Estella Xu

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EDUCATION

Northwestern University | Evanston, IL — Expected June 2025
Bachelor of Arts in Mathematics and Computer Science
GPA: 3.68/4.0 | **Dean's List**
Relevant Courses: AI & Machine Learning, Scalable Software Architectures, Data Structures, Design and Analysis of Algorithms, Data Science Pipeline, Modern Discrete Probability, Stochastics, Optimization, Networking, Operating Systems, Database Systems, Mathematics in Finance

SKILLS

Technical: Python, C/C++, C#, SQL, JavaScript, R, XGBoost, Pandas, NumPy, TensorFlow, Scikit-learn Amazon Web Services, Git, Linux, LaTeX, Excel
Languages: Fluent in Mandarin

WORK EXPERIENCE

PrizeSole, *Software Engineer Intern* — June - August 2024

- Implemented full-stack features for a startup of 30+ employees to build an online shoe store offering discounts and sweepstakes raffles to subscribers.
- Developed a front-end app using Nuxt.js, using frameworks such as TailwindCSS for an enhanced user interface.
- Built a checkout form using PrimeVue components. Integrated the Stripe API to ensure secure transactions.
- Used AWS Lambda functions with the API Gateway to create serverless back-end services, including functions to add users to the database upon sign-up for efficient and scalable user management.

Northwestern's 80th and 81st Dolphin Show, *Director of Sales and Promotions* — September 2022 - June 2024

- Analyzed sales patterns using Excel to increase ticket sales for the nation's largest student produced musical (100+ members).
- Sold 3,525 tickets with a gross of $61,195, generating more revenue than any previous year of the Dolphin Show.
- Piloted inclusive ticketing with a new pay-what-you-can system, providing 70+ students with reduced price tickets.
- Led a team of 6 members; directed weekly meetings and created video tutorials on Excel features.

TEACHING EXPERIENCE

Northwestern University Dept. of Mathematics, *Teaching Assistant* — September 2022 - Present

- Aided Professors Eugene Kushnirsky with MATH 228-1 (Multivariable Differential Calculus for Engineering), Aaron Peterson with MATH 220-1 (Single Variable Differential Calculus), Cristina Sizemore with MATH 220-2 (Single Variable Integral Calculus), and Sonja Mapes with MATH 230-1 (Multivariable Differential Calculus).
- Taught classes of 20+ students and assisted with challenging worksheets. Prepared additional lectures and solutions to expand upon worksheet material.
- Evaluated homework, held weekly office hours, and recommended study strategies.

Private Tutor — June 2021 - Present

- Taught private students from elementary through adult students in mathematics and English reading and writing.

RESEARCH AND TALKS

All files available here.

Coadjoint Orbits of Extensions of Lie Groups, *Independent Researcher* — June - August 2023

- Wrote a grant proposal and was awarded the Summer Undergraduate Research Grant.
- Conducted an 8-week independent research project to rigorously prove new properties of coadjoint orbits of extensions of Lie groups under the guidance of Professor Santiago Cañez.
- Authored a final paper on the subject.
- Reviewed existing research from 4+ publications and examined patterns in the behavior of certain Lie groups.

Northwestern Dept. of Mathematics Directed Reading Program, *Student* — September 2022 - Present

- Dedicated 4+ hours a week to self-studying measure theory's applications to probability, algebraic geometry, and differential geometry under the guidance of graduate student Colin Fan. Fine-tuned proof writing skills and mathematical reasoning.
- Presented material on smooth manifolds and Lie groups to an audience of students and professors.

Optimal Transport Using Network Flows, *Researcher* — May 2023

- Authored a final paper with another student discussing optimal transport using network flows.
- Addressed the following problem: given a network of supply and demand nodes where each path starts in supply and ends in demand, find the minimum amount of work required to transport resources from supply to demand given the weights of each path.
- Presented the algorithm to solve the problem and explicated an example problem.

TECHNICAL PROJECTS

Repositories linked here.

Advertisement Conversion Modeling — *Python, XGBoost, GridSearchCV, pandas, sklearn*

- Implemented functions to clean conversion and non-conversion datasets using Pandas dataframes. Performed data analysis by writing functions to compare continuous and categorical variables (e.g., conversion by zip code).
- Built one classification model using XGBoost and another using GridSearchCV to predict the conversions and non-conversions of advertisements given features such as zip code, browser, etc.
- Trained and tested the classifier by splitting conversion/non-conversion datasets. Achieved ROC AUC score of 0.88.

Fridge and Grocery Application in Amazon Web Services — *Python, JavaScript, AWS, RESTful APIs*

- Built an application allowing users to keep track of items in their fridge and create grocery lists based on ingredients needed for uploaded PDF recipes. Extracted text from images or non-PDF recipe formats.
- Used S3 to store PDFs and RDS to track users following practices for RESTful APIs. Added user authentication.
- Wrote client-side Python code and AWS Lambda functions to create a "serverless" and event-driven architecture.
- Created a similar project with a web server tier in JavaScript using Node.js and Express frameworks. Applied asynchronous execution programming style.

Python Network Scanning Tool — *Python, Security Protocols (DNS, TLS, HTTP, HSTS), nmap, OpenSSL, nslookup*

- Developed a command-line tool to analyze web domains and evaluate network characteristics and security features.
- Automated the retrieval of network data such as IP addresses, HTTP server details, TLS versions, and root certificate authorities using utilities such as `OpenSSL` and `nslookup`.
- Implemented a JSON reporting framework to present results.
- Ensured portability by managing third-party dependencies and creating a distribution-ready package.

Predictive Modeling of Stock Market Movement — *Python, Random Forest Classifiers, yfinance, sklearn*

- Used Random Forest classifiers to predict daily movements of a given stock or index using the opening and closing price, the volume traded, and the highest and lowest price.
- Used the mean reversion theory by adding additional predictors including the ratio between today's closing price and the rolling average over varying periods of time.
- Backtested the model using growing amounts of data to predict subsequent periods.
- Analyzed market sentiment from news data and included it as a predictor.

Derivative Pricing and Financial Modeling — *Python, Financial Theory, Stochastic Volatility, numpy, matplotlib*

- Developed an options pricing model using Black-Scholes to calculate the prices of European options.
- Calculated the Greeks to assess the sensitivity of option prices to market factors.
- Improved the model to account for volatility fluctuations using Heston's Model.
- Implemented a Monte Carlo simulation to predict portolio values over time. Analyzed historical data and applied Cholesky decomposition to simulate correlated returns.
- Interpreted simulation results by computing measures such as value at risk, variance, and confidence intervals.

Operating System Projects in the Nautilus Kernel — *C, Nautilus Kernel, Operating Systems*

- Implemented schedulers including FIFO, non-preemptive shortest job first, preemptive shortest remaining time first, preemptive static priority, round robin, and stride.
- Prevented concurrency issues by using the spinlock, mutex, and semaphore implementations of ring buffer concurrency that resolved issues with both threads and interrupts.
- Developed a device driver for a parallel port and a GPU.
- Implemented virtual address spaces using x86 paging. Allowed the kernel to manipulate the address space using regions; wrote functions to add/remove/move regions and alter region permission. Handled requests such as switching to and from an address space, invoking exceptions, and adding/removing threads.

Asteroid Game — *Unity, C#*

- Developed a flight-simulator type 3D game in Unity.
- Implemented flight controls and projectile shooting. Added enemy objects and tracking to shoot projectiles at player.
- Used collision mechanics to add shooting mechanisms.

- Added scoring and sound effects.

Jointed Assemblies with Shading and Lighting — *OpenGL, JavaScript, HTML, Shading and Lighting Techniques*

- Implemented several jointed assemblies in 3D via the vertex buffer object.
- Allowed users to navigate 3D space using keyboard and mouse inputs.
- Implemented Phong and Goraud shading and Phong and Blinn-Phong lighting with variable parameters (i.e. RGB values for the ambient, diffuse, and specular terms).
- Added options to change materials.

Navigation using OpenStreetMap — *C++*

- Developed a program to perform basic navigation given a map from OpenStreetMap.
- Implemented a graph class in C++ and used it to read a map by importing nodes and paths.
- Used binary search to output information about the map.
- Implemented Dijkstra's Algorithm to navigate the map.

Simple Structured Query Language — *C*

- Implemented a simple version of SQL.
- Wrote a lexical analyzer turning SQL inputs into storeable tokens. Implemented a parser to enforce syntax rules and an analyzer to enforce semantic rules, detecting any grammatical or conceptual errors in user input.
- Wrote a program to execute and output results of a query, respecting order, operators, functions, and limits.

ADDITIONAL INTERESTS

- Orchestral/Solo Bassoon (former student of Prof. David McGill at Bienen School of Music), Solo Piano Performance (former student of Steinway Artist and speaker Dr. Yelena Balabanova).
- Puzzle-Solving (programmed an algorithm to solve the Magnets puzzle, a puzzle in which the player must fill a grid with magnets given the number of positives and negatives in each row and column).