Kumar Ashutosh

https://thechargedneutron.github.io/

Interests

- Reinforcement Learning
- Computer Vision
- Graphics & AR/VR
- Online Learning

Education

Indian Institute of Technology, Bombay, Mumbai, India
Dual Degree (Bachelor and Master of Technology) July 2016 - June 2021

- Majoring in Electrical Engineering with overall CPI: 9.00/10
- Specializing in Communication and Signal Processing (Specialization CPI: 9.57/10)
- Completed Minor in Computer Science and Engineering

Publications

[5] 3D-NVS: A 3D Supervision Approach for Next View Selection
Under review at *IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR)*
K. Ashutosh, S. Kumar, S. Chaudhuri

[4] Bandit algorithms: Letting go of logarithmic regret for statistical robustness [Paper, Code]
Under review at *International Conference on Artificial Intelligence and Statistics (AISTATS)*
K. Ashutosh, J. Nair, A. Kagrecha, K. Jagannathan

[3] Lower Bounds for Policy Iteration on Multi-action MDPs [Paper, Code]
IEEE Conference on Decision and Control (CDC) 2020
K. Ashutosh[†], S. Consul[†], B. Dedhia[†], P. Khirwadkar[†], S. Shah[†], and S. Kalyanakrishnan

[2] Hardware Performance Analysis of Mobile-Based Augmented Reality Systems [Paper, Slides]
IEEE International Conference on Computational Performance Evaluation (ComPE), 2020
K. Ashutosh

[1] A Multilayer Network Approach for Studying Creative Ideation Markers from EEG [Paper]
Brain Informatics Conference (BI) 2018
R. Bose[†], **K. Ashutosh**[†], A. Bezerianos, N. Thakor, J. Li and A. Dragomir ([†] joint first-author)

Master's Thesis

Three-Dimensional Shape Reconstruction using View Predictions Jul'20 - Present
Guide: Prof. Subhasis Chaudhuri, Director, IIT Bombay

Background: SoTA reconstruction algorithms choose highly constrained viewpoints. We propose view-selection aided reconstruction using images without depth values and achieve improvement.

- Obtained images by rendering 3D meshes from 24 custom viewpoints on ShapeNet dataset
- Developed a two-staged CNN to jointly learn view selection and voxel grid reconstruction
- Outperformed existing two-view results by obtaining an improvement of 3% in IoU and demonstrated an effective view prediction without direct supervision of ground truth next views

R&D Experience

Statistically Robust Multi-armed Bandit Algorithms [Paper, Code, Blog] Jan'20 - Jun'20
Guide: Prof. Jayakrishnan Nair, Electrical Engineering, IIT Bombay

Background: Classical MAB algorithms assume a known distribution, or bounds on the rewards, or both. We propose statistically robust algorithms which requires minimal assumption on rewards.

- Established fragility of classical algorithms with respect to the parameters or class of its reward distribution i.e. these algorithms can incur *inconsistent* regret with mismatched parameter
- Proposed 3 novel statistically robust algorithms incurring a regret *slightly worse* than logarithmic
- Obtained slowly-growing confidence bounds which are oblivious to reward parameters

Lower Bounds for Policy Iteration on Multi-action MDPs [Paper, Code, Blog] Sep'19 - Mar'20
Guide: Prof. Shivaram Kalyanakrishnan, Computer Science and Engineering, IIT Bombay

Background: Lower bounds for Policy Iterations are either not known or known for fixed states (eg. $n = 2$). We achieve a tight close bounds on a variety of stochastic and deterministic PI algorithms.

- Proposed a variant of PI, along with MDP construction achieving a lower bound of $\Omega(k^{0.5n})$
- Proved a lower bound of $\Omega(k.2^n)$ for Simple PI and $\Omega(k.n)$ for Howard's PI (Greedy PI)
- Generalised the lower bound for randomized PI having $\log(k)$ scaling for action-selection

RLConnect: a Reinforcement Learning agent to play Dots and Boxes [Play] Sep'20 - Dec'20
Guide: Prof. Amit Sethi, Electrical Engineering, IIT Bombay
Background: We develop a game-playing agent to play Dots and Boxes by choosing appropriate state variables and feature vectors. We minimize the decision time and compare with other SoTA.

- Developed web-based GUI with human-human, human-computer and computer-computer play
- Added feature for self-play to significantly increase number of games for learning optimal policy
- Compared win ratio against humans for agent trained with Q-Learning, SARSA and DQN

Capture the Flag: a novel Augmented Reality based tabletop game [Report] Jan'19 - May'19
Guide: Prof. Parag Chaudhuri, Computer Science and Engineering, IIT Bombay
Background: We propose a novel AR game concept that is spatially-aware and adjusts game elements based on real-world terrain of game area. We show its effectiveness in education and training.

- Surveyed Augmented Reality applications and developed a novel AR-based tabletop game
- Designed challenging levels and added elements like staircase which adapts to real-world terrain
- Conducted user survey to assess novelty, scalability and relevance and obtained positive results

Discriminative Localisation in Medical Images [Blog] Jan'18 - May'18
Guide: Prof. Amit Sethi, Electrical Engineering, IIT Bombay
Background: Recent work in CNN architectures have enabled us to visualise class specific activation regions. We apply this method to more challenging Pathology Images to explore hidden features.

- Developed algorithm to visualize the parts of an image influencing decision in CNN architectures
- Deployed the algorithm to Breast Cancer Dataset and obtained activation regions in tissues
- Investigated hidden features in 4 classes - Benign, In-Situ, Normal and Invasive tissues

Internships

HoloSnap: Augmented Reality application to share Point Clouds Budapest, Hungary
Guide: Mr. Zsolt Mihályfi, CEO, 360World Nov, 2019 - Jan, 2020

- Developed an iOS-based prototype application that uses Depth Capture to record 3D point clouds
- Integrated the application with Spatial Anchors to place the 3D point cloud at a geo-location
- Designed the application in Unity 3D with Firebase backend and tested the app on iOS devices

Prototyping and Signal Processing for around Ear EEG system Kanagawa, Japan
Guide: Mr. Yota Komoriya, Sony Corporation May, 2019 - Jul, 2019

- Made prototype devices, experimental protocol and software for evaluation of ear-EEG
- Evaluated EEG signal around ear in the same way as the designated literature

Extended Visualization: Focus in GLSL Remote
Guide: Prof. Eleftherios Garyfallidis, Indiana University Bloomington May, 2018 - Aug, 2018

- Employed OpenGL Shading Language to build GPU-accelerated visualisations of high-poly data
- Studied the various uses of Fragment, Vertex and Geometry Shaders and extended the viz module
- Implemented fast Shader-based rendering capable of displaying 10k+ high-poly spheres on GPU

Multi-layered Analysis of Brain Networks [Paper] Singapore
Guide: Prof. Nitish Thakor, NUS and Johns Hopkins University May, 2018 - Jul, 2018

- Investigated the differences in Brain Connectivity Pattern during creative ideation using EEG
- Obtained Statistically Significant difference between convergent thinking and divergent thinking

Achievements

Awarded **Department Color** for valuable contribution to mentorship program of IITB 2020
Invited to witness Republic Day Parade as a guest of Hon'ble Prime Minister of India 2017
Bagged Rashtrapati Puraskar (**President's Award**) by the Hon'ble President of India 2016

Exams & Scholarships

JEE Mains - 99.97 %ile out of 1.2 million | JEE Advanced - 99.14 %ile out of 0.15 million 2016
Indian National Mathematical Olympiad (INMO) to select team to represent India at IMO 2015
National Talent Search Scholarship (NTSE) to nurture young talent 2012-19
Kishore Vyagyanik Protsahan Yojana (KVPY) scholarship for research in Basic Sciences 2015

Talks

Augmented Reality Applications - organized by Electronics and Robotics Club, IITB 2020

Teaching Methodology of Mathematics - organized by NERIST, Arunachal Pradesh 2016

Academic Projects

An Optimizer's approach to Stochastic Control Problems

Guide: Prof. Ankur Kulkarni, IIT Bombay Aug, 2020 - Dec, 2020

- Studied existing literature on general optimization-based framework for solving *nonconvex* Stochastic Control Problems with Nonclassical Information Structures through *convex relations*
- Used data processing inequalities to construct suitable convex relaxations for new cost functions

Snapshot Compressed Sensing [Code, Slides]

Guide: Prof. Ajit Rajwade, IIT Bombay Jan, 2020 - Jun, 2020

- Surveyed literature in Snapshot Compression techniques and its application in images and videos
- Investigated the performance of two recent algorithms - both theoretically and experimentally
- Compared the reconstruction losses with different sensing matrices, noise levels and distributions

Video Cartoonification [Slides]

Guide: Prof. Ajit Rajwade, IIT Bombay Aug, 2019 - Nov, 2019

- Studied various image cartoonification techniques and analysed its generalizability to video frames
- Applied Edge Tangent Flow (ETF), Flow-Based Bilateral Filter (FBL) to cartoonify videos
- Achieved 77% faster average time and robustness to noise compared to per-frame cartoonification

Kalman Filter based Object Tracking [Report]

Guide: Prof. Debraj Chakraborty, IIT Bombay Aug, 2019 - Nov, 2019

- Demonstrated multi-object tracking in video frames using Kalman Filter and obtained smooth tracking of objects in videos with static camera and additive Gaussian noise
- Employed standard image algorithms to extract features and chose standard state variables

Key Coursework

Computer Science: Advances in Intelligent and Learning Agents, Advanced Machine Learning, Computer Graphics, Data Structures and Algorithms, Advanced Image Processing

Electrical Engineering: Computer Vision, Advanced Signal Processing, Speech Processing, Control Systems, Analog and Digital Circuits, Microprocessors, Communication Systems

Basics: Calculus, Linear Algebra, Probability, Computer Programming, Electricity and Magnetism

Open Source

scikit-learn: Contributed 2k+ lines of code & introduced RegressorChain [doc] & other features

dipy: Implemented GPU-accelerated OpenGL based rendering of brain image dataset

Programming

Python (with PyTorch, TensorFlow etc.), C++, C, OpenGL, MATLAB, Unity3D

Positions of Responsibility

Teaching Assistant in Fall 2020 for EE 635 – Applied Linear Algebra, IIT Bombay

- Conducted online sessions, prepared and assessed assignments and planned the logistics

Department Academic Mentor Coordinator, Electrical Engineering, IIT Bombay

- Spearheaded a team of 24 mentors, chosen after a rigorous process of interviewing more than 80 candidates, to guide 150+ students of EE Department facing academic and personal issues

Institute and Department Academic Mentor, IIT Bombay

- Assisted more than 30 students over 3 academic years in overcoming academic and co-curricular issues and help them decide between various opportunities in the university

Extras

Storytelling, Football, Long-distance Running, Traveling, Adventure Sports, Trained Scout

References

Prof. Subhasis Chaudhuri, Director, IIT Bombay [webpage, email]

Prof. Shivaram Kalyanakrishnan, Associate Professor, CSE, IIT Bombay [webpage, email]

Prof. Jayakrishnan Nair, Associate Professor, EE, IIT Bombay [webpage, email]

Prof. Eleftherios Garyfallidis, Assistant Professor, Indiana University [webpage, email]