

Raghav Arora

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Education

- 2017–2022 **B.E. (Hons.) - Electrical and Electronics Engineering + MSc.(Hons.) Chemistry**, *Birla Institute of Technology and Science, Pilani*, (CGPA: 8.86).
2017 **CBSE (Class XII)**, *KV ONGC, Dehradun*, (Percentage: 88%).
2015 **ICSE (Class X)**, *St. Thomas' College, Dehradun*, (Percentage: 91.6%).

Research Projects

Embodied AI for Household Agents (ongoing)

Guide: [Prof. K Madhava Krishna](#)

- As a part of the [Robotics Research Center](#), I am leading multiple projects focused on vision and language-guided robotic applications.
- Integrating graph networks with multimodal input data to develop Common-sense Reasoning and mapping objects to their correct rooms for the [rearrangement task](#) in Embodied AI.
- Incorporating world knowledge displayed by LLMs to allow a household agent to anticipate future tasks.
- Using classical PDDL-based planners to generate plans of robotic actions for long-horizon anticipated tasks.
- Showing downstream applications of projects in different simulation environments like [AIHabitat](#), [AI2THOR](#), and [VirtualHome](#).

Deep learning for quantum chemistry using Density Functional Tight-Binding Method

Guide: [Prof. Alexandre Tkatchenko](#)

- This project leveraged machine learning for generating a well modeled chemical compound space that maps chemical properties of molecules to their molecular structure.
- I worked on developing novel molecular descriptors to mathematically encode molecules in a way that can be input to neural networks. In this method, existing geometric descriptors are combined with electronic properties obtained from semi-empirical quantum-chemistry methods to generate appropriate molecular representation. I designed Deep Learning architectures to use the molecular descriptors for predicting different physico-chemical properties.
- With a focus on transferability and scalability of ML models, this project aimed to improve the prediction of properties, which is crucial for drug discovery.

Investigation of image mosaicing techniques for UAV navigation

Guide: [Prof. Meetha V. Shenoy](#)

- In this project, multiple aerial images captured by Unmanned Aerial Vehicles are stitched together in real time using image registration and blending algorithms.
- The project started with the literature review of existing image mosaicing techniques for navigation of unmanned aerial vehicles, followed by the performance comparison of the algorithms. Using a combination of SIFT(Scale Invariant Feature Transform) and SURF(Speeded Up Robust Features) feature descriptors, patterns between the images are detected. RANSAC variation of BaySac algorithm is used for seamlessly blending the images.
- The new image hence generated can be used for the navigation of swarm of small robots.

Real-Time Single Image and Video Super-Resolution
Guide: [Dr. Surekha Bhanot](#)

- For conversion of Low Resolution Images to High Resolution, traditional approaches make use of interpolation to upscale the image in the 1st step, which makes the entire process computationally extensive.
- This project makes use of an efficient sub-pixel convolutional layer, which is the last layer of the CNN for upscaling the image. Hence, the process becomes computationally fast, and can be used for real-time applications.

Molecular Dynamics Simulations for Room Temperature Ionic Liquids
Guide: [Prof. Prashant U. Manohar](#)

- Laboratory oriented project to simulate acetonitrile in the presence of room-temperature ionic liquids using Amber MD software, and present alternatives to traditional organic solvents.
- Multiple physical and chemical properties of ionic liquid [bmim][BF₄] were analysed in the presence of acetonitrile to obtain their relative stability and the possibility of using RTILs as solvents was studied.

Publications

- [1] **Raghav Arora**, Ayush Agrawal, Ahana Datta, Snehasis Banerjee, Brojeshwar Bhowmick, Krishna Murthy Jatavallabhula, Mohan Sridharan, and Madhava Krishna. **2023a**
“CLIPGraphs: Multimodal Graph Networks to Infer Object-Room Affinities”. In: *32nd IEEE International Conference on Robot and Human Interactive Communication (RO-MAN)*. Busan, Korea.
- [2] **Raghav Arora**, Shivam Singh, Karthik Swaminathan, Ahana Datta, Snehasis Banerjee, Brojeshwar Bhowmick, Krishna Murthy Jatavallabhula, Mohan Sridharan, and Madhava Krishna. **2023b**
“Anticipate & Act: Integrating LLMs and Classical Planning for Efficient Task Execution in Household Environments”. Under Review at IEEE International Conference on Robotics and Automation (ICRA). Yokohama, Japan.

Workshops

Eastern European Machine Learning Summer School, 2023

Košice, Slovakia July, 2023

- I attended the 5th edition of the [EEML summer school](#) co-organized by Google DeepMind, ESET, and AlslovakIA.
- Comprised of lectures, hands-on tutorials, roundtables, and poster sessions.
- Featured top, world-class researchers, professors, and business actors as speakers.
- I presented our work on [CLIPgraphs](#) that combines commonsense domain knowledge, data-driven methods, and recent advances in multimodal learning to learn object-room affinities based on embeddings of the prior knowledge and the vision-language features.

Learning Projects

Machine Vision for Earth Observation (Ongoing)

A part of the [MVEO workshop](#) for British Machine Vision Conference 2023, this challenge aims on identifying a core set of the most valuable samples from [DFC 2022 dataset](#) for training a U-Net model for semantic segmentation of satellite images.

CityLearn-2022

A part of [NeurIPS 2022 Competition](#), this challenge uses Reinforcement Learning to coordinate the energy consumed by a list of buildings within a simulated micro-grid.

E-Wallet

Development RESTful APIs used by college students to make payments using the college app. It was used during college fest with a total participation of 4000 participants generating sales worth \$30,000 in five days. Major drawback involved a bug in the E-Wallet: race conditions. It took months of reading and rewriting the code to fix the bug, and ultimately, I made use of celery to make the firebase calls asynchronous to solve the problem.

Project Erlebnisse	Built an e-voting application using Ethereum Blockchain protocol and deployed it on Microsoft Azure, as a part of Microsoft Codefundopp. Gained expertise in blockchain, hashing algorithms and other security protocols. Hands-on experience with Solidity, blockchain technology internals, expertise on smart contracts.
Integrated Reports Management and Decision Support System	Built a system to generate customised reports and make a knowledge base using Information Retrieval technique for making necessary predictions using the library database at the Scientific Information and Resource Division (SIRD), IGCAR. The Decision Support System was developed through hypothesis testing around the library database using the Koha Library Management System.

Technical Skills

- o Areas of interest: Intelligent Agents, Computer Vision, Natural Language Processing, Reinforcement Learning
- o Proficient in: Python, PyTorch, Keras, OpenCV, Git, \LaTeX
- o Familiar With: Verilog, Javascript, Blockchain, LTSpice, Arduino, Java, AmberMD

Relevant Courses

Computer Science	Neural Networks and Fuzzy Logic, Digital Image Processing, Applied Calculus, Linear Algebra, Probability and Statistics, Differential Equations, Optimization Techniques, Digital Design, Microprocessors and Interfacing
Electrical and Electronics	Control Systems, Electronic Devices, Electrical Machines, Microelectronic Circuits, Analog and Digital VLSI Design, Communication Systems, Analog Electronics, Power Electronics, Power Systems
MOOCs	Introduction to Algorithms and Analysis , Learning from Data , Introduction to Programming with MATLAB