Michael Bradley Johanson

Contact Information	Michael Johanson 9837 92 Ave NW Edmonton, Alberta Canada T6E 2V4	*Phone:* (780) 908-4841 *E-mail:* michael.johanson@gmail.com *Web:* johanson.ca Updated: May 2023

Research Interests

Artificial Intelligence and Reinforcement Learning. Learning and behaviour in multi-agent and multi-human scenarios, agent learning in rich environments, and computational game theory.

Education

University of Alberta, Edmonton, Alberta, Canada

Ph.D., Computing Science **January 2016**

- Advisor: Michael Bowling
- Thesis Title: Robust Strategies and Counter-Strategies: From Superhuman to Optimal Play
- Winner of the Department of Computing Science Outstanding PhD Thesis award

M.Sc., Computing Science **September 2007**

- Advisor: Michael Bowling
- Thesis Title: Robust Strategies and Counter-Strategies: Building a Champion Level Computer Poker Player
- One of three finalists for the Department of Computing Science Best MSc Thesis award

B.Sc., Computing Science **April 2003**

- Business Minor

Work Experience

Co-founder **April 2023 to Present**

Artificial.Agency

Senior Research Scientist **July 2017 to March 2023**

Google DeepMind

Consulting Game Theorist **June 2014 to June 2017**

Self Employed

Research Scientist **September 2016 to April 2017**

Cogitai

Awards and Honors

University of Alberta Computing Science Outstanding PhD Thesis Award **2016**

Selected as the author of the department's best PhD thesis in 2016.

Outstanding AICML Student award **2016**

Awarded by the Alberta Innovates Centre for Machine Learning, for research included in my PhD thesis.

Solved Heads-up Limit Hold'em Poker **2015**

Member of the team that solved heads-up limit hold'em poker, as described in our Science article [1].

This was the first nontrivial imperfect information game played by humans to be solved, and among the first nontrivial stochastic games to be solved.

Annual Computer Poker Competition **2006-2013**

Core member of the University of Alberta team that has placed 1st in 23 out of 36 events.

Nominated for the AAMAS 2012 Best Paper award **2012**

For "Efficient Nash Equilibrium Approximation through Monte Carlo Counterfactual Regret Minimization".

One of three finalists.

Second Man-vs-Machine Poker Championship **2008**

Core member of the team that produced Polaris, the first computer agent to defeat top human professional poker players in a meaningful competition.

Nominated for the University of Alberta Computing Science Best MSc Thesis award **2007**

One of three finalists.

University of Alberta Graduate Student Teaching Award **2005**

Winner in 2005 and nominee in 2004 as a lab instructor for second year C and C++ courses.

Publications

Refereed Journals

[1] Yoram Bachrach, Richard Everett, Edward Hughes, Angeliki Lazaridou, Joel Z. Leibo, Marc Lanctot, Michael Johanson, Wojciech M. Czarnecki, Thore Graepel. Negotiating Team Formation using Deep Reinforcement Learning. Artificial Intelligence, Volume 288. 2020.

[2] Matej Moravčík, Martin Schmid, Neil Burch, Viliam Lisý, Dustin Morrill, Nolan Bard, Trevor Davis, Kevin Waugh, Michael Johanson, Michael Bowling. DeepStack: Expert-Level Artificial Intelligence in No-Limit Poker. Science, Volume 356 Number 6337, Pages 508-513. 2017.

[3] Michael Bowling, Neil Burch, Michael Johanson and Oskari Tammelin. Heads-up Limit Hold'em Poker is Solved. Science, Volume 347 Number 6218, Pages 145–149. 2015.

[4] Ryan Hayward, Yngvi Björnsson, Michael Johanson, Morgan Kan, Nathan Po and Jack van Rijswijck. Solving 7×7 Hex with Domination, Fill-In, and Virtual Connections. Theoretical Computer Science, Volume 349 Issue 2, Pages 123-139. 2005.

Refereed Conferences

[5] Oskari Tammelin, Neil Burch, Michael Johanson and Michael Bowling. Solving Heads-up Limit Texas Hold'em. Proceedings of the 24th International Joint Conference on Artificial Intelligence (IJCAI 2015). 2015.

[6] Neil Burch, Michael Johanson and Michael Bowling. Solving Imperfect Information Games using Decomposition. Proceedings of the Twenty-Eighth AAAI Conference on Artificial Intelligence (AAAI 2014). 2014.

[7] Nolan Bard, Michael Johanson and Michael Bowling. Asymmetric Abstractions for Adversarial Settings. Proceedings of the Thirteenth International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2014). 2014.

[8] Michael Johanson, Neil Burch, Richard Valenzano and Michael Bowling. Evaluating State-Space Abstractions in Extensive-Form Games. Proceedings of the Twelfth International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2013). 2013.

[9] Nolan Bard, Michael Johanson, Neil Burch and Michael Bowling. Online Implicit Agent Modelling. Proceedings of the Twelfth International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2013). 2013.

[10] Michael Johanson, Nolan Bard, Neil Burch and Michael Bowling. Finding Optimal Abstract Strategies in Extensive-Form Games. Procedings of the Twenty-Sixth Conference on Artificial Intelligence (AAAI 2012). 2012.

[11] Michael Johanson, Nolan Bard, Marc Lanctot, Richard Gibson and Michael Bowling. Efficient Nash Equilibrium Approximation through Monte Carlo Counterfactual Regret Minimization. Proceedings of the Eleventh International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2012). 2012. One of three finalists for the AAMAS 2012 Best Paper award.

[12] Michael Johanson, Kevin Waugh, Michael Bowling and Martin Zinkevich. Accelerating Best Response Calculation in Large Extensive Games. Proceedings of the Twenty-Second International Joint Conference on Artificial Intelligence (IJCAI 2011). 2011.

[13] Michael Johanson and Michael Bowling. Data Biased Robust Counter Strategies. Proceedings of the Twelfth International Conference on Artificial Intelligence and Statistics (AISTATS 2009). 2009.

[14] Kevin Waugh, Martin Zinkevich, Michael Johanson, Morgan Kan, David Schnizlein and Michael Bowling. A Practical Use of Imperfect Recall. Proceedings of the Eighth Symposium on Abstraction, Reformulataion and Approximation (SARA 2009). 2009.

[15] Michael Bowling, Michael Johanson, Neil Burch and Duane Szafron. Strategy Evaluation in Extensive Games with Importance Sampling. Proceedings of the Twenty-Fifth International Conference on Machine Learning (ICML 2008). 2008.

[16] Michael Johanson, Martin Zinkevich and Michael Bowling. Computing Robust Counter-Strategies. Proceedings of the Twenty-First Annual Conference on Neural Information Processing Systems (NIPS 2007). 2007.

[17] Martin Zinkevich, Michael Johanson, Michael Bowling and Carmelo Piccione. Regret Minimization in Games with Incomplete Information. Proceedings of the Twenty-First Annual Conference on Neural Information Processing Systems (NIPS 2007). 2007.

[18] Yngvi Björnnson, Ryan Hayward, Michael Johanson and Jack van Rijswijck. Dead Cell Analysis in Hex and the Shannon Game. Graph Theory in Paris: Proceedings of a Conference in Memory of Claude Berge (GT04 Paris). Birkauser 2007, pages 45-60. 2007.

[19] Ryan Hayward, Yngvi Björnsson, Michael Johanson, Morgan Kan, Nathan Po and Jack van Rijswijck. Solving 7×7 Hex: Virtual Connections and Game-State Reduction. Advances in Computer Games 10 (ACG 2004). 2004.

Theses

[20] Michael Johanson. Robust Strategies and Counter-Strategies: From Superhuman to Optimal Play. PhD thesis, Computing Science Department, University of Alberta, Edmonton, Alberta. January 2016.

[21] Michael Johanson. Robust Strategies and Counter-Strategies: Building a Champion Level Computer Poker Program. MSc thesis, Computing Science Department, University of Alberta, Edmonton, Alberta. September 2007.

Other Publications

[22] Michael Johanson. Measuring the Size of Large No-Limit Poker Games. Technical Report, Computing Science Department, University of Alberta, Edmonton, Alberta. February 2013.

[23] John P. Agapiou, Alexander Sasha Vezhnevets,, Edgar A. Duéñez-Guzmán,, Jayd Matyas, Yiran Mao, Peter Sunehag, Raphael Köster, Udari Madhushani, Kavya Kopparapu, Ramona Comanescu, DJ Strouse, Michael B. Johanson, Sukhdeep Singh, Julia Haas, Igor Mordatch, Dean Mobbs and Joel Z. Leibo. Melting Pot 2.0. Arxiv. 2022.

[24] Michael Bradley Johanson, Edward Hughes, Finbarr Timbers, Joel Z. Leibo. Emergent Bartering Behaviour in Multi-Agent Reinforcement Learning. Arxiv. 2022.

[25] Patrick M. Pilarski, Andrew Butcher, Elnaz Davoodi, Michael Bradley Johanson, Dylan J.A. Brenneis, Andrew S.R. Parker, Leslie Acker, Matthew M. Botvinick, Joseph Modayil, Adam White. The Frost Hollow Experiments: Pavlovian Signalling as a Path to Coordination and Communication Between Agents. Arxiv. 2022.

[26] Patrick M. Pilarski, Andrew Butcher, Michael Johanson, Matthew M. Botvinick, Andrew Bolt, Adam S.R. Parker. Learned human-agent decision-making, communication and joint action in a virtual reality environment. Arxiv. 2019.

Academic Experience

University of Alberta, Edmonton, Alberta, Canada

Sessional Instructor **September 2014 to December 2014**

- Instructor for CMPUT 201, a second-year course teaching C/C++, Unix, and fundamental systems programming.
- Taught a class of 88 students and supervised 7 teaching assistants.
- Teaching evaluation scores in the top quartile of instructors, with a median score of 4.8/5 for the statement "Overall, this instructor was excellent".

Graduate Research Assistant **September 2008 to June 2014**

- Created the first tractable algorithm for objective analysis of computer agent strength in Texas hold'em poker.
- Developed a series of game-theoretic computer poker agents that placed at or near the top in each year's Annual Computer Poker Competition.
- Publication in Science [1] for creating an optimal, unbeatable computer agent for playing heads-up limit Texas hold'em. This is the first time that a human-scale imperfect information game had been solved.

Research Programmer **October 2007 to August 2008**

- Co-creator of Polaris, the first poker playing computer program to defeat top human professionals in a meaningful competition.
- Focussed on the engineering challenges of creating Polaris: state-space abstraction, efficient programs for solving large extensive form games, and unbiased variance reduction techniques for evaluating performance.

Graduate Research Assistant **January 2006 to September 2007**

- Contributed to developing Counterfactual Regret Minimization [14], the current state-of-the-art algorithm for Nash equilibrium approximation in large extensive-form games.
- Used Texas hold'em poker as a testbed to study the tradeoff between limiting worst-case performance and maximizing utility against a flawed adversary.

Teaching Assistant **September 2004 to December 2005**

- Laboratory Instructor for three first and second year introductory programming courses on C, C++ and Java (CMPUT 201 and CMPUT 115).
- One-time winner and two-time nominee of the University of Alberta Graduate Student Teaching Award.

Academic Service

Journal Reviewing

Transactions on Computational Intelligence and AI in Games (TCAIG) **2012**

Conference Reviewing

AAAI	**2018, 2016, 2014**
ICLR	**2022, 2021**
ICML	**2020, 2011, 2010**
IJCAI	**2019, 2018, 2013, 2010**
NeurIPS	**2019, 2013**

Workshop Organization

AAAI Workshop on Computer Poker and Imperfect Information **2013**

University Service

University of Alberta

President, Computing Science Graduate Student Association **2009**

Treasurer, Computing Science Graduate Student Association **2005**

Publicity Director, Undergraduate Association of Computing Science **2002**

Scholarships

University of Alberta

Alberta Innovates Technology Futures Graduate Student Scholarship **September 2008-August 2012**

- $36,000/year, $1,500/year research stipend.

Outreach

Public Presentations and Demonstrations

SC15 Conference, Austin, TX **2015**

Telus World of Science, Edmonton, AB **2015**

The Second Man-Machine Poker Championship, Las Vegas, NV **2008**

The First Man-Machine Poker Championship, Vancouver, BC **2007**

Major Media Attention

Solving HULHE: Nature, Science, Washington Post, CNN, BBC, CBC, The Times, and many more **2015**

Computational Game Theory: CBC Radio **2010**

First Man-vs-Machine Poker Championship: BBC Radio **2007**

Technical Skills

Frequently used programming languages and frameworks: C/C++, Python, JAX

Experience with high performance computing: Batch scheduling on clusters, large SMP systems.

Operating Systems: OSX, Linux, Windows

Personal Information

Citizenship: Canada

Family: Single

Hobbies: Geocaching, cooking, curling, and games of all kinds.