Katherine Avanesov

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Education

California Institute of Technology (Pasadena, CA September 2023 - June 2027)
- Double Major: Physics and Computer Science.
- Cumulative GPA: 4.2
- Relevant coursework: Computer Systems, Software Design, Data Structures and Algorithms, Discrete Mathematics, Computational Physics, Quantum Computation, Mathematical Chaos, Mathematical Methods in Physics.

Experience

Princeton CMS Group (2024-Present)
- Summer '24 and '25: 10 weeks on-site CERN site in Geneva, Switzerland with short-term User contract.
- Led the development of neural network-based classifiers for particle detection. Improved signal selection by over two orders of magnitude. Designed statistical framework for background estimation.
- Presented at American Physical Society Global Physics Summit 2025: Search for Long-Lived Particles with Hadronic Calorimeter Depth Segmentation.

Automated Anomaly Detection System for Data Quality Monitoring at CERN (2024).
- Developed a web-based autoencoder anomaly detection system to assist in real-time data quality monitoring for LHC collisions (~40 million per second).
- System partially integrated into the Run Registry, with ongoing testing before deployment in the official Data Quality Monitoring (DQM) workflow.

Projects

Doodle Jump (2025).
- Built a C physics engine with collision detection and gravity to create a game similar to the original Doodle Jump, using SDL for rendering and input, and created HTTP server to host game online.
- Game includes keyboard controls; computer-controlled enemies; clear in-game, menu, and stats screens managed by a simple decision-tree structure; progressive difficulty across levels; timed rounds; and selectable player skins.

Java Virtual Machine (Java interpreter) (2025).
- Implemented a minimal Java Virtual Machine supporting class-file parsing, bytecode execution, and operand stack management; capable of running sorting algorithms and recursive programs; tested on programs such as calculating Collatz trajectories for 100k integers.

Anomaly & Wear Detection on Tool Sensor Data (2025).
- Detected worn and broken tools by processing vibrational velocity and acoustic waveforms into smoothed RMS envelopes, aligning cycles, and computing deviation metrics (RMSD, residual AUC, Pearson's r, cross-correlation, Dynamic Time Warping) to pinpoint the anomalous tool via PCA and K-means clustering.

ML-Enhanced Momentum Strategy (2025).
- Developed and back-tested a long-short equity momentum strategy in Python, using LightGBM Random Forest on multiple momentum horizons and firm-level metrics, and Pandas for data-cleaning and manipulation. Performed regressions and risk analysis to evaluate return persistence, robustness across regimes, and liquidity constraints. Achieved statistically significant alpha (~7% annualised) above standard momentum strategy.

Languages and Technologies

- Skilled in Python, C, C++, SQL, Java.
- Fluent Spanish, French, Russian. Elementary Japanese.

Awards

- 2025 Caltech Margie Lauritsen Leighton Prize for academic excellence in Physics
- 2025 Caltech Hallet Smith Prize for best essay on Literature
- 2025 Bill Gross Business Plan Competition Finalist
- 2025 Taylor Lawrence SURF Research Fellow
- 2024 Caltech Robert F. Christy Prize for an Outstanding Freshman in Physics
- 2024 Samuel P. and Frances Krown SURF Research Fellow
- 2023 Top Gold Round 1 and Silver Round 2 British Physics Olympiad; Gold British Chemistry Olympiad
- 2022 Gold Senior Physics Challenge (Awarded by British Physics Olympiad Organization)