Raghav Arora

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Education

- **Birla Institute of Technology and Science** — Pilani, India
  B.E in Electrical and Electronics; M.Sc. in Chemistry; GPA: 8.86/10 (top 10% of the class) — *Aug. 2017 - July. 2023*

Research Experience

- **IIIT Hyderabad** — Robotics Research Centre, Hyderabad
  Research Engineer — *Oct 2022 - Present*
  Direct Supervisor: Prof. Madhava Krishna
  Collaborators: Dr. Mohan Sridharan, Dr. Krishna Murthy Jatavallabhula, Dr. Brojeshwar Bhowmick
  - **CLIPGraphs**:
    - Integrated graph networks with multimodal input data to develop commonsense reasoning. Objects are mapped to their correct rooms for the rearrangement task in Embodied AI.
    - Trained the graph network to generate an embedding space that efficiently represents the similarity between graph nodes.
    - My contributions: Formed and trained the graph convolutional network along with ablations on various contrastive loss functions. Also worked on paper writing and presented the paper at IEEE RO-MAN 2023, and EEML Summer School 2023.
  - **Anticipate & Act**:
    - This project aims to create an intelligent household agent that can learn the pattern of task execution.
    - Used and compared different Large Language Models for extracting user behavior and preferences.
    - Created representations of tasks and actions in Planning Domain Definition Language (PDDL).
    - Paper accepted at IEEE ICRA 2024.
    - My Contributions: I formulated and led this project with a team of 4 students. Generated the diverse state and action space in PDDL, prompted different LLMs along with major part of paper writing.
  - **Task Anticipation for Multi-Agent Systems**:
    - This is an ongoing work on extending LLM based Task Anticipation for multi-agent setting with Human-Robot Collaboration.
    - Representing the state changes by the human-agent using Predictive State Representations (PSRs).
    - Robotic agents anticipate the tasks in the domain, along with possible state changes of other agents to efficiently collaborate.
- **University of Luxembourg** — Theoretical Chemical Physics, Luxembourg
  Research Assistant — *June 2021 - Oct 2022*
  Supervisor: Prof. Alexandre Tkatchenko
  - **Deep learning for quantum chemistry**:
    - This project leveraged machine learning for generating a well modeled chemical compound space that maps chemical properties of molecules to their molecular structure.
    - Developed novel molecular descriptors to mathematically encode molecules. In this method, existing geometric descriptors are combined with electronic properties to generate appropriate molecular representation.
    - Used Autoencoders to reduce the dimensionality of high-dimensional geometric desciptors like SLATM, and Bag-of-bonds, for training the neural network.
    - Aimed to improve the prediction of properties, which is crucial for drug discovery, with a focus on transferability and scalability of ML models.

Publications

- **CLIPGraphs: Multimodal Graph Networks to Infer Object-Room Affinities**: Ayush Agrawal*, **Raghav Arora***, A. Datta, S. Banerjee, B. Bhowmick, K. Jatavallabhula, M. Sridharan, and M. Krishna
  In: 32nd IEEE International Conference on Robot and Human Interactive Communication (). Busan, Korea And, In: Pretraining for Robotics Workshop at the 2023 International Conference on Robotics and Automation - ICRA ()
- **Anticipate & Act: Integrating LLMs and Classical Planning for Efficient Task Execution in Household Environments** : **Raghav Arora**, S. Singh, K. Swaminathan, A. Datta, S. Banerjee, B. Bhowmick, K. Jatavallabhula, M. Sridharan, and M. Krishna
  In: IEEE International Conference on Robotics and Automation (ICRA) (). Yokohama, Japan.

Workshops

- **Eastern European Machine Learning Summer School, 2023 (🔗)** Košice, Slovakia
  Organizers: Google DeepMind, ESET, and AIslovakIA *July 2023*
  - One week summer school including lectures, hands-on tutorials, roundtables, and poster sessions.
  - Featured top, world-class researchers, professors, and business actors as speakers.
  - I collaborated with other attendees to build our solution to multi-choice visual question answering problem, which was submitted to the DeepMind Perception Challenge

Teaching and Leadership Experience

- **Teaching Assistantship (Full Course)**: Neural Networks and Fuzzy Logic (BITS Pilani, 2020). Took lectures, quiz invigilation, and created project assignments in a course of 400 students.
- **Student Assistantship**: (PSD, BITS Pilani, 2020). Organized online industry exposure practice school for junior batches during COVID-19. This included creating a learning management system to allow companies and professors to create online sessions for students, create quizzes and grade them.
- **Lecture**: (RRC Summer School, 2023) Took a session on introduction to Deep Learning, theory and frameworks used in recent research.
- **Volunteer Work**: Teaching underprivileged children at Make a Difference (2022-2023). 3 out of 5 students taught qualified university entrance exams and joined Bachelor of Computer Applications.
- **Projects' Head**: Led a team of 20+ developers for University wide applications and websites (DVM, BITS Pilani, 2019-2020)

Fellowships

- **Eastern European Machine Learning Summer School, 2023**: For attending the summer school and poster presentation on CLIPGraphs.
- **Pioneer Research Grant**: Research Fellowship for conducting my off-campus thesis work on 'Deep learning for quantum chemistry using Density Functional Tight-Binding Method' (IPCD BITS Pilani, 2022)

Projects

- **Investigation of image mosaicing techniques for UAV navigation** Dr. Meetha V. Shenoy
  Mosaicing aerial images captured by swarm of UAVs(Unmanned Aerial Vehicles), using feature detection and blending algorithms. We use Convolutional Neural Networks for extracting relevant features from aerial images, and match the common features to blend different images. RANSAC variation of BaySac algorithm is used for seamlessly blending the images, resulting in a large field of view for navigation.

- **Real-Time Single Image and Video Super-Resolution** Dr. Surekha Bhanot
  Conversion of Low Resolution Images to High Resolution using efficient sub-pixel convolutional layer, which is the last layer of the CNN for upscaling the image. This makes the process computationally fast enough to be used for real-time applications.

- **Molecular Dynamics Simulations for Room Temperature Ionic Liquids** Dr. Prashant Manohar
  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. I developed dense neural networks to model the force fields being used to simulate the ionic liquids

- **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 involvedw 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.

Technical Skills

- **Areas of Interest**: Representation Learning, Robotics, OOD Generalization, Computer Vision
  Proficient in:: Python, PyTorch, Keras, OpenCV, Git, LATEX, HPC, C, Java
  Robotic Simulators: Gazebo, Coppeliasim, AI2THOR, AIHabitat, VirtualHome