Venue : Learning Center 2, Lecture Hall 32

Presenters	Affiliation	Title of the Work
Prakash Dash and **Manash Sahu**	Asian School of Business Management	Implication of Demographic Differences on Volunteer Motivation in Asian Athletics Championship
Bhaskar Basu and Arijit Mitra	XIMB	Towards Developing a Cricket Skill Index for Limited Over Cricket
Baisampayan Sarkar, Sayan Acharya Sarkar, Subhranil Das, Arnab Paul and Suvojit Maity	XLRI Jamshedpur	Effect of T-20 leagues on Global Cricket

Parallel Session :: 2

Session Chair: Deepak Dhayanithy, IIMK Venue : Learning Center 2, Lecture Hall 35

Presenters	Affiliation	Title of the Work
Priyanka Talukdar and Dibyojyoti Bhattacharjee	Assam University	An Investigation of the Role of Opening Partners on the Outcome of Twenty20 Cricket Matches through Pressure Index
Abhishek Rawat, Saket Gupta, Atul Kumar, Sameer Kumar Pandey and Bhanupratap Sankhla	Indian Institute Of Technology(ISM) Dhanbad	Batting Strategy Building in limited overs cricket matches : An Application of Machine learning
Deepak Dhayanithy	Indian Institute of Management Kozhikode	Learning Experiences of Expert Poker Players (LEEPP) - a Word Cloud exploration

Sahadeb Sarkar and **Subhasis Mishra**	Indian Institute of Management Calcutta	Evaluating consistency of batsmen in ODI Cricket and ranking them by multiple criteria

Schedule of Technical Sessions cont...

DAY 2 : DECEMBER 11, 2018 (Tuesday)

Technical Session 2C : 3:30 pm to 5 pm

Parallel Session :: 1

Session Chair: Deepak Dhayanithy, IIMK

Venue : Learning Center 2, Lecture Hall 32

Presenters	Affiliation	Title of the Work
Subhasree Mukherjee and Deepak Dhayanithy	Indian Institute of Management Kozhikode	Interorganizational network of knowledge resource mobility: Study based on Big-5 European professional soccer player transfers
Subhendu Samanta and Dibyojyoti Bhattacharjee	Kalyani University	Comparing Different Methods of Predicting the First Innings Score of a Limited Over Cricket Match
Vishal Kumar, Puneet Garg and Anshul Gupta	Indian Institute Of Technology(ISM) Dhanbad	Score Prediction using old database in Indian Premier League : A Predictive Model

Parallel Session :: 2

Session Chair: Dibyojyoti Bhattacharjee

Venue : Learning Center 2, Lecture Hall 35

Presenters	Affiliation	Title of the Work
Aishwary Choudhary and **Tushar Jape**	Indian Institute Of Technology(ISM) Dhanbad	A Statistical Analysis of Bowling Performance in Cricket
Moloy De	IBM India	Predicting Winner for Soccer World Cup 2018
Balamurugan Annamalai, Sanjeev Varshney, Pingali Venugopal and Atul Pathak	XLRI Jamshedpur	Influence of Sports-Club Engagement on Fan Engagement in Facebook

Schedule of Technical Sessions cont...

DAY 3 : DECEMBER 12, 2018 (Wednesday)

Technical Session 3A : 10 am to 11:30 am

Parallel Session :: 1

Session Chair: Uday Damodaran, XLRI

Venue : Learning Center 2, Lecture Hall 32

Presenters	Affiliation	Title of the Work
Himadri Barman	Dibrugarh University	Online Measurement of Sportsperson's Performance – A Case Study of Fielding Performance Measure in Cricket
Rishikesh Parma, Phil Scarf and Naif Alotaibi	Indian Institute Of Technology(ISM) Dhanbad	Modelling Netball scores
Somroop Siddhanta and **Mithun Kumar Guha**	NSHM Business School	Competitive Balance in the Indian Premier League – an Empirical Analysis

Parallel Session :: 2

Session Chair: Arun Kumar Paul, XIMB

Venue : Learning Center 2, Lecture Hall 35

Presenters	Affiliation	Title of the Work
Utkarsh Maddhesiya, Priyanshu Shrivastava, Kuldeep Rajpurohit and Rishikesh Parma	Indian Institute Of Technology(ISM) Dhanbad	Analysis of competitiveness on Tennis courts
Arun Kumar Paul and Bhaskar Basu	XIMB	Sports event success evaluation by applying fuzzy AHP and fuzzy TOPSIS methodology

Subhasis Mishra, **Somu Gorai** and Utsav Pandey	Indian Institute of Management Calcutta	DEA based analysis of players for an efficient team(s) selection

Schedule of Technical Sessions cont...

DAY 3 : DECEMBER 12, 2018 (Wednesday)

Technical Session 3B : 12 noon to 1:30 pm

Parallel Session :: 1

Session Chair: Teidorlang Lyngdoh, XLRI — Venue : Learning Center 2, Lecture Hall 32

Presenters	Affiliation	Title of the Work
Aakar Dwivedi, Anirudh Jain and Ajeet Singh	Indian Institute Of Technology(ISM) Dhanbad	Prediction of batting averages by modeling uncertainty and luck in sports
Nekkanti Yamini	Star India	Novel performance metrics to evaluate the duel between a batsman and a bowler
Sankara Prasad Kondareddy and Vinay Kalakbandi	DBS Singapore	FIFA 2018: Tournament outcome prediction using Machine Learning aided Reinforcement Learning

Parallel Session :: 2

Session Chair: Suma Damodaran, XLRI — Venue : Learning Center 2, Lecture Hall 35

Presenters	Affiliation	Title of the Work
Hemanta Saikia and Dibyojyoti Bhattacharjee	Assam Agricultural University	Quantifying the Current Form of Cricket Teams and Predicting the Match Winner
Bavneet Singh and Akhil Choudhary	IIIT-D	Smart Tennis Sensor Package to Measure Tennis Player Performance

Dibyojyoti Bhattacharjee and Uday Damodaran	Assam University and XLRI	Surviving after Death: It's all about Successful Death Bowlers

Schedule of Technical Sessions cont...

DAY 3 : DECEMBER 12, 2018 (Wednesday)

Technical Session 3C : 3:30 pm to 5 pm

Parallel Session :: 1

Session Chair: Saswat Patra, SP Jain Institute of Management Venue : Learning Center 2, Lecture Hall 32

Presenters	Affiliation	Title of the Work
Aniket Ninawe and Ajay Mallick	Indian Institute Of Technology(ISM) Dhanbad	Human Action Recognition using Video Retrieval Techniques in Cricket
Saswat Patra and Suranjan Das	S P Jain Institute of Management and Research	Nail Biting Finishes and Spectator Interest: The curious case of Indian Premier League
Bavneet Singh, Nikhil Jha, Pranav Dar, Kshitij Jha and Nitin Jain	IIIT-D	Are you clutch? Answers from analyzing grand slam tennis from 2007-2017
Kaveri Chhikara, Ashima Mehra and Anay Rennie	Deloitte USI	Comparative Economic analysis of countries in allocating budgets for different Sports

Parallel Session :: 2

Session Chair: Dibyojyoti Bhattacharjee, Assam University Venue : Learning Center 2, Lecture Hall 35

Presenters	Affiliation	Title of the Work
Gordon Hunter, Akash Adhikari, Rishabh Saraf and **Rohit Agarwal**	Indian Institute Of Technology(ISM) Dhanbad	Individual Player's Performance Indicators for ODI and/or T20 International Cricket Matches

Bavneet Singh, **Nikhil Jha,** Kshitij Jha, Pranav Dar and Nitin Jain	goSporto IIT-B	Moneyball meets Twenty20 Cricket – can Baseball's Pythagorean Theorem predict team winning percentages in T20 Cricket?
Arnab Adhikari, **Adrija Majumdar** and Gaurav Gupta	Indian Institute of Management Calcutta	An Integrated Efficiency, Consistency, and Importance based Decision Support System for Player selection: Case Study of Cricket
Naman Gupta, Abhinav Agarwal, Ayush Somani and Aditya Mudgil	Indian Institute Of Technology(ISM) Dhanbad	Applying statistics to understand how using different balls can increase the competitiveness of a cricket test match

ABSTRACTS OF TECHNICAL SESSIONS

Technical Session 1A (Parallel session 1) Date: 10th December 2018 (Monday)Time: 10 am to 11:30 am

Driving success at Olympics (Sanjeev Tripathi, Indian Institute of Management, Indore. India Email:sanjeev@iima.ac.in)

Sports contribute to a nation's economic, social, cultural and political development. There is a two way relationship between sports and development, economic success of a nation and societal well-being leads to better performance at sports, also development of sports leads to a positive impact on the economy, social and cultural aspects. The excellence demonstrated by athletes at elite level like Olympics is a symbol of national pride and prestige. For countries success at sports, especially at Olympics is a matter of asserting their supremacy on the world stage and to assert their soft power.
This project seeks to study the various factors that influence the performance of athletes at the summer Olympics. Essentially we investigate the drivers of success at summer Olympics and identify specific factors that drive overall medal counts at Olympics and also gold medal counts. We plan to do an extensive literature review to list the factors that drive Olympic success. Based on the literature in diverse domain we identify various socio-economic and cultural factors that could have a bearing on Olympic success but have not been currently studied. Finally we use medal count data from last three summer Olympics and secondary data to on various parameters to test our model.
Our research has implications both for theory and practice. We expect to contribute to various domains such as the literature on sports management, on elite sports and on sports ecosystems. On practice side we hope that this work may help identify systematic changes that are needed in socio-economic domain and may impact policy making.

More than the Coca-Cola formula: Scheduling the Argentina's Football Superliga (Guillermo Durán, University of Buenos Aires and University of Chile.Argentina Email:gduran@dm.uba.ar , Mario Guajardo , NHH Norwegian School of Economics. Norway Email: Mario.Guajardo@nhh.no, Gonzalo Zamorano, University of Chile .Chile Email: gonzaloz@dii.uchile.cl)

The main professional football league of Argentina has currently 26 teams. The 2018-19 season consists of a single round robin tournament, that is, every team plays against each other one match at the home venue of one of them. This can create potentially large differences in the distances travelled by the teams over the course of the tournament, an important aspect in a league where a round trip to play an away match can involve more than 3,300 kilometres. In addition, as previous tournaments were scheduled manually, little care was taken about alternating the venue in which a same pair of teams would play. This implied that many matches took place at the same venue consecutively in several tournaments. In the most extreme case, a pair of teams played at the same venue for up to six consecutive tournaments. In what for this league was a breakthrough change, the 2018-19 season has been scheduled using an optimization model. Among several other aspects, the model aims at providing a relatively even schedule of travels for neighbour teams and at changing the home venues of the matches that had been played at the same venue two or more consecutive times in the six previous tournaments. The new approach has received great attention in the media; some have colloquially praised it as "more than the Coca-Cola formula". This talk will focus on the design, computational features, and the implementation in practice of this schedule.

Competitive Balance in Football Leagues: Domestic vs International (Aman Sinha, Email: aman.15je1723@am.ism.ac.in; Rohit Agarwal, Email: rohit.15je1668@am.ism.ac.in; Utkarsh Bairolia , Email: utkarsh.bairolia@gmail.com, Vishal Sourav , Email: vishalsrv2@gmail.com all from IIT (ISM) Dhanbad)

The overall success of professional football includes both financial success and sporting success. The success of a football league is dependent on various parameters; one of the major among them is the degree of competitiveness. The degree on which the concept of competitiveness is based is cited as competitive balance (Inan, 2017) among the team results in the overall attendance of spectators. We here present a study of competitive balance analysis in various domestic leagues and international matches over several years to capture the trend of seasonal fluctuation in popularity of certain leagues and factors that are affected by the degree of competitiveness. We define a cost function that calculates the competitiveness of a football league. It compares the competitiveness among the leagues and also within a league over seasons. The uncertainty of the game outcome also adds to strengthen the competitive balance which is an important aspect because in a highly competitive match, the result being uncertain increases the interest of spectators and supporters whereas an uneven balance may lead to falling in overall spectator demand and in turn, affect the finance. Our approach is to show the use of competitive balance to enhance overall football success.

Technical Session 1A (Parallel session 2) Date: 10th December 2018 (Monday)Time: 10 am to 11:30 am

Big data analysis using small data in sports – identifying best tennis player of all times (Bikramjit Ray Chaudhuri, S P Jain Institute of Management and Research. India Email: bikramjitr12@email.iimcal.ac.in and Diptarag Ray Chaudhuri, Hiranandani Foundation School, India Email: bikrujit@yahoo.com)

Can small data provide the same utility as big data? Big data, in general, refers to so voluminous in size that tradition data processing software becomes insufficient to handle them. One of the significant challenges of such voluminous data is to bring out meaningful insights from it. But, small data can also provide the same utility as big data if various datasets are smartly handled to get useful insight from them. We carry out the exercise of bringing out meaningful insights from reasonable small data (small enough for human comprehension, but representing the total domain-data) handling among various datasets in the sports area. Who does not love a great debate, especially in sports? And, one of the most regular discussions in sports, especially in individual sports, is, who the BEST EVER in that sports is. We try to identify the best tennis male player of all times using the combination technique of multiple databases. Identification of the 'best' in any field depends on the criteria on which the evaluator is judging the phenomenon. While most of the existing researches in this area give importance to the achievements or end-results, i.e., tournaments won, dyadic matches won, and other measures (e.g., Baker and McHale, 2014; Radicchi, 2011), we focus on the mental toughness, and three technical capabilities – service quality, return quality, and balance between service and return quality as the evaluation criteria, instead of the end-results. We identify ten criteria to measure these four areas. To reach such process-level information, we have to go deep into data from the ATP website, up to the individual point-level, since 1991. We also carry out the sensitivity analyses of our findings. Overall, this research has opened an interesting angle to look into the data to bring out meaningful insights. Hope that it will motivate future researchers to use multiple datasets to bring out more eloquent comprehensions in sports and other areas.

Mistakes Provoke Further Mistakes: Evidence from Chess (Dmitry Dagaev, National Research University, Moscow, Email :dagaev@gmail.com; Akash Adhikari, Indian Institute of Technology (Indian School Of Mines) Dhanbad, Email :rajaadhikari23@gmail.com)

Tilt is a term mostly used in poker and computer games to describe an emotional state of mind that leads to repeatedly suboptimal strategic decisions and resulting in expected losses. In the games of chance, the player's psychological status could be influenced by realization of random events. Hence, bad luck is one of the reasons that make a player tilting. Often it is regarded as the main and even the only reason of tilt. We consider another possible force that dumps player to the state of tilt. It is realizing of making suboptimal moves at the previous stages of the game. To separate both effects from each other, we consider a game of chess, a pure strategic game of skill with no gambling elements. We find that sub-optimal moves on the previous stage of the chess game is an important explanatory factor of the subsequent mistakes. It means that tilt is not a special feature of games of chance. Data is extracted for 100 chess games using Stockfish 9 which gives the best line for every position and the numerical evaluation of the position after playing the corresponding best line. We have consider parameter "Diff" which is the defined for white as the difference between the evaluations given by Stockfish 9 after and before the move played for white player. Similarly, for black player, Diff is the difference between the evaluations before and after the move played. The negative Diff is what we can interpret as mistake made by the player. Thus, we focus on the internal structure of the Diff and its relation with the moves with the course of game. The regression estimates show that the value of Diff becomes more negative as the game goes on. Player tends to make more mistakes towards the end of the game. Moreover autoregressive model shows that mistake at move N-1 provokes increases probability of a further new mistake at move N.

Understanding Deviation in User Preferences: Insights from Twitter Analytics (Reema Aswani, Indian Institute of Technology Delhi, India Email: reemaswani@gmail.com; Purva Grover, Indian Institute of

Technology Delhi, India Email: groverdpurva@gmail.com; Arpan Kar, Indian Institute of Technology Delhi, India Email: arpan_kar@yahoo.co.in; Vigneswara Ilavarasan, Indian Institute of Technology Delhi, India Email: evignesh@gmail.com)

In the current scenario, social media platforms play an inevitable role when it comes to communication and engagement among people. These engagements often tend to increase during major events which could either be specific to a country or may be worldwide. Similar trends have been noticed for breakthrough sports events. People share their opinions and views on victories, losses and controversies which often change based on the events' outcome. However, some social media users tend to be active only on an event trigger whereas others are genuinely keen and interested in the respective sport. This study aims to understand the dynamics of user personalities for the people who tend to participate in discussions once an event occurs. The study uses a set of keywords and/or hashtags to extract relevant tweets surrounding the latest sports events where Indians won, leading to discussions on social media, specifically on Twitter. The research proposition is to explore if users change their preferences and do the interests and inclinations vary in terms of their preferred sport if their country wins in a specific sport. The study tends to explore synergy among the users who extensively involved themselves in discussions surrounding two sports events (Badminton and Boxing) when an Indian won and followed other popular sports of the country (Football or Cricket) before the win versus were they equally involved in the mentioned events even before the win. It is interesting to see how a nation specific event can help a sport gain traction from people who haven't been following that particular sport lately. The users tweeting about these two events are identified and past tweets of these users are analysed to explore possible synergy and interest in the specific sport before India bagged the wins. The attributes of these profiles are mapped to Big Five Personality Framework to generalise the personality of such users.

Technical Session 1B (Parallel session 1) Date: 10th December 2018 (Monday)Time: 12 noon to 1:30 pm

Evaluating Service Quality Models in Spectator Sports through Fan satisfaction: Evidence from India

(Bhaskar Basu, XIMB. India Email: bhaskar@ximb.ac.in, Arun Kumar Paul, XIMB. India Email : arun@ximb.ac.in)

The purpose of this study is to enhance understanding of fans perceptions of event quality at major spectator sports events by gauging the effectiveness of the service quality models in the context of field hockey in India. Utilizing a comprehensive literature, a couple of established service quality models in sports (TEAMQUAL and SPORTSERV) is tested using statistical measures for their accuracy and robustness in predicting fan satisfaction. Randomly selected spectators of a professional field hockey game in Bhubaneswar, Odisha, India participated in the study. The empirical results of the study determine the reliability and validity of the service quality models and possibility of alternate model in the Indian context. The results contribute to the theoretical understanding of the factors that predict fans' loyalty in a professional spectator sport like field hockey in the Indian context. Limitations: Service quality models in sports like TEAMQUAL and SPORTSERV have been tested in spectator sports like basketball and baseball which primarily have an American and European audience.

Understanding Determinants of Attendance Behaviour in Sporting Events (Subhasis Sen, Email: subhasis_sen@scmhrd.edu; Kannan Rajagopal, Email: k_rajagopal@scmhrd.edu; Shantanu Prasad, Email: shantanu_prasad@scmhrd.edu all from - SCMHRD, Symbiosis International)

Sport consumers can be spectators, participants or sponsors targeted for an event or sports goods. A survey has indicated that viewers today want more relevant messaging, ticket pricing that gives choice, flexibility and accessibility across platforms (Berman et al., 2011). Sport events result in two types of involvement mainly participation and attendance which are influenced by economical, sociological, psychological and motivational parameters like age, gender, leisure time and family size (Lera-López & Rapún-Gárate, 2011). Even social media has changed the way consumer takes decision by influencing the evaluate and advocate stages of buying behaviour (Hudson & Hudson, 2013). The sports industry is continually looking for ways to deliver differentiated experiences. Innovative technology solutions help to fuel new experiences and growth by connecting sports contests, teams, fans and the masses (Petrović et al., 2015). According to a study by Buning and Walker (2016), participation motivations for events have been influenced by health and weight concerns, personal growth, affiliation and psychographic needs. In a study by Foroughi et al. (2014) with relation to Iranian football premier league, data on game quality, augmented service, interaction, outcome, environment and fan satisfaction has been collected. The results highlight significant relationship between fan satisfaction and attendance. However, the research effort for estimating spectator attendance to measure event quality is lacking. Even there is a need to understand whether motive impacts attachment and build positive attitudinal loyalty towards sporting events (Kirkup & Sutherland, 2017). Therefore, it has become evident to understand the determinants behind sports participation for the viewers as well as athletes. The study here attempts to identify and analyze the determinants like ticket pricing, social media, technology, branding, culture and demographics which directly or indirectly influence the attendance behaviour.

A Blackbox for White Ball Cricket: Optimal Run-Chasing Strategy (Arth Shah, Indian Institute of Technology Madras, India Email: me14b104@smail.iitm.ac.in and
Phil Scarf, Salford Business School, United Kingdom Email: p.a.scarf@salford.ac.uk)

The famous 2011 Cricket World Cup final run chase by India has been etched in cricket fans' memory forever. What makes the likes of MS Dhoni and Virat Kohli so good at chasing targets in One Day International (ODI) Cricket? In this paper, we seek to model the construction of a successful run-chase. That is, we develop a model that trades-off maximising run-scoring and minimising the risk of getting out. In so doing, we formulate optimal batting strategy by combining deep learning with reinforcement learning. Given the state of a match after t overs, we aim to find the optimal scoring rate in the (t+1)th over in order to win the match. We model the state of a match to incorporate: player dependent factors such as player strengths, dynamic player performance, remaining resources; current match situation factors such as required runs, wickets in hand, required run rate; and player independent factors such as toss outcome, venue, game type (day or day/night). The data we collect and use include ball by ball ODI match details, player statistics, and ground statistics. We train a recurrent neural network to learn the model dynamics. The model dynamics describe the probability of outcomes given the current state. We define action as the number of runs batsmen aim to score in an over. Although the actions are not explicitly known or observed, we determine them implicitly based on the learned model dynamics, since

a match state with high required run rate necessitates a high scoring action, and vice versa. Thereafter, the reinforcement learning algorithm learns a policy that maximizes cumulative future reward at the given state. We employ model predictive control, which executes only the first action from the learned policy and then replans at the next step with updated state information. Our model can be used by players and coaches to strategize an ODI run-chase over by over.

Technical Session 1B (Parallel session 2) Date: 10th December 2018 (Monday)Time: 12 noon to 1:30 pm

Predicting the Career Path of Professional Soccer Players (Ayush Tiwari, Faculty of Computer Science, Dalhousie University, Canada Email: tiwariayush1998@gmail.com; Yannick Marchand, Faculty of Computer Science, Dalhousie University, Canada Email: ymarchan@dal.ca)

Professional soccer players switch teams and relocate frequently. Their transfers are sought to be somewhat dependent on the economic market and erratic. However, it may be possible to automatically anticipate soccer player relocation. This study aimed to see if Markov Chains (MC) could be used to predict what national league (i.e. country) a soccer player would transfer to next. It was hypothesized that the MC classification accuracy will outperform a simple baseline approach that consists of assigning the penultimate country to the output variable. A dataset of 1376 professional soccer players from 7 major European leagues (England, France, Germany, Italy, Netherlands, Portugal, and Spain) was created by mining Wikipedia data. For each of these players, the sequence of the countries in which their professional career took place was obtained (e.g. Cristiano Ronaldo has the following sequence or career path: Portugal, Portugal, England, Spain and Italy). The goal of the study was to predict the most recent country that a professional soccer players transferred using their past career paths. Markov Chains were generated for each of the 7 country leagues. A 'one leave out procedure' was used, whereby the data from all the players was included in the MC, with the exception of the player to be tested. The results confirmed our hypothesis. An accuracy of 78.8% was obtained using MC highlighting the fact that this machine learning method can reasonably predict career transfers. MC performance accuracy was significantly higher than the 68.6% accuracy of our baseline method (p-value<0.01). We plan to extend this work using other machine learning models (e.g. RNN, N-gram) to determine the most accurate approach as well as attempt to predict players career path at a finer granularity, namely on city and club levels.

Analyzing the competitiveness of European Football Leagues through Social Networking (Abhishek Chakraborty, XLRI Xavier School of Management. India Email :abhishekc@xlri.ac.in)

Competitiveness in football leagues is an essential component for attracting more spectators. The prevailing uncertainty regarding both the top four finish in top European football leagues and the relegation battle has the capacity of making the spectators glued either to their TV sets or in the stadium. With the commercializing of most of the leagues across sports, competitiveness or competitive balance creates uncertainties which both attract the spectators as well as provide incentives for betting markets. If a few teams keep on dominating the top spot battle year after year, it affects the competitive balance of leagues and could dissuade spectators away to some other leagues. In order to ensure the competitive

balance increases, UEFA introduced Financial Fair Play (FFP) to prevent teams from spending more than their income and was implemented in the 2011-12 season onward. As far as measuring competitive balance in a league is concerned, several researchers and practitioners have come up with various models, a lot of them being borrowed from Economics literature. Some of the commonly used measures include standard deviation of win percentages, the range of win percentages, the Gini coefficient of win percentages, standard deviation of league points, difference in goals scored, difference in league ranking, seasonal coefficient of variation, Herfindahl index etc. The biggest issue with all these metrics is they restrict themselves to the aggregate performance of the teams and not how the teams have fared against the other teams at an individual level. In our work we propose a social network approach that will look into pairwise comparison of team's performance both on home-away format across top five European leagues over a period of excess of 15 years to provide a metric of competitive balance. We will further show as how the competitive balance have changed over the years across leagues and also whether the introduction of financial fair play has really helped to boost up the competitive balance of the leagues.

Ranking using Factor Scores in T20 Cricket (Jimut Bahan Chakrabarty, Indian Institute of Management Kozhikode, India Email: jimutb08fpm@iimk.ac.in and Prashant Premkumar, Indian Institute of Management Kozhikode, India Email: nairp08fpm@iimk.ac.in)

In this paper, we introduce certain key performance indicators, on which the ranking of a player should depend in T20 cricket. Many of these variables have been ignored by the earlier ranking systems including the most widely used ICC ranking system. Using a dynamic rather than a static approach of generating factor scores through the factor analysis, on a match by match basis, this paper ranks batsmen and bowlers who have played T20 International cricket during 2017-18.

Framing the Positive or Negative Reputation in Sports – Inputs from Governing Bodies using Social Media Analytics (Purva Grover**,** Indian Institute of Technology, Delhi. India Email: groverdpurva@gmail.com, Arpan Kumar Kar, Indian Institute of Technology, Delhi. India Email: arpan_kar@yahoo.co.in)

In today's digital era, social media i.e. Twitter and Facebook are serving as an engagement platform for the fans. Therefore now day's even governing bodies in sports i.e. FIFA are advertising on Twitter to increase their brand awareness and reach among fans and stakeholders. Literature indicates during world cup period many motivated fans seek for engagement and interaction. Using the tweets posted by @FIFAWorldCup, official Twitter account of the FIFA World Cup by applying netnographic methodology, the study tries to explore the following research question: (a) how the tweets posted by @FIFAWorldCup on Twitter being shared and liked among the fans? (b) Whether the frequency of the tweets posted by FIFA during the world cup increases or remains the same? (c) The study also tries to explore how social media is seeding the decision on stakeholders to decide which team is better and which is not? The tweets posted by FIFA had been classified on the content type basis into informational, entertainment and social tweets. The tweets were also classified in terms of whether the tweets contains @mention for sport organization, players and other stakeholders. Further to analyse the usage of the Twitter account by FIFA social media analytics had been applied. The insights derived from above had been discussed using social

interaction theory given Fischer and Reuber (2011). The study also tries to list the best practises which can be followed by governing bodies in sports in future to increase their brand awareness and reach among fans and stakeholders. To best of our knowledge this is the first study to explore FIFA usage of the social media for co-creating their brand value among different stakeholders.

Technical Session 1C (Parallel Session 1) Date: 10th December 2018 (Monday) Time: 3:30 pm to 5 pm

Are Better Predictions Related to Better than Average Effect (Divya Aggarwal, XLRI. India Email :fb14007@astra.xlri.ac.in)

This paper aims to examine association between better than average heuristic as a proxy for overconfidence and forecasting ability for predicting most accurately a real world event: outcome of 2018 FIFA World Cup. Post graduate students enrolled in a 2 years master's program in one of the most premier Indian B-school, participated in the study. They were asked to respond to measure of better than average effect and give probabilistic estimate for tournament outcomes. A decomposition analysis of probability estimates using Brier scores was also done to examine if participants having better than average tendencies gave poorer or sound estimates.

Decision model for Club Transfer of Football Players (Harsh Kumar Mohanka, Email: hkm.15je000952@am.ism.ac.in; Shubham Gaurav, Email: shubhamgaurav019@gmail.com and Himanshu Bhadani, Email: himanshu.15je1562@am.ism.ac.in - all from IIT(ISM) Dhanbad, India)

Great talent is not always the right talent, with only around 50% of new signings proving successful in Club football, this paper aims to propose a model for professional club managers and team management with basic guidelines for making better transfer decisions that would result in the collective benefit of the entire team. The research is based on the case study of various players from the football clubs participating majorly in European Football Leagues. For every player, the total time played, numbers of goals, assists, shots on target, shots off target and many other variables are taken into account and subsequently calibrated points are calculated using agile technique. Results show that the combination of two strikers of the same level will not benefit the team compared to a good striker paired with an average one. In addition, players tend to lose confidence when they get less playing time, which affects their performance, and consequently, the performance of the team. This reversible process slowly weakens a player and leads to a change of clubs, which can have potential repercussions on the player's career and team performance. The paper also uses the concept of spikes introduced in the paper "Suggestive model for career decisions in Football" presented by A.Rennie and A.Gupta at EURO 2016 conference. Spikes are quantitative indicators that can be used to help players as well as club-managers in making important decisions.

Upset Index of a tournament (Shubhabrata Das, Indian Institute of Management Bangalore, India Email: shubho@iimb.ac.in)

The chance of an upset result in a match between two competing teams (or players) is a function of how close are their strengths. This leads to our selected model probability formulation of upset index in any

given match. We consider two frame-works; in the first, the strength of a team is pre-determined on the basis of rank, while in the second it is estimated based on the outcomes of the matches. Different models are considered under both the frameworks. To start with we consider repeated games between two teams to decide the winner based on 'best of n'. We study the behavior of the eventual upset outcome as n increases. The above is then extended to tournaments of different design with increasing number of teams and complexities as we construct overall upset index of the tournament based on upset probabilities of the constituent matches and the tournament structure. The behavior of the upset index is subsequently studied in details to reflect on competitiveness of tournaments of different structures. For more complex tournament, overall upset index is split into the different stages for examination. The key objective of the study is to draw a balance between unpredictability and fairness in selecting a tournament design. A second goal is to compare different tournaments as well as sports. A third goal, achieved through changing problem parameters, is to determine criticality of individual matches in the overall tournament. In addition to various model based approaches, results from few repeated tournaments will be presented for illustration.

Technical Session 1C (Parallel Session 1) Date: 10th December 2018 (Monday) Time: 3:30 pm to 5 pm

Winning the Brand Loyalty Cup: The Psychological Play of Symbol-related Brand Elements of Football Clubs
(Aravind R, Email: arvindr08fpm@iimk.ac.in and Joshy Joseph Indian Email: joshyjoseph@iimk.ac.in – both from Institute of Management Kozhikode, India)

The growing commercialization and professionalization of team-sport clubs and leagues have made brand management a central issue in sports (Blumrodt, Bryson and Flanagan 2012; Bauer, Stokburger-Sauer, and Exler 2008). In line with this understanding, professional football clubs can be considered as full-fledged brands and past studies have indicated that brand is their most important asset, similar to any other business entity of modern era (Blumrodt et al 2012; Bodet and Chanavat 2010). Out of the top ten sports teams based on revenue, eight are from the area of football (Forbes rank list 2016). Loyalty of the fans has been a crucial factor in the success of these brands. For any brand, its building blocks, the brand elements can be tools to create distinct associations in the minds of consumers, thereby helping in brand loyalty. This study explores the relationship between symbol-related brand elements of football clubs and brand loyalty towards the clubs. We found that the brand elements History of the club, Jersey design and Logo design positively influence loyalty towards a football club in that respective order of significance. Interestingly, a club's anthem and mascot were not found to have any influence on brand loyalty. Findings of this study help brand managers and sponsors of football clubs to focus attention or investment on to the brand elements that matters the most in brand management. In addition, we add value to the brand management of sports leagues and clubs around the world, by helping them create unique brand associations and attracting loyal followers.

Self-improvement Artificial intelligence tool for Football players (Anay Rennie , Deloitte USI. India Email: anayrennie@gmail.com; Parardha Kumar, Indian Institute of Technology (ISM) Dhanbad. India Email:parardhakumar@gmail.com, Aakar Dwivedi, Indian Institute of Technology (ISM) Dhanbad, India Email :dwivediaakar@gmail.com)

This paper aims to propose a prototype model for developing Self-improvement Artificial intelligence tool for professional football players and club managers that would improve the effective play of the players

as well as the entire team. Each pass in a football match produces 100's of data variables, thus producing 1000's of records in a match for all those variables and hence creating a big set of data. Using, data mining techniques we have categorized those variables and quantified them using co-ordinate geometry and agile techniques. Further each categorized variable gives 100's of meaningful attributes about a player's performance in the current match, past match and possible future matches. We have build a prototype model to develop an AI tool using which a player can improve their skills and manager can improve their tactics.

Advancement in Batting and Bowling strengths and their influence on match outcome (Shubham Krishna, Email: shubhamkrishna.ism@gmail.com and Krishna Singh, Email: krrish.singh.11@gmail.com both from Samsung Research and Development, Bangalore, India and Rishikesh Parma, IIT(ISM) Dhanbad. India Email: rishikesh.parma9@gmail.com)

Cricket has evolved a lot in the past four decades. The Batting and Bowling strength has changed dramatically over time. From the introduction of rules like Powerplays to the limitation on number of bouncers per over has encouraged the batsman to play big shots and paralyzed the bowling strength. Our aim is to study these variations in Batting and Bowling strength using statistics and machine learning and hence introduce a mathematical model for the same. The sample data taken is of the international one day matches from 1980 to 2018. The parameters to model batting strength involves the study of number of runs in an inning, batting averages, strike rates, centuries and boundaries. Whereas wickets, runs conceded, dot balls, maiden overs, bowling strike rates are the parameters to estimate bowling strength. We also look at the impact of these strengths on the outcome of matches. This study can prove to be useful in performance assessment of teams and can also be used to bring modifications in rules to make outcomes more uncertain.

RobinX: an XML-driven classification for round-robin sports timetabling (David Van Bulck, Dries Goossens, Jörn Schönberger, Mario Guajardo, Email: David.VanBulck@ugent.be)

The round-robin sports-timetabling problem consists in designing a timetable, often called a schedule, for a set of teams that play against each other a fixed number of times. Although a few contributions have been made to organize the various constraints that occur in sports timetabling, they did not result in a generally applicable classification or file format for problem instances and solutions. The lack of a such a data format makes it extremely difficult to assess algorithmic performance. This paper presents preliminary results of an XML-driven three-field classification scheme for round-robin sports-timetabling problems. In this scheme the first field describes the competition format, the compactness, and required symmetry properties of the timetable. The second field lists around 20 constraints partitioned into five constraint groups that classify the vast majority of the constraints from the literature. To reduce the total number of constraints in this list, constraints are defined in such a way that they are applicable for any set of teams (team groups) and any set of time slots (time groups) and can be either hard or soft. Lastly, the third field refers to the objective function in use. Motivated by the success of XML in other research disciplines, we propose three XML-file-based templates to respectively store problem instances, timetable solutions, and bounds on the objective value. In addition, we present RobinX: a free and open-source C++-library to read, write, generate, manipulate, validate, and evaluate these XML-files. RobinX is embedded in a user-friendly web application with a database of benchmark instances and their best-known solutions. Furthermore, the website offers a query tool that can be used to construct benchmark sets having

instances with specific problem features. With this paper, we invite researchers to join the project and submit their own problem instances and solutions.

Technical Session 2A (Parallel Session 1) Date: 11th December 2018 (Tuesday) Time: 10 am to 11:30 am

Setting target scores of better acceptability in interrupted limited over cricket matches by introducing a concept "the makeup factor" (V Jayadevan, Vidya Academy of Science and Technology, Thrissur, Kerala, India, Email: vjdcricket@gmail.com)

The actual score made by the team batting second at the time of interruption is not a parameter for setting their revised target either in DL/DLS systems followed by the international cricket council since 1998 or in its closest competitor, the VJD system, followed in Indian domestic since 2007. In DL(S) systems, with the resources available and utilized concept, including this parameter is out of question. VJD system however is flexible enough to bring in this parameter into the target calculations. Application of the makeup factor theory introduced by the author by including this additional parameter is illustrated in this paper with suitable examples from ODI and T20. The advantage a team enjoys by doing better than what the par-score demands at the time of interruption is something which should spreads over the full remaining overs. When the remaining overs get significantly reduced due to interruption, in present methods, this entire advantage gets concentrated to a much lesser number of overs thus increasing their winning probability significantly. Makeup factor is a feature which makes a proportionate reduction in this advantage/disadvantage based on the percentage of the remaining overs to the originally remaining overs at the interruption. Though this concept was originally introduced in 2006, it is yet to be discussed in any important forum. Make up factor, Mf = (Par score-Actual score) * f(x). Function f(x) is empirically arrived at in which 'x' is the percentage of "the overs remaining after the interruption" to "the overs remaining before the interruption". The makeup factor gets added up or subtracted from the par score while computing the made up par score and this will be carried over for further calculations and hence the consistency will be maintained during subsequent interruptions.

Relationship between event-sponsor fit and attitude towards sponsors: A study on IPL team sponsorships (Giridhar Kamath, Manipal Academy of Higher Education,India Email: giridhar.kamath@manipal.edu; Simon George, T A PAI MANAGEMENT INSTITUTE. India Email: simon@tapmi.edu.in; Shirshendu Ganguli, T A PAI MANAGEMENT INSTITUTE. India Email:shirshenduganguli@tapmi.edu.in)

This study examines the fit between the sponsor brands of the Indian Premier League (IPL) teams with IPLT20 event as a whole. Researchers have shown that fit between the sponsor and the sponsored property is of prime importance because it determines the amount of thought a person gives to the perceived connection. This study explores the impact that perceived fit of the viewers on the attitude towards the sponsor brands thereby studying its impact on the purchase intention and word of mouth of these brands. Using theory of planned behavior as the underlying theory for the study, hypotheses were formulated relating the perceived fit with the attitude towards the sponsors and the intention to purchase

the sponsor's products. One main sponsor of each of the eight teams were selected for the study and based on self-reported questionnaire survey method, data was collected from 203 IPL viewers. The data was analyzed using SPSS and AMOS. The results showed that perceived fit had an impact on the attitude towards the sponsor brands. However, in low-fit cases, the viewers' attitude towards the sponsors were not so favorable. The results can help the marketers while taking sponsorship decisions with respect to IPL.

Selection of Players Considering the Characteristics of Japan Team in the Super Rugby by Using Data Envelopment Analysis (Makoto Kiuchi, Juntendo Email: makotos621115@yahoo.co.jp; Nobuyoshi Hirotsu, Email: nobuyoshihirotsu@yahoo.co.jp – both from Juntendo University, Japan)

Japan will host the Rugby World Cup in 2019. The aim of the Japanese national rugby team is to advance to the final round as the host country. In order to strengthen the team, Japan team has been participating in the Super Rugby since the 2016 season. However, the ranking of Japan team is low in the Super Rugby. One of the problems may be due to the selection of players. Japan team seems not to select the players who are suitable for the characteristics of the team. Data Envelopment Analysis (DEA) can be used as a method to evaluate the characteristics of the players, and may also be applied to select players. So, we show the characteristics of Japan team in the Super Rugby and then select players who are suitable for the characteristics of the team by using DEA. Here, we analyze the data consisting of 10 items which were taken in the Super Rugby 2016, and the rank of Japan team in each item was used to evaluate the level of Japan team. We found that the Japan team is weak especially in "tackle" and "effective attack". Therefore, we then try to find the players who are good at tackle and/or effective attack. To find the players, the data from the Japan Rugby Top League 2016-2017 season were analyzed using DEA. We used play time as the input and the numbers of five play items as outputs. With the help of DEA, we found the players who are characterized by tackles and effective attacks in each position. Some of those players have never been selected for Japan team in the Super Rugby. Using this method, we can identify the players who are suitable for Japan team, and this result may be helpful to strengthen Japan team.

Emergent relational structures of knowledge resource mobility: an ERGM analysis of professional soccer player transfers (Subhasree Mukherjee, Email: subhasreem08fpm@iimk.ac.in, Deepak Dhayanithy, Email: deepak.dhayanithy@gmail.com- both from Indian Institute of Management, Kozhikode, India)

The inter-firm mobility of KRs is a result of competition between firms to obtain the best resources and culminates into forming inter-organizational relations. Hence we develop our theoretical rationale based on resource dependence theory (RDT) and network analysis to examine the network structures formed due to KR mobility. The relational structure of the interfirm network is central in predicting the pattern of future tie formations by mobilizing knowledge resources between firms. Inter-organizational relational structures are operationalized by popularity, activity spread, network closure, and multiple connectivity. Impact of firm performance on establishing inter-organizational ties is also explored. We plan to test our hypotheses in the empirical context of professional football player transfers among the Big 5 European leagues. Player transfers data for 2015 and season end standings will be

obtained from transfermarkt.com, and club and player ratings from fifaindex.com. Each node in the network represents a club that participated in player transfer in that particular season. A tie between nodes represents a completed player movement. This player mobility network and the network properties it bestows upon clubs as well as club and player ratings to the subsequent season"s player transfers will be analyzed using Exponential Random Graph Modelling (ERGM). We found that the network of knowledge resource mobility tends to be more connected and closed with lesser bridging ties. Also, players of the clubs with better performance are sought after by other clubs. However, performance of clubs which are buying players, does not impact player transfers. We also found that popularity of clubs has negative effect on player transfer and so does the activity spread. The network of knowledge resource mobility is not centralized and concentrated around few clubs.

Technical Session 2A (Parallel Session 2) Date: 11th December 2018 (Tuesday) Time: 10 am to 11:30 am

An analytic approach towards assessing the effect of twenty over cricket match on test cricket with special focus on India's performance (Subhasis Ray, IISWBM, Calcutta University, India Email: subhasisray@rediffmail.com)

The oldest and longest format of the game i.e. Test Cricket is being played since 1877, the 50 over One Day International (ODI) format is in existence since 1971. The smallest and youngest format i.e. Twenty twenty International (T20I) had started only in 2005. But, mass acceptance of the shortest version of cricket was epitomized by the success of the franchise based Indian Premier League (IPL) started in 2008. Buoyed by the success of IPL, many other countries followed the suit. The present work ratifies that the purists still consider test cricket to be the ultimate 'test-bed' of a cricketer / team's cricketing ability and advocate a cricketer's progression from long term to short term cricket rather than the other way round. But the reality is spectators have started filling up the ground to enjoy big shots of T20 and the lure of big money made cricketers including the budding ones embrace this format. T20 is helping cricket penetrate Associate and even non-member countries under International Cricket Council (ICC). However, cricketers are retiring from Tests to lengthen their T20 career. The base version of no other sport had been challenged as much as Cricket's (i.e. Test matches) even though many other sports have now started franchise based customised league. Ray and Sengupta (2017) had come up with a meta-metrics framework as a tool for conducting formative assessment of measuring the influence of 20 over cricket match on Test cricket. The present research work applies this framework on the secondary data available at www.cricinfo.com for T20I and Test cricket matches played between 1 Apr 2000 and 31 Mar 2016, allowing 8 years of cricket before and after IPL started. Various advanced statistical analyses e.g. Testing of Hypothesis, Longitudinal Analysis, ANOVA, ANCOVA and Data Visualization techniques were used, that revealed a number of startling facts quite contrary to common perception e.g. a) Test matches have become more decisive, b) they yield higher run rate post IPL, c) Volume of Test cricket is shrinking due to limited overs cricket.

Is there a home advantage in professional road cycling? (Rishabh Saraf, Indian Institute of Technology (ISM) Dhanbad, India Email:rishabh.saraf23@gmail.com and Dries Goossens, Ghent University, Belgium Email: Dries.Goossens@ugent.be)

In sports, we can define the home advantage as the consistent finding that teams or athletes perform better in their home venue or country than in other circumstances. The home advantage has been studied and found significant in many sports, such as baseball, field hockey, ice hockey, and especially soccer. In this contribution, we study the existence of a home advantage in professional road cycling. Indeed, there is reason to believe that professional road cyclists perform better in races organized in their home country or region. This can be motivated by the fact that they are more familiar with the roads, more used to the climate, and/or more supported by the fans along the course. We test this on a large database, containing results of all World Tour and Continental races since 1999.

Application of Zero Inflated Poisson distribution to predict the Performance of Wicket Keepers in Cricket: A Study Based on Last Five IPL Seasons (Dibyojyoti Bhattacharjee, Department of Statistics, Assam University, India Email: djb.stat@gmail.com, Deepjyoti Choudhury, Department of Business Administration, Assam University, India Email: choudhurydeepjyoti@gmail.com)

The importance of wicket keeper in a cricket team is indispensable. A perfect wicket keeper keeps the morale of the team high and acts as the confidence booster to the bowler and the entire team. The performance of a wicket keeper in a match can change the fate of the game. A wicket keeper should be capable of several cricketing skills like stamping, catching, appealing for a dismissal and in these days an important decision maker of call for a decision review. However, the International Cricket Council (ICC) which regularly publishes ranking for batsman, bowlers, all-rounders and cricket teams do not produce any ranking for wicket keepers. Thus, considering the importance of a wicket keeper in a cricket team, the researchers feel that it is necessary to measure the performance of wicket keeper. The exercise can help in selecting the best keeper for a team from a host of available options. In this study an attempt has been made to measure and predict the performance of wicket keepers with the help of a zero inflated Poisson distribution. Previous experiences of the researchers with score card of matches of Twenty20 cricket, it is seen that in most of the matches a wicket keeper goes without any dismissal. So the frequency distribution of the dismissals of a wicket keeper in a host of matches is expected to be inflated at zero. Thus, a zero inflated Poisson distribution may be suitable and fit the data as it takes care of excess zero in the data. Here, in this study zero inflated Poisson distribution is applied on wicket keeping data of selected players taken from last five editions of Indian Premiere League and accordingly extracts the wicket keeper with most expected number of dismissals.

Technical Session 2B (Parallel Session 1) Date: 11th December 2018 (Tuesday) Time: 12 noon to 1:30 pm

Implication of Demographic Differences on Volunteer Motivation in Asian Athletics Championship (Prakash Dash, Email: dashprakash04@gmail.com and Manash Sahu, Email: manash.mbabu@gmail.com both from Asian School of Business Management, India)

The importance of volunteers in various sporting events has been extensively acknowledged during the past decade. Volunteers are a core component of sports service delivery (Daly, 1991) and a crucial element

of sports event management, including promotion, coordination and management of multiple activities, such as marketing, hospitality, media, logistics and security. More often than not, sporting events are managed with only a few members on the organising team, thereby requiring the assistance of volunteers for operational purposes. The success of such events greatly depends on volunteer motivation (Hallmann and Harms, 2012). Previous research has illustrated the significance of and need for volunteers in the successful operation of sporting events (Green and Chalip, 1998; Strigas and Jackson, 2003; Hardin et al., 2007). The present study explores the motivation of volunteers at the Asian Athletics Championships, held between July 6 and July 9, 2017 in Odisha, India. The event that saw 560 athletes from 41 nations participated in 42 events, gave researchers an opportunity to interact with its contributing volunteers for the purpose of this study. This investigation was designed to examine the primary motivation of volunteers for the Asian Athletics Championship held in Odisha, India. The research posed three questions: 1. What is the demographic profile of volunteers for Asian Athletics Championship? 2. Which factor(s) describe volunteer motivation in a mega athletic event specifically in the Indian context? 3. Are there any significant differences across volunteers' motivational factors based on selected demographic variables (such as gender, age and education)? Previous research has examined the motivation of volunteers in a variety of contexts, including social services (Clary et al., 1992), health professions (Fletcher and Major, 2004) and events (Farrell et al., 1998; Strigas and Jackson, 2003; Hamm and MacLean, 2007). Consistently, the two key motives for volunteering emerge in most studies: paying back to society in a worthwhile manner and community service. Volunteers also clearly indicate a need to feel a sense of belonging and be part of a team. These are critical components to volunteer management within all organisations. Research has recognised that the motivation that drives sport volunteers is distinct from that of other volunteers (Strigas and Jackson, 2003). The work within sports has fit with the typology developed by Clary et al. (1998). A study by Strigas and Jackson (2003), focused on volunteers at a regional marathon. The researchers developed an instrument to assess their motivation in a sports setting, defining five factors — material, purposive, leisure, egoistic, and external — also fitting into the model developed by Clary et al. (1998). Researchers have begun to explore the demographic profile, motivation, and intention of volunteers in various sporting events. Hardin et al. (2007) utilised an exploratory analysis to identify and assess four factors that explain how individuals characterize their motivation to volunteers: self-interest, external, purposive and escapism. The instrument consisted of two parts, demographics and volunteer motivation. With variables derived from literature review, 35 items were used to measure the volunteer motivation domain and four questions were included to help understand the demographic profile of the population. Volunteer motivation was examined utilising the sport volunteer motivation scale developed by Bang and Chelladurai (2009) and Strigas and Jackson (2003). The authors decided to base their research on the 40 item instrument developed by Strigas and Jackson (2009) because: (a) the five factors in the instrument (material, purposive, egoistic, external, and leisure) were adequately representing most of the volunteer dimensions identified in the review of literature; and (b) the instrument was capable of measuring the motivational patterns of sport volunteers in a valid and reliable way. These scales were modified to suit the Indian context based on in-depth interviews with sports persons and sports event organizers. The final 35 item measure of volunteer motivation contained five factors: purposive, expression of values, interpersonal motive, escapism and love for sports. A total of 318 responses were collected during the course of the event: 66 on the first day, 87 on day two, and 165 on the other two days of the event. After filtering out the incomplete responses, only 260 were found suitable for further analysis. The final number of volunteers considered for this study represents approximately 26% of the total volunteers who were part of the event. Factor analysis used for collected data was found suitable in terms of correlation analysis, variable analysis of sampling adequacy, KMO test of sampling adequacy, and Bartlett's test of sphericity (Boyd et al., 2002; Malhotra, 2004). The data was then subjected to Principal Component Analysis (PCA) with Varimax rotation. After a series of deletions, the factory output was received in the form of five extracted factors for a 25-variable

scale. The demographic profile of the volunteers is presented in Table 1 depicts that male volunteers are more in number (60.8%) as compared to female volunteers (39.2%). Most of them (46.2%) are between age 16 and 25, while 27.7% are in the age group of 15 years and below. It is noteworthy that more than 43% of volunteers had at least a bachelor's degree. The second part of the survey instrument was intended to determine why people volunteered at sports events such as the Asian Athletics Championships. An EFA revealed that the volunteers were mostly motivated by purpose, expression of values, interpersonal motives, escapism, and love for sports. It is evident that there is a marked difference (a 0.05 level of significance) in the case of two of five volunteer motivation factors. Across the age group of volunteers the factors purposive ($p < 0.001$) and interpersonal motives ($p < 0.002$) differ considerably, requiring the organizers to adopt a strategy that not only keeps the volunteers motivated but also makes the event a grand success. However, there is no significant difference found in volunteer motivation across gender and educational levels of the volunteers at this event. Hardin et al. (2007) and Pauline et al. (2008) found a majority of volunteers to be male, which is confirmed by the findings of this study with a whopping 60 per cent of male volunteers. However, while their research showed a majority of volunteers to be married, the marital status of most of the volunteers at this event was single. The average age of volunteers for the Asian Athletics Championships was noted to be between 16 and 25 years, yet previous studies such as that by Strigas and Jackson (2003) found the mean age to be 40 years. The differences could be attributed to the type of work as well as commitment required of the volunteers. It can therefore be concluded that different events will attract different types of volunteers. There is a need for more research in this area, specifically for other sports events organised in India, in order to more accurately determine the volunteer demographic categorisation in the country. It can be said that the association with the sport can further assist in making the volunteer experience enjoyable. It allows the volunteer to be part of the event team albeit for a brief period of time. As with many professional sporting events, it is evident in this event also that volunteers are integral to event execution, owing to the limited number of full-time staff members In fact, the responsibility that are often assigned to volunteers mirror those of the full-time staff. Interestingly, the top reason to volunteer in the present study was focused around the enjoyment derived from it. Depending on the event needs, if knowledge of sports in not a prerequisite, event managers can employ various tactics to draw a broader volunteer base. The motivating reasons and factors exhibit some similarities and differences when compared to results in other studies. In contrast to the existing literature, Williams et al. (1995), Farrell et al. (1998), and Strigas and Jackson (2003), found that motivation related to the material factor least influenced decisions to volunteer. However in this study, the strongest motivation was purposive. Interesting, while material factors were the most motivating, the top reason is "It will look good on my resume and would be beneficial in any job." There was also a genuine concern for the event and community as a whole. Overall, the results of this align with some previous research on volunteer motivation (Williams et al., 1995; Farrell et al.,1998; Hardin et al., 2007), yet differ from more recent studies (Strigas and Jackson,2003; Hamm and MacLean,2007; Pauline et al.,2008). Further research needs to examine the differences in motivation from different events in the Indian context. The third purpose of this study was to explore the role that demographics (gender and age) play in motivational factors for volunteering. Gender does not show a significant impact on motivation whereas age showed significant motivation. This is consistent with the previous research (e.g. Hardin et al., 2007; Pauline et al., 2008) and is a call for event organisers to ensure the younger masses to be part of bigger events. The application of the findings from the present study can be utilized to provide recommendations to appeal to what has been found to be the most important motivational factor purposive. For example, to appeal to the purposive factor, event organizers should ensure that they offer the tangible benefits sought by volunteers, as this appears to be a cornerstone management strategy for sustaining events. This can be as simple as a token of appreciation or even event merchandise (such as event tickets, t-shirts, and certificates). Such items should be marketed during the recruitment process

based on the level of importance of material gain to volunteers. This may reach volunteers from a different segment, which is necessary based on the growing need, yet limited supply, of volunteers for long run.

Towards Developing a Cricket Skill Index for Limited over Cricket (Bhaskar Basu, Email: bhaskar@ximb.ac.in and Arijit Mitra, Email : arijit@ximb.edu.in, XIMB, India)

Developing a comprehensive cricket skill index (CSI) for cricketers in the 50-over or one-day format based upon their on-field performances in the 50-over and T-20 format. Review of several research articles published in the domain of cricketer performance leads to the formulation of a single comprehensive index to quantify all the batting, bowling and wicket-keeping/fielding ability of a cricketer and is termed as Cricket Skill Index (CSI). Possible attributes for evaluating batsmen, bowlers, allrounders and wicketkeepers are compiled from experts and the generalized index is proposed. In attempting so, the performance of a cricketer both in ODI (overseas and home) and in T-20 (overseas, home and IPL) are considered as parameters for the index. It is assumed that test cricket performance of a cricketer may not be relevant in this context because of the difference in nature of test cricket and limited over cricket. It is, therefore, considered out of the scope of this study. It is also assumed that age is not a factor for computing the skill index, if the cricketer meets the mandatory fitness clause prescribed by the respective board of cricket of the country. The index provides ease and transparency in player selection by respective boards of cricket and provide the corporates a scientific basis to reward cricketers based on their performances periodically. Latent factors like cricket pitch behavior towards batsmen or bowler, day-night or day game, position of batsmen dismissed by bowlers, ease of catches, run-outs and stumping are not considered in developing the index.

Effect of T-20 leagues on Global Cricket (Baisampayan Sarkar, Email:baisampayansarkar2410@gmail.com; Sayan Acharya Sarkar, Email:g18091@astra.xlri.ac.in; Subhranil Das, Email:g18046@astra.xlri.ac.in; Arnab Paul, XLRI, Jamshedpur. India Email: g18008@astra.xlri.ac.in, Suvojit Maity, Email:g18100@astra.xlri.ac.in- all from XLRI, Jamshedpur)

As the popularity of 5-day test cricket was gradually dwindling in the early 2000, cricket boards around the world were looking for an alternative which was fast and had a shorter duration. As always been the torch-bearer of the game of cricket, it was the England Cricket Board (ECB) who came up with the idea of a cricket match of 20-overs a side. The first official Twenty-20 match was played in June, 2003 between two English counties in their domestic T-20 tournament. Gradually over the years, popularity of T-20 started spreading across the globe. Even though, India played its first international T20 versus South Africa in 2006, the format shot to fame in India only after the team won the inaugural T-20 World Cup in 2007. Following this, numerous commercial domestic Twenty-20 league had sprung up across the world of which the Indian Premier League (IPL), the Big Bash League (BBL) in Australia and the Caribbean Premier League (CPL) in the West Indies are the most popular ones. In this project we will be exploring the effects of T-20 cricket through data analytics on the following criteria: (i) Over-all Strike Rate of Batsmen have increased (ii) Over-all Economy Rate of Bowlers have increased (iii) Tendency to score or chase down scores more the 300 in the traditional 50 overs format has increased. We will use Change-Point Analysis to check for the changes in the series of data of Strike Rate and Economy Rate of batsmen and bowlers respectively since the introduction of ODI cricket in 1971. It can also be hypothesized that these parameters have sharply been increasing since the introduction of IPL and the other T20 leagues. We will try to detect the presence of Structural Break using the Chow Test and Bai-Perron Test. We will also test for Heteroscedasticity using the Goldfeld-Quandt Test.

Technical Session 2B (Parallel Session 2) Date: 11th December 2018 (Tuesday) Time: 12 noon to 1:30 pm

An Investigation of the Role of Opening Partners on the Outcome of Twenty20 Cricket Matches through Pressure Index (Priyanka Talukdar, Email: talukdarpriyanka2013@gmail.com and Dibyojyoti Bhattacharjee, Email:djb.stat@gmail.com both from Department of Statistics, Assam University)

In cricket, irrespective of the format of the game, batting always takes place in pairs. The two batsmen who bat together are colloquially called as batting partners. The pair of batsmen who come to bat at the beginning of any innings is called opening partners. In Twenty20 matches, the shortest and the latest version of cricket, the opening partners have to start their innings with a definite strategy. In one hand, they are advantageous of having only two fielders outside the 30 yard circle for the first six overs (technically called as the power play), and so both openers are expected to play lofted high scoring shots and score runs quickly for their team. On the other hand what goes against them are- the ball is new, so is the pitch and the bowlers are fresh and energetic. When any one of the opening batsmen gets out the opening partnership comes to an end. This work tries to figure out the influence of the opening partnership of the second innings, on the outcome of Twenty20 matches. Ideally one shall think of the runs scored by the opening partnership, target runs, number of balls consumed etc. as the explanatory variables for the purpose. But the authors plan to apply, the Pressure index (developed by earlier researchers) as a replacement of all the explanatory variables in the logistic regression model to find out if the performance of opening partnership (of the team batting second) influences the outcome of Twenty20 matches. The data used for the exercise is from Twenty20 international cricket matches played within the period January, 2012 to June, 2018. As a bi-product of this exercise, the best opening batting partners of different countries (among the opening partners of the countries considered during the study period) can also be identified.

Batting Strategy Building in limited overs cricket matches: An Application of Machine learning (Abhishek Rawat, Email: abhishek.16je002545@am.ism.ac.in, Saket Gupta, Email: saketgupta1008@gmail.com; Atul Kumar, Email: atul.16je002507@am.ism.ac.in, Sameer Kumar Pandey, Email: skpba304@gmail.com and Bhanupratap Sankhla, Email: sankhlabhanupratap@gmail.com- all from IIT (ISM) Dhanbad.India)

Cricket has been amongst the most popular sports in the world, though not as much popular as football, it has its own enigma and it has various aspects where statistical models could be used. Even if a Cricket team squad is comprised of the limited number of players, the combination of them makes out a complicated problem with a huge number of possible line-ups. The problem of selection of the best eleven players, with easily available data, has attracted many sports analysts to work on. Our Idea is to select the best playing eleven from the squad and decide their batting order so as to maximize the target in first innings. This research proposes a new mathematical (ensemble) model to maximize the target to be set by the team batting first, ultimately increases the chance of winning. Our model will classify the playing eleven among three categories, batsmen, bowlers, and allrounders. The best player for each position is selected through ensemble modeling and neural network. Each player is represented through a feature vector in which features will be like durability, performance index per match, impact on the team winning. It can have extended application in various leagues around the world like IPL, Big Bash, and various domestic tournaments. Training data has been collected from cricbuzz and espncricinfo.

Learning Experiences of Expert Poker Players (LEEPP) - a Word Cloud exploration (Deepak Dhayanithy, Indian Institute of Management Kozhikode (IIMK).India Email: deepak@iimk.ac.in)

This paper's objective is to examine the learning dimension of the game of poker. While there have been many studies focussing on the skill aspects of poker, there is relatively little said about learning especially the lifelong learning of expert poker players (EPPs). It studies the learning and coaching experiences of EPPs. Twelve EPPs were interviewed at an important poker tournament in India, in 2018, which featured many international and professional players. Structured interviews consisted of questions pertaining to the lived experiences of these EPPs and care was taken to avoid any sequencing or focusing biases (toward learning or coaching). The interviews were then transcribed and used as the source data for construction of Word Clouds for each of the respondent EPPs, using NVIVO software. This visualization, on the basis of word frequencies, shows that there is a strong learning experience of EPPs driven by diverse coaching inputs. 'Change', 'Long term orientation', 'theory', 'time', 'studying', 'community', 'personal development', 'tournaments' and 'understanding people' emerged from the Word Cloud analysis as key features of EPPs' learning experiences. EPPs learning experiences appear to be characterized by double and triple-loop learning. Their learning is supported/ enabled by diverse coaching inputs in terms of the 'what?', 'how?' and 'who?' of the coaching cube model. EPPs' coaching mechanisms are strongly similar to that of management executives and leaders. This paper use a simple and intuitive visual method to understand and think about interview data. It contributes to the hitherto ignored aspects of research – learning and coaching of expert poker players. The conceptual bridge it identifies between coaching in poker and coaching in business may well be reason why poker has for long been an activity held close to heart by various business professionals (Bridgewater Capital) and leaders (Warren Buffett).

Evaluating consistency of batsmen in ODI Cricket and ranking them by multiple criteria (Sahadeb Sarkar, Email: sahadeb@iimcal.ac.in, Subhasis Mishra, Email: subhasism15@iimcal.ac.in both from Indian Institute of Management Calcutta. India)

Over the years, in one day international (ODI) format of Cricket, many batsmen have risen above their peers during their era. Although, circumstances keep changing across eras, yet contention about who is a better batsman prevails, akin to comparing "oranges with apples." This paper is an attempt to enable this comparison by reducing the subjectivity of the viewers. Historically, batsmen have been compared on the dimensions of batting average (BA) and strike rate (SR), with former being more prevalent. More often than not, BA is sought for as conclusive evidence for ranking batsmen, as they are also synonymous to the consistency of a batsman. A batsman's BA is the number of runs scored by him on an average before he loses his wicket. One can arrive at the same measure if runs scored by a player is assumed to constitute a random sample from an exponential distribution (considering continuous distribution) or geometric distribution (considering discrete distribution) and the expected number of runs scored is a maximum likelihood estimate (MLE) of the runs that the batsman will score in each innings. The biggest demerit of such an assumption is that two batsmen having similar batting average would be considered equally consistent. However, there are cases galore which suggest otherwise. For example, de Villiers and Bevan have a very similar batting average of 54.1 and 53.2 respectively and thus, former would be rated higher on consistency and average runs. However, this defies the common perception of Bevan being more consistent. Sarkar & Banerjee (2016) advocate for Weibull distribution as more suitable to estimate a batsman's consistency and the number of runs expected of him, though in the context of test matches. For proper statistical assessment of batting consistency, we fit Weibull distribution that allows

measurement of standard deviation (SD) independent of the mean. In this paper, we evaluate batsmen on three measures, viz. BA, consistency, and SR. While SR is available at ESPN Cricinfo , BA and consistency is evaluated by fitting Weibull distribution to each player's score in each of the innings. We then evaluate the ranks of selected players on the basis of various combinations of all measures to gain insights into a player's strengths and scope of improvement. During the evaluation of ranks, weights assigned are derived objectively through principal component analysis. Table 1 provides the list of batsmen who have been considered for our analysis. These 34 batsmen have played 270 ODI matches on an average and have scored 9288 ODI runs and 16.6 centuries on an average. Because of the restriction on batting average of 35, players like Jayasuria, Jayawardene, de Silva, SR Waugh and NJ Astle do not feature in our list. The likelihood ratio tests (LRT) show that, for 14 (18) out of 34 cases considered in our study (Table 2), the Weibull distribution with its shape and scale parameters gives a much better fit than an exponential distribution at 5% (10%) significance level. The fitted Weibull model gives a very sensible estimate of batting inconsistency and thus can distinguish players' batting consistency. For de Villiers and Bevan, the Weibull model gives the MLEs of their batting inconsistency as 79.37 and 68.36 respectively which is intuitive given that Bevan is generally considered to be more consistent. Table 2 also reports the MLEs of the batting mean and consistency parameters for all the batsmen. Let $\hat{\alpha},\hat{\theta}$ denote the MLEs under the Weibull(α,θ) model and $\tilde{\theta}$ denote the MLE under the exponential(θ), i.e., Weibull(α =1,θ) model. For five of 34 selected group of batsmen in our study, the $\hat{\alpha}$ values are greater than one with the MLE of batting mean being less than the respective reported batting average. Ranks based on the MLE of mean and consistency has few significant results. Sourav Ganguly jumps up the list by eight positions leapfrogging the likes of Ponting. Ranking in terms of consistency throws a surprise in form of Michael Bevan, perceived as Mr. Consistent in ODI, being ranked at 26 while explosive batsmen like Gilchrist and Sehwag are ranked 2 and three respectively. On combining the Z-Scores of BA and Consistency, surprisingly, Tendulkar is ranked twenty. Sehwag holds the top rank when BA and SR are combined with consistency. This is highly surprising because of two reasons. Firstly, Sehwag has a very low reported BA and secondly, he is not considered as a very consistent player owing to his explosive style of batting. Z-score of a batsman for each of the criterion can also be used to evaluate each player's strength and weakness. For instance, AB de Villiers and Kohli are firm on their BA and SR, however, they lack consistency. We evaluate truly exceptional players using Mahalanobis distance as described and used by Sarkar & Banerjee (2016). Table 3 tabulates the Z-scores for each of the parameters for all the batsmen and the chi-square statistic as defined before. In terms of two most important criteria, batting mean and strike rate, Kohli and de Villiers are genuinely exceptional having large positive Z-scores for both criteria whereas Sehwag and Gilchrist stand out for having high Z-score in strike rate, but low Z-score in batting mean. As mentioned earlier, a measure of batting (in)consistency of a player is not given by the ICC or ESPN Cricinfo. This paper presents a proper and statistically reliable estimate (MLE) of batting (in)consistency of an ODI player under the Weibull distribution model following the approach of Sarkar and Banerjee (2016). The Weibull model gives a superior fit for more than half of the select group of 34 ODI batsmen relative to the exponential model. The resulting MLE of the batting mean reduces the conventionally computed batting average for five players and increases for 29 players. Bevan's batting average reduces by more than two runs and Ganguly's average increases by almost six runs. These computed MLEs of the batting mean, consistency, and strike rate, are used as yardsticks for judging strengths and weaknesses of the elite group of ODI batsmen. While ranking, we have used correlation

analysis to decide on dissimilar sets of criteria and assigned principal component-based relative weights to various factors or criteria, thus avoiding the need for subjective assignment of weights.

Technical Session 2C (Parallel Session 1) Date: 11th December 2018 (Tuesday) Time: 3:30 pm to 5 pm

Interorganizational network of knowledge resource mobility: Study based on Big-5 European professional soccer player transfers (Subhasree Mukherjee, Email: subhasreem08fpm@iimk.ac.in, Deepak Dhayanithy, Email: deepak.dhayanithy@gmail.com- both from Indian Institute of Management, Kozhikode, India)

The inter-firm mobility of knowledge resources leads to the formation of interorganizational network (ION). Prior studies indicate the importance of such ION on firm performance. However, the significance of the network partner due to knowledge resource dependence is yet to be studied. In this study, we implement resource dependence theory (RDT) and ION to examine the effect network partner on focal firm performance in the context of knowledge resource mobility. Specifically, we develop our theoretical framework to examine how performance of network partner, difference in network status, and autonomy of the focal firm affect focal firm performance. We test our hypotheses on a novel dataset of interfirm resource mobility ties. It is constructed using data of professional soccer player transfers involving the 'Big-5' European soccer leagues (of England, France, Spain, Italy and Germany) from 2004-'15 to 2015-'16. 1170 club-season observations were recorded from 39211 player transfers. Since our dependent variable is based on season-end points accumulated by a club, we ploy Poisson fixed effects regression estimation. As robustness check, we employ alternate measure for club performance as season-end ranking in their respective Big-5 leagues. We estimate the alternate model using fixed effects ordered logit model for panel data. Overall, our findings suggest the prior performance of the partner impacts the current performance of the focal firm positively. We show an adverse effect of network status difference in the performance of focal firms. Further we contend maintenance of autonomy not only reduces failure rates but also improves firm performance. Thus we contribute to the ION and RDT literature by establishing the importance of knowledge resource dependence.

Comparing Different Methods of Predicting the First Innings Score of a Limited over Cricket Match (Subhendu Samanta, University of Kalyani , India Email:samanta.stats@gmail.com and Dibyojyoti Bhattacharjee , Assam University. India Email :djb.stat@gmail.com)

A limited over cricket match comprises of two innings. One of the two teams playing the match bats first (Team A, say) against the bowling of the other team (Team B, say). At the end of the first innings (generally end of all the limited number of overs) Team A sets a target for Team B to chase and achieve in order to win the match. Team A tries to maximize the target for Team B so that the chance of Team B winning the match is minimized. Likewise, Team B shall try to ball and field in a way so that they can minimize the runs scored by Team A, increasing their (Team B's) chance of winning. Several authors working in the area of Cricket Analytics tried to predict the score of the first innings at the beginning of the match, while some others tried to achieve it when the match is in progress. Most of the authors initially identified the factors influencing the first innings score of a team based on information from previous matches. The identified factors are generally the following- like venue of the match, pitch report, weather, ranking of the teams, past performance and form of the team in that series or against that team etc. Then appropriate statistical model or machine learning algorithm was used for the purpose. Others who tried to predict the score

when the match is in progress considered resource already utilized by Team A in that innings along with some of the aforesaid factors for the purpose of first innings score prediction. In this paper we try to summarize the different methods available for score prediction in the literature and then try to find out the best of the available methods for score prediction. The predicted score through different methods shall be compared with the actual score of several limited over matches to attain the said objective. Some utility of predicting the first innings score of a limited over match shall also be discussed.

Score Prediction using old database in Indian Premier League: A Predictive Model (Vishal Kumar, Email: vishalkm123@gmail.com, Puneet Garg, Email: puneet.16je002217@am.ism.ac.in and Anshul Gupta, Email: guptajianshul299@gmail.com – all from IIT ISM DHANBAD, India)

The Indian Premier League (IPL), regarded as the world's most popular Twenty20 tournament. IPL has changed the entire landscape of cricket while attracting a huge pool of fans and high paying endorsement. This bat and ball game has always attracted Mathematicians and Statisticians for the enormous scope of research to improve the game. Predicting the final score of an inning has always been a matter of interest for commentator, spectators and sports analysts. In recent years, it is found that the projected score - calculated as the product of current run rate and the overs remaining, has become deficient. More Often, the score increases tremendously if the team loses no or less wickets in 16 to 20 overs. The previous works has failed to take into account the quality of the batting team and bowling attack. Our idea is to predict the total score of an inning through statistical operations and machine learning technique overs from 16 to 20 for IPL matches from 2008 to 2018. Ball by ball data is collected for this analysis. Survival analysis of Batsmen playing within 16 to 20 overs is done. Factors such as wickets fallen in the last overs and runs scored and ball faced in between the fall of those wickets. We have used these parameters to calculate probability factor to predict the final score. This will ultimately help to build the strategy of attack and defence in the limited overs IPL matches. In addition to this, people who frequently play bets and are very much enthusiastic about gambling can make good use of the this model to bet on the final score.

Technical Session 2C (Parallel session 2) Date: 11th December 2018 (Tuesday) Time: 3:30 pm to 5 pm

A Statistical Analysis of Bowling Performance in Cricket (Aishwary Choudhary, Email: aaishwarychoudhary7@gmail.com and Tushar Jape, Email: tusharjape007@gmail.com- both from IIT(ISM) Dhanbad .India)

There is a widespread notion in cricketing world that with increasing pace the performance of a bowler improves. Moreover, many cricketing experts believe pace bowlers are invulnerable to lower batting order. The present study puts these two ubiquitous notions under test by statistically analysing the differences in performance of bowlers from three sub populations based on average release velocities. Results from one-way ANOVA reveal faster bowlers to be performing better, in terms of Average and Strike-rate, but no significant differences in the case of Economy rate and CBR. Lower and Middle order batsmen were found to be more vulnerable against faster bowling. However, there was no statistically significant difference in performance of Fast and Fast-Medium bowlers against a top-order batter.

Predicting Winner for Soccer World Cup 2018 (Moloy De, IBM, India Email. demoloy@gmail.com)

A simple Poisson Model is used to simulate the match scores where the parameter Lambda is estimated from past data. Then the entire World Cup 2018 Fixture is simulated to find the probabilities of being the champion for different participating countries. The results obtained are found to be consistent over multiple simulations.

Influence of Sports-Club Engagement on Fan Engagement in Facebook (Balamurugan Annamalai, Email:fb15002@astra.xlri.ac.in ; Sanjeev Varshney, Email:sanjeev.varshney@xlri.ac.in ; Pingali Venugopal, Email: pingali@xlri.ac.in – from XLRI, Jamshedpur and Atul Pathak, IIM Nagpur. India Email :atulpathak@iimnagpur.ac.in)

This paper investigates the effect of sports club engagement on fan engagement in the Facebook context. The data used for this study is retrieved from 8 cricket club owned Facebook pages of India,that participated in Indian Premier League, during the event period between April 1 and May 31, 2018. Fan engagement is measured using both volume and composite valence volume metric. The valence is estimated through lexicon-based sentiment analysis. The sports-club engagement denotes the characteristics of the Facebook post - content type and media type of content. The post categories are coded using a supervised machine learning technique. The content shared by clubs exert a varying effect on active fan engagement expressed as liking, commenting and sharing. The study is limited only to observe the engagement during the peak period and do not consider the influence of team performance and the cultural affiliation of the sports club. Future studies need to follow the influence over an extended time-period as a cross-country study. The findings are relevant to the sports club and provide valuable insights for devising an effective content strategy. The study addresses the call for research on sports in the Asian context and the need to observe fan sentiments in social media engagement.

Technical Session 3A (Parallel session 1) Date: 12th December 2018 (Wednesday) Time: 10 am to 11:30 am

Online Measurement of Sportsperson's Performance – A Case Study of Fielding Performance Measure in Cricket

(Himadri Barman, Dibrugarh University, Assam, India Email: himadri@dibru.ac.in)

Popular sports around the world are becoming highly professional. Cricket is one such sport which has become more competitive and popular in the last decade with the birth of the franchisee leagues. Traditionally, it is the batsman, bowlers, all-rounders and international teams whose performances have been measured and ranked. Computation was never attempted seriously either by the Cricket governing bodies or by researchers as far as fielding is concerned. But fielding is the third important dimension of cricket after batting and bowling. With the popularity of the Twenty20 format of cricket, fielding has acquired further importance. The only extensive work of quantifying the fielding performance of cricketers on a ball-by-ball analysis is that of Saikia, Bhattacharjee and Lemmer (2012). But considering the extensive computation and the information that is required for quantification, the development of software is necessitated. This paper looks at the implementation of an online system of the model for the fielding performance measure using open source technologies. Front-end has been developed using HTML, CSS, JavaScript and PHP. The back-end uses MySQL as the database for storing fielding related data. The online system which is named Field-o-meter can be used to record fielding data, display fielding data, compute fielding performance measure and generate reports. The system has facilities for different categories of users, viz., administrators, data entry operators and viewers. Users need to login to access

the system. Data corresponding to teams, fielders and matches played can be added, deleted and edited. Fielding data can be downloaded in Excel format and simple graphical reports can be displayed online. Being an online system hosted on a web server, it can be accessed from anywhere with an Internet connection. The web-based system is easy to use with a simply designed interface. The system's interface gets adjusted to mobile devices and as such can be used with a mobile browser. The system has been tested successfully for all the leading web browsers – Google Chrome, Firefox, Microsoft Edge, Opera and Safari.

Modelling Netball Scores (Rishikesh Parma, IIT(ISM) Dhanbad, India, Email: rishikesh786@am.ism.ac.in; Phil Scarf, Salford Business School, United Kingdom Email: p.a.scarf@salford.ac.uk and Naif Alotaibi, Al-Imam Mohammad Ibn Saud Islamic University, Saudi Arabia, Email: naif_ot@hotmail.com)

Professional sports leagues are in the business of selling sporting competitions to broadcasters and thus to consumers. A higher level of competitive balance, reflected in more uncertain outcomes, increases match attendances, television audiences and overall interest (Forrest and Simmons 2002; Borland and Macdonald 2003; Dobson and Goddard 2011), making a tournament more valuable. Scarf et al. (2018) studied the relationship between scoring rates and uncertainty of outcome in the context of a "Poisson-match", whereby scores in a match between two teams follow independent Poisson distributions. Outcomes in soccer and rugby union, with low and moderate scoring rates respectively, approximate to a Poisson-match (Maher, 1982), and Scarf et al. (2018) showed by implication that scoring rates in soccer are such that outcomes are highly unpredictable, reinforcing the findings of Ben-Naim et al. (2007). They also showed that outcomes in rugby union are more predictable and becoming more so over time. Now, in this paper, we model match outcomes in Netball, a sport with high scoring rates, using data from UK Superleague Netball, and discuss uncertainty of outcome and scoring rates in the context of this model.

Competitive Balance in the Indian Premier League – an Empirical Analysis (Somroop Siddhanta, Email: somroop_bcet@rediffmail.com, Mithun Kumar Guha, Email: mithun.guha@nshm.com– both from NSHM Business School, India)

This study attempts to analyze the level of Competitive Balance in the largest sporting league in India and the largest cricket league in the world in terms of prize money, the Indian Premier League (IPL) with a view to ascertain the degree to which there is parity in the results of the league. Popular techniques to study Competitive Balance viz. Standard Deviation of Win Percentage (both Season and Team-wise), Herfindahl-Hirschman Index (HHI), Noll-Scully Ratio, Spearman's Rank Correlation Coefficient and ANOVA based Competitive Balance, were considered for the study. Since in the IPL, the number of teams each year, and hence games played, has varied across the last eleven years, the Standard Deviation of Win Percentages was not considered due to its sensitivity with these numbers. The HHI also has a limitation in that the maximum share of points is not possible as no team can win matches played between two other clubs. Owing to the above, the Noll-Scully Ratio, Spearman's Rank Correlation Coefficient and ANOVA based Competitive Balance were calculated for the IPL for eleven seasons from 2008 to 2018. A high Noll-Scully Ratio is indicative of Competitive Balance being low in the IPL. Similarly, the Spearman's Rank Correlation Coefficient is positive for most seasons indicating minimal reordering in the league. The ANOVA results

also reject the Null Hypothesis of 'Mean is same between Teams' as the calculated F values are significant at 5% levels. Thus, all the three metrics used in the study above indicate that the Competitive Balance in IPL is far from good. The results imply that the IPL is low in competitive balance as of the eleven seasons completed thus far, with few teams ruling the roost over others.

Technical Session 3A (Parallel Session 2) Date: 12th December 2018 (Wednesday) Time: 10 am to 11:30 am

Analysis of competitiveness on Tennis courts (Utkarsh Maddhesiya, IIT(ISM) Dhanbad,India Email: madhesiautkarsh02@gmail.com; Priyanshu Shrivastava, IIT(ISM) Dhanbad.India Email:priyanshu.16je001871@am.ism.ac.in; Kuldeep Rajpurohit, Amity University Noida.India Email: rajpurohit0298@gmail.com; Rishikesh Parma, IIT(ISM) Dhanbad, India Email: rishikesh786@am.ism.ac.in)

Tennis is one of the prominent individual player sport. Being played on different courts, it is very important to study the variation in competitiveness on courts with respect to each other. Our aim is to examine the relative competitiveness at Hard court, Clay court and Grass court and investigate the analogy among the courts. We define relative competitiveness as the cost function for the model. The number sets, rallies, Aces, Deuces, Tiebreaks all per round per match are the parameters used to define the cost function. The sample data is taken from all the Grand slam matches from 2011-2017. Since the prominence of sports depends on its competitive balance, this model will help to study performance of players and the uncertainty in match outcomes at different courts. The objective of this paper is review the existing body of literature related to critical success factors of sports events organized by committees or organizations, and then suggest a methodological approach that would assist in evaluating success of the event under multi criteria decision making environment. In most of the real life managerial decision making problems, there would be multiple (and at times conflicting) objectives that need to be satisfied simultaneously. A sports event organizing body, with possibility of organizing a variety of sports event, would face a similar problem. After a comprehensive review of literature (for example, Coleman, B.J., (2012), G. Bortolan, G. and Degani, R. (1985), Gutierrez, I. and Carmona S. (1995), Altrock, C.V. and Krause, B. (1994), Chen, T.Y. et al. (2001), Wang, J.W. (2009), Chou, S-W., and Chang, Y-C., (2008), Saaty, T.L. (1980), Veeraraghavan, S and Vaidyanathan, R. (2009), Greene, W. H. (2003), Bonomo, F. et al (2014), Ribeiro, C.C. (2012)) , the considered problem is stated as a multi-criteria decision making problem. The criteria are defined by the knowledge and experience of the decision makers, who may consult with functional experts. The fuzzy rating weights of each pair of the considered criteria and uncertain criteria values for the defined quality goals are described by linguistic expressions which are modeled by triangular fuzzy numbers. The weights vector of criteria is calculated by the fuzzy Analytic Hierarchical Process (AHP). The extension of the fuzzy Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) is applied to rank quality goals. The proposed model is illustrated by an appropriate hypothetical example. The discussed methodology and results obtained contribute to the theoretical understanding of the aspects that apply to the multi-criteria decision making under conflicting objectives in the context of organizing successful sports event, and this should be useful for both academicians and managers organizing events. The quantification and subsequent treatment of uncertainty and comparison of criteria is subjective in AHP. Decision-makers may show bias in dealing the uncertainty and ambiguity from subjective perceptions and experiences.

Sports event success evaluation by applying fuzzy AHP and fuzzy TOPSIS methodology (Arun Kumar Paul, Email: arun@ximb.ac.in, Bhaskar Basu, Email: bhaskar@ximb.ac.in - both from Xavier Institute of Management (XIMB), Xavier University Bhubaneswar (XUB), India)

The objective of this paper is review the existing body of literature related to critical success factors of sports events organized by committees or organizations, and then suggest a methodological approach that would assist in evaluating success of the event under multi criteria decision making environment. In most of the real life managerial decision making problems, there would be multiple (and at times conflicting) objectives that need to be satisfied simultaneously. A sports event organizing body, with possibility of organizing a variety of sports event, would face a similar problem. After a comprehensive review of literature (for example, Coleman, B.J., (2012), G. Bortolan, G. and Degani, R. (1985), Gutierrez, I. and Carmona S. (1995), Altrock, C.V. and Krause, B. (1994), Chen, T.Y. et al. (2001), Wang, J.W. (2009), Chou, S-W., and Chang, Y-C., (2008), Saaty, T.L. (1980), Veeraraghavan, S and Vaidyanathan, R. (2009), Greene, W. H. (2003), Bonomo, F. et al (2014), Ribeiro, C.C. (2012)) , the considered problem is stated as a multi-criteria decision making problem. The criteria are defined by the knowledge and experience of the decision makers, who may consult with functional experts. The fuzzy rating weights of each pair of the considered criteria and uncertain criteria values for the defined quality goals are described by linguistic expressions which are modeled by triangular fuzzy numbers. The weights vector of criteria is calculated by the fuzzy Analytic Hierarchical Process (AHP). The extension of the fuzzy Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) is applied to rank quality goals. The proposed model is illustrated by an appropriate hypothetical example. The discussed methodology and results obtained contribute to the theoretical understanding of the aspects that apply to the multi-criteria decision making under conflicting objectives in the context of organizing successful sports event, and this should be useful for both academicians and managers organizing events. The quantification and subsequent treatment of uncertainty and comparison of criteria is subjective in AHP. Decision-makers may show bias in dealing the uncertainty and ambiguity from subjective perceptions and experiences. This paper, along with the review of relevant literature, attempts to extend the multi-criteria decision making process in the context of organizing sports event, and this methodology can be extended to analysis of other management decision problems in diverse industrial engineering research areas.

DEA based analysis of players for an efficient team(s) selection (Subhasis Mishra , Email: subhasism15@iimcal.ac.in; Somu Gorai, Email: somug15@iimcal.ac.in and Utsav Pandey, Email: utsavp16@iimcal.ac.in- all from IIM Calcutta. India)

Cricket is a game played by two teams with eleven players on each side. Each of the eleven players in a team brings to table a different set of skills. Generally, players of a team can be classified by their skill sets into batsmen, bowlers, all-rounders, and wicketkeeper (at least one). Selection of a team given a pool of players has been an essential aspect of decision making by a team manager or selection body. In this paper, we propose a methodology to solve the team selection problem given a pool of players, taking into due consideration performance of each of the players in the past, the prevailing conditions for the match and the stage of the match (quarterfinal or semi-final or final or any other stage) from the tournament perspective. This work draws inspiration from the various cricketing fantasy leagues for tournaments,

wherein a participant is required to select a team of eleven players consisting of sets of players from different skill-sets within a given budget. These fantasy leagues assign points to each player based on the performance in the past matches in the given tournament. For instance, Dream XI fantasy league assign 0.5 points for every run scored by a batsman irrespective of the conditions or scenarios in which they are scored, i.e. a batsman scoring 10 runs against a weaker bowling attack would be considered equally valuable as scoring those runs against a stronger bowling attack. Moreover, while a run is assigned a weight of 0.5, a wicket taken is assigned a weight of 10. We propose the usage of Data Envelopment Analysis (DEA) to overcome such subjective assignment of weights. The proposed DEA model takes into account the contribution of each of the performance on the outcome of the match given the situation, and thus, weights assigned becomes non-subjective. We then use, integer based programming (using CPLEX) to assign players to a team such that various constraints pertaining to the need of players from each skill-set and the budget (only if required) are met. We develop a VBA based application to arrive at the weights which in turn is used by CPLEX to find the team composition. To evaluate the efficiency of the team formed on the basis of the points derived from the DEA model, we compare it with the team formed from the weights determined by DREAM XI. We consider a scenario wherein we form different teams with different possible combinations of players such that we reach break-even under both the weight assignment system. We find that we reach break-even with a much lesser team with weights derived from our DEA based model. This work can also be utilized in bidding for players in auctions or selection of players for a tournament.

Technical Session 3B (Parallel Session 1) Date: 12th December 2018 (Wednesday) Time: 12 noon to 1:30 pm

Prediction of batting averages by modeling uncertainty and luck in sports (Aakar Dwivedi, Email: dwivediaakar@gmail.com; Anirudh Jain, Email: anirudh_jain@am.ism.ac.in and Ajeet Singh, Email: ajeetsingh@me.ism.ac.in – all from Indian Institute of Technology (Indian School of Mines), Dhanbad. India)

We propose a fully Bayesian pipeline to predict batting averages for IPL T20 matches using ball-by-ball data from publicly available sources. Traditionally, prediction algorithms for any sports tend to ignore the luck factor which makes any data collected from a match to be inherently noisy. In the past, Bayesian approaches such as approximate Bayesian inference methods, like Markov Chains Monte Carlo and variational Inference, and Gaussian Processes have shown to deal with such noisy data. Another advantage of using the Bayesian approach is the availability of uncertainty for each prediction, which represents the inherent influence of luck in sports. Each cricket match contains many potential features and data points which can be used to make predictions over the outcome of the matches and individual player performance. We aim to develop a fully Bayesian architecture which can learn the 'luck' factor as a distinct model parameter and represent the influence of luck as uncertainty of the predictions made by the mode. A Bayesian approach is specially useful for this task as we can set up different priors over the model which represent our beliefs and assumptions over the model parameters and gets updated as our model is fed data. We aim to place a standard Gaussian prior over the 'luck' factor, which will represent noise inherent in our data and check prediction inaccuracies by varying the variance of the Gaussian prior.

Novel performance metrics to evaluate the duel between a batsman and a bowler (Nekkanti Yamini, XLRI.India Email: b15090@astra.xlri.ac.in)

In the current system of cricket, the commonly used measures to evaluate a players' performance are Batting & Bowling average, Strike rate & Economy rate. These measures are easy to compute and understand, however, they fail to reflect a complete picture of the players' performance as they don't consider the context of the match. Various factors such as runs left, balls faced and left, wickets remaining, the skill level of the opponent are not being considered while evaluating the players' performance. Also, these conventional measures fail to compare a batsman performance against a bowler or vice versa. The objective of this paper is to arrive at a measure which will better explain the performance of the players while incorporating some of the factors as stated above. In this paper, we propose to use the concept of Elo ratings, in order to evaluate the duel between a batsman and a bowler. Elo ratings, are commonly used measures to evaluate a chess players' performance considering the players' skill level in each combat. In this regard we have examined the duel between bowler and batsman using a ball by ball simulation technique to arrive at the final ratings of the players and thereby conclude a winner in the duel.

FIFA 2018: Tournament outcome prediction using Machine Learning aided Reinforcement Learning
(Sankara Prasad Kondareddy, DBS Singapore. Singapore Email:k.shankarprasad@gmail.com, Vinay Kalakbandi, Institute of Management Technology Hyderabad. India Email: vinayk@imthyderabad.edu.in)

Machine learning found success in several industry applications but its use in sports predictions is not well researched. Tournaments that have historical data (like FIFA World cup) are conducive to be modeled as a multilevel decision process that can be effectively solved with Reinforcement learning. This work aims at combining the advantages of Machine learning algorithms with Reinforcement learning to build a robust probabilistic multilevel decision-making model for tournament outcome prediction. We make use of the Random Forest algorithm as the classifier that captures the temporal structure of the data. Reinforcement learning is then used on the top of Random Forest Predictions to build a more robust multi-level decision making solution. We apply the proposed framework on the historical FIFA World cup data to accurately predict the winner of the competition.

Technical Session 3B (Parallel Session 2) Date: 12th December 2018 (Wednesday) Time: 12 noon to 1:30 pm

Quantifying the Current Form of Cricket Teams and Predicting the Match Winner (Hemanat Saikia, Assam Agricultural University. India Email: h.saikia456@gmail.com, Dibyojyoti Bhattacharjee, Assam University. India Email: djb.stat@gmail.com)

The study tries to predict the outcome of Twenty20 cricket matches based on two prime skills of the game batting and bowling. The two different measures viz. Batting Performance (BP) and Adjusted Combined Bowling Rate (ACBR) developed by Lemmer (2011) and Lemmer (2005) respectively, are used to quantify the overall batting and bowling performance of the cricket teams. The rational of choosing BP is that it takes into consideration the match situation against which the runs are scored and ACBR considers the strength of a batsman dismissed by the fielding team. Thereafter, both the measures BP and ACBR are combined to get the overall performance of a cricket team prior to the knock-out stage of any given tournament. The overall performance score of a team is being used to quantify the current form of a cricket team. Now if the current form of team A (say) considerably higher than team B (say) then Team A will win the match and vice-versa.

Smart Tennis Sensor Package to Measure Tennis Player Performance (Bavneet Singh, Email: bavneet12132@iiitd.ac.in, Akhil Choudhary, Email:akhil12012@iiitd.ac.in – both from IIIT-D. India)

Sports and the technologies related to sports have changed continuously. There has been development in the manufacturing of sports goods, the material used and the technique. In recent years there has been a lot of application based advancement, where sports engineers and scientists have studied and implemented integration of technology in sports. Our research aims at understanding the underlying engineering involved in the development of a portable smart tennis sensor package. In individual racket sports like tennis, in order to improve, it is very important to track the performance. It will be easier for players to plan and strategize their practice sessions if they get actionable intel of their training session. A smart sensor package which could be placed on any racket would enable the player to analyze his/her performance and coach himself/herself. We aim to help the player improve his/her performance by allowing the player to know the various parameters of his/her game involved in the sport of tennis. We are presenting a proof of concept through the sensor package prototype which distinguishes between a forehand and a backhand based on the accelerometer sensor values and distinguishes between impact location (centre hit - indicator of sweet spot or side hit) based on the gyroscope sensor values. For testing and collecting accelerometer and gyroscope sensor data, we created a test bench that would provide similar conditions like playing tennis. We processed the sensor data and fed it to the SVM machine learning model for training purpose and finally, after training the machine learning model of SVM with more than 10,000 data points, an accuracy of ~80% was achieved over prediction testing of distinguishing between a forehand and a backhand and impact location.

Surviving after Death: It's all about Successful Death Bowlers (Dibyojyoti Bhattacharjee, Assam University, India Email: djb.stat@gmail.com and Uday Damodaran, XLRI Xavier School of Management, India email: uday@xlri.ac.in)

Bowling the last few overs in either innings of a limited over match is a tough and thoughtful activity for a bowler. The batsmen at this stage try an unabashed display of the intent to hit the ball around the park for runs. In modern day cricket, both bowlers and batsman are found to develop strategy and counter strategy for being successful at the death overs. Though yorkers are supposed to be the best bowling option at the death for pacers but these days a lot of other options to restrict scoring the batsman like bowling back of length, slow bouncers, change of pace and bowling full and wide are often seen. Though pacers are mostly preferred by captains to bowl death overs but in several cases the spinners are also found to accomplish such responsibility successfully. The paper tries to measure the performance of Asian bowlers in death overs in the international Twenty20 matches played during the last three years. The concept of pressure index developed by Bhattacharjee and Lemmer (2016) is used to measure the bowling performance along with the Combined Bowling Rate defined by Lemmer (2012) as both the measures can consider the match situation during the quantification. The exercise can suggest which bowlers are more successful during death overs. This shall help the captain of a team to plan his bowling resources in limited over matches and also the possibility of using spinners for death bowling.

Technical Session 3C (Parallel Session 1) Date: 12th December 2018 (Wednesday) Time: 3:30 pm to 5 pm

Human Action Recognition using Video Retrieval Techniques in Cricket (Aniket Ninawe, Email:ninawe.aniket@gmail.com and Ajay Mallick, Email:mallickajay6@gmail.com – both from , IIT (ISM) Dhanbad. India)

With the exponential evolution of digital technology and its complexity to manage complex and diverse multimedia resources in the current scenario reveals an imperative demand of retrieval technique which are both effective in both time and space.In this paper, we propose a novel video retrieval approach for human action recognition. Given a set of training key frames, we first extract a scale invariant contour-based pose feature from silhouettes and feature are clustered to build a set of prototypical key poses. Based on their relative discriminating power for action recognition, proposed method learn weights that favor distinctive key poses. Image pre-processing are employed by Gaussian and Sobel edge filter, called the first stage tuning, for reducing dress effect, and a mean eigenspace is produced by taking a mean of the similar postures, called the second stage tuning, for avoiding the preceding problems. Our approach goes beyond these traditional approaches and applies spatial and functional constraints on each of the perceptual elements for coherent semantic interpretation.

Nail Biting Finishes and Spectator Interest: The curious case of Indian Premier League (Saswat Patra, Email:saswat.patra@iimb.ernet.in and Suranjan Das, Email: suranjan.das@spjimr.org – both from S P Jain Institute of Management and Research, India)

This paper assesses the impact of uncertainty in the outcomes of cricket matches on the spectators in the stadium as well as on TV and other digital media in the context of Indian Premier League. We develop this paper on the basis of the Uncertainty of Outcome Hypothesis (UOH) and address different measures of UOH in our study to prevent methodology bias in the results. Interestingly, we find that spectators in the stadium prefer nail biting finishes whereas the TV and digital media audience prefer matches with more certain outcomes. The results could have implications on how the contracts for TV and digital media rights for the Indian Premier League are structured. The rights for matches that lack uncertainty in results can be sold at a premium while matches that are more likely to be uncertain would command a lower rate. On the other hand for the spectators in the stadium, tickets for matches with more uncertain outcomes and nail biting finishes could be priced highly whereas for matches that lack uncertainty, tickets should be sold at discounts. There are implications for large corporate houses as well. The brands should aggressively bid for only those slots for which they expect the maximum audience whereas the slots in other matches shouldn't command the same price. These slots/matches would differ for stadium and live coverage on TV/digital media platforms as shown in the paper.

Are you clutch? Answers from analyzing grand slam tennis from 2007-2017 (Bavneet Singh, IIIT-D. India Email: bavneet12132@iiitd.ac.in; Nikhil Jha, goSporto, IIT-B. India Email: nikhil.jha@gmail.com; Pranav Dar, Analytics Vidhya, University of Pune. India Email:pranavdar@gmail.com; Kshitij Jha, University of Akron, India Email: kcj.uakron@gmail.com; Nitin Jain, goSporto, IIT-Ropar. India Email: jain.3.nitin@gmail.com)

We often hear or read comments by journalists and professional commentators, mostly qualitative, on the "clutch" performance of a tennis player. It is commonly observed that conversion on break-points is key to a win. However, there is considerable nuance that is missed by not grouping data in categories that define winning performance. Federer, arguably the greatest player of all time, is the worst amongst active

players at winning more points when losing a match. This is an applied example of the amalgamation paradox, where trends are reversed or lost upon grouping correlated variables. How can we define Federer's intuitive picks? Which points move a game, a set, or a match? Is there an optimal level of effort in winning a match? We assign weights to winning points conditional on their context in the match as also level of the game, viz. grand slam round and opponent quality. The model is further defined through assignment of technical and tactical weights that improve predictive accuracy of the relative probabilities of winning a match based on performance in key situations. A final filter of intuitive check to garner actionable insights is applied. Our models are envisioned as being helpful for training academies and junior level tennis for scouting tennis talent. This is perhaps even more critical in developing economies where optimal resource utilization in next level talent is a make or break choice for tennis federations. The models may also be translatable to other sports where the IQ of the quarterback, point guard, starting pitcher, etc. is seen as intangible, and a need exists for defining "clutch" performance.

Comparative Economic analysis of countries in allocating budgets for different Sports (Kaveri Chhikara, Email: kaveri.chhikara@gmail.com; Ashima Mehra, Email: ashima.mehra281@gmail.com and Anay Rennie, India Email : anayrennie@gmail.com - all from , Deloitte USI, India)

The global sports industry today is growing faster than the overall GDP and long-term growth prospects remain strong with the increasing role of sports in nation building. The inception of digitization has made it bigger by attracting viewership all over the world. The developing countries identifies sports as one of the most important areas of their development thus investing huge capital and promising efforts for it to grow. On the other hand, the complex business environment features numerous participants from rights owners (clubs, leagues, federations, athletes) to sports agencies, sponsors and broadcasters – all competing for a bigger slice of the pie. In this paper, we have performed comparative economics between the developing countries and the developed countries in variety of sports, thus giving a clear picture on the needs of the nations for the sustainable development of each sports and their future hold of the industry. In addition, the comparative analysis will help developing countries to learn from other superior developing countries and the developed countries in areas of concerns.

Technical Session 3C (Parallel Session 2) Date: 12th December 2018 (Wednesday) Time: 3:30 pm to 5 pm

Individual Player's Performance Indicators for ODI and/or T20 International Cricket Matches (Gordon Hunter, Kingston University, London, U.K. Email: G.Hunter@kingston.ac.uk; Akash Adhikari, Email : rajaadhikari23@gmail.com; Rishabh Saraf, Email: rishabh.15je1745@am.ism.ac.in and Rohit Agarwal, Email : rohit.15je1668@am.ism.ac.in- all three from Indian Institute of Technology(ISM), Dhanbad, India)

Individual player performances – and their influence on the final outcomes of matches – are a topic of much interest and debate amongst sports analysts, commentators and fans. This is especially true for cricket. However, the traditional measures used in First Class and Test Cricket – the number of runs scored or wickets taken in a single game, or the conventional batting and bowling averages – are not necessarily the most appropriate measures for One Day International (ODI), other "List A" one day matches or short format Twenty-Twenty (T20) games. For example, an individual batsman may score 100 runs in a one day game, but face 200 balls in so doing, and hence actually reduce his team's chances of winning the match.

Similarly, a bowler may take 6 wickets in an innings of a one day match, but concede 60 runs off just 6 overs, which again is not necessarily good for his team. However, the simpler of the alternative performance measures used, such as batting run (or strike) rate - runs scored divided by balls faced - and "economy rate" for bowlers (runs conceded divided by balls bowled) are also deficient. This paper focuses on analyzing an individual player's performance by evaluating his contribution both over several games, and to the team's performance in a single match. Thus, on a match by match basis, data is recorded over several matches for an appropriate set of relevant parameters - (Runs/innings), (Balls/innings) and (Wickets/innings) where those can be runs scored, balls faced and wickets lost for batsmen, or runs conceded, balls bowled and wickets taken for bowlers. These data are normalized by the number of innings each player has played. We have used Principal Components Analysis on the logarithms of the resulting data to construct a model that gives improved indicators of player performance in limited overs cricket, which generalize the simpler but inadequate measure of batting and bowling averages, and batting strike rate and bowling economy rate.

Moneyball meets Twenty20 Cricket – can Baseball's Pythagorean Theorem predict team winning percentages in T20 Cricket? (Bavneet Singh, IIIT-D. India Email:bavneet12132@iiitd.ac.in, Nikhil Jha, goSporto, IIT-B. India Email: nikhil.jha@gmail.com, Kshitij Jha, University of Akron, IIT-D.India Email: kcj.uakron@gmail.com, Pranav Dar, Analytics Vidhya, University of Pune. India Email:pranavdar@gmail.com and Nitin Jain, goSporto, IIT-Ropar. India Email: jain.3.nitin@gmail.com)

Bill James, the most celebrated advocate of applying mathematics to sports analysis, studied many years of Major League Baseball (MLB) standings to come up with a formula that approximates the percentage of games won by a team during a season:
(Runs Scored)2 / [(Runs Scored)2 + (Runs Allowed)2] = estimate of percentage of games won by a team
Sports analysts have adapted this 'Pythagorean Theorem' for Baseball to multiple sports such as Basketball & NFL. As a result of this wider adaptation, the formula has since been represented as:
(Runs Scored)exp / [(Runs Scored)exp + (Runs Allowed)exp] = estimate of percentage of games won by a team
The value of 'exp', of course, varies from one sport to the other. The advent of T20 Cricket in the past 10 years, with its striking similarities with Baseball, opened up a new avenue for adapting the popular theorem. The aim of this study is to analyze data from the top T20 leagues (IPL & BBL) across cricket playing countries and arrive at an exponent that best approximates winning percentages in Cricket. The approach used is to capture the results from the top leagues, from 2008-2018; adapt the team scores to arrive at a corrected score in 20 overs and run simulations with multiple assigned values of 'exp' to find out the closest approximation for T20 cricket. The immediate utility of the theorem is to predict the future – whether a team that has lost some close finishes will ultimately rally back to clinch a playoff spot. More importantly, it can also be used to determine how many extra wins (or losses) will result from a player transfer; in conjunction with 'player contribution' analysis (how many runs does a player contribute in a team).

An Integrated Efficiency, Consistency, and Importance based Decision Support System for Player selection: Case Study of Cricket (Arnab Adhikari, Indian Institute of Management Ranchi, India Email:arnab.a@iimranchi.ac.in and Adrija Majumdar, Indian Institute of Management Calcutta, India Email :adrijam13@iimcal.ac.in)

In recent times, there is a rising interest in club cricket as well as the online fantasy cricket games across the world. In this background, the player selection emerges as a matter of concern. A judicious scientific team selection methodology will be immensely beneficial to improve the sports performance of the teams. Further, the club owners and the online fantasy game players can maximize their profits by selecting a well-performing team. Thus, we propose a novel decision support system based on a player's efficiency, consistency and the player's importance in the team strategy. To calculate the efficiency, we have used a modified version of data envelopment analysis (DEA) method, 'super-efficiency' DEA model. To compute the consistency of the players we propose an index based on the semi-variance approach. Additionally, we aggregate the various consistency indices into a single index using entropy-based concept. Furthermore, we determine a player's value index based on his presence in the final team. It reflects the importance of a player in the team strategy and indirectly captures the player's fitness level. Finally, we compute the overall performance index of a player by aggregating the efficiency score, the consistency score, and the value index. To test our proposed methodology, we have done an extensive numerical analysis by using one-day international (ODI) data for period from 1971 to 2015 and determine the all-time best ODI team. We collect the data for our analysis from the ESPN Cricinfo website. Additionally, we compare the results obtained by our proposed methodology and the team announced by ICC in 2011 and BBC in 2015.

Applying statistics to understand how using different balls can increase the competitiveness of a cricket test match (Naman Gupta, Email: namanknl2110@gmail.com; Abhinav Agarwal, Email: agarwal1996abhi@gmail.com; Ayush Somani, Email: somaniayush001@gmail.com and Aditya Mudgil, Email: adityamudgil25055@gmail.com- all from IIT ISM Dhanbad.India)

Cricket is one of the trending game which attracts Mathematicians and Statisticians for the enormous scope of research to improve the game from ages. Our idea is to implement the statistical operations and data science, to check whether the competitiveness can be enhanced by using an alternative ball in the test match. As the specification of ball differs in terms of weight distribution, manufacturing process, surface texture, the effect of weather and pitch conditions. There are three main manufacturers of cricket ball used in international matches: Kookaburra, Dukes, and SG. The manufacturing varies depending on location: India and subcontinent use SG, England, Ireland and the West Indies use Dukes, and all other countries use Kookaburra. Kookaburra balls are machine made and have a low seam which offers swing for 20-25 overs after that batting become easy and there is no help for spinners, while SG balls are handmade and have a most uptight seam which remains in good condition up to 80-90 overs and used in a rough condition like India. It offers good reverse swing and helps spinners. Duke balls like SG are also handmade. These are darker in color due to the coating of lacquer which makes it ideal for swing and best for fast bowlers. These balls have a prouder seam and will tend to swing more than a Kookaburra ball – providing a home advantage when playing against a team unfamiliar with the ball. Our data comprise the stats of matches with different balls under the similar influencing factors to decrease the leverage of the home team and provide a better competitive ambiance for the conflicting teams. This shall give fair justice to the visiting team and create a better gameplay to enhance the interest of spectators too. Bowlers will thereby get a better opportunity and shift in match dominance factor just from the batting point of view to bowling arena.

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