

# Machine Learning Lab (MLL): Research Overview

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

## About the centre

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

## Faculties

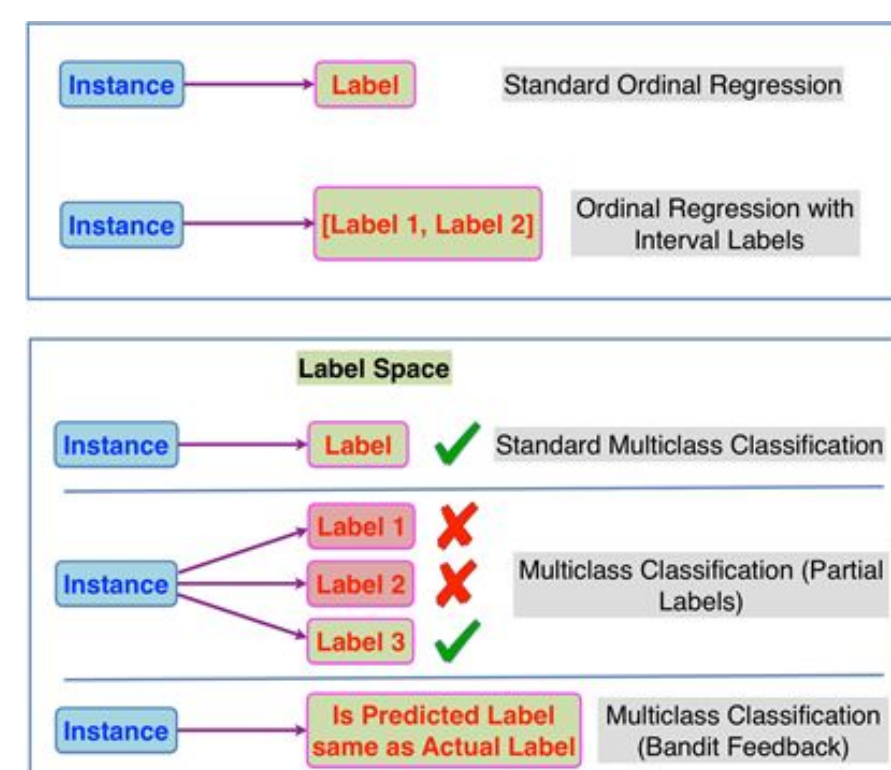
- Dr. C.V. Jawahar
- Dr. Praveen Paruchuri
- Dr. Sujit Gujar
- Dr. Naresh Manwani

## 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:

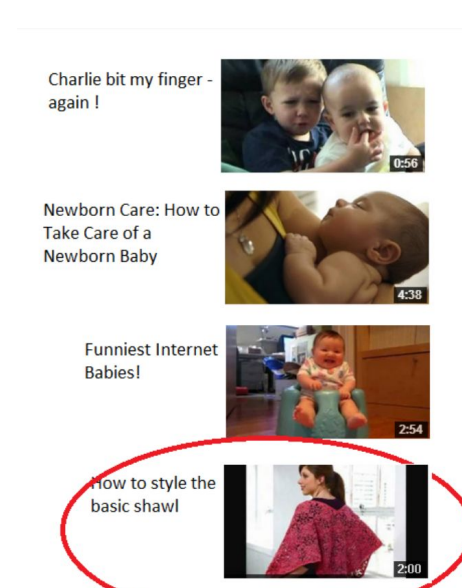
- Ordinal regression with interval labels.
- Multiclass classification with bandit feedback
- Multiclass classification with partial labels



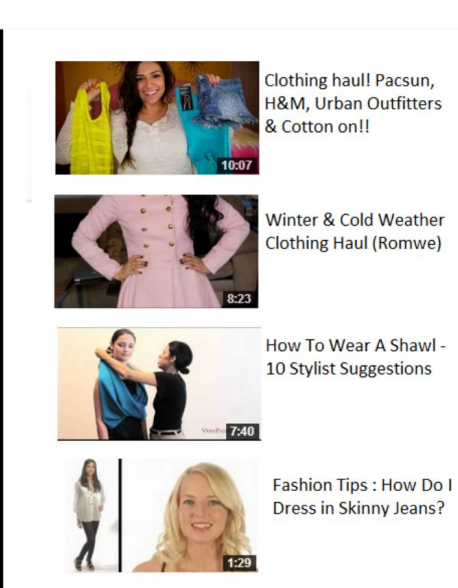
- Manwani, Naresh. "PRIL: Perceptron Ranking Using Interval Labels." (CoDS-COMAD 2019)
- Manwani, Naresh, and Mohit Chandra. "Exact Passive-Aggressive Algorithms for Learning to Rank Using Interval Labels." arXiv preprint arXiv:1808.06107 (2018).

### Robust Learning

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



Baby



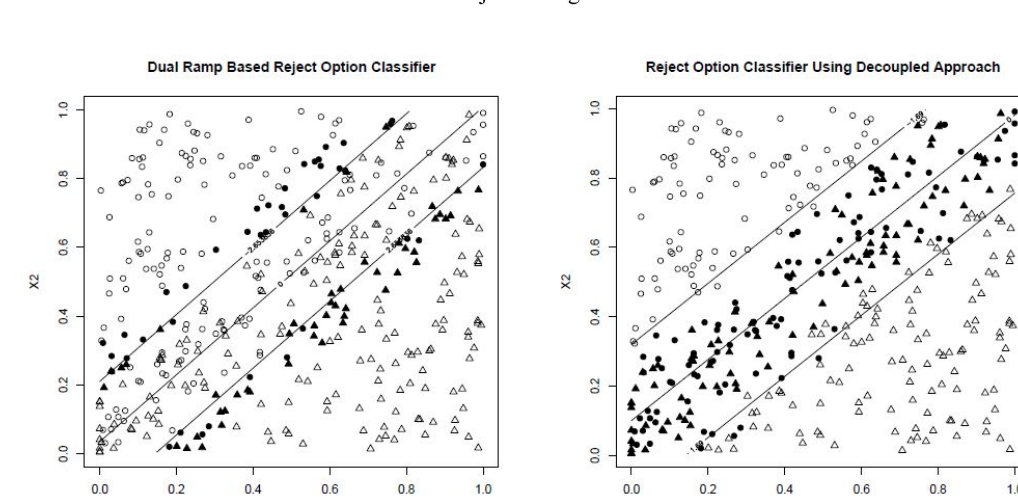
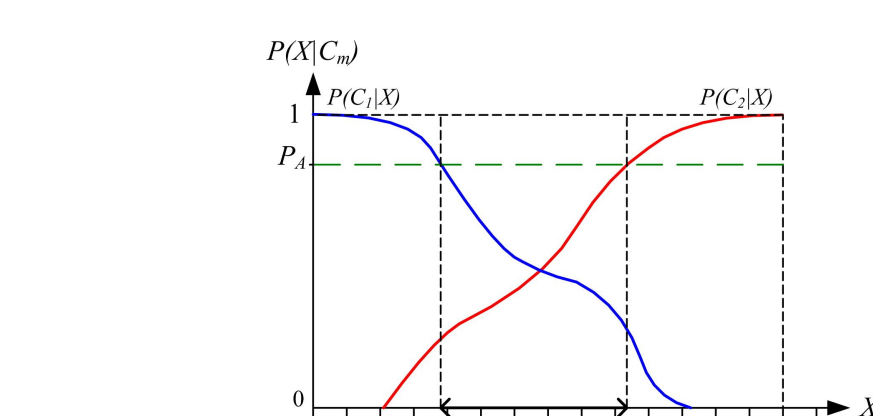
Clothing



- 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.

### 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

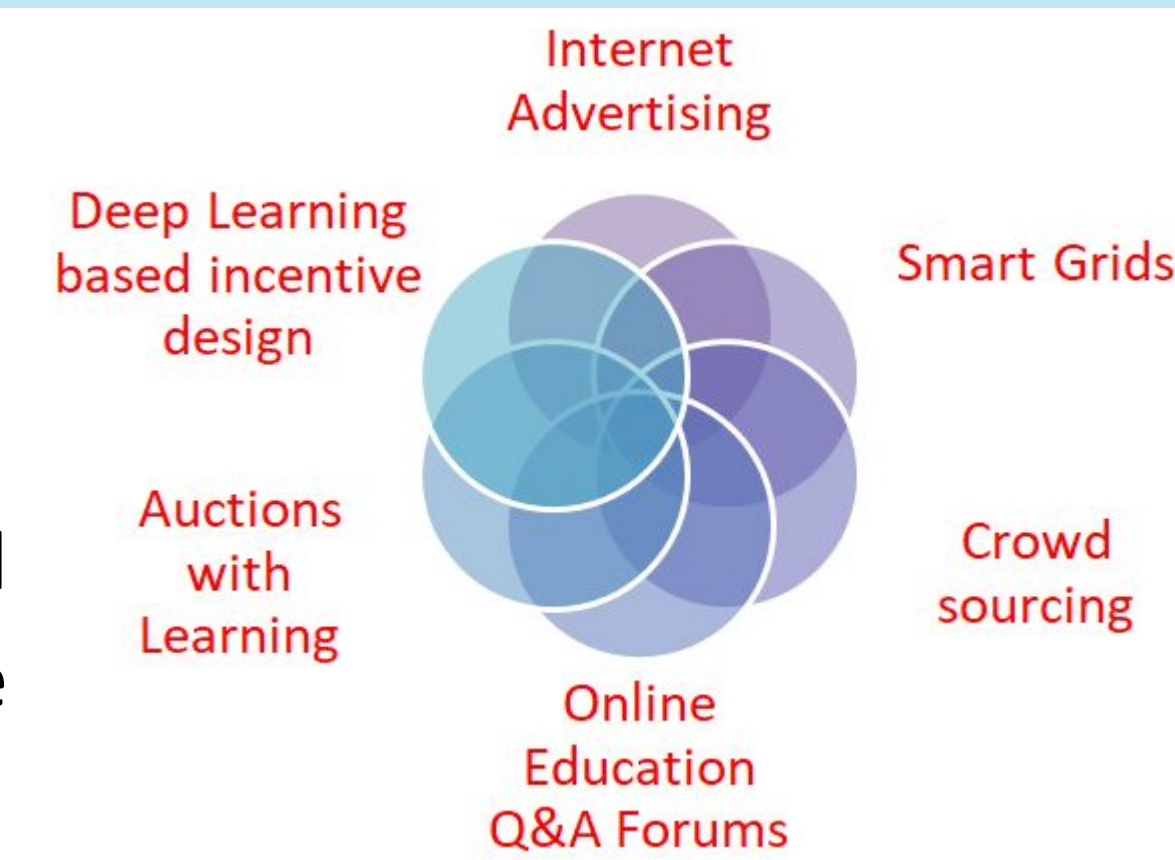


- Shah, Kulin, and Naresh Manwani. "Sparse Reject Option Classifier using Successive Linear Programming." (AAAI 2019)
- Manwani, Naresh, Kalpit Desai, Sanand Sasidharan, and Ramasubramanian Sundararajan. "Double Ramp Loss Based Reject Option Classifier." (PAKDD 2015)

## Machine Learning Meets Game Theory

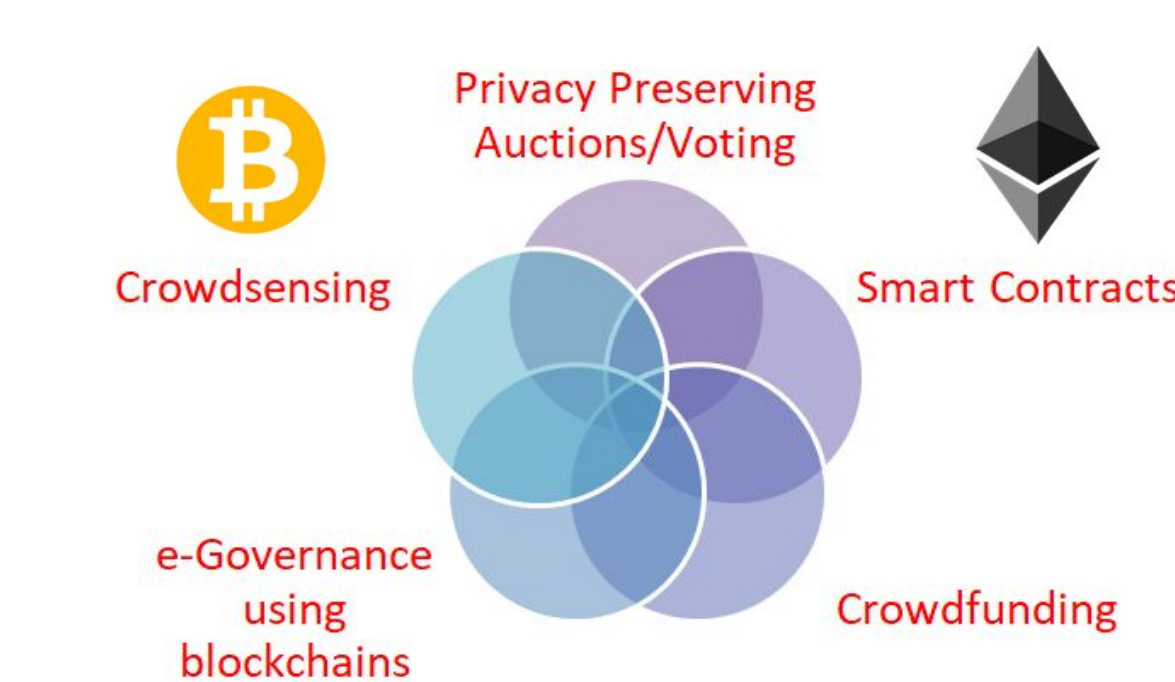
### Learning Mechanisms

- 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.



### Economics of Privacy, Blockchains and Trust

- In many economic institutions, (auctions/voting) participants prefer **decentralization, anonymity and trust**. E.g., bidders do not want competitors to know what were their bids even after the auction is over
- **Blockchain** Technology is the disruptive innovation that has solved the above problems



- Shweta Jain, Sujit Gujar, Satyanath Bhat, Onno Zoeter, Y. Narahari, "A Quality Assuring, Cost Optimal Multi-Armed Bandit Mechanism for Expertsourcing", Journal of Artificial Intelligence (AI) 254 (2018): 44-63.
- Susobhan Ghosh, Easwar Subramanian, Sanjay P. Bhat, Sujit P. Gujar and Praveen Paruchuri, "ViduyutVanika: A Reinforcement Learning Based Broker Agent for a Power Trading Competition", (AAAI '19)
- Satyanath Bhat, Shweta Jain, Sujit Gujar and Y. Narahari, "An Optimal Bidimensional Multi-Armed Bandit Auction for Multi-Unit Procurement", Annals of Mathematics and Artificial Intelligence (AMAI), January 2019, Volume 85(1), pp 1-19.
- Sankarshan Damle, Boi Faltings and Sujit Gujar, "A Truthful Privacy-Preserving Approximately Efficient Combinatorial Auction For Single-minded Bidders", (AAMAS '19)
- Manisha Padala and Sujit Gujar, "Thompson Sampling Based Multi-Armed-Bandit Mechanism Using Neural Networks", (AAMAS '19)
- Sankarshan Damle, Moin Hussain Moti, Praphul Chandra and Sujit Gujar, "Aggregating Citizen Preferences for Public Projects Through Civic Crowdfunding", (AAMAS '19)

## 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)



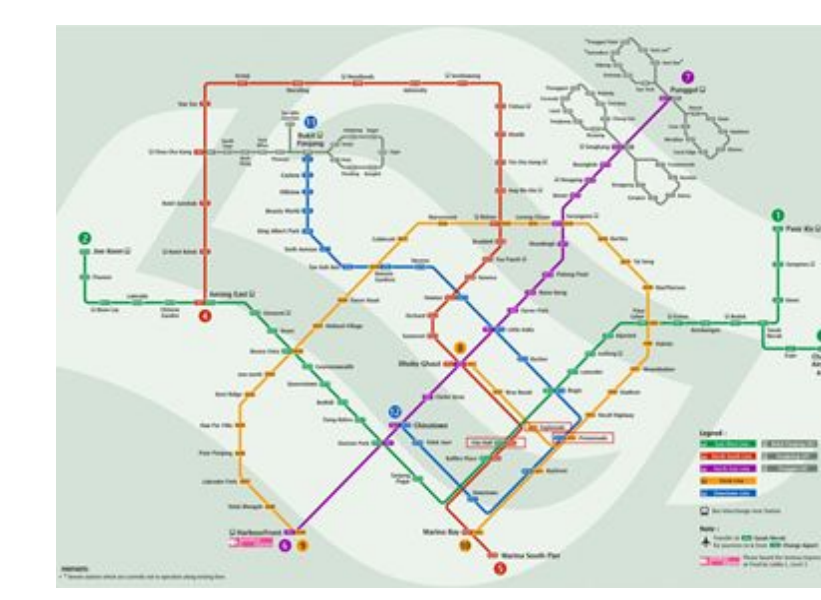
### Improving Surveillance using CTO

- 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

- 4 papers accepted as extended abstract at **AAMAS 2019**
- 3 papers presented at **AAAI 2019**
- Team **ViduyutVanika**, 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)
- Sreeja Kamishetty, attended EMEA Google Student Retreat

## 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
- 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: 1
- Dual Degree: 14
- MS: 5
- Honors: 9