Anantha S Rao

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Education

- **Indian Institute of Science Education and Research, Pune** — Pune, India
  Department of Physics, B.S-M.S Dual Degree; GPA:(8.8/10) — *Aug'18 - May'23*
  - **Research Interests** : Quantum Information Science, Condensed Matter Physics, Artificial Intelligence

Research Experience

- **Variational quantum algorithms for generative learning** — IBM Research Labs, India
  Master's research student | Supervisor: Dr. L Venkata Subramaniam — *June 2022 - Present*
  - Proposed and implemented a novel hybrid quantum-classical neural network for generative machine learning that can learn classically hard distributions with exponentially fewer parameters.
  - Verified results on IBM Hardware with zero-noise extrapolation and similar error mitigation techniques.
- **Continuous-time Quantum Walks and the Quantum Kicked Rotor** — IISER Pune, India
  Undergraduate Research Assistant | Supervisor: Prof MS Santhanam — *Jan 2021 - May 2022*
  - Reviewed literature on quantum chaos, many-body localization, performed simulations to reproduce results of Out-of-time-order correlators (OTOCs) for integrable systems, and developed an efficient algorithm to compute OTOCs for the 3-dimensional quantum kicked rotator.
  - Reviewed 15+ research papers, reproduced results of continuous-time quantum walks on graphs, developed a correspondence between quantum walks and the quantum-kicked rotor model, and analytically demonstrated quadratic advantage of quantum walks over classical walks using the first hitting time distribution.
  - Developed a formalism to test the first-hitting time distributions for the resonant quantum kicked rotor experimentally using ultracold atoms and probe coherence times in quantum systems.
- **Studying NMR spin-echos from 2D strongly-correlated materials** — Brown University, USA
  Student Researcher | Supervisors: Prof Brad Marston and Dr.Stephen Carr — *May 2021 - Aug 2021*
  - Collaborated with an international group of researchers to study and identify electronic phases in strongly-correlated systems under the Google Summer of Code program.
  - Reviewed literature on Hahn echos in magnetic resonance, developed **"NMR ML"**, a general-purpose python package to read, preprocess, extract, and interpret important features from spin-echo simulations.
  - Implemented unsupervised learning methods (PCA, K-Means, t-SNE, VAE) to identify clusters in spin-echo responses and discovered them to be based on the electronic correlations of the material.
  - Evaluated and optimized the performance of multiple machine learning models on time-series classification, multi-parameter regression that resulted in a publication and a poster.
- **iGEM IISER Pune and Curem Biotech** — IISER Pune, India
  Software and Modelling - Team Leader | Supervisor: Prof Sanjeev Galande — *Jan 2020 - Oct 2021*
  - Identified novel protein-peptide interactions, engineered a library of peptide drugs against falciparum Malaria, and performed equilibrium molecular dynamics simulations with an insilico efficacy of >95%.
  - Designed, programmed and deployed **DeleMa-Detect**, an open-source deep learning application for real-time Malaria diagnosis through blood-smear images based on Mobilenetv2 transfer learning and an accuracy of 96%.
  - Spearheaded the IISER Pune team at the International Genetically Engineered Machine (iGEM) bioengineering competition to win the Gold Medal and the best project award among 250+ contesting teams from 40+ countries.
  - Co-founded a startup, contributed to 5 research grants and design of the Minimum Viable Product that was awarded the ₹50 Lakh grant by the National Biotechnology ignition grant and the $10,000 cash price at the iGEM 2021 Startup showcase competition.

Technical Reports and Publications

- **A. Rao**, S. Carr, C. Snider, DE. Feldman, C. Ramanathan, VF. Mitrovic (2022, Dec 04) Machine learning assisted determination of electronic correlations from magnetic resonance (*preprint*:2212.01946)
- **A. Rao** (2022, May 15). Continuous-time quantum walks with the kicked rotor. IISER Pune Digital Repository
- **A. Rao** (2020, Dec 10). Insilico design of peptide inhibitors against Cerebral Malaria. IISER Pune Digital Repository.

Technical Skills

- **Programming** : Python, Julia, BASH, Fortran, R, MATLAB, C++, GROMACS, Quantum Espresso
- **Data Science** : NumPy, Scipy, Pandas, Matplotlib, Scikit-learn, Seaborn, QuTiP, Tensorflow, Keras, PyTorch
- **Quantum Computing Libraries** : Qiskit, Cirq, Amazon Braket, Pennylane, Mitiq
- **Tools** : Linux, Git, LATEX, Vim, GIMP, MS-Office
- **MOOC Certifications** : Machine Learning, Computational Neuroscience, Deep Learning specialization

Conferences and Summer schools

- **Conference on Nonlinear Systems and Dynamics (2022)** : Presenting my work on time-series analysis of NMR signals and machine learning techniques applied to echo-responses.
- **Amazon Research Days India (2022)** : Internal research conference of Amazon. (*invited*)
- **Qiskit global summer school (2022, 2021, 2020)** : Summer schools focussing on the theory and practical assignments to address problems in Quantum simulations, machine learning, and computing respectively.
- **Amazon summer school (2022)** : Competitive school on state-of-the-art methods in machine learning.
- **Google quantum summer symposium (2021, 2022)** : Conference on research trends at Google.
- **All India iGEM Meet (2020)** : Presented our work on modeling protein inhibitors for malaria.

Open source projects

- **QuantChaos** : Tools to study quantum chaos and localization with the quantum kicked rotor.
- **ComPhys** : Repository of numerical recipes in Fortran to solve physics problems numerically.
- **Qcompiler** : A quantum simulator based on unitary dynamics.
- **ProgProtPy** : Tools to learn bioinformatics (sequence alignments, sequencing, hidden markov models).
- **PACMal** : Peptides Against Cerebral Malaria - an open source solution.

Awards and Achievements

- **Qiskit Spring Challenge (2022)** : Top performer at the hackathon focussing on quantum simulations.
- **Chanakya Postgraduate Fellowship (2022)** : Among 34 scholars from 1000+ applicants to receive the fellowship by Govt. of India to pursue research in quantum information science.
- **iGEM's Startup Showcase (2021)** : Won the Benchling and Hummingbird VC prize (cash award of $10,000)
- **National Graduate Physics Examination (2021)** : 2th in the State of Maharasthra, Top 50 in the country.
- **Mitacs Globalink Research Fellowship (2021)** : Selected for the competitive fully-funded summer program at Universtiy of Waterloo on loss characterization of superconducting resonators; cancelled due to the pandemic.
- **iGEM Gold Medal and iGEMer's award (2020)** : Best project amongst 250+ teams from 40+ countries.
- **Kishore Vaigyanik Protsahan Yojana (KVPY) (2018 - Present)** : Placed among top 0.05% candidates in the KVPY examinations; awarded a competitive scholarship by the Department of Science and Technology.
- **Indian National Physics Olympiad(INPhO) (2017)** : Selected to the state team. (20 among 5000+)

Volunteering and Leadership Roles

- **Abhyudaya Foundation (2021-Present)** : Teaching Science and Mathematics to underprivileged children.
- **TowardsDataScience (2021-Present)** : Technical Writer on data science and open-source software.
- **JuliaDynamics (2021)** : Open source software contributor (Dynamical component analysis)
- **Karavaan Annual Fest (2019, 2020)** : IISER Pune's annual socio-cultural event; Student co-ordinator of Corporate relations department (2020); Research and Analysis Department (2019)
- **Mimamsa Annual Fest (2020)** : Supervised and managed India's largest UG science quiz in the state of Goa.
- **Disha (Spread the smile) (2018 - Present)** : IISER Pune's social outreach program; Raising social awareness and inculcating scientific temper among bright young minds through planned workshops and activities.
- **IISER Pune Quiz Club (2018-Present)** : Conducting quiz programs for university and school audiences; (Elementary 2019, Karavaan (2018, 2019), various quizzes at IISER Pune)
- **IISER Pune Astronomy Club (2018, 2019)** : Conducted sky-watching workshops and communicated developments in astronomy and cosmology research through Dhruva,the annual student-led magazine.
- **Nature Walkers (2018)** : Trekking leader and camping co-ordinator to western ghats and Kudremukha hills.
- **Bangalore Urban Cricket Team (2014-6)** : Represented Bangalore Urban and school as cricket captain.
- **School Head boy (2015)** : Elected school president.
- **School Asst-Head boy (2014)** : Elected school vice-president.