MATHEMATICS & STATISTICS
IIT KANPUR

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ALPHA

The Stamatics' newsletter

MATHEMATICS & STATISTICS
IIT KANPUR

Pure mathematics is, in its way, the poetry of logical ideas.

Albert Einstein

Stamatics
IIT Kanpur

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DR. AMIT KUBER, CONVENER, STAMATICS

Dr. Amit Kuber is currently serving our department as an Assistant Professor. He has completed his PhD from University of Manchester, UK and worked as a postdoctoral fellow at Masaryk University, Brno, Czech Republic and Second University of Naples, Caserta, Italy.
His specialization is Category theory, Model theory, Categorical logic, Abstract homotopy theory and his research interests include the study of categorical syntax-semantics dualities in the context of various fragments of first-order logic as well as parallels between additive and non-additive categories in these contexts. He has been a tutor of Probability and Statistics (MSO 201A) last year and in the current year he is taking two courses viz. Logic and Set Theory as well as Category Theory. Apart from these he likes to work in connecting two different fields of Mathematics.

Among his several achievements, some of his awards and fellowships include :

- Eduard Cech Institute (Czech Republic) postdoc fellowship (2016)
- School of Mathematics, University of Manchester (UK) overseas students scholarship (2011-14)
- Cambridge Commonwealth Trust scholarship (2010-11)

NBHM M.Sc. scholarship (2008-10)

- Lt. Padmabhushan A. Garware Memorial award and Lt. R.G. Kunte Memorial award for first rank in B.Sc. (Maths) in Pune University

Some of his selected publications include-

- A. Kuber, On the Grothendieck ring of varieties, Math. Proc. Camb. Phil. Soc., 158(03) (2015), 477-486.
- A. Kuber, Grothendieck rings of theories of modules, Annals of pure and applied logic, 166(3) (2015), 369-407.

MESSAGE FOR THE STUDENTS

When asked for some suggestions to help enhancing the knowledge of mathematics in the young minds, he advised us not to just mug up things but to focus on understanding the concepts, to study for knowledge and to focus on knowledge and not on grades since grades will come eventually. He encouraged us to take part in seminars and dedicate more time on analyzing the concepts. He motivated us not to give up if we are facing difficulty in catching anything in the initial days, as he righteously remarked "At first you may get only 2% of what is taught, but with time you will get to know the art of learning and hence you'll understand the concepts discussed in seminars or taught in the class." It is very interesting to know that apart from mathematics, he takes keen interest in Indian classical and light music: vocal, harmonium and tabla and he also has a poetic touch as he enjoys writing poems.

STAMATICS INTERNATIONAL

An Article by DR. SEMENOV, Tomsk Polytechnic University, Russia

I graduated from the Department of Applied Mathematics and Cybernetics, Tomsk State University in 2000. I received my PhD in Mathematics with honors from Tomsk State University, Russia and then I worked for Tomsk State University of Architecture and Building 2006-2011. Since 2010, I became the associate professor at the Department of Higher Mathematics and Mathematical Physics, Institute of Physics and Technology, National Research Tomsk Polytechnic University (TPU). Now I have published more than 100 papers and 2 monographs. In recent years, I focused on the mathematical modeling of finance time series and got some important success. I am delivering lectures, seminars and tutorials on Mathematical Modeling and Discrete Mathematics.
My research interests include applied mathematics, statistical computing, numerical methods, and social network analysis. My research group includes a PhD-student, five master students and six bachelor students. Every year on March 14 (Pi Day), our students take part in University Mathematical Olympiad. I believe, mathematics is the language of universe, and no language barrier acts

In 2016, we have started an on-going research on 'Social Network Changes' among the members of the students' group. The purpose of this research is to detect project teams in a group. A key point in considering group's relationships is the reciprocal influence, where group's members influence each other. A survey was conducted based on reciprocal nomination method, and then a social network was constructed. Participants were 20 first-year bachelor students of TPU. We used various social network analysis algorithms to cluster the network into communities. The research results were presented and discussed at the International Conference on Analysis of Images, Social Networks, and Texts (Yekaterinburg, Russia). Now I am using the results in my teaching activity to create project teams, which can make successful collective actions. We are going to continue this longitudinal research in the future. At first, it is community detection in terms of motifs, i.e. dyads, triads (two or three students are only connected to each other) as a subgraph with a fixed number of vertices and with a given topology. We hope that such description allows us to formulate recommendations of distributing the projects, taking into account their complexity among teams and, therefore, then we can use different assessment methods for a team's performance.

After such successful work, I continued my collaboration with IITK. One of the points of collaboration is the joint scientific proposal on the VARJA faculty scheme together with Prof. Debasis Kundu from the Department of Mathematics and Statistics (IITK). This proposal deals with the representation and analysis of multivariate dependencies. We propose to use the copulas models. The application of copula theory is widespread in the fields of biomedical studies, process control, signal detection problem, hydrological modeling, econometrics, actuarial science, automotive industry, and finance. We think we can make some contributions on estimation and copula goodness of fit. Another possible point is to carry out collaboration research in framework of winter internship and then participate in the XV International Conference of Students and Young Scientists "Prospects of Fundamental Sciences Development" to be held in April 2018 in Tomsk, Russia, http://science-persp.tpu.ru

Homepage: http://portal.tpu.ru/SHARED/s/SME/eng

At second, it is an application of qualitative analysis of relations inside and outside project teams and assessment of the potential predictive factors of relations. In 2017, we took part a the International Conference on Information Technologies and Nanotechnologies (Samara, Russia) where a model for constructing an options portfolio was presented. The portfolio optimization problem is the basic problem of financial analysis. In the study, the optimization model for constructing the basket of options with a certain payoff function has been proposed. The model formulated as an integer linear programming problem and includes an objective payoff function and a system of constraints. In order to demonstrate the performance of the proposed model, we have constructed the portfolio on the European call and put options of the Taiwan Futures Exchange. Our approach is quite general and has the potential to design option's portfolios on financial markets.

Alan Turing

Alan Turing, in full Alan Mathison Turing (born June 23, 1912, London, England and died on June 7, 1954, Wilmslow, Cheshire), British mathematician and logician, who made major contributions to mathematics, cryptanalysis, logic, philosophy, and mathematical biology and also to the new areas later named computer science, cognitive science, artificial intelligence, and artificial life.

Early Life and Career

The son of a civil servant, Turing was educated at a top private school. He entered the University of Cambridge to study mathematics in 1931. After graduating in 1934, he was elected to a fellowship at King's College (his college since 1931) in recognition of his research in probability theory. In 1936 Turing's seminal paper "On Computable Numbers, with an Application to the Entscheidungsproblem[Decision Problem]" was recommended for publication by the American mathematical logician Alonzo Church, who had himself just published a paper that reached the same conclusion as Turing's, although by a different method. Turing's method (but not so much Church's) had profound significance for the emerging science of computing. Later that year Turing moved to Princeton University to study for a Ph.D. in mathematical logic under Church's direction (completed in 1938)

The Church-Turing Thesis

An important step in Turing's argument about the Entscheidungs problem was the claim, now called the Church-Turing thesis, that everything humanly computable can also be computed by the universal Turing machine. The claim is important because it marks out the limits of human computation. Church in his work used instead the thesis that all human-computable functions are identical to what he called lambda-definable functions (functions on the positive integers whose values can be calculated by a process of repeated substitution). Turing showed in 1936 that Church's thesis was equivalent to his own, by proving that every lambda-definable function is computable by the universal Turing machine and vice versa. In a review of Turing's work,

> Church acknowledged the superiority of Turing's formulation of the thesis over his own (which made no reference to computing machinery), saying that the concept of computability by a Turing machine "has the advantage of making the identification with effectiveness...evident immediately."

The Entscheidungs Problem

What mathematicians called an "effective" method for solving a problem was simply one that could be carried by a human mathematical clerk working by rote. In Turing's time, those rote-workers were in fact called "computers," and human computers carried out some aspects of the work later done by electronic computers. The Entscheidungs problem sought an effective method for solving the fundamental mathematical problem of determining exactly which mathematical statements are provable within a given formal mathematical system and which are not. A method for determining this is called a decision method. In 1936 Turing and Church independently showed that, in general, the Entscheidungs problem has no resolution, proving that no consistent formal system of arithmetic has an effective decision method.

In fact, Turing and Church showed that even some purely logical systems, considerably weaker than arithmetic, have no effective decision method. This result and others—notably mathematician-logician Kurt Gödel's incompleteness results—dashed the hopes, held by some mathematicians, of discovering a formal system that would reduce the whole of mathematics to methods that (human) computers could carry out. It was in the course of his work on the Entscheidungsproblem that Turing invented the universal Turing machine, an abstract computing machine that encapsulates the fundamental logical principles of the digital computer.

Code Breaker

Having returned from the United States to his fellowship at King's College in the summer of 1938, Turing went on to join the Government Code and Cypher School, and, at the outbreak of war with Germany in September 1939, he moved to the organization's wartime headquarters at Bletchley Park, Buckinghamshire. A few weeks previously, the Polish government had given Britain and France details of the Polish successes against Enigma, the principal cipher machine used by the German military to encrypt radio communications. As early as 1932, a small team of Polish mathematician-cryptanalysts, led by Marian Rejewski, had succeeded in deducing the internal wiring of Enigma, and by 1938 Rejewski's team had devised a code-breaking machine they called the Bomba (the Polish word for a type of ice cream). The Bomba depended for its success on German operating procedures, and a change in those procedures in May 1940 rendered the Bomba useless.

During the autumn of 1939 and the spring of 1940, Turing and others designed a related, but very different, code-breaking machine known as the Bombe. For the rest of the war, Bombes supplied the Allies with large quantities of military intelligence. By early 1942 the cryptanalysts at Bletchley Park were decoding about 39,000 intercepted messages each month, a figure that rose subsequently to more than 84,000 per month—two messages every minute, day and night. In 1942 Turing also devised the first systematic method for breaking messages encrypted by the sophisticated German cipher machine that the British called "Tunny." At the end of the war, Turing was made an Officer of the Most Excellent Order of the British Empire (OBE) for his code-breaking work.

CANTOR'S THEOREM

In this article, I will talk about Cantor's theorem which has a elegant and beautiful proof. The proof of this theorem is based on a famous argument given by cantor called the diagonal argument. The theorem says that cardinality of any set A is strictly less than the cardinality of power set of A. Mathematically, the theorem is as follows: (#($\mathcal{A}$) means cardinality of the set $\mathcal{A}$)

Theorem: If $\mathcal{A}$ is any set then $\#\mathcal{A} < \#\mathcal{P}(\mathcal{A})$

This might seem as a trivial result because all the elements of the set $\mathcal{A}$ are present in its power set as sets. But the following examples will show the beauty and non-triviality of this theorem. Let's consider two sets one the set of naturals ($\mathbb{N}$) and other the set of even naturals ($2\mathbb{N}$) and compare their cardinalities. One can simply argue that $2\mathbb{N}$ is strictly contained in $\mathbb{N}$ and hence set of naturals will have a larger cardinality. This intuition completely breaks when one talks about cardinality of infinite sets (this is where things become weird). Now, I will give you a bijective map between these two sets which will show both sets have the same cardinality.

$$f : \mathbb{N} \to 2\mathbb{N}$$
$$x \mapsto 2x$$

One can easily check that f is bijective which means $\#(\mathbb{N}) = \#(2\mathbb{N})$ (This is really difficult to digest but that's how infinity behaves and is highly counter intuitive). Now, let's get back to cantor's theorem, when cardinality of $\mathcal{A}$ is finite the result is trivial but the results becomes non-trivial for the infinite case. It's possible that for some infinite set $\mathcal{A}$, $\mathcal{P}(\mathcal{A})$ and $\mathcal{A}$ have same cardinality (just like the case of $\mathbb{N}$ and $2\mathbb{N}$) but cantor's theorem excludes that possibility. Now let's start the interesting part: proof of the cantor's theorem. In the proof, I will use the following result which is stated as lemma:

Lemma: For any two sets $\mathcal{A}$ and $\mathcal{B}$, $\#(\mathcal{A}) < \#(\mathcal{B})$ if and only if there doesn't any surjective map from $\mathcal{A}$ to $\mathcal{B}$.

To prove the theorem, I will show that there doesn't exist any surjective map from $\mathcal{A}$ to $\mathcal{P}(\mathcal{A})$. The idea of the proof is given any arbitrary function, I will find an element in the co-domain which will not be in the range.

Let f be any arbitrary function between $\mathcal{A}$ and $\mathcal{P}(\mathcal{A})$. Consider the set $\mathcal{B} = \{x \in A | x \notin f(x)\}$. Claim is set $\mathcal{B}$ doesn't belong to the range of f. Let's argue by contradiction, assume $\mathcal{B}$ lies in the range i.e $\exists$ x $\in \mathcal{A}$ such that $\mathcal{B} = f(x)$. But x $\in \mathcal{B} \Leftrightarrow$ x $\notin f(x) = \mathcal{B}$ which gives a contradiction. Thus, $\mathcal{B}$ is in co-domain and not in range of f. This shows that there doesn't exist any surjective map from $\mathcal{A}$ to $\mathcal{P}(\mathcal{A})$.

THE P VS NP PROBLEM

In a 2002 poll, 61 mathematicians and computer scientists said that they thought P probably didn't equal NP, to only nine who thought it did — and of those nine, several told the pollster that they took the position just to be contrary. But so far, no one's been able to decisively answer the question one way or the other. Frequently called the most important outstanding question in theoretical computer science, the equivalency of P and NP is one of the seven problems that the Clay Mathematics Institute will give you a million dollars for proving — or disproving. Roughly speaking, P is a set of relatively easy problems, and NP is a set that includes what seem to be very, very hard problems, so P = NP would imply that the apparently hard problems actually have relatively easy solutions. But the details are more complicated.

> Computer science is largely concerned with a single question: How long does it take to execute a given algorithm? But computer scientists don't give the answer in minutes or milliseconds; they give it relative to the number of elements the algorithm has to manipulate.

Imagine, for instance, that you have an unsorted list of numbers, and you want to write an algorithm to find the largest one. The algorithm has to look at all the numbers in the list: there's no way around that. But if it simply keeps a record of the largest number it's seen so far, it has to look at each entry only once. The algorithm's execution time is thus directly proportional to the number of elements it's handling — which computer scientists designate N. Of course, most algorithms are more complicated, and thus less efficient, than the one for finding the largest number in a list; but many common algorithms have execution times proportional to N2, or N times the logarithm of N, or the like.
A mathematical expression that involves N's and N2s and N's raised to other powers is called a polynomial, and that's what the "P" in "P = NP" stands for. P is the set of problems whose solution times are proportional to polynomials involving N's.Obviously, an algorithm whose execution time is proportional to N3 is slower than one whose execution time is proportional to N. But such differences dwindle to insignificance compared to another distinction, between polynomial expressions — where N is the number being raised to a power — and expressions where a number is raised to the Nth power, like, say, 2N.
If an algorithm whose execution time is proportional to N takes a second to perform a computation involving 100 elements, an algorithm whose execution time is proportional to N3 takes almost three hours. But an algorithm whose execution time is proportional to 2N takes 300 quintillion years. And that discrepancy gets much, much worse the larger N grows.

> NP (which stands for nondeterministic polynomial time) is the set of problems whose solutions can be verified in polynomial time. But as far as anyone can tell, many of those problems take exponential time to solve. Perhaps the most famous exponential-time problem in NP, for example, is finding prime factors of a large number.

So the question "Does P equal NP?" means "If the solution to a problem can be verified in polynomial time, can it be found in polynomial time?" Part of the question's allure is that the vast majority of NP problems whose solutions seem to require exponential time are what's called NP-complete, meaning that a polynomial-time solution to one can be adapted to solve all the others. And in real life, NP-complete problems are fairly common, especially in large scheduling tasks. The most famous NP-complete problem, for instance, is the so-called traveling-salesman problem: given N cities and the distances between them, can you find a route that hits all of them but is shorter than … whatever limit you choose to set?
Given that P probably doesn't equal NP, however — that efficient solutions to NP problems will probably never be found — what's all the fuss about? Michael Sipser, the head of the Department of Mathematics at MIT and a member of the Computer Science and Artificial Intelligence Lab's Theory of Computation Group (TOC), says that the P-versus-NP problem is important for deepening our understanding of computational complexity.

THE ALUMNI BLOG

NEER BHARADWAJ

Int MSc , MTH, Y10, IIT Kanpur
Currently pursuing PhD at the University of Illinois

Getting into a Ph.D. program, of course, includes going through evaluations of all kinds and basically convincing a program that you are 'good enough' to get in, whatever that means. But, we (must) ask ourselves that question too. Well, so one may contemplate whether such an endeavour is suited to one's intellectual abilities, inclinations, motivations and so on. I, for one, may have focused inordinately on answering questions related to the first on the list and it is not exactly I believe, a novel error. Acquiring any kind of understanding about oneself through mere rumination, although quite possible, is not exactly the easiest thing one may do in life. So, the easiest (only?) way to know whether you're suited to mathematical research is perhaps to try it out (as with most things). Returning to convincing people other than yourself regarding your mathematical ability and/or potential, if anything can be 'true signal', surely (only?) something that helps you convince yourself could be. So, after you have acquired any kind of solid background in mathematics, go out there and try out any kind of genuine mathematical research, if at all possible. You may find it is one of the most fun things to do, or not.

NIHAR GARGAVA

BS, MTH, IIT Kanpur, 2013 Batch
Currently pursuing Masters in Mathematics at École Polytechnique Fédérale de Lausanne, Switzerland

Hello, my friends.
It's my pleasure to write for Alpha. I will lend some thoughts that I think may be important for the current student of our beloved department. I have seen many students in our department being afraid or repelled by theoretical mathematics. A common complaint is that the courses in analysis, algebra, etc. appear too abstract and it seems almost inconsequential to study those things.

This concern is justified, because of the upside down methodology of teaching mathematics. When you do these courses, the concepts and skills are rigorously established before making you understand their context of application. Logically, it makes sense, because without knowing the concept you cannot know how to use it properly. However historically, nearly all mathematics has come into shape the other way, namely, in trying to answer natural questions that arise in the flow of logic in justifying mathematical arguments. Without feeling the need of those concepts yourself, it is natural to make such a complaint. It is when you encounter these questions yourself, is when you start to see the importance of theoretical mathematics.

I will try to justify my above belief with an example. I was told that during some placement interview for a finance company the following question was asked. "If the surface of a white sphere is painted eighty percent red, prove that you can fit a cube inside the sphere with all of its vertices lying on the red part".
Now anyone who has done a higher course in analysis will be quickly able to point out that the red part must be a measurable subset of the surface of the sphere! Any attempt at a solution will have to incorporate this fact. You see, knowing the theory will put you at the top of the game! Thanks for reading my little piece. Good luck for your future!

FOOD FOR THOUGHT

THE AXIOM OF CHOICE IS WRONG

PUZZLE BY GREG MULLER

When discussing the validity of the Axiom of Choice, the most common argument for not taking it as gospel is the Banach-Tarski paradox. Yet, this never particularly bothered me. The argument against the Axiom of Choice which really hit a chord I first heard at the Olivetti Club, our graduate colloquium. It's an extension of a basic logic puzzle, so let's review that one first.

STAGE ONE

100 prisoners are placed in a line, facing forward so they can see everyone in front of them in line. The warden will place either a black or white hat on each prisoner's head, and then starting from the back of the line, he will ask each prisoner what the color of his own hat is (ie, he first asks the person who can see all other prisoners). Any prisoner who is correct may go free. Every prisoner can hear everyone else's guesses and whether or not they were right. If all the prisoners can agree on a strategy beforehand, what is the best strategy?

The answer to this in a moment; but first, the relevant generalization.

STAGE TWO

A countable infinite number of prisoners are placed on the natural numbers, facing in the positive direction (ie, everyone can see an infinite number of prisoners). Hats will be placed and each prisoner will be asked what his hat color is. However, to complicate things, prisoners cannot hear previous guesses or whether they were correct. In this new situation, what is the best strategy?

HAT GUESSING PUZZLE

BY GREG MULLER

Unlike the previous one, this puzzle isn't meant to attack the foundations of mathematics. The problem is as follows:

Three people are sitting in a circle. Black or white hats (50% chance of each) will all be placed on their heads, and they will be able to see everyone's hat color but their own. They will all simultaneously write down on a piece of paper either "Black", "White", or "Pass", trying to guess their own hat color. All the people collectively win (whatever that means) if at least someone guesses their hat correctly and no one guesses incorrectly. They lose if anyone guesses incorrectly, or everyone passes. If they can agree on a strategy beforehand, what is their best chance of winning?

RESEARCH BY STUDENTS

DEEPAK KUMAR PRADHAN

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A left shift operator S on a complex sequence space X is defined in the following way,

$$S(e)(n) = \begin{cases} e_{n-1} & \text{if } n \geqslant 1, \\ 0 & \text{otherwise} , \end{cases}$$

where $e = (e_n) \in X$. This apparent discrete map has been of utmost importance in the theory of Hilbert space operators; reason being the following simple observation.

The left shift applied on the sequence of co-efficients of a power series $\sum_{n=0}^{\infty} a_n z^n$ *is the sequence of co-efficients of the series* $\sum_{n=0}^{\infty} a_n z^{n+1} = z \sum_{n=0}^{\infty} a_n z^n$.

One encounters many examples of Hilbert spaces of holomoprhic functions in literature, which are in variant under the multiplication by z. One such example being the Hardy space of the unit disk $\mathbb{D} \subset \mathbb{C}$;

$$\mathbb{H}^2(\mathbb{D}) := \{\sum_{n=0}^{\infty} a_n z^n \mid z \in \mathbb{D} \text{ and } \sum_{n=0}^{\infty} |a_n|^2 < \infty\}.$$

It is now easy to observe that, if $X = \ell^2(\mathbb{N})$ then S (upto unitary equivalence) is multiplication by the z on $\mathbb{H}^2(\mathbb{D})$. To this end, one might be tempted to ask what if we shift the sequences to the right. We leave it to interested readers to dig deeper into the rabbit hole.

We now shift our attention to our main objects of study, that is the weighted shift operators on rooted directed trees with countably infinite vertex sets. For us, a directed tree is a directed graph ($\mathcal{T} = (V, E)$) with no directed or undirected loops. Further, if there is a unique vertex say $r \in V$, such that we can traverse on a directed path from r to any given vertex but r, then we call the tree a rooted directed tree. Since we are assuming the vertex set to be countably infinite a trivial example of a rooted directed tree is the natural numbers $\mathbb{N}$ with the directed edges induced from the predecessor-successor relation. In fact, as we did for natural numbers, we can define shifts on $\ell^2(V)$ in the following way

$$S(e_v) = \sum_{w \in v\downarrow} e_w \quad (v \in V).$$

Here the $v\downarrow = \{w \in V \mid (v, w) \in E\}$. We can generalize the definition to give weights $(\lambda_{(\cdot)} \in \mathbb{C})$ as follows,

$$S_\lambda(e_v) = \sum_{w \in v\downarrow} \lambda_w e_w \quad (v \in V).$$

My research work is concerned with these operators and their analytic behavior. The interplay between graph theory, operator theory and complex analysis makes it all the more exciting. So far we have been able to show that a particular class of these operators do admit multiplication by z like property on certain spaces of vector valued holomorphic functions. Weighted shifts on $\mathbb{N}$ also give rise to multiplication by z operator on certain function spaces, for interested readers literature is available in abundance.

Estimation of Rank Correlation Coefficients

Tathagata Dutta

M.Sc , Statistics
IIT Kanpur

I pursued a project under Prof. Arijit Chaudhuri (ISI Kolkata) in the topic of Sample Survey . Sample Survey is one of the classical topics in Statistics . We need to consider a sample often in any statistical problem . Sample Survey deals with different topics such as the method by which the sample is chosen, estimation of the parameters based on the sampling scheme etc. We worked on the problem of estimating Rank Correlation Coefficient in finite surveys permitting Unequal Probability Selection .

Given a finite population U = (1,2,.....,i,....N) on which two real variables (x,y) are defined having values (x_i, y_i) ; i=1,2,....,N , the product-moment correlation coefficient R_N between x & y can be estimated by r . But , if the individuals i in U are ranked according to their (x,y) values with u_i , v_i as their ranks respectively, then taking $d_i = u_i - v_i$, Spearman's rank correlation coefficient , R_N (with $x_i = u_i$ and $y_i = v_i$) cannot be estimated as r provides an estimator for R_N . But , as a saving grace using the ranks u_i, v_i for i = 1,2, ..., N, Kendall's Rank Correlation Coefficient can be eventually estimated . In the project we have tried estimated Kendall's Tau (τ) in Rao - Hartley - Cochran scheme using-

1) Rao - Hartley - Cochran (RHC) estimator
2) Horvitz - Thompson (HT) estimator

We proposed an approximately unbiased estimator for Kendall's Tau (τ) for both the cases along with their approximately unbiased variance estimator. We also presented some numerical exercise to support our proposition.

Our work was submitted to a journal ' Rashi ' and it was published as a paper in the Jouranl 'Rashi' , Journal of the society for application of Statistics in Agriculture and Allied Sciences (SASAA) Vol. 2 , issue 1 , 2017 .

NEW FACULTY IN THE MTH DEPARTMENT

DR. AJAY SINGH THAKUR

Dr.Ajay Singh Ramdin Thakur has joined our department as an Assistant Professor as recently as February 2017. Before joining IIT Kanpur he was a DST-Inspire Faculty Fellow, ISI, Bangalore, Jan. 2014 - Jan. 2017.
He completed his PhD from The Institute of Mathematical Sciences, Chennai, India, Aug 2005 -Sep 2011. His research area includes Algebraic Topology, Topology of Complex Manifolds.

Work Experience

- Post-doc at University of Haifa, Israel, April 2013 - Jan. 2014. 4.
- Post-doc at TIFR, Mumbai, Sep. 2012 - Mar. 2013. 5.
- Post-doc at ISI, Bangalore, Oct. 2011 - Sep. 2012.

For more information:
http://www.iitk.ac.in/new/ajay-singh-thakur

DR. SOMNATH JHA

Dr. Somnath Jha has joined our department in 2015. He is an DST INSPIRE Faculty grant, 2014-19. Before joining IIT Kanpur he was a Faculty member at School of Physical Sciences, Jawaharlal Nehru University, New Delhi from 2014 to 2015. He was also an JSPS postdoctoral fellow in the Department of Mathematics at Osaka University with Prof. Tadashi Ochiai, 2012 - 14 and MATCH postdoctoral fellow in the working group of Prof. Otmar Venjakob at University of Heidelberg, 2011-12.

He completed his PhD from Tata Institute of Fundamental Research, Mumbai in 2012 (Thesis- Fine Selmer group of Hida deformations). He completed M.Math from ISI Kolkata in 2006. When asked about his research interests he said "The broad areas of my research are Number Theory and Arithmetic Geometry. More specifically, I am working on problems related to Iwasawa Theory, Hida Theory, Galois representations. The basic objects of my study are elliptic curves and modular forms."

COURSES offered by Dr.Jha so far:

- Commutative Algebra (MTH612A), Monsoon semester 2017-18.
- Abstract Algebra (MTH204), Winter semester 2016-17.
- Topics in Arithmetic (MTH688A), Monsoon semester 2016-17.
- A first course in Algebraic Number Theory (MTH 712A), Winter semester 2015-16.

He was also a tutor for Linear Algebra & ODE (MTH 102A) Winter 2015-16, 2016-17.

DR. SUDHANSHU SHEKHER

Dr. Sudhanshu Shekhar has joined our department on August 2016. Before joining IIT Kanpur, he worked as DST Inspire faculty in Indian Institute of Science Education and Research (IISER), Mohali from August 2014 to July 2016. He completed his post doc from Mathematisches Institut, Ruprecht-Karls-Universitat Heidelberg, Germany on August 2015 and was a research scholar in School of Mathematics, Tata Institute of Fundamental Research, Mumbai from August 2008 to April 2013 where he earned his PhD. His research interests include Arithmetic Geometry and Algebraic Number theory : Arithmetic of elliptic curves, Iwasawa Theory of p-adic Lie extensions, Galois representations, Congruences between special values of L-functions and Hida theory.

Some of his achievements :

- Inspire fellowship, Department of Science and Technology, Government of India, 2014.
- Postdoctoral Fellowship, Mathematics Center Heidelberg (MATCH).
- PhD research Scholarship, Tata Institute of Fundamental Research, Mumbai.
- Qualified for Junior Research Fellowship (JRF) and National Eligibility Test for
- Lectureship (NET) conducted by Council for Scientific and Industrial Research, India in 2008.

For more information :
http://www.iitk.ac.in/new/sudhanshu-shekhar

DR. ASHIS MANDAL

Dr. Ashis Mandal has recently joined our department. He has completed his Ph.D. in Mathematics in 2008 from Indian Statistical Institute Kolkata. He has attained Master degree in Pure Mathematics in 2002 from University of Calcutta and has completed his undergraduate studies in Mathematics in 2000 from Ramakrishna Mission Residential College, Narendrapur, University of Calcutta.
He was a Research Associate under C.S.I.R. fellowship, Statistics and Mathematics Unit, Indian Statistical Institute, Kolkata, India. His professional affiliations include-

- Visiting Scientist, Statistics and Mathematics Unit, Indian Statistical Institute, Kolkata, India.
- Postdoctoral researcher, Mathematics Research Unit, University of Luxembourg, Luxembourg.
- Visiting faculty, School of Mathematical Sciences National Institute of Science Education and Research, Bhubaneswar, Orissa.

Research interests :
Algebraic Topology, Deformation theory of algebraic structures, Operads and related fields.
Web: http://www.iitk.ac.in/new/ashis-mandal

Among his several achievements, some of the awards and fellowships are-

- AFR postdoctoral fellowship grant PDR-09062 in 2010.
- N.B.H.M. Postdoctoral Fellowships in Mathematics in 2009.
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COMPILATION CREDITS

1. MESSAGE FROM CONVENER
   - Ashu Prakash, Kallol Datta
2. STAMATICS INTERNATIONAL
   - Ashu Prakash
3. ALAN TURING
   - Rohan Garg
4. CANTOR'S THEOREM
   - Shubham Gupta, Divyat Mahajan
5. P vs NP:
   - Rohan Garg
6. ALUMNI BLOG
   - Apoorva Singh
7. FOOD FOR THOUGHT
   - Divyat Mahajan, Shubham Gupta
8. RESEARCH BY STUDENTS
   - Tathagata Dutta
9. NEW FACULTY IN THE DEPARTEMNT
   - Kallol Datta, Rohan Garg

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