Statement of Intent

I am Abdus Salam Azad. My research interests broadly span the field of Machine Learning (ML). In my undergraduate and Master's thesis, I have worked on Memetic Algorithms. I have also attempted to explore the domain of ML further and its application in relevant fields through several courses, projects, and research collaborations. For my future research, I am particularly interested to develop learning algorithms for Image and Natural Language Understanding. Hereby I express my interest to participate in the PhD-Track MSc Program in the Department of Computer Science at The University of British Columbia(UBC)—a suitable place to pursue research in this area.

I had my first major research experience during my undergraduate thesis. I worked on Genetic Algorithms(GA) to solve MDPVRP—a lesser studied variant of the well-known Vehicle Routing Problem (VRP), which extends VRP with multiple depots and periods. I was supervised by Prof. Md. Monirul Islam, who has been working on GAs for the past 20 years. For GAs to perform well, maintaining the population diversity is very crucial. To keep the population diverse, the existing GA approaches for VRPs incorporate a diversity measure with the solutions' fitness, which can be computationally expensive. Our proposed method aimed at maintaining the population diversity solely by the use of selection operators. We also proposed a new formulation for MDPVRP which allows interdependent operations among depots to provide cheaper solutions at the cost of a bigger search space. Our work was acknowledged as the winner in the yearly thesis poster competition organized by CSE, BUET (1st out of 57 submissions).

In my Master's thesis, I continued my work with Prof. Islam on our proposed MDPVRP formulation. This time, we developed a Memetic Algorithm (MA)—a hybrid GA with a local improvement component. The existing MA methods focus extensively on greediness, which typically leads them to a premature convergence and require additional techniques such as population restart for further progress. Our proposed method introduces a stochastic local improvement component to address this problem. The component focuses simultaneously on both greediness and randomness to maintain the balance between exploration and exploitation, which consequently helps to avoid a premature convergence. We also proposed a heuristic, partly greedy and partly stochastic, to construct the initial solutions. Extensive experiments on the benchmark problems revealed significant improvements over the state-of-the-art methods. This work has been accepted in the IEEE Transactions on Cybernetics.

I developed a decent understanding of search techniques and constrained combinatorial optimization during my thesis. To get a greater overview and deeper understanding of the topics of AI & ML, I have taken a number of related courses during my undergrad and Master's, including AI, ML, Pattern Recognition, and Data Mining. I have also participated in MOOCs on ML (Coursera) and Deep Learning (Udacity). To strengthen my foundation in image analysis, I also took the Advanced Image Processing course during my Master's. I learned a number of useful and fundamental techniques, e.g., image enhancement, filtering, segmentation, and compression. I also implemented a paper on content-based image retrieval.

My interest towards Image and Natural Language understanding piqued during one of my Master's projects. I surveyed the literature of bidirectional image-sentence search, searching

images with sentence descriptions (and vice versa), and analyzed three of the state-of-the-art methods. I also proposed a two-stage approach that decouples object detection within the images from the inference of their inherent semantic relations. In the first phase, the representation of the objects in the images are learned in a joint "Object embedding space" to have close proximities with their matching words (e.g., an image of dog will have similar "Object" representation of the word "dog"). In the next step, the "Semantic" representation of the images and sentences are learned leveraging the object representations.

I am currently working on two research projects: machine/reading comprehension and citation recommendation. In machine comprehension (answering questions based on passages), we have modelled the problem as a path-finding game in a passage graph, where an agent traverses the graph to locate the answer. The graph is constructed from the passage utilizing word embeddings, parse trees, and coreference resolution. I am training the agent using reinforcement learning. In the citation recommendation project, the task is to recommend the most relevant works from the literature, given a research idea or, abstract as a query. A paper may cite another paper for a number of different reasons, such as having similarity in the applied methodology, problem definition, and/or datasets. To incorporate such multidimensional similarity we propose a multi-objective optimization based Learning to Rank algorithm.

Since my undergraduate studies, I have attempted to explore AI, ML, and relevant fields through my research, courses, and different projects. In my Ph.D., I am interested in designing learning algorithms which can gather knowledge from data, especially from text and/or images, to solve meaningful problems by utilizing their inherent semantics. There has been a significant advancement in this field, particularly with deep learning approaches. However, there is room for further improvement. The current state-of-the-art supervised deep learning methods need lots of labelled training examples. I would like to design algorithms which can utilize unlabeled or partially labelled data. I am also interested in developing algorithms that solve problem of a particular domain (e.g, text) by utilizing data from another relevant domain (e.g., video) as auxiliary supervision.

I consider the Department of Computer Science at The University of British Columbia (UBC) one of the most suitable places for research in the field of Image and Natural Language Understanding. UBC provides an excellent environment for cutting-edge research with top-notch research facilities and extraordinary faculty members working in this area. I am particularly interested to work with Prof. Leonid Sigal on visual understanding using machine learning techniques. I am equally interested to be a part of the Natural Language Processing (NLP) group. The works of Prof. Giuseppe Carenini and Prof. Raymond T. Ng on raw unstructured texts for summarizing, visual text analytics, and text generation are intriguing. I am also open to working with others who have interest in developing machine learning algorithms for solving problems arising in Image and Natural Language Understanding. I believe an opportunity to participate in the PhD-Track MSc Program in the prestigious Department of Computer Science at UBC will enable me to strengthen my foundation in this area through focused course-works and conduct impactful research to advance towards a research-oriented career in academia.

Publications

- **Abdus Salam Azad**, Md. Monirul Islam, and Saikat Chakroborty. **A Heuristic Initialized Stochastic Memetic Algorithm for MDPVRP with Interdependent Depot Operations.** IEEE Transactions on Cybernetics, vol. 47, no. 12, pp. 4302-4315, Dec 2017. doi: 10.1109/TCYB.2016.2607220.

- **Abdus Salam Azad**, Md.Kamrul Hasan, M.Arif Imtiazur Rahman, Md.Mustafizur Rahman, and Nashid Shahriar. **Exploring the behavior and changing trends of rainfall and temperature using statistical computing techniques.** In Tanvir Islam, Prashant K. Srivastava, Manika Gupta, Xuan Zhu, and Saumitra Mukherjee, editors, Computational Intelligence Techniques in Earth and Environmental Sciences, pages 53-78. Springer Netherlands, 2014.

Summary of Honors, Scholarships, Fellowships, Grants, and Awards

- Winner, 1st Undergraduate Thesis Poster Presentation, 2014, CSE, BUET.

- Travel Grant, NUS School of Computing Summer School, 2017, National University of Singapore

- Winner, Android Application Development Contest, Samsung R&D, Bangladesh, 2013

- Dean's Honor List, BUET

- University Merit Scholarship, BUET