Akarsh Kumar

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Research Statement

I want to understand intelligence and its emergence by creating agents that reason and learn more intelligently in increasingly complex environments. I am interested in **meta-learning** and **AI generating algorithms** and combining **stochastic gradient descent** with **quality-diverse** and **open-ended evolutionary algorithms**.

Education

University of Texas at Austin — Austin, TX

B.S. in Electrical/Computer Engineering | GPA: 3.95/4.00, Major GPA: 3.97/4.00 — *Aug. 2018 – May 2022*

- Graduate classes: Convex Optim., Adv. Topics in Comp. Vision, Neural Computation, Probability
- Notable classes: Data Science Principles+Lab, Prob., Matrices, Discrete, Algo., Signal Proc., Img Proc., SWE II
- **Teaching Assistant** for Software Engineering (SWE) II
- **Won best (software) project awards** in three engineering classes

Arkansas School for Math, Science, and the Arts — Hot Springs, Arkansas

High School Diploma | GPA: 4.23/4.00, ACT: 35/36 — *Aug. 2016 – May 2018*

Publications

1. Akarsh Kumar, Aditya R. Vaidya, and Alexander G. Huth. Physically plausible pose refinement using fully differentiable forces, 2021

2. Akarsh Kumar, Bo Liu, Risto Miikkulainen, and Peter Stone. Effective mutation rate adaptation through group elite selection. In *Under Review at AAAI 2022*

Research Experience

Undergraduate Researcher @ Huthlab w/ Dr. Alexander Huth — November 2019 – May 2021

UT Austin — *Austin, TX*

- Developed a novel CV motion capture algorithm to reconstruct hand-object interactions from RGB-D data
- Estimated the hand-object poses and physical contact forces acting between them
- **Published first author paper in CVPR 2021 EPIC Workshop**, link to presentation and paper
- Algorithm to be used in an fMRI neuroscience study on how the brain processes tactile information

Undergraduate Researcher @ LARG w/ Dr. Peter Stone — May 2021 – Present

UT Austin — *Austin, TX*

- Developed a genetic algorithm that optimally adapts mutation rate in deep neuroevolution
- **Submitted first author paper to AAAI 2022** (currently under review)

Undergraduate Researcher @ VITA w/ Dr. Zhangyang Atlas Wang

UT Austin — *Austin, TX*

- Developed a novel deep learning architecture "MLP-Shaker", generalizing MLP-Mixer for Senior Capstone Project
- MLP-Shaker operates on arbitrary n-D tensors rather than MLP-Mixer's 2-D tensors

Highschool Researcher w/ Dr. Brian Monson — August 2017 – May 2018

ASMSA — *Hot Springs, AR*

- Found the theoretical bound on the energy transfer efficiency when using lasers and photovoltaic cells
- **Won state science fair for physics and attended Intel ISEF**, link to poster and paper

AI Projects

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

Audio Source Separation with GANs | Github: DSProject | *PyTorch*
- Designed and trained U-Net CNN architecture as a GAN to distinguish between noisy and noiseless spectrograms
- Used this GAN as a supervised loss function for an audio source separation (spectrogram segmentation) network

BetterKey | Github: betterkey | *Java*
- Genetic algorithm to optimize keyboard layouts, resulting in 60% reduced typos, and 10% increased typing speed

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

Basketball-RL | Github: basketball-rl | *PyTorch*
- Developed a custom differentiable 2-D basketball reinforcement learning environment
- End-to-end trained RNN agent to maximize reward

Reimplementations of Previous Work | *PyTorch, Java*
- Implemented AlphaZero in PyTorch for Connect4
- Implemented a dense NN+backpropagation algorithm from scratch in Java and reached 95% accuracy on MNIST
- Implemented NEAT (neuroevolution) algorithm 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

Code-Viz | Github: code-viz | *Python*
- Parsed and visualized a Python codebase in a directed graph of class/method dependencies

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

C++ Physics Simulation | Github: PhysicsSimulation | *C++*
- Developed a rigid body physics simulation to test a personal theory on magnet behavior

CAS and Graphing Calculator | Github: LibAK-CAS | *Java*
- Parsed math strings into a syntax tree for analytical computing of expressions and their derivatives
- Extended CAS to a graphing library which allows mouse dragging and point selection

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**

Online Chat Platform | Github: EE-422C | *Java*
- Developed client-server paradigm chat platform capable of sending texts, images, and files in iMessage style GUI
- **Won best project in Software Design II class**

Work Experience

Software Engineering Intern @ Prolitfic January 2019 – August 2019
UT Austin Startup
- Developed a robust review ranking algo on an existing Django codebase **(used in production for 1 year)**

Intern @ Freek Geek Arkansas August 2017 – May 2018
Nonprofit Hardware Company
- Developed software for tracking volunteers' hours for a nonprofit company **(used in production for 3 years)**

Technical Skills

Languages: Python, C/C++, Java
Libraries: PyTorch, NumPy, Matplotlib, Pandas