

Hala Mostafa

Research Scientist
United Technologies Research Center
mostafh@utrc.utc.com

<http://www.hmostafa.com/>

RESEARCH INTERESTS

- ◇ **Decision making under uncertainty:** Centralized and distributed sequential decision making and planning. Modeling and solving problems as (Dec-)(PO)MDPs.
- ◇ **Mathematical optimization:** Formulating open- and closed-loop planning problems as mathematical programs. Exploiting problem structure for compact formulations.
- ◇ **Distributed optimization:** Distributed Constraint Optimization Problems and their variants. Applying and extending algorithms to leverage domain-specific structure.
- ◇ **Applied machine learning:** Graphical models for representing and doing probabilistic inference in stochastic partially observable systems. Learning network diffusion models from observed propagation cascades. Optimizing decisions that affect diffusion.

EDUCATION

- ◇ **University of Massachusetts, Amherst** (2011)
Ph.D. in Computer Science
“Exploiting Structure In Coordinating Multiple Decision Makers”
Adviser: Prof. Victor Lesser
- ◇ **Cairo University, Egypt** (2004)
M.Sc. in Computer Science
- ◇ **Cairo University, Egypt** (2001)
B.Sc. in Computer Science

RESEARCH EXPERIENCE

- ◇ **United Technologies Research Center** (March 2015 - Present)
Research Scientist in the Decision Support and Machine Intelligence Group.
- ◇ **Singapore Management University** (May 2014 - Feb 2015)
Visiting Research Scientist at the Living Analytics Research Center, a joint research initiative between Singapore Management University and Carnegie Mellon University.
- ◇ **BBN Technologies** (2011 - 2014)
Research Scientist in the Distributed Systems Group.
- ◇ **University of Massachusetts, Amherst** (2005 - 2011)
Research Assistant in the Multi-Agent Systems Lab.
- ◇ **IBM Cairo Technology Development Center, Egypt** (2004 - 2005)
Researcher in the Human Languages Technologies team.
- ◇ **Swedish Institute of Computer Science (SICS), Sweden** (2002)
Guest Researcher in the Distributed Systems Lab.

REFEREED PUBLICATIONS

- ◇ Akshat Kumar, **Hala Mostafa**, Shlomo Zilberstein. *Dual Formulations for Optimizing Dec-POMDP Controllers*. International Conference on Automated Planning and Scheduling (ICAPS), London, UK, 2016.
- ◇ **Hala Mostafa**, Akshat Kumar, Hoong Chuin Lau. *Simultaneous Optimization And Sampling Of Agent Trajectories Over A Network*. International Workshop on Optimization in Multi-Agent Systems (OptMAS). In conjunction with AAMAS, Singapore, 2016.

- ◇ Pradeep Varakantham, **Hala Mostafa**, Na Fu, Hoong Chuin Lau. *DIRECT: A Scalable Approach for Route Guidance in Selfish Orienteering Problems*. International Conference on Autonomous and Multi-Agent Systems (AAMAS), Istanbul, Turkey, 2015.
- ◇ Karen Zita Haigh, **Hala Mostafa**, Joanne Como, Dianne Egnor. *Modeling RF Interference Performance*, 43rd Annual Collaborative Electronic Warfare Symposium, CA, April 2014.
- ◇ Karen Zita Haigh, John Tranquilli, Dianne Egnor, **Hala Mostafa**, Guevara Noubir, Scott Roche, Ravi Sundaram. *Optimizing Mitigation Strategies: Learning to choose communication strategies to mitigate interference*, CUMC, McLean VA, November 2013.
- ◇ **Hala Mostafa**, Partha Pal, Patrick Hurley. *Message Passing for Distributed QoS-Security Tradeoffs*. The Computer Journal, doi: 10.1093/comjnl/bxt064, 2013.
- ◇ Aaron Adler, Fusun Yaman, Jacob Beal, Jeffrey Cleveland, **Hala Mostafa**, Annan Mozeika. *A Morphogenetically Assisted Design Variation Tool*. AAAI, July, 2013.
- ◇ Jacob Beal, Aaron Adler, **Hala Mostafa**. *Mixed Geometric-Topological Representation for Electromechanical Design*. GECCO, Amsterdam, The Netherlands, July 2013.
- ◇ **Hala Mostafa**, Nathaniel Soule, Nicholas Hoff, Partha Pal, Patrick Hurley. *Applying Distributed Optimization for QoS-Security Tradeoff in a Distributed Information System*. In Proceedings of the Twelfth International Conference on Autonomous and Multi-Agent Systems (AAMAS), Minnesota, USA, June 2013.
- ◇ **Hala Mostafa**, Partha Pal, Patrick Hurley. *Message Passing for Distributed QoS-Security Tradeoffs*. In Proceedings of the Fifth International Workshop on Optimisation in Multi-Agent Systems (OptMAS) in conjunction with the Eleventh International Conference on Autonomous and Multi-Agent Systems (AAMAS), Spain, June 2012.
- ◇ Jacob Beal, **Hala Mostafa**, Benjamin Axelrod, Annan Mozeika, Aaron Adler, Gretchen Markiewicz, Kyle Usbeck. *A Manifold Operator Representation for Adaptive Design*. In Proceedings of the Genetic and Evolutionary Computation Conference (GECCO 2012), Philadelphia, USA, July 2012.
- ◇ **Hala Mostafa**, Victor Lesser. *Compact Mathematical Programs For DEC-MDPs With Structured Agent Interactions*. In Proceedings of the 27th Conference on Uncertainty in Artificial Intelligence (UAI 2011), Barcelona, Spain, July 2011.
- ◇ **Hala Mostafa**, Victor Lesser. *Exploiting Structure To Efficiently Solve Loosely Coupled Stochastic Games*. In Proceedings of the AAMAS'10 Workshop on Multi-Agent Sequential Decision Making in Uncertain Domains (MSDM 2010), Toronto, Canada, May 2010.
- ◇ **Hala Mostafa**, Victor Lesser. *Offline Planning for Communication by Exploiting Structured Interactions in Decentralized MDPs*. In Proceedings of 2009 IEEE/WIC/ACM International Conference on Web Intelligence and Intelligent Agent Technology, Milan, Italy, September 2009.
- ◇ Zhang, Xiaoqin; Yoon, S.; DiBona, P.; Appling, D.S.; Ding, L.; Doppa, J.R.; Green, D.; Guo, J.K.; Kuter, U.; Levine, G.; MacTavish, R.L.; McFarlane, D.; Michaelis, J.R.; **Mostafa, Hala**; et al.. *An Ensemble Learning and Problem-Solving Architecture for Airspace Management*. In proceedings of the Twenty-First Annual Conference on Innovative Applications of Artificial Intelligence (IAAI-09), Pasadena, California, July 2009.
- ◇ **Hala Mostafa**, Victor Lesser, Gerome Miklau: *Self-interested Database Managers Playing The View Maintenance Game*. In Proceedings of the Seventh International Conference on Autonomous Agents and Multi-Agent Systems (AAMAS'08), Estoril, Portugal, May 2008.
- ◇ **Hala Mostafa**, Victor Lesser: *Approximately Solving Sequential Games with Incomplete Information*. In Proceedings of the AAMAS'08 Workshop on Multi-Agent Sequential Decision Making in Uncertain Domains (MSDM 2008), Estoril, Portugal, May 2008.
- ◇ **Hala Mostafa**, Victor Lesser: *Minimizing Privacy Loss in the View Maintenance Problem*. Grace Hopper Celebration of Women in Computing, Orlando, Florida, October 2007.

Hala Mostafa

- ◇ Mark Sims, **Hala Mostafa**, Bryan Horling, Haizheng Zhang, Victor Lesser, Daniel Corkill and John Phelps: *Lateral and Hierarchical Partial Centralization for Distributed Coordination and Scheduling of Complex Hierarchical Task Networks*. AAAI Spring Symposium on distributed plan and schedule management, 2006.
- ◇ **Hala Mostafa**, Reem Bahgat: *The Agent Visualization System: A Graphical and Textual Representation For Multi-Agent Systems*. Information Visualization Journal 4(2005), 83-94.
- ◇ **Hala Mostafa**, Reem Bahgat: *Using Mozart for Visualizing Agent-Based Simulations* . In Proceedings of the Second International Mozart-Oz Conference, Charleroi, Belgium, 2004. Also appeared in Springer-Verlag Lecture Notes in Computer Science Volume 3389 / 2005.

PATENT Hany M. Hassan, **Hala Mostafa**: *Method and System for Extracting and Visualizing Graph Structured Relations from Unstructured Text*. Filed by IBM. United States Patent Application 20070124291. International application 05111462.7.

- ACTIVITIES & SERVICES
- ◇ Member of the Doctoral Consortium Career Panel, AAMAS 2013.
 - ◇ Member of the CRA-W/CDC Discipline-specific Mentoring Panel, AAMAS 2013.
 - ◇ Member of the CS Women’s Professionalism Panel at University of Massachusetts, 2012.
 - ◇ Reviewer for The Computer Journal
 - ◇ Program Committee Member
 - International Joint Conference On Artificial Intelligence (IJCAI) 2015
 - International Conference on Autonomous Agents and Multiagent Systems (AAMAS) 2013-2015
 - Twenty-Sixth Conference on Artificial Intelligence (AAAI) 2012
 - Workshop on Multiagent Sequential Decision Making Workshop (MSDM) 2011-2015
 - Workshop on Optimization In Multiagent Systems (OptMAS) 2013-2015
 - Workshop on Agents and CyberSecurity (ACySe) 2014
 - ◇ Auxiliary Reviewer
 - AAAI 2015
 - AAMAS 2012
 - International Joint Conference On Artificial Intelligence (IJCAI) 2011

TEACHING EXPERIENCE

- ◇ **University of Massachusetts, Amherst** (2009 - 2011)
- ◇ **Cairo University, Egypt** (2001 - 2005)

RESEARCH PROJECTS

- ◇ **Misc. projects at United Technologies Research Center** (2015-Present)
At UTRC, I am the technical lead on a project using machine learning techniques to solve a variety of data analytics problems for Pratt and Whitney. I interact with an array of customers from very different backgrounds and with different data needs. In addition to business unit projects that deliver immediate value to the customer, I am also involved in more research-oriented projects where I use sequential decision making techniques to address problems that give our businesses competitive advantages down the line.
- ◇ **Misc. projects at the Living Analytics Research Center** (2014)
At LARC, we are looking at a number of real-world problems together with our industrial partners. We use machine learning and mathematical optimization techniques to address issues like handling the congestion of visitors at venues like theme parks and world expos and learning customer behavior to optimize marketing decisions.

- ◇ **Continuous adaptation of QoS and IA (Technical Lead) (2011 - 2014)**

This AFRL-funded project at BBN is concerned with the assessment and management of the levels of Quality of Service (QoS) and Information Assurance (IA) in a distributed system. QoS and IA compete for the same set of resources, often making it impossible to employ the full range of security mechanisms while maintaining highest QoS levels. In the first phase of the project, I addressed the problem of which IA security mechanisms to deploy and which QoS decisions to make on every node in the distributed system to maximize user satisfaction given resource constraints. I formulated the problem as a Distributed Constraint Optimization Problem, devised a value propagation algorithm to complement existing utility propagation algorithms, and deployed our algorithms on a simulated distributed system running on multiple virtual machines.

In our setting, each node needs to be within d hops of a leader. In the second phase of the project, we addressed networks with dynamic topologies where a node's route to its leader can be disrupted due to link failure and existing leaders can become redundant due to link healing. I developed a suite of robust distributed algorithms to find d -hop dominating set in a graph whose edge set changes during algorithm execution.
- ◇ **Communications in Extreme RF Spectrum Conditions (CommEx) (2012)**

The electromagnetic spectrum is used by friendly and adversary users, resulting in an increasingly congested space, time and frequency environment. To communicate successfully amid these challenges, a communication system must exhibit significant adaptivity and flexibility. DARPA's CommEx program is interested in technologies and techniques that address communications in severe jamming. My role in this project concerns the sequential decision process of the communication system that needs to take into account uncertainty about both the adversary and the environment.
- ◇ **Exploiting structured interactions among decision makers (2009 - 2011)**

In many real life situations with agents/multiple decision makers, there is a fair degree of independence among the agents' sub-problems. I exploited this structured interaction to realize representational and computational savings in situations involving both cooperative and self-interested agents. I obtained representational savings through a model that is much more compact than general game trees and decentralized MDPs. I obtained computational savings through heuristics and solution algorithms that leverage the explicit representation of interactions in my model.
- ◇ **Sequential decision making using mathematical optimization (2010)**

I investigated mathematical optimization techniques and solvers to solve decision- and game-theoretic models. I explored a number of formulations of general DEC-MDPs as mathematical programs. I obtained significantly more compact formulations by abstracting and aggregating actions of one agent from the point of view of another agent. Other approaches I tried include homotopy methods for solving a formulation of my problem as a system of nonlinear equations, and decompositions for solving mathematical programs that become less difficult once a set of complicating variables is fixed.
- ◇ **Distributed interpretation in communication-limited environments (2007 - 2009)**

In this project, I studied communication in two settings. The first involved selfish agents that need to disclose some information in order to obtain a reward that depends on the quantity and quality of information disclosed by all agents. Each agent decides what it should disclose over the course of the game to maximize its reward and minimize its privacy loss. I formulated this problem as a sequential game of incomplete information and developed an approximate anytime hill-climbing algorithm for it. In the second setting, I studied communication among cooperative agents. I developed heuristics for introducing communication into a DEC-MDP in a controlled manner that limits the computational cost of reasoning about communication. My heuristics assess the impact of a potential message on the recipient's belief at a given point, thereby estimating the importance of making communication available at that point.
- ◇ **GILA: Generalized Integrated Learning Architecture (2008)**

Hala Mostafa

GILA was one of the teams in the DARPA Integrated Learning program. We studied the coordination of multiple learning agents with different learning algorithms whose performances depend on the context, and integrating their hypotheses to cooperatively and incrementally solve complex problems (e.g. air traffic flight planning). My role was to study the use of a feature-based context representation to choose which learners to use.

◇ **Coordination Decision Support Assistants (COORDINATORs)** (2005-2006)

The goal of this DARPA project was creating distributed intelligent software systems that help fielded units adapt their mission plans as the situation around them changes and impacts their plans. I was one of the leaders of the UMass effort which resulted in a new approach to coordinating the scheduling and execution of complex hierarchical task structures that are distributed among agents.