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Neil Burch

Research Interests

Artificial intelligence and machine learning. I am interested in game theory, search, reinforcement learning, and how these fit together in an agent that adapts to a changing environment with other agents.

Education

University of Alberta 2011-2017
PhD, Computing Science
Thesis title: *Time and Space: Why Imperfect Information Games are Hard*
Advisor: Dr. Michael Bowling

University of Alberta 1998-2001
MSc, Computing Science
Thesis title: *Self Stabilisation and Analog Computation*
Advisor: Dr. H. James Hoover

University of Alberta 1994-1998
BSc with Honours, Computing Science

Awards and Achievements

- Canada CIFAR AI Chair 2021
- Amii Fellow 2021
- Depth-limited Imperfect Information Search (published in *Science*) 2016
  Helped develop DeepStack, which beat professional players at no-limit poker
- Solved heads-up limit Texas Hold'em (published in *Science*) 2015
- Annual Computer Poker Competition 2006-2014
  First place in 24 out of 44 events, top three in 40 events

- Man-Machine Poker Competitions 2007,2008
  Helped develop Polaris, which beat professional players in 2008
- Solved checkers (published in *Science*) 2007
- Best paper prize 2005
  "Solving Checkers"
  Nineteenth International Joint Conference on Artificial Intelligence (IJCAI)

Work Experience

University of Alberta 2021-present
Adjunct Professor

- Graduate student supervision in Department of Computing Science

DeepMind 2017-present
Senior Research Scientist

- Collaborate on projects related to search and imperfect information
- Propose and carry out independent research projects

University of Alberta 2015
Sessional Instructor

- Taught two sections of CMPUT 201 (C/C++ programming in UNIX)

University of Alberta 2001-2011
Research Associate

- Worked with different research groups on assorted research projects
- Coding support for large software systems, used as part of 12 MSc and PhD dissertation projects and 30 refereed publications

University of Alberta 2000-2001
Programmer Analyst for campus Research Support Group

- Assist researchers with code optimisation and parallelisation
- System administration for campus HPC systems

University of Alberta 1998
Research Assistant for Dr. Jonathan Schaeffer

- Worked with PhD student on single-agent search in Sokoban

University of Alberta 1996,1997
Research Assistant for Dr. Ron Unrau

- Developed an object oriented intermediate language for compiler optimisations

Journal Publications

[1] Julien Perolat, Bart De Vylder, Daniel Hennes, Eugene Tarassov, Florian Strub, Vincent de Boer, Paul Muller, Jerome T Connor, Neil Burch, Thomas Anthony, et al. "Mastering the game of Stratego with model-free multiagent reinforcement learning". In: *Science* 378.6623 (2022), pp. 990–996.

[2] Vojtěch Kovařík, Martin Schmid, Neil Burch, Michael Bowling, and Viliam Lisý. "Rethinking formal models of partially observable multiagent decision making". In: *Artificial Intelligence* 303 (2022), p. 103645. ISSN: 0004-3702.

[3] Nolan Bard, Jakob N Foerster, Sarath Chandar, Neil Burch, Marc Lanctot, H Francis Song, Emilio Parisotto, Vincent Dumoulin, Subhodeep Moitra, Edward Hughes, Iain Dunning, Shibl Mourad, Hugo Larochelle, Marc G Bellemare, and Michael Bowling. "The Hanabi Challenge: A New Frontier for AI Research". In: *Artificial Intelligence* 280 (2020), p. 103216.

[4] Neil Burch, Matej Moravcik, and Martin Schmid. "Revisiting CFR+ and alternating updates". In: *Journal of Artificial Intelligence Research* 64 (2019), pp. 429–443.

[5] Matej Moravčík, Martin Schmid, Neil Burch, Viliam Lisý, Dustin Morrill, Nolan Bard, Trevor Davis, Kevin Waugh, Michael Johanson, and Michael Bowling. "DeepStack: Expert-level artificial intelligence in heads-up no-limit poker". In: *Science* 356.6337 (2017), pp. 508–513.

[6] Michael Bowling, Neil Burch, Michael Johanson, and Oskari Tammelin. "Heads-up Limit Hold'em Poker is Solved". In: *Science* 347.6218 (2015), pp. 145–149.

[7] Robert C. Holte and Neil Burch. "Automatic move pruning for single-agent search". In: *AI Communications* 27.4 (2014), pp. 363–383.

[8] Uzi Zahavi, Ariel Felner, Neil Burch, and Robert C. Holte. "Predicting the Performance of IDA* using Conditional Distributions". In: *Journal of Artificial Intelligence Research (JAIR)* 37 (2010), pp. 41–83.

[9] J. Schaeffer, N. Burch, Y. Björnsson, A. Kishimoto, M. Müller, R. Lake, P. Lu, and S. Sutphen. "Checkers is solved". In: *Science* 317.5844 (2007), p. 1518.

Conference Proceedings

[10] Julien Perolat, Remi Munos, Jean-Baptiste Lespiau, Shayegan Omidshafiei, Mark Rowland, Pedro Ortega, Neil Burch, Thomas Anthony, David Balduzzi, Bart De Vylder, et al. "From Poincaré recurrence to convergence in imperfect information games: Finding equilibrium via regularization". In: *International Conference on Machine Learning*. PMLR. 2021, pp. 8525–8535.

[11] Samuel Sokota, Edward Lockhart, Finbarr Timbers, Elnaz Davoodi, Ryan D'Orazio, Neil Burch, Martin Schmid, Michael Bowling, and Marc Lanctot. "Solving common-payoff games with approximate policy iteration". In: *Proceedings of the AAAI Conference on Artificial Intelligence*. Vol. 35. 11. 2021, pp. 9695–9703.

[12] Michal Šustr, Martin Schmid, Matej Moravčík, Neil Burch, Marc Lanctot, and Michael Bowling. "Sound Algorithms in Imperfect Information Games". In: *Proceedings of the 20th International Conference on Autonomous Agents and MultiAgent Systems*. 2021, pp. 1674–1676.

[13] Martin Schmid, Neil Burch, Marc Lanctot, Matej Moravcik, Rudolf Kadlec, and Michael Bowling. "Variance reduction in Monte Carlo Counterfactual Regret Minimization (VR-MCCFR) for Extensive Form Games Using Baselines". In: *Proceedings of the Thirty-Third AAAI Conference on Artificial Intelligence*. 2019.

[14] Jakob Foerster, Francis Song, Edward Hughes, Neil Burch, Iain Dunning, Shimon Whiteson, Matthew Botvinick, and Michael Bowling. "Bayesian Action Decoder for Deep Multi-Agent Reinforcement Learning". In: *Proceedings of the Thirty-Sixth International Conference on Machine Learning (ICML)*. 2019.

[15] Neil Burch, Martin Schmid, Matej Moravcik, and Michael Bowling. "AIVAT: A New Variance Reduction Technique for Agent Evaluation in Imperfect Information Games". In: *AAAI Workshop on Computer Poker and Imperfect Information Games*. 2017.

[16] Oskari Tammelin, Neil Burch, Michael Johanson, and Michael Bowling. "Solving Heads-up Limit Texas Hold'em". In: *Proceedings of the Twenty-Fourth International Joint Conference on Artificial Intelligence (IJCAI)*. 2015.

[17] Neil Burch, Michael Johanson, and Michael Bowling. "Solving Imperfect Information Games Using Decomposition". In: *Proceedings of the Twenty-Eighth AAAI Conference on Artificial Intelligence*. 2014, pp. 602–608.

[18] Trevor Davis, Neil Burch, and Michael Bowling. "Using Response Functions to Measure Strategy Strength". In: *Proceedings of the Twenty-Eighth AAAI Conference on Artificial Intelligence*. 2014, pp. 630–636.

[19] Nolan Bard, Michael Johanson, Neil Burch, and Michael Bowling. "Online implicit agent modelling". In: *Proceedings of the Twelfth International Conference on Autonomous Agents and Multiagent Systems (AAMAS-13)*. 2013, pp. 255–262.

[20] Michael Johanson, Neil Burch, Richard Valenzano, and Michael Bowling. "Evaluating State-Space Abstractions in Extensive-Form Games". In: *Proceedings of the Twelfth International Conference on Autonomous Agents and Multiagent Systems (AAMAS-13)*. 2013.

[21] Christopher Archibald, Neil Burch, Michael Bowling, and Matthew Rutherford. "Rating players in games with real-valued outcomes". In: *Proceedings of the Twelfth International Conference on Autonomous Agents and Multiagent Systems (AAMAS-13)*. 2013, pp. 1307–1308.

[22] Richard G. Gibson, Marc Lanctot, Neil Burch, Duane Szafron, and Michael Bowling. "Generalized Sampling and Variance in Counterfactual Regret Minimization". In: *Proceedings of the Twenty-Sixth AAAI Conference on Artificial Intelligence*. 2012.

[23] Richard Gibson, Marc Lanctot, Neil Burch, and Duane Szafron. "Efficient Nash equilibrium approximation through Monte Carlo counterfactual regret minimization". In: *Advances in Neural Information Processing Systems 25 (NIPS)*. 2012.

[24] Marc Lanctot, Richard Gibson, Neil Burch, Marty Zinkevich, and Michael Bowling. "No-Regret Learning in Extensive-Form Games with Imperfect Recall". In: *Proceedings of the Twenty-Ninth International Conference on Machine Learning (ICML)*. 2012.

[25] Michael Johanson, Nolan Bard, Neil Burch, and Michael Bowling. "Finding Optimal Abstract Strategies in Extensive-Form Games". In: *Proceedings of the Twenty-Sixth AAAI Conference on Artificial Intelligence*. 2012.

[26] Neil Burch and Robert C. Holte. "Automatic Move Pruning Revisited". In: *Proceedings of the Fifth Annual Symposium on Combinatorial Search (SOCS)*. 2012.

[27] Peter Yap, Neil Burch, Robert C. Holte, and Jonathan Schaeffer. "Block A*: Database-Driven Search with Applications in Any-Angle Path-Planning". In: *Proceedings of the Twenty-Fifth AAAI Conference on Artificial Intelligence*. 2011.

[28] Neil Burch and Robert C. Holte. "Automatic Move Pruning in General Single-Player Games". In: *Proceedings of the Fourth Annual Symposium on Combinatorial Search (SOCS)*. 2011.

[29] Neil Burch, Robert C. Holte, Martin Müller, David O'Connell, and Jonathan Schaeffer. "Automating Layouts of Sewers in Subdivisions". In: *European Conference on Artificial Intelligence (ECAI)*. 2010, pp. 655–660.

[30] Nathan R. Sturtevant, Ariel Felner, Max Barer, Jonathan Schaeffer, and Neil Burch. "Memory-Based Heuristics for Explicit State Spaces". In: *Proceedings of the Twenty-First International Joint Conference on Artificial Intelligence (IJCAI)*. 2009, pp. 609–614.

[31] Michael Bowling, Michael Johanson, Neil Burch, and Duane Szafron. "Strategy Evaluation in Extensive Games with Importance Sampling". In: *Proceedings of the Twenty-Fifth International Conference on Machine Learning (ICML)*. 2008, pp. 72–79.

[32] Martin Zinkevich, Michael H. Bowling, and Neil Burch. "A New Algorithm for Generating Equilibria in Massive Zero-Sum Games". In: *Proceedings of the Twenty-Second AAAI Conference on Artificial Intelligence*. 2007, pp. 788–794.

[33] Jonathan Schaeffer, Yngvi Björnsson, Neil Burch, Akihiro Kishimoto, Martin Müller, Robert Lake, Paul Lu, and Steve Sutphen. "Solving Checkers". In: *Proceedings of the Nineteenth International Joint Conference on Artificial Intelligence (IJCAI)*. 2005, pp. 292–297.

[34] Finnegan Southey, Michael Bowling, Bryce Larson, Carmelo Piccione, Neil Burch, Darse Billings, and Chris Rayner. "Bayes' Bluff: Opponent Modelling in Poker". In: *Proceedings of the Twenty-First Conference on Uncertainty in Artificial Intelligence (UAI-05)*. 2005.

[35] Darse Billings, Aaron Davidson, Terence Schauenberg, Neil Burch, Michael H. Bowling, Robert C. Holte, Jonathan Schaeffer, and Duane Szafron. "Game-Tree Search with Adaptation in Stochastic Imperfect-Information Games". In: *Computers and Games*. 2004, pp. 21–34.

[36] Jonathan Schaeffer, Yngvi Björnsson, Neil Burch, Robert Lake, Paul Lu, and Steve Sutphen. "Building the Checkers 10-piece Endgame Databases". In: *Advances in Computer Games (ACG)*. 2003, pp. 193–210.

[37] Darse Billings, Neil Burch, Aaaron Davidson, Robert Holte, Jonathan Schaeffer, Terence Schauenberg, and Duane Szafron. "Approximating Game-Theoretic Optimal Strategies for Full-scale Poker". In: *Proceedings of the Eighteenth International Joint Conference on Artificial Intelligence (IJCAI)*. 2003, pp. 661–668.

Academic Service

Co-chair

- Annual Computer Poker Competition 2013, 2014

Paper Review

- Senior Program Committee Member: AAAI 2023
- Program Committee Member: AAMAS, IJCAI, AAAI, NeurIPS, ICML 2016-

Code Released

- RL research environment for the cooperative multiplayer game Hanabi
- Game engine and network server for Annual Computer Poker Competition
- PSVN to C compiler and tool set for single-agent search problems
- CFR$^+$: high performance distributed code used to solve limit Hold'em