Akarsh Kumar

akarshkumar0101@gmail.com | akarshkumar.com | Github: akarshkumar0101

Research Statement

I study emergent intelligence by creating+analyzing embodied AI agents that reason+learn in increasingly complex environments. For this, I employ **AI-Generating Algorithms** (**meta-learning** architectures, learning algorithms, and environments) and **Open-Ended** **Quality-Diverse Evolutionary Algorithms**.

Education

Massachusetts Institute of Technology, *Ph.D. in CS | Advisor: Phillip Isola* 09/22 – 05/27

- **NSF Graduate Research Fellowship**
- Research: AI-GAs/meta-learning, Open-Endedness, exploration, curriculum learning
- Graduate classes: Deep RL, NLP, Theory of Computation

University of Texas at Austin, *B.S. in ECE (Honors) | GPA: 3.97* 08/18 – 05/22

- Graduate classes: Convex Optimization, Probability, Neural Computation, Computer Vision
- Notable classes: Data Science, Matrices, Discrete Math, Algorithms, Signal Processing, Image Processing
- Teaching assistant for Software Engineering II
- **Best project award** in three engineering classes

Peer Reviewed Research

1. Ryan Sullivan, **Akarsh Kumar**, Shengyi Huang, John P. Dickerson, and Joseph Suarez. Reward Scale Robustness for Proximal Policy Optimization via DreamerV3 Tricks. *NeurIPS 2023*.
2. Kevin Frans* and **Akarsh Kumar***. Human-Like Open-Ended Design via Foundation Models. *EvoCraft Challenge @ GECCO 2022*.
3. **Akarsh Kumar**, Bo Liu, Risto Miikkulainen, and Peter Stone. Effective Mutation Rate Adaptation through Group Elite Selection. *GECCO 2022*.
4. **Akarsh Kumar**, Aditya R. Vaidya, and Alexander G. Huth. Physically Plausible Pose Refinement using Fully Differentiable Forces. *Egocentric Perception, Interaction and Computing @ CVPR 2021*.
5. **Akarsh Kumar**. Optimization of the Efficiency of Photovoltaic Cells for Laser Light: An Application to Laser Power Beaming. *Intel ISEF 2018*.

Research Experience

Ph.D. Student @ Isolab w/ Prof. Phillip Isola 08/22 – now

MIT

- Developed novel long-range memory mechanism for Transformers (report)
- First place at the GECCO 2022 Minecraft Open-Endedness Challenge (video)
- Ongoing Project: For RL foundation models, exploration pretraining generalizes better than task pretraining

Undergraduate Researcher @ LARG w/ Prof. Peter Stone 05/21 – 12/21

UT Austin

- Developed novel genetic algorithm that optimally adapts its mutation rate based on group outlier statistics
- **Published first author paper at GECCO 2022** (paper)

Undergraduate Researcher @ Huthlab w/ Prof. Alexander Huth 11/19 – 05/21

UT Austin

- Developed novel CV motion capture algorithm to reconstruct hand-object interaction forces from RGB-D
- To be used in fMRI neuroscience study on how the brain processes tactile information
- **Published first author paper at CVPR 2021 workshop** (presentation, paper)

Undergraduate Researcher @ VITA w/ Prof. Zhangyang Atlas Wang 09/21 – 05/22

UT Austin

- Developed novel NN architecture "MLP-Shaker", generalizing MLP-Mixer to n-D tensors

Highschool Researcher w/ Dr. Brian Monson 08/17 – 05/18

ASMSA

- Discovered novel theoretical bound on energy transfer efficiency with lasers and photovoltaic cells
- **Won state science fair for physics and attended Intel ISEF** (poster, paper)

AI Projects

NBA-3D | Github: nba-3d
- Reconstructed NBA players as 3D figures with multiple RGB videos of the scene
- Estimated camera pose using differentiable renderer, matching synthetic views and real views of the court
- **Won best project Image Processing class** (visual, presentation)

Basketball-RL | Github: basketball-rl
- Developed end-to-end differentiable 2D basketball environment and collected+cleaned real NBA movement data
- Behavior cloned a policy and fine-tuned it with RL

Audio Source Separation with GANs | Github: DSProject
- Developed U-Net GAN to distinguish noisy and clean spectrograms
- Used GAN as a loss function for spectrogram segmentation network (blog)

BetterKey | Github: betterkey
- Genetic algorithm to find optimal keyboard layout: **60% reduced typos, 10% increased typing speed** (blog)

BEVO | Github: ALD
- Used speech-to-text and CV object detection models to assist blind people in finding everyday objects (blog)

Reimplementations of Previous Work
- Implemented AlphaZero for Connect4
- Implemented dense NN+backpropagation from scratch in Java and reached 95% accuracy on MNIST
- Implemented NEAT (neuroevolution) from scratch in Java and solved CartPole and FlappyBird

Software Projects

Strategic Anomalies | Github: StrategicAnomalies | *Java*
- Developed online strategic board game from scratch using IO streams, sockets, Swing, and multi-threading
- Used advanced pregame lobby+gameplay and server+client software engineering paradigms (visual)

Online Chat Platform | Github: EE-422C | *Java*
- Developed a full stack (client-server) chat platform for sending texts, images, and files in an iMessage-like GUI
- **Won best project in Software Engineering II class**

CAS and Graphing Calculator | Github: LibAK-CAS | *Java*
- Developed CAS for parsing math strings into syntax trees for analytical computations of expressiosn+derivatives
- Developed graphing library, allows mouse dragging and point selection (visual)

C++/OpenGL GUI API | Github: LibAKCpp | *C++*
- Developed high level window manager+GUI API (akin to Java's Swing API) from scratch with C++/OpenGL
- Supports windowing, rendering shapes, images, and hierarchical pane layouts (visual)

Embedded Systems 3D Shooter | Github: EE-319K | *C++*
- Developed first person shooter survival game for an embedded system
- **Won best project in Embedded Systems class** (visual)

Work Experience

Software Intern @ Prolitfic 01/19 – 08/19
Publishing Startup
- Developed a customer review ranking algorithm **(used in production for 1 year)**

Software Intern @ Free Geek Arkansas 08/17 – 05/18
Nonprofit Hardware Company
- Developed software for tracking volunteer hours **(used in production for 3 years)**

Community Service

- Reviewer at NeurIPS 2023 GCRL Workshop

Skills

Python (Jax/Flax, PyTorch), C/C++, Java, Javascript