

# Raihan Seraj

DOCTORAL STUDENT · MCGILL UNIVERSITY

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## Research Interest

Reinforcement learning, Deep learning, Multi-agent systems, Game theory

## Education

### McGill University

Montreal, Canada

PHD, DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

Jan. 2019 - Present

- **Affiliations:** Montreal Institute of Learning Algorithms (MILA), Group for Research in Decision Analysis (GERAD), Center for Intelligent Machines (CIM).
- **Research:** Reinforcement learning for multi-agent systems.

### McGill University

Montreal, Canada

MENG, DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

Jan. 2017 - Jan. 2019

- Thesis: Learning in the presence of partial observability and concept drifts.
- Graduate Courses: Machine Learning, Optimization and Optimal Control, Reinforcement Learning, Applied Machine Learning, Intelligent Robotics, Reinforcement Learning, Stochastic Control and Markov Decision Processes.

### Islamic University of Technology (IUT)

Dhaka, Bangladesh

BSC, DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Dec. 2011 - Dec. 2015

- Thesis: Classification of malignant and benign tissue using logistic regression with dynamic sigmoid function

### Mastermind

Dhaka, Bangladesh

GCE O AND A LEVEL

Jan. 2009 - Jun. 2011

## Honors & Awards

2019	<b>GERAD co-supervised student award:</b> Winner of the GERAD research grant competition for co supervised graduate students	Montreal, Canada
2019	<b>McGill Engineering Doctoral Award (MEDA):</b> Given to doctoral students based on the excellence of the student's academic and research record.	Montreal, Canada
2018	<b>MITACS Accelerate Fellowship:</b> Award given to students to carry extensive research in industries.	Montreal, Canada
2017,2018	<b>Graduate Excellence fellowship:</b> Award given to support outstanding Master's students.	Montreal, Canada
2016	<b>Champion:</b> Brac Manthan award for e-health category.	Dhaka, Bangladesh
2011	<b>Entrance exam scholarship:</b> Merit based scholarship for at IUT entrance exam.	Dhaka, Bangladesh
2009,2011	<b>Daily Star Award:</b> Given to outstanding performers in GCE O and A level examinations.	Dhaka, Bangladesh

## Research Experience

### Paladin AI

Montreal, Canada

SCIENTIST IN RESIDENCE

Mar. 2020- Oct. 2020

- Worked on learning algorithms for automatic flight data segmentation through automatic feature learning.
- Devised suitable learning algorithms with the R&D team for handling time series data from aircraft simulators that can identify and segment pilot reactions to malfunctions and assign these reactions a proficiency metric.

### Aerial Technologies

Montreal, Canada

RESEARCH SCIENTIST INTERN

Mar. 2018- May. 2019

- Worked on learning algorithms for passive wifi localization, using wifi Channel State Information (CSI) data.
- Worked on deep learning algorithms for time series to classify fall detection from wifi CSI data.
- Used time delayed embeddings to extract useful features necessary for activity recognition.
- Worked on transformer models for fall detection using CSI data.

- Worked on learning algorithms to automatically classify QRS complexes to detect acceptable ECG traces.
- Developed a personal computer based telemedicine system with integrated diagnostic equipment like stethoscope, respiration monitor that use internet for live (real time) data transfer.
- Worked on software development for automatic frequency domain analysis to identify neurological disorder from evoked EMG responses.
- Developed software both in java and android platform for a 12 lead computerized ECG machine that allows near real time data transmission to and from remote areas.
- Developed software for Computerized Dynamic Pedograph System that carry out automatic analysis of pixel values using foot pressures and perform linear plot with pixel values against instant pressure values.

**IUT Innovation lab***Dhaka, Bangladesh*

RESEARCH INTERN

*Feb. 2014- Nov. 2015*

- Worked towards developing an embedded security system using arduino and raspberry pi interfaced with sensors that was integrated in a concrete to build a smart concrete system for homes.
- Worked towards developing an android software using the concept of delay tolerant network capable of handling delayed request for online news paper during lack of network infrastructure.
- Developed a quad-copter with a team to work as an air borne extension providing bird's eye view of a wireless controlled rover capable of sending live video stream.
- Developed a device using twitter api, arduino and raspberry pi that is capable of remotely switching and regulating any 220V ac devices using tweets.

## Publications

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- **Raihan Seraj**, Jerome Le Ny and Aditya Mahajan. "Mean-field approximation of large-population beauty-contest games." (submitted)
- Jayakumar Subramanian, Amit Sinha, **Raihan Seraj** and Aditya Mahajan. "Approximate information state for approximate planning and reinforcement learning in partially observed systems". (submitted)
- Jayakumar Subramanian, **Raihan Seraj** and Aditya Mahajan "Reinforcement learning for mean-field teams" AAMAS Workshop on Adaptive and Learning Agents, Montreal, Canada, 13-17 May, 2019.
- Mohiuddin Ahmed, **Raihan Seraj**, Salimur Chowdhury and Syed Mohammed Samsul Islam. "The k-means Algorithm: A Comprehensive Survey and Performance Evaluation", Electronics 9.8 (2020): 1295.
- Riashat Islam, **Raihan Seraj**, Pierre-Luc Bacon, Doina Precup. "Entropy Regularization with Discounted Future State Distribution in Policy Gradient Methods", NeurIPS 2019 workshop on Optimization Foundations for Reinforcement Learning.
- Riashat Islam, **Raihan Seraj**, Samin Yeasar Arnob, Doina Precup. "Doubly Robust Off-Policy Actor Critic Algorithms for Reinforcement Learning", NeurIPS 2019 workshop on Safety and Robustness in Decision Making.
- Jayakumar Subramanian, **Raihan Seraj** and Aditya Mahajan "Reinforcement learning for mean-field teams" Reinforcement Learning and Decision Making (RLDM), Montreal, Canada, 7–10 July, 2019.
- Jayakumar Subramanian, **Raihan Seraj** and Aditya Mahajan "Decentralized actor decentralized critic for multiagent co-operative environments (under submission)
- **Raihan Seraj**, Mohiuddin Ahmed (2020) Concept Drift for Big Data. In: Fadlullah Z., Khan Pathan AS. (eds) Combating Security Challenges in the Age of Big Data. Advanced Sciences and Technologies for Security Applications. Springer, Cham
- **Patent Provisional** filed with Aerial Technologies on Handling Concept Drifts in Wi-Fi based Localization

## Positions of Responsibility

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2020	<b>Teaching Assistant</b> , COMP 360, Algorithm Design, McGill University.	<i>Montreal, Canada</i>
2019	<b>Teaching Assistant</b> , ECSE 324, Computer Organization, McGill University.	<i>Montreal, Canada</i>
2019	<b>Teaching Assistant</b> , COMP 760, Intelligent Robotics, McGill University.	<i>Montreal, Canada</i>
2018	<b>Volunteer</b> , Neural Information Processing Systems.	<i>Montreal, Canada</i>
2018	<b>Reviewer</b> , International Journal for Computers and Applications.	<i>Montreal, Canada</i>
2014	<b>President</b> , IEEE, IUT Student Branch.	<i>Dhaka, Bangladesh</i>

## Projects

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- **Particle filters for simultaneous localization and mapping in robotics:** Used particle filters for simultaneous localization and mapping for mobile robots. Implemented conditional particle filters which provides an efficient way of tracking the pose of nearby people and robots simultaneously.
- **Learning in games:** Studied different learning frameworks in stochastic games since learning in game theoretic framework is interesting as it does not necessarily guarantee convergence to Nash equilibrium or any concepts of equilibria in general. The project focused on analyzing one of the simplest and earliest form of learning algorithm known as the fictitious play.
- **Evaluation of value-based and policy-based methods in dynamic multi drug therapies for HIV treatment:** Performed a detailed analysis of value based and policy based methods for Reinforcement Learning algorithms in order to learn optimal STI strategies using a set of trajectories generated during clinical trials of different STI protocols.
- **Value iteration algorithms for POMDPs:** Outline the challenges of performing value iteration algorithms for POMDPs, the project involved a critical analysis of existing value iteration algorithms that exploits the PWLC structure of the value function, using belief state as the information state.
- **Soft trust DDPG:** Worked on devising a trust region interpretation for Deep Deterministic Policy gradient algorithms. The proposed architecture allowed the use of regularization for deterministic policies in different continuous control tasks.
- **Reinforcement learning in multi-agent swarms:** An adapted version of conventional single agent RL algorithm was applied for swarm robotics in the context of swarms adapting to different target distribution, the work was further extended to incorporate hierarchical reinforcement learning architecture.
- **ICLR reproducibility challenge:** Analyzed the reproducibility of deep reinforcement learning algorithms for ICLR 2017 reproducibility challenge.
- **Unifying on-policy and off-policy learning in TD Learning and actor critic methods:** Combined the stability of On-Policy TD learning with the efficiency of Off-Policy Learning and proposed a unified approach where the control algorithm either uses on-policy sampled action or off-policy samples depending on the amount of exploration. The idea has been further extended to actor critic methods and  $Q(\sigma)$  algorithm with eligibility traces.
- **Convergence of reinforcement learning algorithms:** Examined the convergence and performance of value iteration, policy iteration and multi-step bootstrapping algorithms for different MDPs and POMDPs along with the proof of convergence of these algorithms.
- **Analysis of regularized logistic regression and kernel function:** Analysed the performance of kernelized logistic regression for objective automatic assessment of rehabilitative speech treatment in Parkinson's disease.
- **Analysis of convergence of BFGS and Conjugate gradient:** Studied the implementation and convergence of a wide optimization techniques for the optimization of unconstrained functions. A detail analysis of convergence of BFGS, Conjugate gradient and Newton's algorithm with back tracking line search was done on Rosenbrock function.

## Programming Language and Skills

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**Languages:** C, C++, Java, Python, Mathematica, Julia, R, Matlab

**Frameworks:** Numpy, Pandas, Scikit-learn, Pytorch, Tensorflow, Chainer, Mxnet, Scipy

**Systems:** Linux, OSX

## References

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Available upon request.