Convergence

SPECIAL EDITION: AZADI KA AMRUT MAHOTSAV

AUGUST '21

IN THIS ISSUE

When Ɛpsilon Met δelta

The Mathematics Society | St. Stephen's College

Hey Taxi!
What's the fare ?

Srinivasa Ramanujan, a brilliant mathematician from Madras, India, moved to the University of Cambridge in England in 1914 on the invitation of two great mathematicians, G.H. Hardy and J.E. Littlewood. During his stay in England, he became ill due to the climatic differences in India and England.

"No, it is a very interesting number: it is the smallest number expressible as the sum of two cubes in two different ways."

-S.Ramanujan.

Hardy once visited Ramanujan while he was ill. The taxi cab he travelled in was numbered 1729, which seemed to him a rather dull number and possibly an unfavorable omen.

To this, Ramanujan replied, "No, it is a very interesting number: it is the smallest number expressible as the sum of two cubes in two different ways.", that is,

$1729 = 1^3 + 12^3$ and $1729 = 9^3 + 10^3$.

In honor of the Ramanujan-Hardy conversation, the smallest number expressible as the sum of two cubes in n different ways is known as the nth taxicab number and is denoted as Taxicab(n). Therefore, with this notation, we see that

Taxicab(1) = $2 = 1^3 + 1^3$

Taxicab(2) = 1729.

Inheritors of Ramanujan's Genius

A look at award-winning Indian Mathematicians

AKSHAY VENKATESH

An Australian professor of Indian origin working at the Institute of Advanced Study, Princeton, New Jersey, he broke headlines when along with four others, he won the prestigious Fields Medal in 2018 or the 'Nobel Prize of Mathematics'. He made profound contributions to a broad range of subjects in Mathematics and solved many longstanding problems by combining methods from seemingly unrelated areas, presented novel viewpoints on classical problems, and produced strikingly far-reaching conjectures.

MANJUL BHARGAVA

Manjul Bhargava FRS is a Professor of Mathematics at Princeton University. The unpretentious, simple and soft-spoken mathematician won the prestigious Fields Medal in 2014 for developing powerful new methods in the geometry of numbers, which he applied to count rings of small rank and to bind the average rank of elliptic curves. Peter Sarnak’s remark of him always stands out: “In mathematics, he's at the very top end. He certainly started out with a bang and has not let it get to his head, which is unusual.”

Inheritors of Ramanujan's Genius

A look at award-winning Indian Mathematicians

NIKHIL SRIVASTAVA

An assistant professor of Mathematics at the University of California, he has won the coveted Michael and Shield Held Prize 2021, along with two of his colleagues, Adam W Marcus of EPFL and Daniel Alan, from Yale. They solved the Kadison-Singer conjecture and answered long standing questions on Ramanujan graphs. "Their proofs provided new tools to address numerous other problems, which have been embraced by other computer scientists seeking to apply the geometry of polynomials to solve discrete optimization problems," the Nation Science Academy said in their honor citation.

ATUL DIXIT

Atul Dixit is an Indian mathematician, working as an assistant professor at the Indian Institute of Technology, Gandhinagar. He is the first Indian mathematician to win the prestigious Gábor Szegö Prize for the year 2021, for impressive scientific work in solving problems related to number theory using special functions, in particular related to the work of Ramanujan. His work in number theory has led him to discover interesting special functions such as generalised modified Bessel and Hurwitz zeta functions.

Inheritors of Ramanujan's Genius

A look at award-winning Indian Mathematicians

SOURAV CHATTERJEE

Sourav Chatterjee is a Mathematician currently working as an assistant professor at Stanford University. Born in Kolkata, Chatterjee was "always into math and math-y things," he says, "from programming computers to playing chess." He recently received the Infosys prize 2021. Rooted in Probability and Statistics, Chatterjee's work has had significant impacts not only in Mathematics but also broadly in Physics, technology and other fields. He is already a recipient of Sloan Fellowship and seeks to further his research in the areas of Mathematical Statistics and Probability.

RAVINDRAN KANAN

Ravindran Kanan is a principal researcher at Microsoft Research, India. Before he joined Microsoft, he was an assistant professor of Computer Science and Professor of Applied Mathematics at Yale University and had taught at MIT. He was awarded the prestigious Knuth Prize in 2011. He has worked on algorithms for integer programming and the geometry of numbers, random walks in n-space, randomized algorithms for linear algebra and learning algorithms for convex sets.

Entertainment, Entertainment & Entertainment!

Cryptograms are puzzles where capital letters stand in for the digits of a number. If the same letter is used twice, it's the same digit in both places, and if different letters are used, the digits are also different.

What digit in place of B would make this sum true?

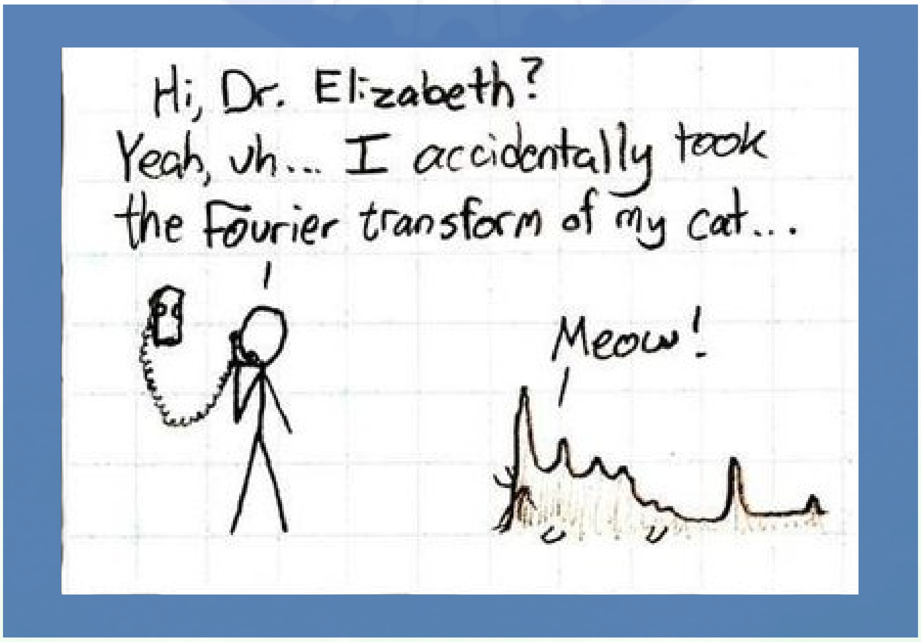
$$\begin{array}{r} 1\,B \\ +\,B\,6 \\ \hline 7\,1 \end{array}$$

$$\begin{array}{r} B\,A \\ \times\,6 \\ \hline 1\,6\,A \end{array}$$

Looking at the last column, B+6 ends in 1, so B must be 5. Checking the rest of the cryptogram, we verify that 15+56=71 is true.
Now try your hand at the cryptogram on the left considering divisibility rules.

THIS MONTH'S CHALLENGE: Each letter corresponds to a different digit and 0 can't be the first digit of a number. What is the sum C + A + R?

$$\begin{array}{r} C\,A\,R \\ +\,C\,A\,R \\ +\,C\,A\,R \\ \hline R\,R\,R \end{array}$$



To Light Up Your Mind!

Oh My Cos(h)!

The Musical Formula

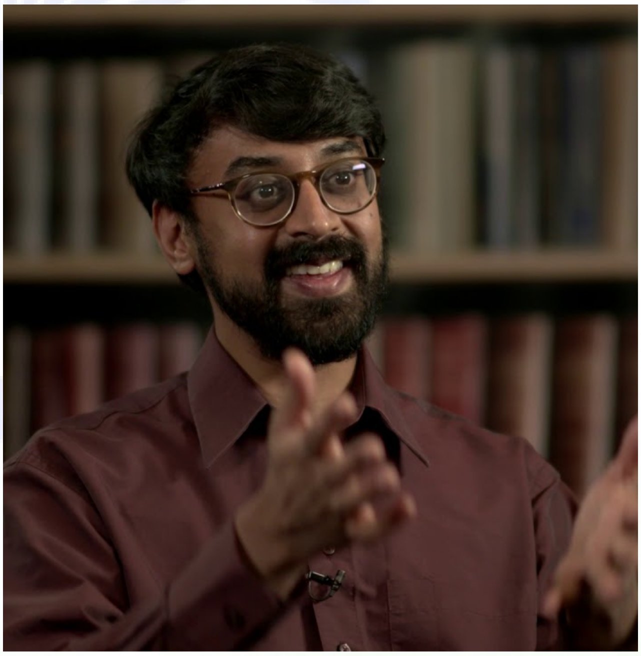
In his lec-dem, Manjul Bhargava, Fields medallist and R. Brandon Fradd, Professor of Mathematics at Princeton University, explained the connection between Music, Mathematics and Sanskrit poetry. Bhargava said phonetics, rhythm and intonations all have a scientific basis in Sanskrit.

In Sanskrit poetry, there are long and short syllables. The long one lasts for two beats and short for one beat. In terms of music, there are two phrases, with one taking twice as long. The long phrase is called guru and the short one is called laghu.

Ancient poets were doing mathematics just by studying this simple set up. How many rhythms of say 8 beats of short (S) and long (L) syllables can you come up with? You can have LLLL, or LLSSL etc. Our ancient poets gave an ingenious way to get the general answer. Write down the numbers 1 and 2. Every subsequent number is obtained by adding the previous two. So you get a sequence like this: 1,2,3,5,8,13, 21, 34, 55, ...

The nth number gives the total number of rhythms of 'n' beats. The eighth number in the sequence is 34. So for eight beats, there are 34 rhythms of longs and shorts.

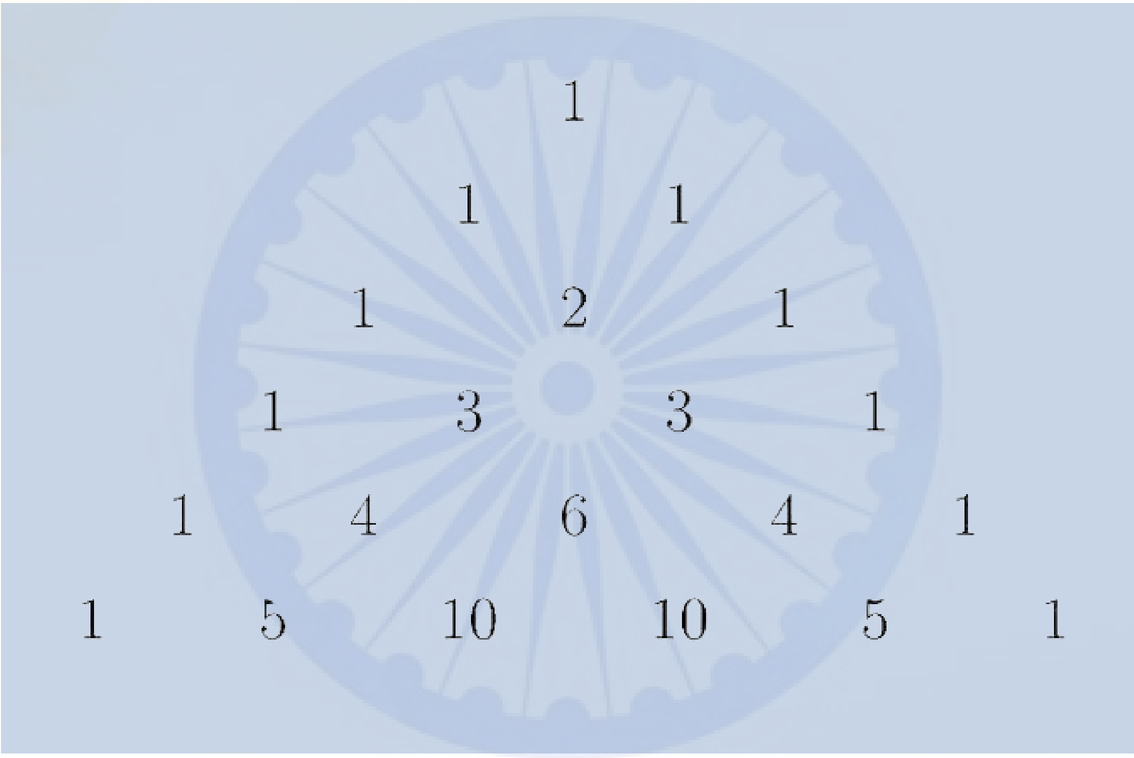
Gujarati scholar Hemachandra gave these numbers in 1150 C.E., although we call them Fibonacci numbers, after the Italian mathematician who came up with the same sequence in 1202 C.E!



Coming to rhythms consisting of 'n' syllables, how many rhythms are there consisting of exactly 'n' syllables? The first syllable can be long or short and the same goes for all syllables up to the nth. So we always have a choice of 2. So, 2x2x2x...= 2^n, and 2^n is the number of rhythms having n syllables.

The Musical Formula

This was described by Pingala (300 B.C.E) in a poem, in which he gives the answer 2 raised to the power of n. Pingala gave a solution for this general 'n,' in what he called a mountain of jewels — Meruprastara (see figure). As can be seen from the figure, in each row, every number is obtained by adding the two numbers immediately above it.
Entries in Meruprastra are called binomial coefficients. However, we refer to Meruprastara as Pascal's triangle, although Pascal came 2000 years after Pingala!
So counting rhythms/meters having a fixed number of beats (matras) yields Hemachandra numbers.



Counting rhythms/meters having a fixed number of syllables yields Pingala's Meruprasatara. The two constructions are related in a beautiful way. You can think of the number of rhythms having 'n' beats and how many syllables you can use to make n beats and you'll see the relation. Now what happens if there are three types of syllables - short (1 beat), long (2 beats) and extra long (3 beats)? You get 'Tremachandra' numbers and you get a three dimensional Meruprastara. These numbers decide how many rhythms with 'n' beats, having a certain number of shorts, longs and extra longs you can get. In mathematics, these are called trinomial coefficients.

Vedic Mathematics

AdyamadyenaSutrai, meaning 'the first by the first and the last by the last', is a simple approach for factorization of polynomial expressions with two or more variables. The product of two numbers in the first case equals the product of two numbers in the second situation, according to this sutra.

For example, consider the polynomial,

$$Q(x, y, z) = 3x^2 + 4y^2 + 3z^2 + 8xy + 10xz + 8yz + 20x + 16y + 12z + 12$$

Such eliminations lead to :-

$$Q(x, 0, 0) = 3x^2 + 20x + 12 = (x+6)(3x+2) \quad (1)$$

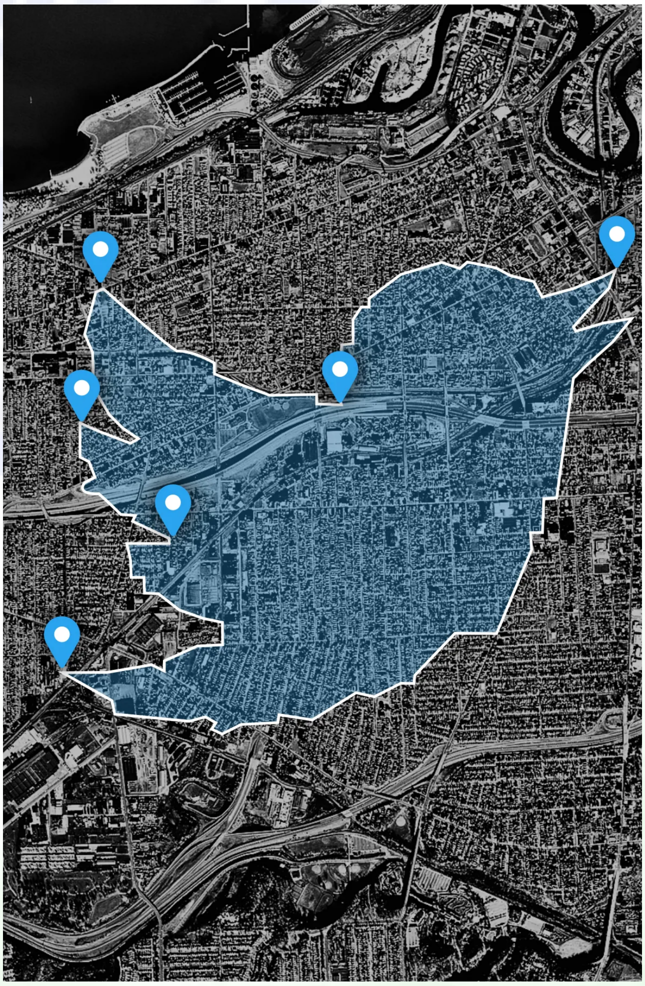
$$Q(0, y, 0) = 4y^2 + 16y + 12 = (2y+6)(2y+2) \quad (2)$$

$$Q(0, 0, z) = 3z^2 + 12z + 12 = (3z+6)(z+2) \quad (3)$$

By comparing the derived factorization in equations 1, 2, and 3, and adding extra terms from other factorizations to each factor, we obtain factorization of Q (x, y, z) as-

$$Q(x, y, z) = (x + 2y + 3z + 6)(3x + 2y + z + 2)$$

Last Month



A quick way to identify the "nth" friends of social media users based on spatial data mining of profiles and behavior on a service such as Twitter is described in the International Journal of Advanced Intelligence Paradigms. D. Gandhimathi of the Research and Development Center, Bharathiar University in Coimbatore and John Sanjeev Kumar of Thiagarajar College of Engineering in Madurai, India, explain that Twitter plays an important role in intentional social action. The team's unconventional quantitative analysis hooks into the geographical metadata of each user's Twitter updates, the geotag, where that is in place and not hidden by the user to provide even richer pickings for the data miners.

References

1. https://phys.org/news/2021-08-friends-social-media.html
2. https://www.thehindu.com/features/friday-review/the-musical-formula/article14090140.ece
3. https://blogs.ams.org/mathgradblog/2013/08/15/ramanujans-taxicab-number/
4. https://qph.fs.quoracdn.net/main-qimg-cde994bda68d6372549e4cebb1fd62bd-c
5. https://www.ndtv.com/india-news/india-questions-math-genius-professor-manjul-bhargava-full-transcript-730559
6. https://news.yale.edu/2021/01/21/yales-daniel-spielman-wins-held-prize-solving-decades-old-problem
7. https://m.economictimes.com/industry/services/education/prof-atul-dixit-from-iit-gandhinagar-wins-gbor-szeg-prize-2021/articleshow/81431106.cms
8. https://news.stanford.edu/today/2021/01/05/sourav-chatterjee-awarded-prestigious-mathematics-prize/
9. https://simons.berkeley.edu/people/ravi-kannan

Curated, Designed and Edited by

Akshita Kumar

Arati Jose

Ayush Stephen Toppo

Rayyan Ahmed

For regular updates, follow us on social media:

(Click on the icon)