Anay Aggarwal

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Education

Stanford University | B.S. Mathematics & Geophysics (incoming) *Stanford, CA · 2026–2030*

Westview High School | National Merit Scholar *Portland, OR · 2026*

Graduate-level coursework: Real Analysis, Abstract Algebra, Probability Theory, Number Theory. AP Scholar with Distinction; SAT 1570, ACT 35; GPA 4.0.

Honors & Awards

- **ISEF Grand & Special Award Winner** — 2nd place, Mathematics, in both 2024 and 2025 (additional awards worth $8,900).
- **MIT RSI Scholar** (2025) — ∼100 selected worldwide.
- **MIT PRIMES-USA Scholar** (2024, 2025) — ∼40 selected nationally.
- **Lehmer Prize**, West Coast Number Theory Conference, 2023; presented at NSA HQ, Fort Meade.
- **USAMO Qualifier & Honorable Mention**; **USAMTS Top Scorer**, Year 34 (74/75); Canada/USA Mathcamp (120 selected worldwide).

Publications & Preprints

- **On primality and atomicity of numerical power monoids**. With F. Gotti, S. Lu. arXiv:2412.05857 (submitted).
- **Fast Modular Exponentiation with Factored Modulus**. With M. Isaacs. arXiv:2401.10497 (submitted).
- **Resolution of a conjecture on Shifted Rényi Divergence**. Preprint, arXiv:2608.07842.
- **Dominance of Monomial Ideals**. With S. Kim, G. Alesandroni (submitted).
- **Weak-Error Analysis of SLMMs for SDEs, Discovery of Dense Unit-Distance Graphs**. In preparation.

Experience

Large Math Initiative | Founding Engineer *Remote · July 2026–Present*

- One of three people (with postdocs J. Shafer, MIT, and G. Gluch, UC Berkeley) building a platform that lets mathematicians point frontier models at open problems and compose model architectures around them; externally funded.
- Own the corpus side end-to-end: built the internet-scale scraper that mines the mathematical literature for open problems and conjectures, producing the structured problem set the platform runs on.
- Beta-tested the platform on live research and used it to resolve an open conjecture in probability, now an arXiv preprint — the system's first end-to-end result.

Hailstorm Prediction for Munich Re | Research Group Contractor *Remote · July 2026–Present*

- Lead the mathematical modeling on a ∼15-engineer team building a low-cost probabilistic hail-forecasting framework for a major reinsurer's catastrophe exposure.
- Approach targets order-of-magnitude reductions in cost and compute versus running full physical ensembles, by replacing repeated simulator calls with a trained surrogate.

AwesomeMath Summer Program | Teaching Assistant *Remote · June–August 2026*

- Taught hundreds of students in graduate-level algebra and number theory; prepared problems and graded homework and exams.

Projects

Dense Unit-Distance Graphs | MIT PRIMES-USA *Remote · 2025*

- Matched the state-of-the-art on dense planar unit-distance graphs with far less compute: reproduced the densest known graphs up to 30 vertices in under 30 minutes on 11 laptop cores (prior work used diverse beam search), and found novel dense graphs in 3D and on the sphere.
- Built the search framework behind it, implementing and comparing PPO reinforcement learning, simulated annealing, and numerical optimization — in the lineage of DeepMind's FunSearch and Wagner's RL-for-combinatorics.
- Reduced the infinite search space to a finite one via number-field lattices (Sage); motivated by the Hadwiger–Nelson problem and Kochen–Specker sets (quantum contextuality). Adv. A. Gritsevskiy & Dr. J. Geneson; code; submitted.

arXiv Conjecture Extraction Pipeline | Large Math Initiative *Remote · 2026*

- Built a GCP pipeline that extracts open conjectures from ∼1.3M arXiv papers, parsing raw LaTeX source and classifying statements with Gemini via Vertex AI batch inference, into a queryable BigQuery database.
- Engineered for cost control at scale (batch inference, budget guardrails, incremental reprocessing), yielding a structured corpus of open problems usable as a research and evaluation target for math-capable models.

Weak-Error Analysis of SDE Solvers | MIT RSI *Cambridge, MA · 2025*

- Built a framework (Kolmogorov backward equation + linear recurrences) that computes the full weak-error expansion of arbitrary stochastic linear multistep methods on Itô and Lévy-driven SDEs.
- Used it to construct multistep schemes that beat standard one-step solvers in weak accuracy for small-noise SDEs; confirmed the gains in numerical simulations.
- 1 of ∼100 selected worldwide for RSI; adv. Joonsoo Lee; presented to MIT math dept., including Dr. John Urschel and Dr. Tanya Khovanova.

Fast Modular Exponentiation | arXiv preprint *Portland, OR · 2023–2024*

- Designed and analyzed a modular-exponentiation algorithm exploiting a known factorization of the modulus, achieving $O(\sqrt{\log m})$ steps for an infinite family of moduli versus $O(\log m)$ for repeated squaring.
- Extended it to matrix exponentiation and general linear recurrences, improving Fiduccia's and Bostan–Mori's methods over $\mathbb{Z}/m\mathbb{Z}$. With M. Isaacs; arXiv:2401.10497; submitted.

Numerical Power Monoids | arXiv preprint *Remote · 2023–2024*

- Answered open questions of Geroldinger and Tringali on the atomic density of numerical power monoids; showed the atom-size distribution's moments converge to those of a $Binomial(n, 12)$ and proved near-non-existence of primal elements. With Dr. F. Gotti (MIT), S. Lu; arXiv:2412.05857; submitted.

Newton Academy | newton-academy.vercel.app *Remote · 2025*

- Founded a paid summer math-bootcamp startup: designed, built, and shipped the React + TypeScript (Vite) marketing site and application app — Vercel serverless functions writing to a Google Sheets backend — end-to-end in under a day.
- Drove 1,000+ application impressions in the first week through social-media marketing and filled 3 sold-out cohorts of 10 students at $599 each (∼$18K revenue). Code.

ML for Thyroid-Cancer Recurrence | MIT PRIMES-USA *Remote · 2024*

- Benchmarked six classifiers (RF, SVM, ANN, LR, KNN, XGBoost) on the UCI DTC dataset in R, cut the feature set from 16 to 5 via PCA/FAMD (95% accuracy), and added a Bayesian ANOVA / ROPE comparison across ROC-AUC, accuracy, and Brier score. Adv. Dr. Marly Gotti.

Teaching & Leadership

Newton Academy | Founder & Instructor *Remote · 2025*

- Taught 3 summer-bootcamp cohorts of 10 students, delivering the competition-math curriculum I designed.

Oregon Math Circle | Co-Leader, A-Team Captain *Portland, OR · 2022–Present*

- Rebuilt Oregon's largest competitive math club post-COVID, growing it from 15 to 70+ students; authored 500+ original contest problems.
- Led Oregon to 3rd (ARML B, 2023), 18th (ARML A, 2024), and 23rd at HMMT (2025) — among the state's best-ever finishes.

Sunshine Elite Education | Instructor *Remote/In-Person · 2022–Present*

- Taught online classes preparing students for MOEMS, MATHCOUNTS, AMC 8/10/12, AIME, and USA(J)MO, plus a week-long in-person MATHCOUNTS summer camp.

The Math Aces | Founder *Remote · 2020–2024*

- Founded and ran a free online math-enrichment org serving hundreds of K–8 students: built curricula, taught classes, and managed volunteers.

Skills

Languages: Python, C++, Java, R, TypeScript, Mathematica, SageMath, LaTeX.

ML & Numerical: PyTorch, Stable-Baselines3, Gymnasium, NumPy/SciPy, pandas, scikit-learn, NetworkX; reinforcement learning (PPO), MCTS, simulated annealing, surrogate modeling and uncertainty quantification, stochastic modeling.

Infrastructure & Web: GCP (Vertex AI batch, BigQuery), large-scale LLM API pipelines, web scraping, Git; React, Vite, Vercel serverless functions.

Interests: Ski mountaineering, backcountry skiing (climate-tech curious).