Divyat Mahajan

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EDUCATION

Indian Institute of Technology, Kanpur   *July 2014-June 2019*
B.S. in Mathematics And Scientific Computing   GPA: 8.6/10.0
Double Major in Computer Science And Engineering

WORK EXPERIENCE

- **Microsoft Research India - Research Fellow**   *July 2019-Present*
Advisor: Dr. Amit Sharma
Projects: Counterfactual Explanations, Out of Distribution Generalizaiton, Causal Inference

- **Aalto University - Research Intern**   *May 2018-July 2018*
Advisor: Prof. Samuel Kaski
Project: Approximate Bayesian Computation, Likelihood Free Inference

- **National University of Singapore - Research Intern**   *May 2017-July 2017*
Advisors: Prof. Wynne Hsu and Prof. Lee Mong Li
Project: Recommender Systems

- **New York Office, IIT Kanpur - Research Track Exploration Intern**   *Jun 2016-July 2016*
Advisor: Prof. Vincent Ng
Project: Stance Classification

PUBLICATIONS

- **Does Learning Stable Features Provide Privacy Benefits for Machine Learning Models?**
Divyat Mahajan, Shruti Tople, Amit Sharma
Under Review

- **Towards Unifying Feature Attribution and Counterfactual Explanations: Different Means to Same End**
Ramaravind Mothilal, Divyat Mahajan, Chenhao Tan, Amit Sharma
Under Review

- **Split-Treatment Analysis to Rank Heterogeneous Causal Effects for Prospective Interventions**
Yanbo Xu, Divyat Mahajan, Liz Manrao, Amit Sharma, Emre Kiciman
14th ACM International Conference on Web Search and Data Mining (**WSDM'21**)

- **Domain Generalization using Causal Matching**   *paper*
Divyat Mahajan, Shruti Tople, Amit Sharma
Workshop on Uncertainty and Robustness in Deep Learning (**ICML'20**)

- **Preserving Causal Constraints in Counterfactual Explanations for Machine Learning Classifiers**   *paper*
Divyat Mahajan, Chenhao Tan, Amit Sharma
Workshop on "Do the right thing": machine learning and causal inference for improved decision making (**NeurIPS'19**)
Selected for Oral Spotlight Presentation

- **A Generative Framework for Zero-Shot Learning with Adversarial Domain Adaptation**   *paper*
Varun Khare*, Divyat Mahajan*, Homanga Bharadhwaj, Vinay Verma, Piyush Rai
IEEE Winter Conference on Applications of Computer Vision (**WACV'20**)

SOFTWARE

- **RobustDG: Toolkit for Building Robust ML models that generalize to unseen domains**
Microsoft — Commits Github

- **DiCE: Diverse Counterfactual Explanations for ML**
InterpretML — Commits Github

RESEARCH EXPERIENCE

● **Domain Generalization & Privacy Attacks in Machine Learning**   *Mar 2020-Present*
Advisors: [Dr. Amit Sharma, Dr. Shruti Tople](), Microsoft Research   [project]()

· Developed a causal framework and derived an object invariant condition for the problem of domain generalization (DG).
· Proposed a novel algorithm (MatchDG) using contrastive learning to satisfy the invariance condition in practial scenarios.
· Experimented on Roated-MNIST,Fashion-MNIST, PACS, ChestXray datasets and obtained better results than the prior state of the art on out-of-domain accuracy.
· Investigated connections between out-of-distribution generalization and privacy attacks by empirical analysis of the algorithms MatchDG, CSD, IRM on Membership Inference attacks and Attribute Inference attacks.
· Created an open source framework (**RobustDG**) for evaluation of various DG algorithms on privacy attacks
· Our work on the MatchDG algorithm was presented at the **ICML UDL Workshop 2020**.

● **Ranking Causal Effects for Prospective Interventions**   *Dec 2020-Oct 2020*
Advisors: [Dr. Amit Sharma, Dr. Emre Kiciman](), Microsoft Research

· Worked on the sensitivity analysis of methods for heterogenous causal effect estimation of novel treatments.
· Developed a technique to capture the sensitivity of a model by generating unobserved confounders that are correlated with both the treatment and the outcome.
· Implemented the unobserved confounder test on a large real world software dataset to select the least sensitive models under the proposed Split Treatment framework.
· The work got accepted in the proceedings of the conference **WSDM 2021**.

● **Counterfactual Explanations for ML Classifiers**   *July 2019-Present*
Advisors: [Dr. Amit Sharma, Prof. Chenhao Tan](), Microsoft Research   [project]()

· Proposed a causal proximity regulariser using Structural Causal Models (SCM) to improve the feasibility of counterfactual (CF) explanations for Machine Learning classifiers.
· Developed a generative framework for efficient CF generation and feasibility preservation under different assumptions of the problem setting like access to SCM, User Feedback, etc.
· Experimented on bayesian networks and Adult-Income datasets to show how our approach improves feasibility of CF explanations by preserving monotonic constraints as compared to the state of art methods.
· Integrated the base generative approach into the open source framework **DiCE** by InterpretML.
· The work got accepted for **Oral Spotlight Presentation** in the **NeurIPS CausalML Workshop 2019**.

● **Generative Zero Shot Learning with Adversarial Domain Adaptation**   *Feb 2018-Nov 2018*
Advisors: [Prof. Piyush Rai](), IIT Kanpur   [project]()

· Developed a Generative framework for Zero Shot Learning that learns the class data distribution conditioned on attribute vectors by end to end learning of the mapping from class attribute to parameters using supervision provided by seen data class
· Extended the model using Adverserial Domain Adaption for better estimation of unseen class data distributions
· Obtained results better than many state of the art Zero Shot Learning models on various benchmark datasets
· The work was accepted in the proceedings of the conference **WACV 2020**

RELEVANT COURSEWORK

Machine Learning	Machine Learning Techniques*, Probabilistic Machine Learning, Visual Recognition* Topics in Probabilistic Modelling and Inference*
Statistics	Probability and Statistics, Applied Stochastic Process, Statistical Inference
Mathematics	Advanced Linear Algebra, Severable Variable Calculus, Mathematical Logic* Real Analysis, Complex Analysis, Abstract Algebra, Numerical Analysis and Scientific Computing*
Algorithms and Theory	Data Structure and Algorithm, Algorithms II, Theory of Computation, Quantum Computing

*: Received Best (A) Grade

AWARDS AND ACHIEVEMENTS

· Received the **Academic Excellence Award, IIT Kanpur** for the academic session 2017-2018
· Received Certificate of Achievement for Rank 33 in **ACM ICPC 2017** Asia Gwalior Online Programming Round (3000+ teams)
· Secured All India Rank 1940 in **JEE-Advanced 2014** out of 150,000 students with Percentile 98.71
· Obtained Merit with **Rank 13** in Matriculation Examination (2012) and **Rank 36** in Senior Secondary Examination (2014)

OTHER RELEVANT PROJECTS

- **Visual Program Synthesis** *Jan 2018-Dec 2018*
  Advisors: Prof. Vinay Namboodiri, IIT Kanpur Presentation Report

  - Proposed a Deep Generative model using Conditional DC GAN and LSTM for program synthesis of Logo language from the given textual specification
  - Created datasets comprising of text caption describing geometrical shapes with basic components like circles and polygons alongwith the corresponding image and logo program
  - Trained the complete pipeline end to end using TensorFlow and generated syntactically and semantically correct Logo program along with good synthesized images for text captions in dataset

- **Interpretable Hierarchical Reinforcement Learning** *Jan 2019-May 2019*
  Advisors: Prof. Vinay Namboodiri, IIT Kanpur Report

  - Worked on designing Interpretable Reinforcement Learning solutions that could generalize to unseen goals
  - Used Meta Learning based heirarchical setup to achieve generalizability with ideas from information maximization to learn interpretable action policies
  - Experimented with the frozen lake environment and showed our model can generalize over all the goals by training on only 8 goals, while maintaining interpretability in the lower/action policies.

- **Approximate Bayesian Computation for Cancer Simulator** *May 2018-Jul 2018*
  Advisors: Prof. Samuel Kaski, Aalto University Presentation

  - Worked on the inference of a complex stochastic simulator based model that represents cancer treatment process of a patient
  - Did literature survey of Approximate Bayesian Computation methods and used Bayesian Optimisation for Likelihood Free Inference approach
  - Work included Exploratory Data Analysis to determine informative statistics for dimensionality reduction and inference of parameters with Bayesian Optimisation framework implemented using Engine for Likelihood Free Inference (ELFI)

- **Recommender Systems** *May 2017-Jul 2017*
  Advisors: Prof. Wynne Hsu and Prof. Lee Mong Li, National University of Singapore Code

  - Worked on building Recommender System that predicts Effectiveness and Side Effects on the usage of a Drug for a Patient
  - Created, Preprocessed a dataset and performed Baseline Evaluations using Matrix Factorization algorithms and Regression Models
  - Implemented a Deep Learning Model to learn better Latent Features and perform Multi Label Classification of Side Effects

- **Stance Classification of Tweets** *June 2016-July 2016*
  Advisors: Prof. Vincent Ng, New York Office, IIT Kanpur Code

  - Worked on predicting Stance for Tweets against a Target using machine learning algorithms, a task in International Workshop on Semantic Evaluation 2016
  - Read research papers on Sentiment Analysis and Stance Classification and used ideas from them to develop a model for tweets that do not express opinion about the main target

TECHNICAL SKILLS

Programming Languages	C, C++, Python, Bash
Software and Utilities	Git, Docker, Latex, PyTorch, TensorFlow, ELFI, DoWhy

EXTRA CURRICULAR ACTIVITIES

- (2020) Managing the Machine Learning Reading Group at Microsoft Research India
- (2018) Project Mentor for the course Machine Learning Techniques (CS771A) offered by Prof. Piyush Rai at IIT Kanpur
- (2018) Mentored 5 freshmen students for a project on Recommender Systems under Association of Computing Activities, IITK
- (2017) Managed a team of 5 members to publish 2 editions of Newsletter Alpha under Statmatics, mathematics society of IITK
- (2016) Volunteered in the Kanpur team of Blood Connect, NGO working to provide a solution for the shortage of blood in India
- (2015) Worked in National Service Scheme at IIT Kanpur to provide better education to underpriviledged children