MACHINE LEARNING LAB (MLL) RESEARCH OVERVIEW

INTERNATIONAL INSTITUTE OF INFORMATION TECHNOLOGY HYDERABAD

R&D SHWCASE 2021

About the lab

Machine Learning is a science that enables machines (especially computers) to learn from environments and make own decisions. At Machine Learning Laboratory (MLL), we carry out research and develop different theoretical foundations for machine learning such as:

- How machines should help in planning activities by learning from environments?
- How machines should learn in the presence of noisy environment?
- How learning gets affected if different machine learning algorithms are trying compete instead of cooperating?

Also, we study the role of deep learning in planning, reinforcement learning and game theory

Research Areas

- Machine Learning: Robustness, Privacy, Interpretability and Scalability
- Game Theory & Mechanism Design
- Multi-Agent Systems
- Blockchains
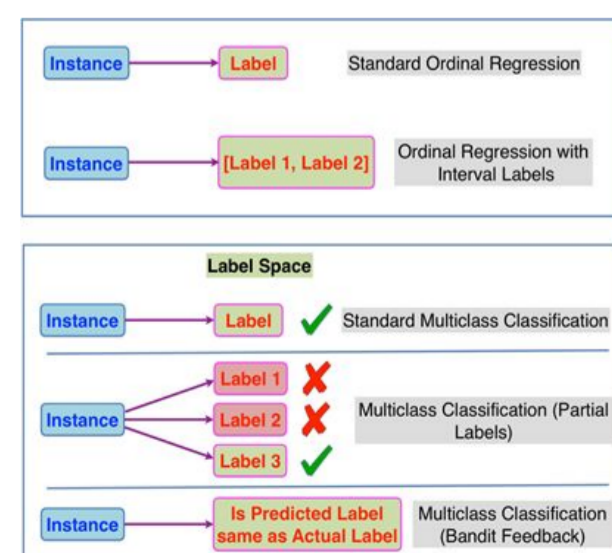- Reinforcement Learning

Faculty

- Dr. C.V. Jawahar
- Dr. Praveen Paruchuri
- Dr. Sujit Gujar
- Dr. Naresh Manwani
- Dr. Girish Varma

Scalable and Robust Machine Learning

Online Learning Under Uncertainty

In many real world problems, data doesn't have exact annotations. The annotations are either partial or exact. Examples:
- Ordinal regression with interval labels.
- Multiclass classification with bandit feedback
- Multiclass classification with partial labels

Robust Learning

In most applications, the data suffers label noise due to subjectivity, insufficient feature set, measurement errors etc.

Baby   Clothing

High variability
- Shape
- How it's worn/ photographed

Ambiguity (class level)

Label noise/ incomplete
Less detailed descriptions or incorrect labeling

Is this a
(a) Puffer jacket
(b) Vest
(c) Both?

Reject Option Classifier

When the misclassification costs are very high (e.g., medical diagnosis etc.), it is useful to have an option of rejection. Which means not taking any decision. Cost of rejection is much lower than misclassification cost

- Manwani, Naresh. "PRIL: Perceptron Ranking Using Interval Labels." (**CoDS-COMAD 2019**)
- Manwani, Naresh, and Mohit Chandra. "Exact Passive-Aggressive Algorithms for Learning to Rank Using Interval Labels." arXiv preprint arXiv:1808.06107 (2018).
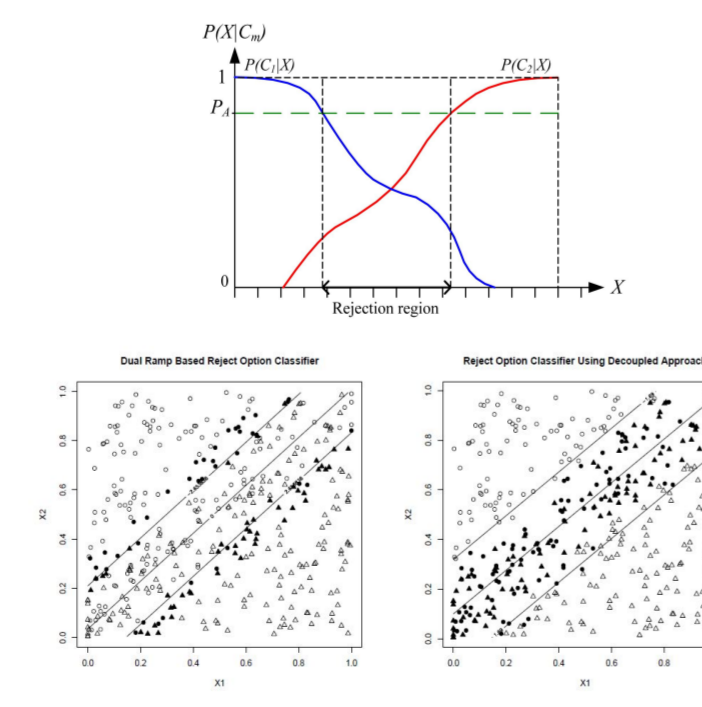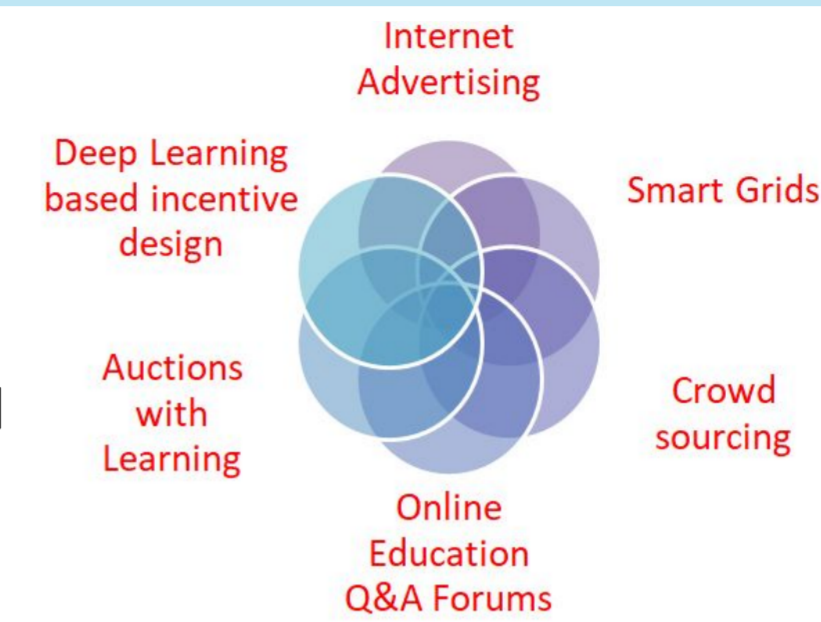
- Ghosh, Aritra, Naresh Manwani, and P. S. Sastry. "On the robustness of decision tree learning under label noise." (**PAKDD 2017**)
- Ghosh, Aritra, Naresh Manwani, and P. S. Sastry. "Making risk minimization tolerant to label noise." **Neurocomputing** 160 (2015): 93-107.

- Shah, Kulin, and Naresh Manwani, "Sparse Reject Option Classifier using Successive Linear Programming", (**AAAI 2019**)
- Manwani, Naresh, Kalpit Desai, Sanand Sasidharan, and Ramasubramanian Sundararajan. "Double Ramp Loss Based Reject Option Classifier." (**PAKDD 2015**)
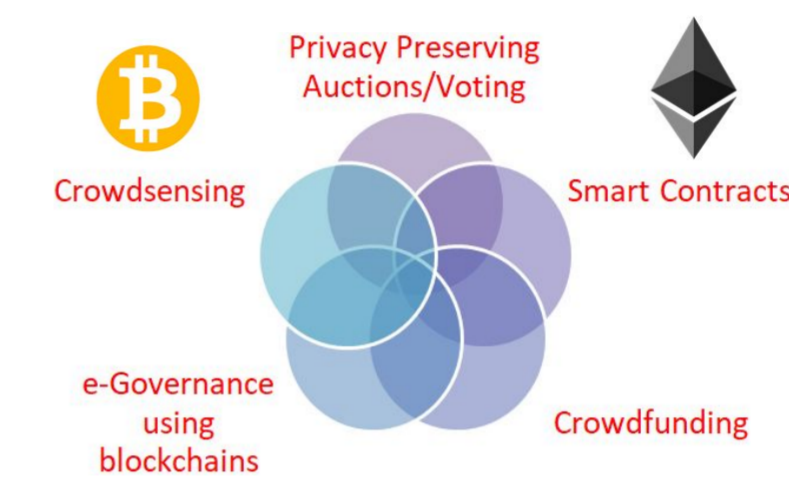
Machine Learning Meets Game Theory

Learning Mechanisms

- Modern problems involve **strategic agents**, private information, **unknown information**, and opportunities to explore and interact with agents, etc.
- ML and Game Theory are well investigated as individual problems. Interesting research questions arise when we try to meld them together.

Internet Advertising

Deep Learning based incentive design

Smart Grids

Auctions with Learning

Crowd sourcing

Online Education Q&A Forums

Economics of Privacy, Blockchains and Trust

- In many economic institutions, (auctions/voting) participants prefer **decentralization**, **anonymity** and **trust**
- **Blockchain** Technology is the disruptive innovation that has solved the above problems

Privacy Preserving Auctions/Voting

Crowdsensing   Smart Contracts

e-Governance using blockchains   Crowdfunding

- Shweta Jain and Sujit Gujar, "A Multiarmed Bandit Based Incentive Mechanism for a Subset Selection of Customers for Demand Response in Smart Grids". (**AAAI '20**)
- Susobhan Ghosh, Easwar Subramanian, Sanjay P. Bhat, Sujit Gujar and Praveen Paruchuri, "Bidding in Smart Grid PDAs: Theory, Analysis and Strategy". (**AAAI '20**)
- Kumar Abhishek, Shweta Jain, Sujit Gujar, "Designing Truthful Contextual Multi-Armed Bandits based Sponsored Search Auctions". (**AAMAS '20**)
- Shoeb Siddiqui, Sujit Gujar, Ganesh Vanahalli, "BitcoinF: Achieving Fairness For Bitcoin In Transaction Fee Only Model". (**AAMAS '20**)
- Ganesh Ghalme, Swapnil Dhamal, Shweta Jain, Sujit Gujar, Yadati Narahari, "Ballooning Multi-Armed Bandits". (**AAMAS '20**)
- Dimitrios Chatzopoulos, Sujit Gujar, Boi Faltings and Pan Hui, "Mneme: A Mobile Distributed Ledger". (**INFOCOM '20**)
- Saurabh Ravindranath, Rahul Baburaj, Vineeth N. Balasubramanian, NageswaraRao Numburu, Sujit Gujar, C. V. Jawahar, "Human Machine Collaboration for Face Recognition". (**CODS-COMAD '20**)

Multi-Agent Systems and Game Theory

Improving Security using Game Theory

- Gave birth to the ARMOR security system deployed at LAX airport since 2007 for setting checkpoints and allocating canine units

Paruchuri, Praveen, Jonathan P. Pearce, Janusz Marecki, Milind Tambe, Fernando Ordonez, and Sarit Kraus. "Playing games for security: An efficient exact algorithm for solving Bayesian Stackelberg games." (**AAMAS 2008**)

Analysis of Lane Level Dynamics

- Slow moving traffic in heavily populated cities is a major issue
- We introduce BLS algorithm to optimize lane level dynamics

Agarwal, Akash, and Praveen Paruchuri. "V2v communication for analysis of lane level dynamics for better ev traversal." (**IEEE IV 2016**)

Improving Surveillance using CTO

- In large gatherings, number of people considered suspicious (targets)
- Micro drones aim to perform surveillance of maximum no. of targets
- Explore-Exploit with Adjustable Randomization

Aswani, Rashi, Sai Krishna Munnangi, and Praveen Paruchuri. "Improving surveillance using cooperative target observation." (**AAAI 2017**)

Planning Using Dec-MDPs

- Interaction of real world agents involves complex rewards
- Dec-MDPs provide formal framework to analyze such interactions
- Scalable algorithms for multi agent coverage problems

Gupta, Tarun, Akshat Kumar, and Praveen Paruchuri. "Planning and learning for decentralized MDPs with event driven rewards." (**AAAI 2018**)

Lab Achievements

- A number of papers accepted at top conferences like **AAAI, AAMAS, IJCAI, PAKDD, HICSS** among others e.g., 3 papers at **AAMAS 2020,** 3 papers at **AAAI 2020** and so on.
- Team **VidyutVanika**, a TCS-IIITH partnership was placed second in the **PowerTAC 2018** competition
  Members: Susobhan Ghosh (student), Prof. Sujit Gujar, Prof. Praveen Paruchuri (IIIT-H), Dr. Easwar Subramaniam, Dr. Sanjay Bhat (TCS)
- Paper on Human Machine Collaboration got **Best paper runner-up** award at CODS-COMAD 2020

Industry Collaborations

- **CognitiveScale** funded a research project under supervision of Dr. Naresh and Dr. Praveen on explainable and robust artificial intelligence
- **Koinearth** funded a research project under supervision of Dr. Sujit on aggregating citizen preferences over blockchains
- **BEL** funded research projects to Dr. Sujit on Game Theory and Dr. Praveen on Multi-agent Systems
- Faculties served on the research advisory board of multiple startups

Executive Programs

- Artificial Intelligence and Machine Learning (AI/ML): Advanced Certification Program
- Blockchain Technologies and Solutions: Advanced Certification Program

Lab Strength

- PhD: 2
- MS: 6
- Dual Degree: 13
- Honors: 9

Homepage: http://mll.iiit.ac.in/