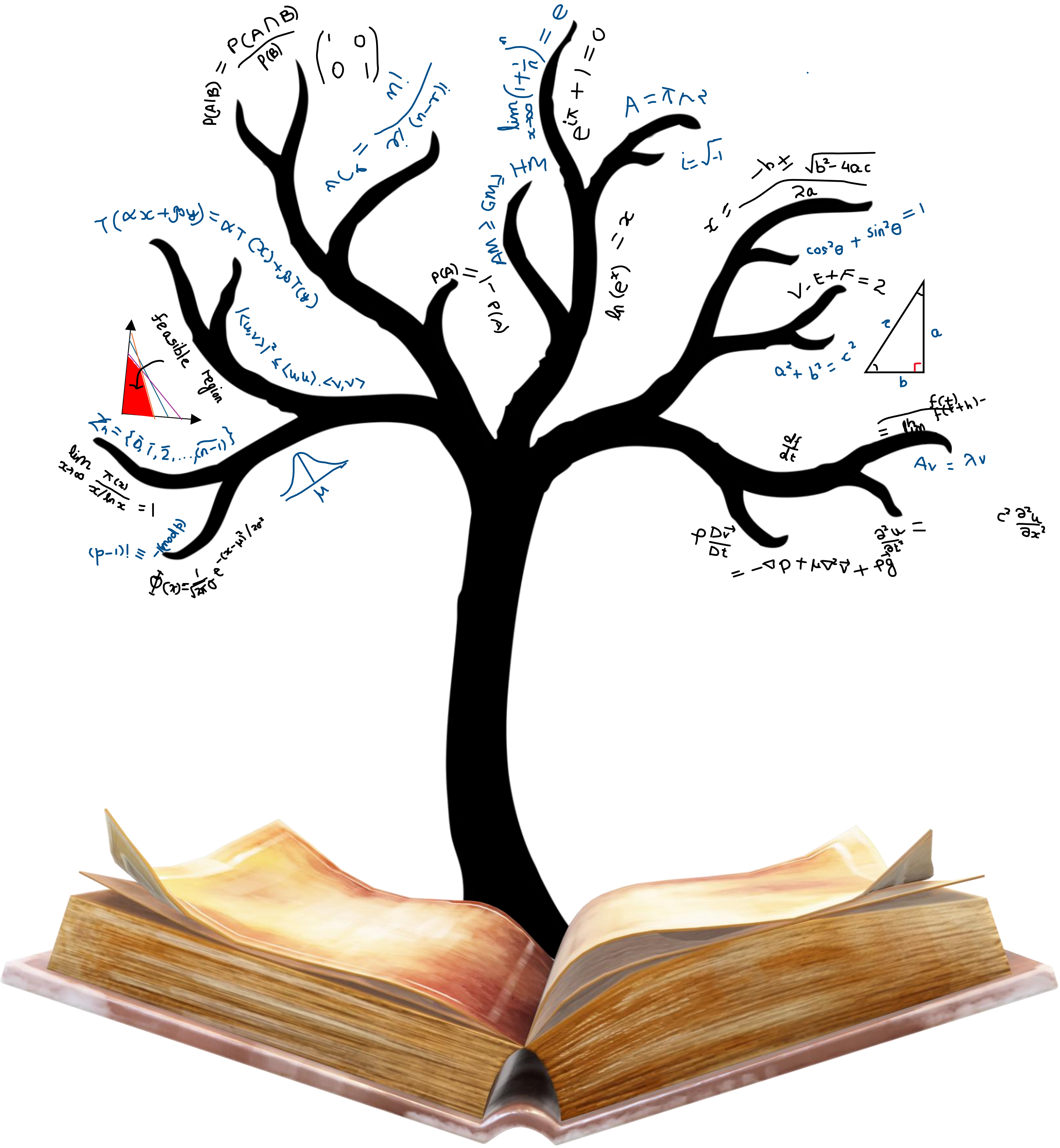

# NITM Mathematical Bi-monthly

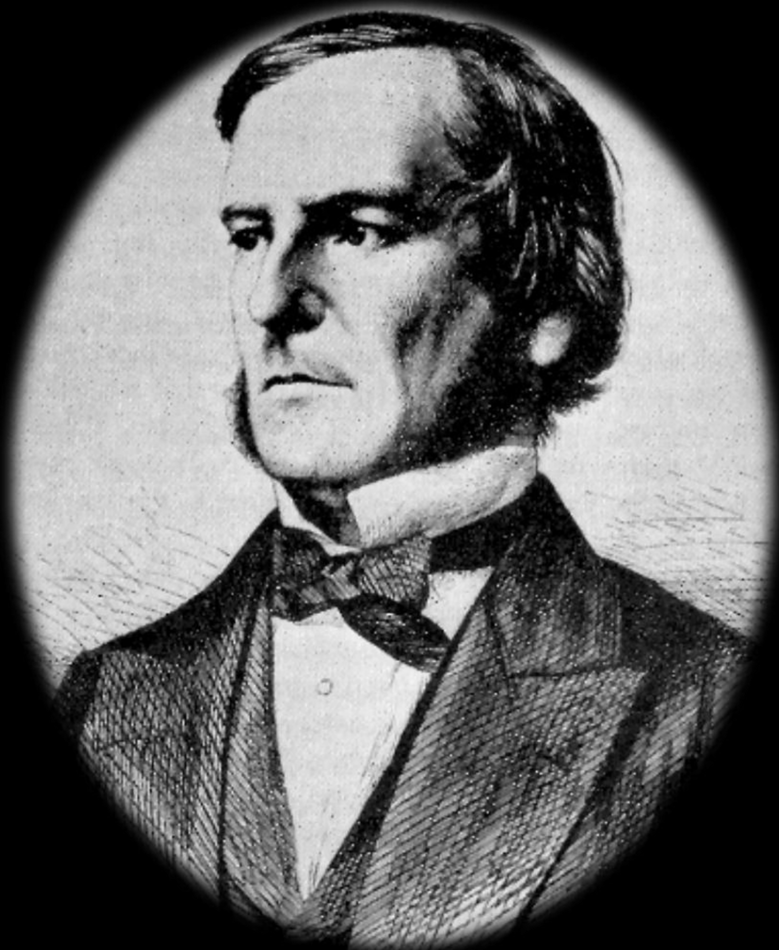

Department of Mathematics,
National Institute of Technology Meghalaya



October-November 2025
Issue No. 8



$P(A|B) = \frac{P(A \cap B)}{P(B)}$
$e^{i\pi} + 1 = 0$
$A = \pi r^2$
$i = \sqrt{-1}$
$\ln(e^x) = x$
$\cos^2\theta + \sin^2\theta = 1$
$V - E + F = 2$
$a^2 + b^2 = c^2$
$Av = \lambda v$
feasible region



**“The general laws of Nature are not, for the most part, immediate objects of perception.”**

**— George Boole**

**(2 November 1815 – 8 December 1864)**

# DIRECTOR'S MESSAGE

Dear Students, Faculty, and Readers,

I am immensely pleased to introduce the 8th issue of the Department of Mathematics' bimonthly magazine. This magazine represents a significant step forward in creating a platform where the department can showcase our students and faculty members' intellectual curiosity, talent, and dedication.

Mathematics is not just a subject confined to classrooms and textbooks; it is a dynamic and evolving field with the power to shape the world around us. I am proud of the department's commitment to fostering academic excellence and a spirit of innovation.

This magazine is a testament to that pursuit of knowledge. It will serve as a medium for not only disseminating new ideas and research but also for encouraging discussions, collaborations, and creativity within our vibrant mathematical community. I encourage each of you—students and faculty alike—to contribute actively to the growth of this magazine and make it a reflection of our collective brilliance.

As we move forward, let us continue to strive for academic distinction, intellectual curiosity, and a passion for solving the complex problems that mathematics presents. The journey is as important as the destination. I believe that together, we will continue to make strides toward a brighter future for the department and the world of mathematics.

I congratulate the editorial team on their hard work in bringing this publication to life, and I look forward to seeing the magazine evolve in the years to come.

**With best wishes,**
**Prof. Pinakeswar Mahanta**
**Director, NIT**

# HoD's Message

Dear esteemed readers,

*Greetings from Department of Mathematics, NIT Meghalaya!*

It gives me immense pleasure and sense of honor to write in the 8th issue of our departmental magazine "NITM Mathematical". The magazine provides a platform to present various accomplishments and activities of the department on a bimonthly basis and serves as a channel for encouraging creativity, sharing knowledge, ideas, research activities and insights of our departmental family.

The Department of Mathematics started in 2012 with the inception of NIT Meghalaya in Shillong. The Department currently offers two years M.Sc. program and Ph.D. program in addition to catering the mathematical support to other departments of the institute. At present, the department has six faculty members with strong academic and diverse research backgrounds. Ever since its inception, our department, has been striving to maintain excellence in teaching and research providing solid foundation in Mathematics to our students and accomplishing quality research output. Moving ahead, we aim to be a center of excellence for learning Mathematics globally, with special focus on supporting the mathematical requirements in the regional level.

Our department is committed to be vibrant and is dedicated to the holistic development of our students. The creation of this magazine stems from a collective desire to share our thoughts, accomplishments, and aspirations. Working together as a team to ensure its successful publication brings immense delight and it is a privilege to be a part of this process.

I express my sincere gratitude to the editorial board, and everyone who have contributed to this issue of the magazine. I extend my best wishes and sincerely hope that this tradition of the departmental magazine continues for generations to come, fostering happiness, unity, and intellectual growth.

**Warm regards,**

**Dr. Tikaram Subedi**

**Associate Professor, HoD, MA**

# Editor's Message

The only way to learn mathematics is to do mathematics. — Paul R. Halmos.

This profound statement not only serves as a guiding principle but also emphasizes the importance of active engagement in mathematics. It brings me great joy to inform you that starting from August 2024, the Department of Mathematics at the National Institute of Technology Meghalaya is introducing its very own publication, the "*NITM Mathematical Bi-monthly.*"

This publication is a collective endeavor by our students and faculty members, designed to ignite a love for mathematics and offer a stage for students to share their insights. Magazines transform the creative potential of our students into tangible contributions, allowing them to identify and showcase their talents through writing. Through this magazine, we aspire to highlight contributions, departmental events, achievements, and the scholarly work of both faculty and students. I encourage all students to participate by submitting interesting mathematical problems, engaging puzzles, stories, and intriguing facts about mathematicians.

I want to express my deepest appreciation to the editorial team—Bankit, Sanchita, Mehjebin, and Dibyasman—for their tremendous dedication and hard work in making this magazine a reality in such a brief period. Our minds are filled with boundless curiosity, and we are continually striving to explore beyond the known. I wish all our students' immense success as they delve into the magazine's contents and set out on fresh intellectual journeys. May this initiative inspire us all to deepen our grasp of mathematics with steadfast determination.

Thank you, and best wishes.

**Dr. Timir Karmakar**
**Assistant Professor**
**Department of Mathematics**

# Featured articles

## The Riemann Hypothesis: A Mystery That Continues to Inspire

*Mehjebin Wahid, Research Scholar*

### A Puzzle of Simplicity

Have you ever wondered how things that appear simple can be extraordinarily difficult to establish? Mathematics is full of such problems, which are easy to state but profoundly difficult to solve. One of the most fascinating problems is the Riemann hypothesis, a problem that has captivated mathematicians since the 19th century. It lies at the crossroads of number theory, complex analysis, and mathematical physics, and governs the hidden structure underlying the distribution of prime numbers. Since its proposal, the hypothesis has influenced vast areas of mathematics, shaping research in new directions and inspiring new theories. Despite more than a century of sustained effort, the hypothesis remains unproven, standing as one of the most formidable intellectual challenges in modern science.

### The Riemann Zeta Function

Before we dive into our discussion of the Riemann hypothesis, we first need to know about a remarkable function, the Riemann zeta function. The Riemann zeta function or Euler–Riemann zeta function is defined for a complex number $s$ with real part greater than 1 by the absolutely convergent infinite series

$$\zeta(s) = \sum_{n=1}^{\infty} \frac{1}{n^s} = 1 + \frac{1}{2^s} + \frac{1}{3^s} + \cdots$$

What makes the zeta function extraordinary is that it connects two seemingly distant branches of mathematics: analysis and number theory. It was first studied in depth by the Swiss mathematician Leonhard Euler in the 18th century. In 1737, he further proved the remarkable identity

$$\zeta(s) = \prod_{p\ prime} \frac{1}{1-p^{-s}} = \frac{1}{1-2^{-s}} . \frac{1}{1-3^{-s}} . \frac{1}{1-5^{-s}} . \frac{1}{1-7^{-s}} \cdots$$

thereby establishing a profound connection between the zeta function and prime numbers.

Further fascinating properties of the zeta function emerge if we actually try to evaluate the value of the function at different integers. For instance, setting $s = 2$ leads to the well-known Basel problem, whose surprising solution is

$$1 + \frac{1}{2^2} + \frac{1}{3^2} + \cdots = \frac{\pi^2}{6}.$$

One of the most intriguing side stories connected to the zeta function is the so-called Ramanujan paradox. Let us consider the series

$$\sum_{n=1}^{\infty} n = 1 + 2 + 3 + \cdots$$

In the usual sense, this sum clearly diverges to infinity. Yet, through a method known as zeta regularization, this series is assigned the value $-\frac{1}{12}$.

With this background in mind, we are now in a position to turn to our main topic.

## Unveiling the Riemann Hypothesis

The Riemann zeta function is a complex-valued function whose argument can be any complex number except $1$ . It has zeros at the negative even integers, that is, $\zeta(s) = 0$ when $s = -2, \ -4, \ -6, \dots$ These are called the trivial zeros. In addition to these, the zeta function also vanishes for some other complex values of $s$, called the nontrivial zeros. The Riemann hypothesis is concerned with the precise locations of these nontrivial zeros, and asserts that:

The real part of every nontrivial zero of the Riemann zeta function is $\frac{1}{2}$.

## Why Mathematicians Care?

Since the dawn of mathematics, prime numbers have possessed a mysterious allure. The sequence $2, 3, 5, 7, 11, 13, 17, 19, \dots$ is so fundamental, yet their pattern seems astonishingly unpredictable, twisting and turning along the number line with no obvious order. Should the Riemann hypothesis prove correct, primes would exhibit the most regular distribution allowed by mathematical laws. This has momentous consequences, influencing not only the theory of numbers but also real-world applications like cryptography, where the strength of modern encryption hinges on the unpredictable yet structured behavior of prime numbers.

## A Story Still Unfolding

Ever since it was proposed in the 19th century, mathematicians have been striving to establish the conjecture. Although a definite proof has yet to be found, the pursuit has inspired a myriad of new mathematical ideas. Today, the Riemann hypothesis is listed among the seven Millennium Prize Problems identified by the Clay Mathematics Institute of Cambridge, Massachusetts in 2000.

The Riemann hypothesis symbolizes the depth and interconnectedness of mathematics. From the distribution of prime numbers to paradoxical infinite sums, it reveals that mathematics is not a collection of isolated facts but a tightly woven structure. Whether solved soon or decades from now, the pursuit of the Riemann hypothesis continues to enrich mathematics, offering new ideas, tools, and perspectives.

# The "Marvelous Harmony": The Evolution of Euler's Equation

*Wanlangkupar Syiemiong, Research Scholar*

Euler's identity, $e^{i\pi} + 1 = 0$, is often celebrated as the most beautiful formula in mathematics for its elegant connection of five fundamental constants. However, historical research reveals that Leonhard Euler never actually wrote the equation in this famous form. Instead, the discovery was the culmination of nearly two centuries of development in complex numbers, logarithms, and geometry.

## The Early Foundations (1545–1685)

The journey began in 1545 when Gerolamo Cardano first encountered "imaginary" roots while solving cubic equations, though he viewed them as mere auxiliary constructions without physical meaning. By 1572, Rafael Bombelli established the rules for adding and multiplying these numbers, yet they remained outside the standard perception of quantities.

In 1637, René Descartes coined the term "imaginary" and began the algebrization of geometry, allowing algebraic operations to be applied to geometric objects like hyperbolas and spirals. Later, in 1685, John Wallis made the first attempt to represent complex numbers geometrically, introducing a prototype of the complex plane.

## Roger Cotes: The "English Euler" (1714)

A major breakthrough occurred in 1714, when Roger Cotes obtained a verbal form of what we now call Euler's formula:

$$\ln(\cos x + i \sin x) = ix.$$

Cotes discovered this while calculating the surface area of a prolate spheroid, realizing a "strange kinship" between circular and logarithmic functions.

## The Debate Over Negative Logarithms (1712–1747)

For decades, mathematicians struggled to define the logarithm of a negative number. Leibniz argued it must be imaginary, while Johann Bernoulli and d'Alembert mistakenly believed that $log(-x) = log(x)$. Euler eventually resolved this conflict by proving that logarithms of negative numbers are not only complex but multivalued.

## Euler's Synthesis (1743–1748)

Beginning in 1730, Leonhard Euler laid the foundations of complex analysis. In 1743, he used power series expansions of sine, cosine, and exponential functions to formally derive:

$$\cos v = \frac{e^{iv} + e^{-iv}}{2}$$
$$\sin v = \frac{e^{iv} - e^{-iv}}{2i}$$

While Euler derived the relationship $e^{\mathrm{iv}} = \cos v + \mathrm{i} \sin v$, he did not highlight the specific case of $\mathrm{v} = \pi$ as a standalone identity. However, he introduced the standard notation we use today:

- $e$ for the base of natural logarithms (1728)
- $\pi$ for the ratio of a circle's circumference to its diameter (1736)
- $i$ for the imaginary unit (1777)

The evolution of Euler's equation demonstrates that mathematical discoveries are rarely the work of a single person in a single moment. It took the geometric insights of Cotes, the analytical rigor of Euler, and centuries of debate over the nature of imaginary quantities to produce the formula that today carries a near-mystical significance.

## References


[1] R. C. Archibald, A. L. Lowell, W. E. Byerly, A.B. Chace, Benjamin Peirce, The American Mathematical Monthly. 32 (1925), 1, 1–30.
[2] Sinkevich, Galina I. “New Discoveries in the History of Euler’s Equation.” *Filomat*, vol. 39, no. 6, 2025, pp. 1927–44.

# Research Publications

1. Aritra Narayan Hisabia and Manideepa Saha, New Properties of Semipositive Matrices and Polyhedral Cones, ***Operators and Matrices***, Vol 19, No 2(2025), 275-294.

# Problems for Readers

The following problems are open to all the readers to solve:

**Problem 1. (Proposed by Dr. Timir Karmakar)**

Calculate $e$ with an error of at most $10^{-7}$.

**Problem 2. (Proposed by Dr. Timir Karmakar)**

The approximation $x \approx sin\ x$ is sometime used for small values of $x$. How good is it if we only use it for $|x| < 0.001$? Within this interval when is $x < sin\ x$ and when is $x > sin\ x$ ?

**Problem 3. (Proposed by Dr. Timir Karmakar)**

The first two terms of the Taylor series for $\sqrt{x}$ at $x = 1$ are $\frac{1}{2} + \frac{1}{2}(x - 1)$. If we approximate $\sqrt{0.95}$ using that polynomial, how accurate will the results be? Use one of the theorems we have had, and then compare the answers you get from the polynomial and $\sqrt{0.95}$ using a calculator? Are these consistent with the theoretical results?

**If you can solve the problems, then send your answer to**

✉ tkarmakar@nitm.ac.in

**If you provide the correct solutions, your name will be published alongside the best solutions in the next edition!**

# Departmental Activities

## World Statistics Day 2025

The Department of Mathematics organized a pre-celebration of the World Statistics Day 2025 at Senate Hall, NIT Meghalaya on 17 October, 2025. Celebrated once every five years worldwide, it emphasizes the importance of accurate, reliable, and timely statistics. As part of the celebration, an expert talk was delivered by Prof. Probal Chaudhuri (Recipient of Shanti Swarup Bhatnagar Prize for Science and Technology), Indian Statistical Institute, Kolkata. The theme focus of the year 2025 is “High-quality statistics empower citizens, policymakers, and businesses to make informed decisions, shining light on challenges that might otherwise remain unseen and supporting the mission to leave no one behind.

Title of the Talk: *Simulated Annealing: Minimization by Monte Carlo*

# World Statistics Day 2025

17.10.2025




Boltzma
limiting
chain)c
Markov


WORLD STATISTICS DAY 2025

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