Aadesh Tikhe

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About Me!

I'm obsessively curious. I can't see a mathematical pattern without wanting to pull it apart and see if it connects to something else. My work is a mix of rigorous research (published on OEIS, presented at conferences) and experimental coding projects where I just try things. I think with whatever knowledge I have, recombine ideas in weird ways, and occasionally stumble onto something that works. I'm not just interested in solving known problems. I want to find the problems no one's asking yet. My north star is building things that are both mathematically elegant and practically useful.

Goal: Advance interpretability in deep learning by applying insights from number theory and algorithmic analysis to neural network behavior. I aspire to build ethical, human-centered systems that simplify complexity and deepen understanding.

Practice: Committed Vipassana meditator — completed 3 ten-day silent residential courses and served in 1. A discipline that shapes how I approach sustained, deep-focus research.

Research Highlights

- **A consistent method across four independent research lines:** take a classical discrete structure (Pascal's triangle, perfect squares, prime factorization, spatial polytopes) and apply difference or floor/ceiling operations to expose a hidden unifying structure underneath it.
- **Layered Pascal Transform Triangles** unified five previously disconnected OEIS sequences (including one of the author's own closed-form contributions, A259569) under a single generating framework — closing a gap that had gone unnoticed since Voigt (1901) and Piza (1947).
- **DSRS** (floor/ceiling structures on perfect squares) was reviewed by **Simon Plouffe** (OEIS co-contributor), who called it "not trivial" and forwarded it to **Jean-Paul Allouche** (CNRS) for further analysis.
- **C2 Conjecture** — a recursive prime decomposition result verified across 1 billion+ primes with zero counterexamples — drew sustained engagement from **Paul Lockhart** (*A Mathematician's Lament*), who assessed it as comparably difficult to open problems like $p = n^2 + 1$.
- **AIDEAS-OEIS** extends this same instinct — pattern-checking and structural validation — into a working AI system, applying LLM + symbolic verification to flag errors across 2,000+ OEIS entries.

Education & Academic Achievements

Amity University, Mumbai *Aug 2023 – June 2026*
Bachelor of Computer Applications (BCA)

- CGPA: 8.39 / 10.0 (till date)
- **Key Coursework:** Operating Systems, Theory of Computation, Comparative Learning Algorithms, Linear Algebra for ML

Wockhardt Global School (IB), Chhatrapati Sambhajinagar *May 2017 – May 2022*
IB Diploma Programme (DP), 2020–2022 — Final Grade: 30 / 45
IB Middle Years Programme (MYP), 2017–2020 — Final Grade: 85%
Head Boy & Leadership Roles

- **Extended Essay:** Analyzed the time complexity of the NegaMax algorithm (Strazilla) vs. Alpha-Beta Pruning (NNUE Stockfish)
- **Main Subjects:** Computer Science HL, Mathematics: AA HL, Business Management HL
- Led school initiatives as **Head Boy**, including playground renovation and MUN 2020 organization
- Represented school at **Harvard Model United Nations (HMUN) 2018**, an international MUN conference
- **Chaired UNICEF at WGS MUN** 2021; facilitated engaging agendas and resolutions
- Served on the **Board of Directors, Rotaract Club Aurangabad**, fostering leadership and collaboration

- Participated in the **Youth India Express Summit**, a national-level youth leadership event
- Led **Stage Management Team at TEDxYouth@WGS**; oversaw technical execution and speaker coordination
- Initiated **Stevia The Developer** (2019–2020): Researched and promoted Stevia farming in Marathwada; grew and tested plants independently, raised awareness among farmers, and overcame stage fear by addressing diverse audiences on health and economic benefits

Curiosity-Driven Research & Publications

Probability in Regular 2-Polytopes *Aug 2022 - Dec 2024*

- Independently conducted research from 2022–2024 on a novel spatial probability model within regular 2D polytopes
- Proposed a Periodic Cotangent Function to model the probability distribution of a 0 polytope relative to the centroid and boundary
- Presented this work at the **Indian Mathematical Society Conference** (MIT-WPU, Pune) on **25 December 2024**, gaining valuable feedback and insights
- Full explanation available via presentation video: youtu.be/Vwe1ojJnU_A; written paper still in progress

Layered Pascal Transform Triangles: A Unified Framework for Iterated Finite Differences on Monomials *Feb 2024 – 2025*

- Organized iterated forward differences $\Delta^{\ell}(x^p)$ as a parametrized family of triangular coefficient arrays indexed by layer ℓ, where Layer 0 recovers classical Pascal's triangle and higher layers yield transformed structures retaining Pascal-like organization
- Derived a closed-form coefficient generator $C_{p,\ell}(v)$ that directly produces individual polynomial coefficients without requiring polynomial expansion or Stirling number basis conversion, enabling $O(\ell)$ access to specific coefficients when $p \gg \ell$
- Unified five previously disconnected OEIS sequences — A259569 (the author's own closed-form contribution), A001117, A000918, A000919, and A000920 — as fixed-layer projections of a single underlying structure
- Connected the framework to historical work by Voigt (1901, "Konformanten") and Piza (1947, "D-coefficients"), showing both contain numerical values matching Layers 2 and 3 but lacked systematic organization, direct coefficient generation, or unification across sequences
- Entire construction uses only elementary combinatorial tools (binomial coefficients, forward difference operator), accessible at the undergraduate level while providing computational utility for sparse coefficient extraction
- Originated from informal exploration of Pascal's triangle patterns in 2023; developed into a formal framework starting February 2024
- Preprint archived on Zenodo with DOI: 10.5281/zenodo.18256084

Fibonacci Numbers from Pascal Rows: A Ternary Coefficient Approach *Apr 2025 – Present*

- Established novel algebraic framework for transforming Pascal triangle rows into Fibonacci numbers through systematic coefficient selection where $c_i \in \{-1, 0, 1\}$
- Developed six complete enumeration strategies with CUDA GPU acceleration, achieving exhaustive analysis up to computational limit 3^{22} (31.4 billion combinations)
- Designed a greedy algorithm leveraging palindromic symmetry and center-dominance properties as a candidate $O(n)$ heuristic for the exponential $O(3^n)$ search space
- Later identified cases where the greedy heuristic does not reliably reproduce correct coefficient selections; currently investigating the boundary conditions under which it holds and does not hold
- Preprint archived on Zenodo with DOI: 10.5281/zenodo.17412193
- Code implementation available at GitHub Repository

Discrete Square Residual Structures (DSRS): A Framework Where Every Integer Reveals Its Own Connection to π *June 2025 – Sept 2025*

- Introduced a purely arithmetic framework using floor and ceiling operations on perfect squares: for fixed μ, defined $U(n) = \lceil n^2/\mu \rceil$ and $L(n) = \lfloor n^2/\mu \rfloor$, producing infinite products $P(\mu) = \prod_{n=n_0}^{\infty} \frac{\Delta_L(n)}{\Delta_U(n)}$

- Computational evidence up to $N = 10^6$ and $\mu \leq 70{,}000$ reveals a sharp dichotomy: $P(\mu) \to \pi/2$ when $\mu \not\equiv 0 \pmod 4$, and $P(\mu) \to 1$ when $\mu \equiv 0 \pmod 4$ or $\mu = 1$
- Provided structural argument showing all non-multiples of 4 reduce to the $\mu = 2$ case (a floor-ceiling encoding of the Wallis product) via residual cancellation, with increasing entropy for larger μ requiring more terms to stabilize
- Identified OEIS correspondences: $\mu = 2$ produces A052928, A007590, A000982, A063196; $\mu = 3$ yields A004523, A000212, A008810, A130823; $\mu = 4$ yields A008619, A002620, A004652, A161239
- Research reviewed by **Simon Plouffe** (OEIS co-contributor, Inverse Symbolic Calculator), who described the work as "an interesting topic" and "not trivial," forwarded the paper to **Jean-Paul Allouche** (CNRS, expert in infinite products and automatic sequences) for further analysis, and offered an ArXiv recommendation
- Preprint archived on Zenodo with DOI: 10.5281/zenodo.17519713; complete source code at GitHub Repository

A Recursive Prime Decomposition Conjecture (C2) *May 2026 – Present*

- Proposed Conjecture C2: for every prime $p > 2$, there exist $q, r \in \{1\} \cup \{\text{primes}\}$ with $q < p$ such that $p = 2q + r$ or $p = 2q - r$; since r also decomposes, every prime unfolds into a binary tree terminating at leaves of 1
- Formulated the strictly stronger C2-Additive variant: additive only ($p = 2q + r$, $q < p/2$), eliminating $\pm$ ambiguity and producing canonical single-direction decomposition trees
- Conjecture is strictly stronger than Lemoine's conjecture (1895) restricted to the prime domain — C2 requires $q < p$, Lemoine does not; if C2 is proved, Lemoine for primes follows as a corollary
- Verified C2 for all 1,008,309,544 primes (up to $\sim 2 \times 10^{10}$) with **zero counterexamples**, using a two-stage CUDA pipeline on NVIDIA RTX 5070: sliding-window search (500 candidates) followed by brute-force on failures with Miller-Rabin primality testing, achieving ∼150M primes/sec throughput; built interactive HTML visualizations of recursive decomposition trees for exploratory analysis
- Reviewed by **Paul Lockhart** (mathematician, author of *A Mathematician's Lament*), who assessed the conjecture as "possibly even more difficult" than classical Diophantine problems like $p = n^2 + 1$, situating it within the structural gap between additive and multiplicative number theory
- Posed the open question: does iterative generation from $S_0 = \{1, 2\}$ via $2q + r$ produce exactly the primes? If yes, this would yield a structural definition of primality independent of the Fundamental Theorem of Arithmetic
- Preprint archived on Zenodo with DOI: 10.5281/zenodo.20225703; source code at GitHub

Blog & Expository Writing

Efficient Fibonacci Computation: Édouard Lucas's Pascal Triangle Method (Medium) *Dec 2024 – Apr 2025*

- Analyzed Lucas's combinatorial approach for calculating the exact n^{th} Fibonacci number without recursion, comparing computational complexity against classical methods (matrix exponentiation, Binet's formula, naive recursion)
- Demonstrated feasibility in resource-constrained environments; code available at GitHub Repository
- Full write-up: Medium Blog

Escaping the Killer by Always Getting Closer (Self-published) *Dec 2025*

- Expository paper exploring how a locally "greedy" rule (always decrease distance to target) can produce paths of arbitrarily large — even infinite — total length, using the Archimedean spiral as the constructive example
- Derived the closed-form arc length formula $L = \frac{\pi R^2}{m}\sqrt{1 + \left(\frac{m}{2\pi R}\right)^2} + \frac{m}{4\pi}\ln\left(\frac{2\pi R}{m}\left(1 + \sqrt{1 + \left(\frac{m}{2\pi R}\right)^2}\right)\right)$ and showed $L \to \infty$ as the radial step $m \to 0^+$
- Connected the result to gradient descent pathologies: locally improving loss at every step does not bound total path complexity or guarantee convergence in practical time
- Available at aadesh24.com

Projects and Contributions

AIDEAS-OEIS — AI-Driven Evaluation of Arithmetic Sequences in OEIS *Jan 2026 – May 2026*
(Python, LLMs)

- Developed a hybrid verification system combining **Qwen2.5-Math:7b** (served locally via Ollama) with SymPy symbolic computation and LODA program synthesis to automatically interpret, validate, and flag erroneous formulas across OEIS entries
- Built a three-verifier pipeline: LODA algorithmic verification (∼19% hit rate) → LLM formula-to-code generation in Restricted Python sandbox → SymPy closed-form evaluation, reconciled via Bayesian classifier with confidence scores
- Validated 2,041 OEIS sequences: **51.6%** HIGH_CONFIDENCE_VALID, 40.3% NEEDS_HUMAN_REVIEW, 8.1% LLM_INTERPRETATION_ERROR — with Wilson 95% confidence intervals confirming statistical stability
- Designed with crash-resume safety (SQLite persistence per sequence), Docker containerization, and CSV/JSON /SQLite export for community-scale deployment
- BCA final-year capstone project (7 credits, scored 90/100); open-source at GitHub Repository

OEIS Contributor – Integer Sequence Research *oeis.org/wiki/User:Aadesh*

- **Authored closed-form formula for OEIS** A259569; later shown to be a Layer 2 projection of the author's unified Pascal transform framework (see Layered Pascal Transform Triangles above)
- **Corrected mathematical inaccuracies in** A130823, improving sequence integrity and documentation
- Active contributor on the OEIS Wiki — a globally recognized encyclopedia of integer sequences

Manim Codes for Math Research Presentation (Python [Manim], C++) *Ongoing*

- Built 10+ Manim animations to visualize novel mathematical concepts (Fibonacci methods, probability distributions), garnering 500+ views on YouTube.
- Used in YouTube presentation: Watch here.
- GitHub Repository

Django-POL_Agro Web Platform (Python, HTML, CSS) *2021 – 2022*

- Built for a client during IBDP; developed a full-stack Django-based CRUD platform.
- Connects fertilizer wholesalers with farmers to streamline queries and product access.
- Hosted on localhost for demo; source code: GitHub Repository.

myBash – Bash & Linux Commands Repository (Shell) *Ongoing*

- A collection of useful Bash commands, Linux one-liners, and `.bashrc` customizations. Includes a cron job for auto-updating Homebrew monthly. Personal notes and hands-on summaries from tutorials.
- GitHub Repository

Key Skills

Languages: C++, C, Python, SQL, Bash, Cuda, Rust
Libraries & Frameworks: Django, Manim, Pandas, NumPy, Matplotlib, Seaborn, Scikit-learn, Pygame
Tools & Platforms: Git, Docker, AWS, Google Colab, LaTeX.
Core Strengths: Mathematics, Data Structures & Algorithms, Artificial Intelligence, Machine Learning, C Programming, Operating Systems (incl. Bash Shell), and Computational Theory
Hobbies & Interests

- Painting – Creative expression through various mediums.
- Cycling & Hiking – Fitness and nature exploration.
- Piano – Self-taught; composed and performed a piano cover, published on YouTube.
- Meditation – Vipassana practice for mindfulness.
- Mathematical Puzzles – Exploring number theory and logic.

Spoken Languages: English, Hindi, Marathi, German (A1 level)

Specialised Courses & Certifications

- **Discrete Mathematics – NPTEL** (IIT/IISC, Jan–Apr 2026): 12-week course; scored **91/100** (Elite certification). Topics include combinatorics, graph theory, recurrence relations, and formal logic. Certificate Link
- **Theory of Computation – NPTEL** (IIT/IISC, Jan–Apr 2026): 12-week course; scored 60/100. Topics include automata theory, context-free grammars, Turing machines, and decidability. Certificate Link
- **Machine Learning Specialization – Andrew Ng (Stanford University, DeepLearning.AI):** Completed comprehensive training in supervised learning, advanced algorithms, and unsupervised learning including recommender systems and reinforcement learning. Certificate Link
- **Certified Lean Six Sigma (White Belt):** Gained process improvement experience using Minitab, Excel, Python, Lucidchart, PowerPoint, and Microsoft Project.