

MATHEMATICAL SCIENCES INSTITUTE BELAGAVI

Quarterly Newsletter of MSI-Belagavi

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<u>From the Desk of Director, MSI</u>

Transition to Higher Mathematics

This is very often the case in our country that a student's parent says he/she was very good (getting a centum often) in Mathematics during high school and suddenly in college math phobia enters into him. This curious phenomenon occurs especially when the student sees the definition-proposition-proof style of mathematical content. The phrase "too abstract" is often associated to these phenomena. They may not say that it is utter nonsense but definitely to a majority of students it has been a turn off.

It is very important for us educators to ensure that learning math is an enjoyable exercise. Importance of logical reasoning needs to be told. Of course if one adds a lot of problem solving skills through the use of mathematical results then there are chances that the monotony is broken and the audience begin to take interest. Sooner or later one should be convinced that mathematics is a blend of aesthetics, logic, reasoning, problem solving and such aspects. On one hand mathematical development rests on foundational material involving set theoretic axioms and on the other hand techniques and algorithms make up a bridge to the 'industrial' community. For example the wavelet transform techniques form an industry in itself especially for multimedia applications. At the same time the success of such algorithms depends on the foundations of mathematics. This issue of the newsletter highlights interdisciplinary aspects

of mathematics, especially the interaction between mathematics and computer science. Number theory is one of the starting points of such an interaction given the fact that in cryptology, machine learning and such other modern applications number theory plays a big role.



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Proof systems

Feature article

By J. V. Ramana Raju

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In the year 1900 David Hilbert asked (among a set of 23 questions/problems) if there is a program that takes as input any given statement and decides whether it is true or not, i.e, it should output either a true or false. This will immediately bring to our mind the questions about automated reasoning, artificial intelligence pattern recognition and such other themes. However the above mentioned question came up in the context of mathematical logic and one should keep in mind the kind of computational power we had back then in the early 1900's. In Mathematics we generally deduce statements from a set of axioms or priorly ascertained facts. So one can imagine feeding a database of mathematical facts and their interrelations and from this create a system to check whether a certain mathematical statement or conjecture is true or false. So we shall call this elusive procedure demanded by David Hilbert as 'Hilbert's program'. In fact a famous result in Mathematics namely the four color problem was approached in a similar fashion.

It was K. Godel and A. Turing who showed the way toward solving Hilbert's question and finally it was known that there were logical obstructions to get the Hilbert's program. Godel showed that the axioms of arithmetic on which proof systems depend sometimes lead to paradoxes thus asserting that there is the so called 'Incompleteness' in logical reasoning. Well Godel and Turing worked independently under different contexts but essentially came to the same conclusion. For more on this one can read [1]. However an Indian origin scientist Madhu Sudan developed the so called probabilistically checkable proof system which uses probability theory to check the correctness of a given proof. The crux of the matter lies in his PCP Theorem (probabilistically checkable proof theorem) for which he was awarded the Rolf Nevanlinna prize in 2002. The PCP theorem says that for some universal constant K, for every n, any mathematical proof of length n can be rewritten as a different proof of length poly(n) that is formally verifiable with 99% accuracy using a randomized algorithm.

References

[1] H. Ramesh, V. Vinay "Who will win the toss?" Resonance Journal of Science Education, April 1998.

[2] S. Arora "Computational complexity : A modern approach" CUP 2009.



Around the world

Prizes and Honours

By Editorial Team

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The 2019 Leroy P. Steele Prize for Seminal Contribution to Research is awarded to Haruzo Hida of the University of California, Los Angeles, for his highly original paper "Galois representations into $GL_2(Z_p[[X]])$ attached to ordinary cusp forms. In this paper, Hida made the fundamental discovery that ordinary cusp forms occur in p-adic analytic families.

J. P. Serre had observed this for Eisenstein series, but there the situation is completely explicit. The methods and perspectives that Hida introduced have been used in the past three decades to solve fundamental problems in the theory of p-adic Galois representations and p-adic L-functions and these advancements have led to some understanding of p-adic analogues of B.S.D Conjecture. Hida families are now ubiquitous in the arithmetic theory of automorphic forms, and his research has changed the way we view the subject.

Others who received the 2019 Leroy P. Steele Prize are I]For Mathematical Exposition awarded to Philippe Flajolet (posthumously) of the Institut National de Recherche en Informatique et en Automatique (INRIA) and Robert Sedgewick of Princeton University for their book.

II]The 2019 Leroy P. Steele Prize for Lifetime Achievement is awarded to Jeff Cheeger of the Courant Institute, New York University, for his fundamental contributions to geometric analysis and their farreaching influence on related areas of mathematics. For more than half a century, Jeff Cheeger has been a central figure in differential geometry and, more broadly, geometric analysis. His work on the profound and subtle effects of curvature on the topology and geometry of manifolds, often under very weak regularity conditions, has laid and continues to lay foundations for much of the progress in these areas ever since his 1967 dissertation. His work, both alone and in collaboration with others, has yielded such spectacular results as the Soul and Splitting Theorems (with Detlef Gromoll) and the Compactness and Collapsing Theories (with Kenji Fukaya and Misha Gromov), which have been among the most important developments in geometry in the past three decades.

Luigi Ambrosio of Scuola Normale Superiore di Pisa has been awarded the 2019 Balzan Prize for Theory of Partial Differential Equations. According to the prize citation, Ambrosio "is a remarkable mathematician whose astonishing capacity for synthesis has made it possible to create hitherto unimaginable bridges between partial differential equations and the calculus of variations.

Daniel Wise of McGill University has been awarded the 2019 Labochevsky Medal for his work in geometric group theory, metric spaces of nonpositive curvature, residually finite groups, subgroup separability, 3dimensional manifolds, and coherence, as well as for his general research in theory of infinite groups with applications to geometry and topology.

The 2019 Oswald Veblen Prize in Geometry is awarded to Xiuxiong Chen, Simon Donaldson, and Song Sun for the three-part series entitled "Kahler-Einstien Metrics on Fano Manifolds, I, II and III" published in 2015 in the Journal of the American Mathematical Society, in which Chen, Donaldson, and Sun proved a remarkable nonlinear Fredholm alternative for the Kahler-Einstien equations on Fano manifolds. They show that this fully nonlinear PDE can be solved if and only if a certain stability condition involving only finite-dimensional algebro-geometric data holds.

Around the world cont'd

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Infosys Award in Mathematical Science

The Infosys Science foundation awarded the Infosys prize in the category of Mathematical Sciences to the Zurich based indian mathematician Siddharth Mishra . In an elaborate prize ceremony at Bengaluru, the Infosys company honored scientists that included this mathematician and several others in various sciences.

Siddharth Mishra is an alumnus of the Applied Mathematics program run jointly by IISc and TIFR-CAM. The Infosys Prize recognized his contribution in designing and analysing computational methods to solve partial differential equations, work that has found applications ranging from simulating cloud dynamics for climate studies to making astrophysical calculations related to exploding supernovas.

SASTRA - Ramanujan Prize

The 2019 SASTRA-Ramanujan prize was awarded to Adam Harper, assistant Professor University of Warwick, England for several of his outstanding contributions to analytic and probabilistic number theory, establishing a number of deep and surprising results. His research, both individually and in collaboration, covers the theory of the Riemann zeta function, random multiplicative functions, S-unit equations, smooth numbers, the large sieve, and the recent highly innovative "pretentious" approach to number theory. In establishing these results, he has shown mastery over probabilistic methods which he has used with remarkable effect in analytic number theory the citation said.

The prize is given each year around 22 December (Ramanujan's birthday) in Kumbakonam (Ramanujan's hometown) during an International Conference conducted by SASTRA University during 21–22 December. The SASTRA-Ramanujan prize assumes importance due to the fact that it recognizes mathematicians at a very young age(age limit is 32 years since Ramanujan died at this age) and also it has gained global repute with the fact that since its inceptionas of now four mathematicians , including Manjul Bhargava and Akshay Venkatesh, who were awarded this prize have gone on to win the Fields Medal later.

Computer Scientist Wins 2019 -Norbert Wienner Prize

The 2019 Norbert Wienner Prize in Applied Mathematics is awarded to Marsha Berger along with Arkadi Nemirovski. Marsha wins this prize for her fundamental contributions to adaptive mesh refinement and to cartesian mesh techniques for automating the simulation of compressible flows in complex geometry. In solving PDE's adaptive mesh refinement(AMR) algorithms can improve the accuracy of a solution by locally and dynamically resolving complex features of such simulations Marsha is one the inventors of AMR. Marsha Berger is a computer scientist at NYU. She was part of the team which won the 2002 software of the year award from NASA for their Cart3D software.





In December precisely 10-11 December 2019, MSI co-organised a national symposium on pure and applied mathematics NSPAM 2019 at IMER. This academic meeting witnessed around 75 participants. Prominent mathematicians who participated were Prof S.G Dani emeritus professor IIT Bombay and Prof Sharad Sane of CMI-Chennai.











MSI - Round Up cont'd

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In February 2020 the history of mathematics lecture series had Prof. C.S.Rajan of TIFR, Mumbai. He spoke on "Some Number Theory Problems". The History of Mathematics lecture series got started during 2016 with the sponsorship of vista Foundation Bengaluru. The first ever History of Mathematics lecture of the MSI was delivered by Prof. Ravi Kulkarni. From 2017 onwards this activity was independently conducted by MSI-Belagavi.



Prof. C. S Rajan of TIFR-Mumbai, Delivering the History of Mathematics Lecture.



Professor C. S Rajan of TIFR-Mumbai



Teachers and Students of Belagavi attending the History of Mathematics Lecture - III



Inaugural Ceremony of the History of Mathematics Lecture -III



Professor T. Venkatesh, Director of Mathematical Sciences Institute, Belagavi (MSIB)



MSI - Round Up cont'd

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In the first week of February 2020, the weekend lecture series on computing got inaugurated. This programme has an ambitious goal of preparing 10 students in the interdisciplinary modules on math and computer science. Following are the students who were selected for weekend lecture series and internship on Math and Computing: Vamshi K. V, Monish .N, Vaishnavi .G, Rajath , Dheemanth .A, Kishore.



Professor T. Venkatesh, Director of Mathematical Sciences Institute, Belagavi (MSIB) - giving the presidential address.



Participants group photo



Chidanand Badiger, Fellow MSIB - delivering a lecture on concept of infinity



J. V. Ramana Raju, Faculty School of Sciences J U Bangalore delivering a lecture on computing with real numbers



Interactive session in progress

Upcoming Events

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The mathematical Sciences Institute has a host of events lined up for the near future. On account of the ongoing health crisis due to COVID-2019 the following list has only indicated tentative periods/months. The concerned programme coordinators shall disseminate the information regarding precise dates.

Lectures on Random Graphs

Professor T. Venkatesh, Director MSIB shall lead a lecture series on Random graphs at IMER Belagavi during october 2020. The expository lectures shall initiate the audience into probabilistic approaches in combinatorics and discrete mathematics.

Deadline for organisers: July 15, 2020.

Deadline for participants: To be announced shortly.

Instructional Conference on Mathematical Finance

MSI will be conducting Instructional Conference on Mathematical Finance at Vijaynagar College, Hospet during September 2020.

Deadline for organisers: July 30, 2020. Deadline for participants: To be announced shortly.

2-Day Workshop on Ramsey Theory

Mathematical Sciences Institute Belagavi shall organise a 2-day workshop on the theme of Ramsey theory tentatively scheduled for October-November 2020. The experts shall deliver lectures that cover the initial questions raised by Paul Erdos and his collaborators on the developments in Ramsey theory. Deadline for organisers: August 20, 2020. Deadline for participants: To be announced shortly.

UGC-CSIR NET/SET Intensive Training

The Mathematical Sciences Institute Belagavi will be conducting a training programme for those who aspire a career in mathematics. The training shall cover essential topics that include Algebra, Real and complex analysis, Linear Algebra, Geometry and Combinatorics. The event is tentatively scheduled for September 2020. For details please contact MSIB office.

2-Day Workshop on Coding Theory

The Mathematical Sciences Institute is organising a 2-day workshop on the essential basics of coding theory. The programme is slated for October 2020. Deadline for organisers: August 20, 2020. Deadline for participants: To be announced shortly.

Symposium on Econometrics

The Mathematical Sciences Institute Belagavi will be conducting a symposium on econometrics during November-December 2020. Interested Institutes who would like to organise this symposium can approach the Director. The event is expected to have a broad range of speakers who work on interdisciplinary themes involving Mathematics, statistics and economics. Deadline for organisers: September 10, 2020.

Deadline for participants: To be announced shortly.

3-Day Work-Shop on Complex Net Works

The Mathematical Sciences Institute Belagavi will be coorganising a 3-day workshop on complex networks in early 2021.Proposals are invited from organisers who would like to host this event. The three-day event is expected to have deliberations on analytic ideas related to large networks and implications of such studies in analysing various real world problems involving graphs and networks.

Deadline for organisers: November 20, 2020. Deadline for participants: To be announced shortly.

Down the memory lane....

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It was during the year 2002, a thought crossed our mind to establish a research institute at Belagavi (then Belgaum) to encourage and identify young talent interested to pursue an early career in mathematics and its allied fields. Further more to organize workshops, conferences and small meetings for teachers to improve quality of teaching and research.

The institute was formally inaugurated on January 23, 2003 by Prof D. H. Rao, Principal Gogte Institute of Technology Belgaum. Prof H. V. Kumbhojkar of Shivaji University Kolhapur who was the founder director of the institute was present on this occasion. Prof H. B. Walikar, Prof H. H. Uliveppa, the then administrator of KUPG Centre Belgaum (now RCU Belagavi), faculty members of department of mathematics, students and research scholars were present. Prof S. S. Bhoosnurmath the then chairman department of mathematics of KUD gave an invited talk on Riemann Hypothesis.

Initially the institute was housed in Gogte Institute of Technology Belgaum and it was later shifted to 'Yamuna' building Bhagyanagar Belagavi. The institute organized several workshops, conferences, symposia with the generous help of local institutions of Belagavi. Eminent mathematicians of national and international repute visited the institute and delivered invited lectures.

In association with Vista Foundation Bengaluru, the institute has initiated 'History of Mathematics' Lecture series. The inaugural lecture was delivered on 29-07-2016 by Prof. Ravindra. S. Kulkarni of Bhaskaracharya Pratisthan Pune, at Jain University, Bengaluru. The lecture was entitled 'A mathematicians view on symmetry'. The second in the series 'Diophantine arithmetic - some episodes' was delivered by Prof S. G. Dani on 13-02-2017 at RCU Belagavi and the third in series 'Some Number Theory Problems' was delivered by Prof C. S. Rajan TIFR, Mumbai at G.S.S College, Belagavi on 6-02-2020. The institute intends to provide internships and also have outreach programs for school children. The institute being first of its kind in Karnataka has an objective of identifying young talent right at the school/college days and engage them with higher mathematics. Interdisciplinary subjects allied with mathematics are also pursued with great

zeal at the institute. We have also observed bright spots in the rural pockets of India and we are hopeful to train such students as well.

The year 2020 is dedicated to international women in mathematics and on this occasion several programmes have been planned.

Question Corner

- 1. Which is greater $e^{\pi} or \pi^{e}$
- 2. Fibonacci sequence is a recursive sequence given as $X_n = X_{n-1} + X_{n-2}$ given $x_0=1$ and $x_1=1$. Prove that this sequence is divergent and also show the link between this sequence and the golden ratio.
- 3. Show that $x^4 + 5x^3 7$ has at least two real roots.
- 4. Prove or disprove that the series $\sum_{1}^{\infty} \frac{(k!)^2}{(2k)!}$ is convergent.
- 5. What is the shape of the point set $\{z \in \mathbb{C} : |z-4| = |z+4\}$

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Note: Those who would like to become individual/institutional members please write to Dr T. Venkatesh, Director MSI.

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