Curriculum Vitae

Yuan(Friedrich) Qiu

Math & CS @Williams '24 | NSF RIPS-UCLA' 23

CEE RSI-MIT'18 | Ross Math-Ohio Uni'18

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Homepage

RESEARCH INTERESTS

Number Theory, Analysis, Theoretical Computer Science, Algorithms, Computational Complexity Theory, Quantum Computing, Combinatorics,

EDUCATION

Williams College (Annually College Award USD 86000)   Williamstown, MA, USA
B. A. with Major in Mathematics, Computer Science (Honors)   *Jun. 2024*
Honors Thesis: Greedy and Speedy: New Iterative Gray Code Algorithms for Generating Signed Permutations
Advisor: Professor Aaron Williams

Math in Moscow Program/HSE (Remote)   Moscow, Russia
Graduate level of math courses and Research   *Fall 2022, Fall.2023, Fall 2024, Spring 2025*

Budapest Semesters in Mathematics Program   Budapest, Hungary
Concentration on Advanced Pure Mathematics   *Spring 2022*

University of California, Berkeley   Berkeley, USA
Berkeley Summer Session   *Summer 2022*

MIT Schwarzman College of Computing (Remote)   Cambridge, USA
Certificate in Applied Data Science   *Spring 2023*

•*Admitted by Mathematics and Computer Science at These Universities in Undergraduate Application 2019:* St. John's College at Oxford University (Math and CS); *Carnegie Mellon University School of Computer Science; University of California, Berkeley (Math); University of California, Los Angeles (Math)*

Major GPA: 3.82/4.0; Cum. GPA: 3.58/4.0

♦   Quantum Information and Quantum Computation (Quantum Logic and Quantum Probability), Advanced Linear Algebra, Representation theory, Functional Analysis, Probability, Introduction to Topology, Introduction to Homology and Cohomology Theory, Riemann Surfaces, Algebraic Number Theory, Number Theory, Algebraic Geometry, Dance of the Primes (Analytic Number Theory), Abstract Algebra, Graduate Descriptive Set Theory, Independent Research-Quadratic Forms in Analytic Number Theory, Galois Theory, Real Analysis, Complex Analysis, Partial Differential Equations, Advanced Combinatorics, Graduate Graph Theory, Discrete Mathematics, Multivariable Calculus, Operations Research, Differential Equation, Numerical Analysis, Little Questions (Problem Solving), Mathematics of LEGO.

♦   Honors Research in Computer Science, Deep Learning, Theory of Computation, Algorithm Design and Analysis, Data Structure & Advanced Prog., Quantum Algorithms, Machine Learning, Natural Language Processing, Computer Graphics, Human & AI Interaction, Advanced Algorithms, Computer Organization, Principles of Programming languages, Storage System, Applied Data Science (Certificate-MIT)

♦ Quantum Physics, Math Methods for Scientists, General Physics II

GRE Test
♦ GRE Math Subject: 930/990, 95% (*Paper-Delivered Test, September 17, 2022*)
♦ GRE General: 333; Q 170/170, V 163/170 (*On-Site Test, June 27, 2021*)

PUBLICATIONS / PRESENTATIONS / POSTERS

♦ **Yuan Qiu**[1], Sudatta Hor[1], Ellen Chlachidze[1], Triet Ha[1], *Expressibility of Quantum Circuits for Chemistry*, JMM 2024, January 3-5, 2024. **Poster at https://friedrichq2002.github.io/simple-website-template/QuantumPoster.pdf**

♦ **Yuan Qiu**[1], Sudatta Hor[1], Ellen Chlachidze[1], Triet Ha[1], *Benchmarking Quantum Chemistry Circuit Costs for Near Term Quantum Computers*, IBM Quantum Group Symposium in Almaden, August 2023; UCLA IPAM RIPS Symposium, August 2023 **(Oral)**.

♦ Hùng Viêt Chu, Kevin Huule, Steven J. Miller, **Yuan Qiu,** Liyang Shen, *Linear Recurrences of Order at Most Two in Nontrivial Small Divisors and Large Divisors*, Combinatorial and Additive Number Theory (CANT) 2023, May 23-26, 2023 **(Oral)**. **Paper at https://friedrichq2002.github.io/simple-website-template/MathPaper.pdf**

♦ **Yuan Qiu**, *Exploring Properties of Twin Primes and Brun's Theorem*, Mathematics Colloquium at the Department of Mathematics and Statistics, Williams College, February 19, 2024 **(Oral).**

♦ **Yuan Qiu**[1], Aaron Williams[1], *Generating Signed Permutations by Twisting Two-Sided Ribbons*, arXiv:2311.06974v2 [cs.DS] 14 Jun 2024, presented at the 16th Latin American Symposium, Puerto Varas, Chile, March 18–22, 2024, Proceedings of LATIN 2024: Theoretical Informatics, Pages 114-129, Part I, Springer **(Oral). Paper at https://friedrichq2002.github.io/simple-website-template/CSPaper.pdf**

♦ **Yuan Qiu**[1], Aaron Williams[1], *Maximize the Rightmost Digit: Gray Codes for Restricted Growth Strings*, the 19th International Conference and Workshops on Algorithms and Computation, Submitted, February 28 - March 2, 2025. **Paper at https://friedrichq2002.github.io/simple-website-template/CSPaper.pdf**

♦ **Yuan Qiu**[1], Aaron Williams, *Greedy and Speedy: New Iterative Gray Code Algorithms for Generating Signed Permutations*, Honors Thesis Proposal Colloquium at the Department of Computer Science, Williams College, February 2024 **(Oral).**

♦ **Yuan Qiu**[1], Eric Grinberg[1], *Exploring Admissible Complexes of the Radon Transform over Finite Field*, S.-T. Yau High School Science Award in Mathematics (Second Prize), November 1-7, 2018 **(Oral);** CEE Research Science Institute Symposium-M.I.T. **(Oral).**

HONORS AND AWARDS

♦ **William Lowell Putnam Mathematics Competition**	2023, 2022, 2021, 2019
Roughly Top 7%, First Place at Williams College, Team Leader	
♦ **USA Mathematical Olympiad (USAMO) Qualifier (*x 3*)**	2018-2016
Roughly Top 20 Worldwide, Top 1 in China	
♦ **Witte Problem Solving Prize at Williams (only two students awarded)**	2024
♦ **Honors in Computer Science**	2024
♦ **Sigma Xi 2024**	2024
♦ **Williams College Award**	2024-2019
Annually USD 86000	
♦ **Dean's List (x 6)**	Spring 2024-Fall 2020
♦ **Harvard-MIT Math Tournament in February**	2018, 2017
Placed 9th Individual in Geometry, 23rd individual in Algebra and Number Theory, Team Leader	
♦ **S.-T. Yau High School Science Award**	2018
Second Prize in Mathematics	

- **American Regions Mathematics League (ARML)** 2017
  Placed 1st Internationally, Team Leader
- **Stanford-Math League Tournament** 2016
  Placed 1st, Gold Medal, High School Group Individual
- **The Mathematics League** 2017-2012
  Placed 2nd Internationally, Honor Roll of Distinction Certificate (x 6)
- **National Olympiad in Informatics in Provinces (China)** 2017-2015
  First Prize (x 3), Accepted to Winter Camp (x 3)
- **United Kingdom Chemistry Olympiad** 2018
  Placed 14th Internationally
- **USA Chemistry Olympiad** 2018
  Placed 30th Internationally
- **British Physics Olympiad** 2018
  Placed 23rd Internationally
- **Princeton University Physics Competition** 2018
  Bronze Prize
- **National Linguistics Olympiad (China)** 2018
  First Prize

RESEARCH INTERNSHIPS

Benchmarking Quantum Chemistry Circuit Costs for Near Term Quantum Computers Summer 2023-Present
RIPS REU# Funded by NSF and IBM *UCLA Institute for Pure and Applied Mathematics*
Advisor: Dr. Scott Smart, Dr. Ieva Liepuoniute, Dr. Bibek Pokharel, Dr. Mirko Amico   UCLA and IBM Quantum, Almaden

- Was one of 4 selected quantum computing group members (1% acceptance rate 36/3000+) at the UCLA IPAM Research in Industrial Projects for Students REU program funded by NSF and IBM Quantum. Worked with 3 undergraduates to focus on Quantum Computing for chemistry, specifically benchmarking quantum chemistry circuits on quantum simulators under the guidance and support of Dr. Scott Smart (Narang Lab, UCLA), Dr. Ieva Liepuoniute (IBM Quantum), Dr. Bibek Pokharel (IBM Quantum), Dr. Mirko Amico (IBM Quantum).
- Set benchmarks for application-specific metrics to evaluate the efficiency and applicability of the near-term quantum computers. Evaluate the computational cost of executing various quantum chemistry circuits in relation to the topology of IBMQ quantum device connections, type of native entangling interactions, and noise overhead.
- Explore the cost and depth of quantum chemistry circuits to determine which problems are more suited to which hardware. Determine the noise cost of running a particular circuit by dividing circuits into layers of one-qubit and two-qubit operations, and calculate the noise overhead required to reduce observable measurements of that circuit to noise-free values.
- Analyze the effect of adding repeating layers on the expressibility of parametrized quantum circuits for both hardware-efficient and chemistry-inspired circuits. Experiment on the effect under both ideal and noisy conditions, and extend the result on more qubits and higher circuit depth with supercomputer executions.
- Investigate the circuit depth of prototypical quantum chemistry circuits and present ideal layouts for certain connectivities.
- Propose a new metrics that is more representative of chemistry applications and examine its correlation with the performance of quantum chemistry.
- Presented research at the IBM Quantum Group Symposium in Almaden and the IPAM RIPS Symposium at UCLA.
- Accepted and Invited for poster on Expressibility of Quantum Circuits for Chemistry Applications at the JMM 2024 Conference.
- Completed a 64-page co-first-authored research report on Benchmarking Quantum Chemistry Circuit Costs for Near Term Quantum Computers. According to the IPAM RIPS REU program regulations, our research can not be published publicly.

Error term of Omega Theorem on Summation of Fractional Divisor-sum Functions   May 2024-Present
Advisor: Prof. Dr. Alexander Kalmynin   National Research University Higher School of Economics

♦   An Independent research on Error term of Omega Theorem on Summation of Fractional Divisor-sum Functions under the guidance of Prof. Alexander Kalmynin from National Research University Higher School of Economics.

♦   Work on the summation of fractional divisor-sum functions through applying functional equation for L-functions, Cauchy's residue theorem and shifting the contour of complex integration. Formulate the residue as an infinite sum of Gamma function, which was later transformed into summation of Bessel functions and modified Bessel functions.

♦   Study a truncated version of our infinite integral through Perron's formula, with the hope that the infinite integral can be approximated. Transform the linear combination of Bessel functions into a summation of trigonometric functions through asymptotic formulas. Researching on the usage of Soundararajan's Lemma on the summation for deriving an adequate lower bound.

♦   Paper in Preparation.

Linear Recurrences of Order at Most Two in Nontrivial Small Divisors and Large Divisors   Summer 2022
Advisor: Prof. Dr. Steven Miller   *Williams College*

♦   Continued Polymath REU in Number Theory (partially supported by NSF award) with a PhD., two undergrads under the guidance of Prof. Steven Miller from Williams College.

♦   Examined the patterns of linear recurrence of order at most two among the divisor sets of any given integers. Used programming to help discover patterns and exclude certain configurations through algorithms.

♦   Determined the range, configuration and asymptotic counts for these numbers with case analysis in both large divisor set and small divisor set.

♦   Paper accepted and presented on CANT 2023.

Polymath Research Experience for Undergraduates (REU) in Number Theory   Summer 2021
Advisor: Prof. Dr. Steven Miller   *Williams College*

♦   Selected to the Polymath REU to conduct number theory research (partially supported by NSF award) with a PhD., two undergrads under the guidance of Prof. Steven Miller from Williams College.

♦   Explored avoiding 3-term geometric progressions in non-commutative settings. Studied the problem in two different settings, namely on quaternions and free groups, the "large" and "small" divisor sets, and analyzed possible results on the largest sets of integers that do not contain geometric sequences.

♦   Enumerated all possible configurations of integers that have divisor sets with such recurrence, and examined possible schemes for generating these integers.

Irregularities in Distribution of Pythagorean Triples   Sept. 2023-Dec. 2023
Advisor: Prof. Dr. Alexander Kalmynin   National Research University Higher School of Economics

♦   An independent research on Irregularities in Distribution of Pythagorean Triples under the guidance of Prof. Alexander Kalmynin from National Research University Higher School Economics.

♦   Worked on the fluctuations of the asymptotic formula for counting Pythagorean triples with the largest term less than a given magnitude x.

♦   Focused on some logarithmic improvements on the known bound of error term $\Omega(x^{1/3})$ using Voronoi-type summation formulas and modern strategies of obtaining lower bounds for oscillating sums.

Exploring Properties of Twin Primes and Brun's Theorem   Sep.2023-Feb.2024
Advisor: Prof. Dr. Steven Miller   *Williams College*

♦   Explore properties of twin primes, which are primes differing by two. Discuss infinity of primes and distribution of primes, leading to the natural (and still unsolved) question on whether or not there are infinitely many twin primes.

♦   Present Brun's Theorem, which states that the sum of the reciprocals of the twin primes converges; As the sum of the reciprocals of the primes diverges, this implies that even if there are infinitely many twin primes, their density is much less than that of the primes.

♦ Show that Brun's Theorem is a consequence of determining a sufficiently good upper bound on the number of twin primes at most x, and sketch the inclusion-exclusion argument behind the proof.

Talk on the mathematics colloquium at Williams College.

Generating Signed Permutations by Twisting Two-Sided Ribbons Apr. 2023-Dec. 2023
Advisor: Prof. Dr. Aaron Williams *Williams College*

♦ Work as an Algorithms Researcher on Generating Signed Permutations by Twisting Two-Sided Ribbons with Prof. Dr. Aaron Williams from the Computer Science Department of Williams College.

♦ Develop efficient programs for generating gray codes for several types of sequences with a large variety of rulesets. Rediscover classical gray codes from Steinhaus-Johnson-Trotter algorithm using greedy algorithm, recursive programming and sequence-based algorithms.

♦ Extend search for gray codes in the unlearned field of signed permutations. Generate all possible grey code configurations of signed permutation of integers using loopless algorithm with linear time complexity from extremely simple programs.

♦ Co-First-Authored paper on arXiv 2311.06974, Nov. 2023, presented at the 16th Latin American Symposium, Puerto Varas, Chile, March 18-22, 2024, Proceedings of LATIN 2024: Theoretical Informatics, Pages 114-129, Part I, Springer.

Maximize the Rightmost Digit: Gray Codes for Restricted Growth Strings Oct. 2023-Present
Advisor: Prof. Dr. Aaron Williams *Williams College*

♦ Work as an Algorithms Researcher on Maximize the Rightmost Digit: Gray Codes for Restricted Growth Strings with Prof. Dr. Aaron Williams from the Computer Science Department of Williams College.

♦ Develop effective constant amortized time (CAT) and loopless algorithms for generating Bell and k-Catalan counting strings from a universal mixed-radix string generator.

♦ Derive unprecedented bijection between pre-order traversal of k-ary trees and k-Catalan counting strings.

♦ Research on extension of bijection between set partition and Bell counting strings to k-Bell counting strings.

♦ Co-First-Authored paper submitted to WALCOM 2025.

Greedy and Speedy: New Gray Code Algorithms for Generating Signed Permutations Dec. 2023-Present
Advisor: Prof. Dr. Aaron Williams *Williams College*

♦ Completed my honors thesis on Greedy and Speedy: New Gray Code Algorithms for Generating Signed Permutations guided by Prof. Dr. Aaron Williams from the Computer Science Department of Williams College.

♦ Summarized and designed constant amortized time (CAT) and loopless algorithms for both signed permutations and restricted growth strings. Constructed proofs for validity of all greedy Gray codes for signed permutation and their corresponding generating rulesets.

♦ Developed novel Gray codes for spanning trees of complete graphs based on greedy basis-exchange algorithm of matroids with impressive features, which provides an elegant solution to one of Don Knuth's unsolved open problems. Investigating other types of graphs, including bipartite graph and grid graphs, to develop another solution.

♦ Paper in Preparation.

Machine Learning and Deep Learning Algorithm Model in Business Decision Jan. 2023-Apr. 2023
Advisor: Profs. Munther Dahleh and Bhaskar Pant *Massachusetts Institute of Technology*

♦ Certificate in Applied Data Science from MIT Schwarzman College of Computing.

♦ Examined the features of diabetes among the Pima Indian tribe with exploratory data analysis, descriptive statistics and Python. Researched on the significance of correlation between occurrence of diabetes and factors such as pregnancy, skin thickness and BMI.

♦ Created a Deep Learning model that is able to recognize street view housing number digits, which can be used to improve quality of location recognition on map apps. Applied both Artificial Neural Network (ANN) and Convolutional Neural Network (CNN) blocks in the model and produced industry-level accuracy to the task.

♦ Built a computer vision model that distinguishes between different emotions on over 20,000 images of facial emotions with the aim to enhance the experience of human-AI interaction. Implemented a sophisticated model consisting of a large

variety of neural network layers, which yielded significantly stronger results than popular neural network structures including VGG16, ResNet2 and EfficientNet.

Human-AI Project: Prediction with Machine Learning Model

Sep. 2020 -Dec. 2020

Advisor: Prof. Dr. Iris Howley

Williams College

♦ Worked independently on Human-AI research under the guidance of Prof. Iris Howley from Williams College.

♦ Read 100+ papers on Machine learning and Human and AI Interaction.

♦ Visualized Predictive Models for Users in Dating App. Built a machine learning model to predict whether a user will agree to match with another user in speed dating events.

♦ Designed visualization of the model for different groups of people based on dating data of thousands of users.

♦ Designed AI Front Ends. Created mock-ups of the front end of a loan application app. Allowed users to see what's happening in the technical back end. Applied machine learning to home loans. Classified data of over 3000 loan applicants, and predicted whether banks would approve loans to applicants.

RSI Scholar: Exploring Admissible Complexes of the Radon Transform over Finite Field

Summer 2018

Advisor: Prof. Dr. Eric Grinberg

CEE Research Science Institute at M.I.T

♦ Was one of 80+ top STEM talents from around the world (3% acceptance rate) at the Center for Excellence in Education (CEE) Research Science Institute (RSI) at M.I.T. Completed independently a graduate-level thesis under the guidance of Prof. Dr. Eric Grinberg.

♦ Explored variety of Plane Radon transform; Developed the Bolker condition as a tool to verify the invertibility of Radon transform. Discussed the invertibility of the transform in these finite geometries and used computer force and casework to calculate the number of collections of measurement objects (planes and lines). Calculated the number of Admissible Complexes in unit cube and hypercube.

♦ Presented my research at the Research Science Institute Symposium-M.I.T. Invited to present my research at the S.-T. Yau High School Science Award (Second Prize in Mathematics).

Ross Math Summer Camp Participant: Number Theory

Summer 2018

Advisor: Prof. Dr. Daniel Shapiro

Ohio State University

♦ Was one of 60+ from around the world at the Ross Math Camp in the USA.

♦ Attended lectures and courses on Bernoulli Number and Zeta Function, Number Theory, Abstract Algebra; attended sessions, group meetings for the discussion. Worked on intensive problems in the field of number theory and math proofs with professors and peers.

♦ Left Ross camp and went to RSI at MIT in two weeks with the permission of Professor Daniel Shapiro due to the conflict of time. Continued and completed problem sets in three months.

STUDY ABROAD EXPERIENCES

Budapest Semesters in Mathematics (BSM) Program

Jan. 2022-May 2022

♦ Enrolled in graduate-level pure mathematics courses at the BSM program and enjoyed creative problem solving and the excitement of mathematical discovery.

♦ Participated regularly in the discussion and seminars on Combinatorics, Graph Theory, etc. The seminar on recent development in graph limits given by Abel Laureates Laszlo Lovasz at BSM greatly broadened my horizons.

♦ Found my strong research interest and passion for Quantum Computing and Quantum Algorithms through the study and discussion of quantum bits and quantum computers, complexity and quantum complexity, the algorithm for a quantum computer, Grover's search algorithm, and Shor's algorithm for factorizing numbers.

Math in Moscow (MiM) Program (Online Courses in Pure Math)

Fall 2022, Fall 2023

♦ Focus on 4 graduate courses. Attend group discussions on Analytic Number Theory, Homology and Cohomology, Representation theory, Riemann Surfaces with professors and peers.

♦ Work independently on number theory research under the guidance of Prof. Alexander Kalmynin.

♦ Enjoy interactive, in-depth teaching and discussion of pure math with mathematically motivated students.

TEACHING EXPERIENCE

Williams College   Fall 2023, spring 2024

♦   TA for Math 150-Multivariable Calculus instructed by Prof. Stewart Johnson at Williams College in Fall 2023; TA for CSCI 361-Theory of Computation instructed by Prof. Dr. Aaron Williams at Williams College in Spring 2024.

♦   Work closely with professor to develop appropriate teaching methods and skills.

♦   Tutor and assist students individually or in groups to grasp and reinforce concepts, theorem and provide help to master assignments during office hours.

♦   Grade homework and exams, and observe and evaluate students' performance.

♦   Attend department meetings and report on students' progress.

CAREER EXPERIENCE

Discover Citadel & Citadel Securities, USA   Apr. 2021

Virtual Internship

♦   Invited to the Discover Citadel & Citadel Securities internship, a virtual event to learn more about Citadel for exceptional undergraduates. Participated in team building, intellectual competitions, and problem solving. Heard from and networked with leaders, team members, campus recruiters, and fellow participating students.

♦   Received Quantitative Researcher Intern Interview offers from Two Sigma, Jane Street, Bridgewater, Millennium Management LLC., and Software Engineer Intern Interview offers from Google, Meta (Facebook), etc.

Deutsche Bank, China   Jun. 2021 -Aug. 2021

Intern Quantitative Researcher (Remote)

♦   Used Python to calculate the weight of different categories of assets in various strategies of asset allocation.

♦   Evaluated the profit and risk of various investment strategies through rate of return, Sharpe ratio, and maximum drawdown rate.

♦   Worked knowledge of Statistical Modeling: Linear and non-linear regression analysis. Contributed to the production of statistical reports using data.

♦   Collaborated closely with quantitative researchers, etc.

Tencent, China   Mar. 2021 – May 2021

Intern AI Algorithm Designer/Data Analyst (Remote)

♦   Developed machine learning models using word2vec and cross-validation for remedying the loss of user access data in online video apps and predicting preferences for 5 million users.

♦   Formulated models for optimizing advertisement strategies in the videos using the deep learning platform PyTorch, a 30% improvement over the traditional xgboost-based models.

♦   Implemented DeepFM, and Deep Interest Network model with PyTorch.

TECHNICAL SKILLS

Programming• 12 yrs experience	C/C++(fluent), Python(fluent), Qiskit(fluent), MatLab(fluent), LaTeX(fluent), Neural Network, Mathematica, Java, Stata, Go, HTML, CSS, Rust, R, Swift, SQL, LUA
Software&Tool	OpenMPI, Git, PyTorch, Hadoop, TensorFlow, NumPy, Keras, SciPy, Pandas, Matplotlib
Computational Techniques	Quantum Computing, Quantum Algorithms, Quantum Mechanics, Quantum Chemistry, Quantum Physics, Monte Carlo, ODE, PDE, Machine Learning, Deep Learning, NLP, Econometrics
Languages	English, *fluent*; Chinese, *native* ; German, Basic

VOLUNTEER AND LEADERSHIP

Paper Reading Tutor at CEE Research Science Institute (RSI)-MIT   Summer 2024, 2023, 2022, 2021
♦ Helped to read and revise penultimate drafts and final papers in Number Theory, Quantum Computing, Algebra Geometry, Geometry and Graph Theory for 8 students from RSI at MIT in the summer of 2021, 2022, 2023,2024, gave them feedback and suggested revisions. Helped students prepare for the final presentation.

Urgent Aid Volunteer online   2020-Present
♦ Participate in flood rescue volunteer team and release disaster information through social network websites, like WeChat, TikTok; Make phone calls and message to rescue team.
♦ At the beginning of Covid-19 outbreak, connected with medical agency and friends in China to donate 1000 protection masks to my college.

Head and Founder of Running Math Boys Online   Jun. 2017-Present
♦ Guide and mentor 100+ students residing in China to solve AMC problems, which over 30 students entered AIME.
♦ Provide free, virtual tutoring services to over 50+ students K-12 across all levels in the south rural areas of China.

Founder and President of the Smile-Sky Club   Sep. 2015-Present
♦ Host students in Poor Gifted Person Plan from the southwest areas in China.
♦ Outreach the headmaster and director from Chenxi Special Education School to organize donation for disabled children.
Initiated crowdfunding 50000 RMB to buy hearing aids and necessities for disabled children. Going on furthe