Arnav Kumar

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Achievements

- Technical Achievement award, **UW Game Dev Club Game Jam** ..... Fall 2024
- 335th (top 10%), with score 26, **William Lowell Putnam Mathematical Competition** 2022
- 10th in Canada, **Asian Pacific Mathematics Olympiad (APMO)** 2022
- 11th in Canada, **Canadian Association of Physicists High School Exam** 2022
- 12th in Canada, 17th internationally, **Sir Isaac Newton Physics Exam** ..... 2021 - 2022
- 18th in Canada, 2 time qualifier, **Canadian Mathematical Olympiad (CMO)** ..... 2021 - 2022
- Canadian Honour Roll, Top in Alberta, **Canadian Open Mathematics Challenge** ..... 2017 - 2022
- 2 time qualifier, **American Invitational Mathematics Exmaination** ..... 2021 - 2022
- Part II winner, 3 time part I winner, **Alberta High School Mathematics Competition** ..... 2018 - 2022
- Invited to write, **United States of America Mathematical Olympiad (USAMO)** 2022
- Bronze medalist for machine learning project on prognosing IPF, **Canada Wide Science Fair** 2021
- Estuary Sponsor Prize Winner, **UofTHacks X** 2023

Experience

Software Engineer @ Trend Micro Jan 2025 - Apr 2025
Kanata, ON.
- Spearheaded Alicloud infrastructure deployment using Terraform, and developed functionality for disk snapshots.
- Engineered utility functions for Alicloud's Object Storage Service and Parameter Store, optimizing cloud workflows and enhancing secure data management.
- Developed serverless functions to send scan metrics and results to the backend, helping identify details about customer errors and cutting customer costs by 50%.

Combinatorics Researcher @ University of Waterloo May 2024 - Aug 2024
Waterloo, ON.
- Authored a paper (The dimension of sparse random graph orders) in pre-print in arXiv (https://arxiv.org/abs/2504.19029).
- Worked on novel research exploring random graph orders and poset dimension utilizing configuration models, approximation techniques, convergence in probability, devising constructions, and computationally searching for counterexamples.
- Developed two theorems about the nature of poset dimension for bipartite posets based on the dimension of induced subposets and for random graph orders.
- Engaged in regular meetings to discuss and advance research, demonstrating capacity for effective collaboration.

Blockchain Software Engineer @ Dandelion Networks May 2023 - Aug 2023
Online
- Developed and implemented an enhanced lattice syncing and node discovery algorithm in Go, querying peers with Protocol Buffers to identify and address missing blocks in the local lattice with secure and concurrent updates.
- Created and deployed a locally hosted debugging website in Go to be run by each node of the blockchain network.
- Designed multiple mock servers, clients, and services with Ginkgo and Gomega to test the algorithms.
- Created Jenkins pipeline which automatically build, test, vet, and format pushed code to catch regressions.

Data Science Intern @ Tektorch.ai Apr 2022 - Aug 2022
Online
- Extracted features such as job title, location, classification, and pay from a job listing website using Python, Beautiful Soup 4, NumPy, and Pandas to create a dataset for analysis.
- Developed an end-to-end data visualization pipeline to ingest data and display trends using Matplotlib and NumPy.

Math Competition Teacher @ Webber Academy Aug 2021 - June 2022
Calgary, AB.
- Taught 4 children competition mathematics every week for 90 minutes after school.
- Covered topics including tricks in algebra, number theory, inequalitites, and some basic combinatorics.

Coding Instructor @ Code Ninjas West Springs Mar 2022 - Apr 2022
Calgary, AB.
- Taught over 45 students to complete programming challenges in Scratch, MakeCode, and JavaScript.
- Managed the progress of the students and directly relayed feedback to the manager.

Student Council President @ Webber Academy Sep 2021 - Jun 2022
Calgary, AB.
- Organized numerous successful school events such as trivia nights, dances, and tournaments.
- Lead monthly school assemblies, and weekly general student council and student council exercutive meetings.
- Reported all of the student councils activities and event proposals to the prinicpal weekly.

Machine Learning Research Intern @ University of Alberta Jul 2021 - Aug 2021
Online
- Trained and employed Natural Language Processing (NLP) models to help determine the cause of a change in depressive language in Tweets as part of a psychology study.
- Created an evaluation framework with graphs and videos to analyse subject mouse position data during exams.
- Developed automation pipeline in Bash to reduce time spent by 20× on the application of the evaluation framework.

Education

Candidate for BSc. Computer Science (3rd year) @ University of Waterloo 2022 - Present
Waterloo, ON.
- 4.0 GPA, all advanced level courses, and term distinction.
- Received the Ronald G. Dunkley National Scholarship ($18,000), the President's Entrance Scholarship ($3,500), the NSERC undergraduate research scholarship ($6,000), and the Cenovus Energy STEM Scholarship ($18,500).

High School Diploma @ Webber Academy 2008 - 2022
Calgary, AB.
- President of the Student Union and annual merit scholarship recipient.

Presentations

Dimension of Posets and Random Graph Orders @ University of Waterloo Aug 2024
Waterloo, ON.
- A presentation of work completed during my research term under Jane Gao.

Streams and Lazy Evalutation @ Webber Academy Programming Club Oct 2023
Calgary, AB.
- An introduction to simulating infinite lists with streams and their manipulation.

On the Catalan Numbers @ Webber Academy Math Society Oct 2023
Calgary, AB.
- A derivation of the closed formula for the Catalan Numbers and examples of well known problems where the Catalan Numbers appear.

Introductory Combinatory Logic @ Webber Academy Math Society Oct 2022
Calgary, AB.
- Understanding how combinators interact with each other and showing natural numbers and their operations can be expressed as combinators.

Attended Programs

- **International Summer School for Young Physicists (ISSYP)** @ Perimeter Institute ..... Summer 2021
- **Auckland Lloyd Invitational Math Camp** @ University of Waterloo ..... June 2021
- **Quantum Cryptography School for Young Students (QCSYS)** @ IQC, University of Waterloo ... Summer 2020

Projects

Software Rasterizer | *Elm*
- Created rasterizing essentials such as drawing shaded triangles pixel by pixel
- Implemented a projection algorithm to view 3D objects from a camera.

Renovating the Labyrinth (Game) | *JavaScript*
- Solo submission made in 72 hours with vanilla JavaScript on an HTML canvas for the UW Game Dev Club's fall 2024 game jam; voted winner of the technical achievement award.
- Built a real time optimized ray caster with ordered Bayer matrix dithering.
- Programmed 2D rigid body collision behaviour and a randomized Prim's algorithm for map generation.

Software Raycaster | *JavaScript*
- Built a raycaster that renders a specified scene to a canvas element.
- Enabled options for Bayer matrix dithering, scene customization, and different casting algorithms.

Bloom (Game) | *Godot, GDScript*
- Team submission made in 72 hours with Godot for the UW Game Dev Club's spring 2024 game jam.
- Implemented colour mixing, screen wrapping, movement, and flower spawning mechanics.

InterPlanetary File Explorer (IPFE) | *Go, Python, Scikit-learn, Estuary, Co:here, Three.js*
- Created vector embeddings for files with their headers using Co:here's NLP embeddings to facilitate classification of files.
- Performed principal component analysis of the vector embeddings to reduce the dimensionality from 4096 to 3 to be plotted and displayed interactively in 3D space using Three.js.

Prognosing Idiopathic Pulmonary Fibrosis (IPF) | *Python, Tensorflow2, Pandas, Scikit-learn*

- Implemented an auto-encoder, linear regression, dense neural network, and bayesian model in order to accurately predict future lung capacity and give a confidence value using initial lung capacity data, age, sex, smoking status, and more.
- Obtained a Laplace Log Likelihood score of -6.9 (much better than the baseline score -8.1) with $\sigma \approx 200$mL.

Custom Language Interpreter | *Haskell*
- Created an expression evaluator for a self-made stack-based language.
- Implemented zipper traversal to determine which part of the stack has already been processed.

CLI Chess | *Haskell*
- Created a local mulitplayer chess clone in Haskell that can be played in the CLI with the Haskell REPL.
- Developed safe and scalable functions to determine the state of the board and indentify check and checkmate.
- Employed lists as applicative functors and monads to write concise, readable code for determining all valid next moves.

Blackjack | *C++*
- Used object oriented programming to implement a local multiplayer blackjack game with a computer playing as the house.
- Probabilistically optimized the holding value that the computer house uses.