

Noam Brown

Noam Brown
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RESEARCH AREA

Artificial intelligence, game theory, machine learning, reinforcement learning, no-regret learning, equilibrium computation, extensive-form games, imperfect-information games.

EDUCATION

Ph.D., Computer Science
Carnegie Mellon University

August 2014 – *Present*

MS, Robotics
Carnegie Mellon University

August 2012 – August 2014

BA, Mathematics and Computer Science (*summa cum laude*)
Rutgers University
Rutgers College Honors Program

September 2005 – December 2008

PUBLICATIONS

Journal Papers

- **Superhuman AI for Heads-Up No-Limit Poker: Libratus Beats Top Professionals.** Noam Brown and Tuomas Sandholm. *Science*, 2017.

Highly Refereed Conference Papers

- **Solving Imperfect-Information Games via Discounted Regret Minimization.** Noam Brown and Tuomas Sandholm. *Under Review*. 2018.
- **Depth-Limited Solving for Imperfect-Information Games.** Noam Brown, Tuomas Sandholm, and Brandon Amos. *Neural Information Processing Systems (NIPS)*. 2018.
- **Safe and Nested Subgame Solving for Imperfect-Information Games.** Noam Brown and Tuomas Sandholm. *Neural Information Processing Systems (NIPS)*, 2017. **Best Paper Award**.
- **Reduced Space and Faster Convergence in Imperfect-Information Games via Pruning.** Noam Brown and Tuomas Sandholm. *International Conference on Machine Learning (ICML)*, 2017.
- **Dynamic Thresholding and Pruning for Regret Minimization.** Noam Brown, Christian Kroer, and Tuomas Sandholm. *Conference on Artificial Intelligence (AAAI)*, 2017.
- **Strategy-Based Warm Starting for Regret Minimization in Games.** Noam Brown and Tuomas Sandholm. *Conference on Artificial Intelligence (AAAI)*, 2016.

- **Regret-Based Pruning in Extensive-Form Games.** Noam Brown and Tuomas Sandholm. *Neural Information Processing Systems (NIPS)*, 2015.
- **Simultaneous Abstraction and Equilibrium Finding in Games.** Noam Brown and Tuomas Sandholm. *International Joint Conference on Artificial Intelligence (IJCAI)*, 2015.
- **Hierarchical Abstraction, Distributed Equilibrium Computation, and Post-Processing, with Application to a Champion No-Limit Texas Hold'em Agent.** Noam Brown, Sam Ganzfried, Tuomas Sandholm. *International Conference on Autonomous Agents and Multiagent Systems (AAMAS)*, 2015.
- **Regret Transfer and Parameter Optimization.** Noam Brown and Tuomas Sandholm. *Conference on Artificial Intelligence (AAAI)*, 2014.

Refereed Demonstrations

- ***Libratus*: Beating Top Humans in No-Limit Poker.** Noam Brown and Tuomas Sandholm. Demonstrations Program at *Neural Information Processing Systems (NIPS)*, 2017.
- ***Libratus*: The Superhuman AI for No-Limit Poker.** Noam Brown and Tuomas Sandholm. Demonstrations Program at the *International Joint Conference on Artificial Intelligence (IJCAI)*, 2017.
- **Baby Tartanian8: Winning Agent from the 2016 Annual Computer Poker Competition.** Noam Brown and Tuomas Sandholm. Demonstrations Program at the *International Joint Conference on Artificial Intelligence (IJCAI)*, 2016.
- **Claudico: The World's Strongest No-Limit Texas Hold'em Poker AI.** Noam Brown and Tuomas Sandholm. Demonstrations Program at *Neural Information Processing Systems (NIPS)*, 2015.
- **Tartanian7: A Champion Two-Player No-Limit Texas Hold'em Poker-Playing Program.** Noam Brown, Sam Ganzfried, Tuomas Sandholm. Demonstrations Program at the *AAAI Conference on Artificial Intelligence (AAAI)*, 2015.

Invited Talks

- **From Poker AI to Negotiation AI: Dealing with Hidden Information.** *TTI/Vanguard: Intelligence, Natural and Artificial*. June 2018.
- ***Libratus*: Beating Top Pros in No-Limit Poker.** *6th Toulouse Economics and Biology Workshop*. May 2018.
- ***Libratus*: Beating Top Pros in No-Limit Poker.** *Jane Street Capital*. January 2018.
- **Safe and Nested Subgame Solving for Imperfect-Information Games.** *NIPS Oral Presentation*. December 2017.
- ***Libratus*: Beating Top Humans in No-Limit Poker.** *Facebook AI Research*. May 2017.
- ***Libratus*: Beating Top Humans in No-Limit Poker.** *Rutgers University*. October 2017.
- ***Libratus*: Beating Top Humans in No-Limit Poker.** *Princeton University*. October 2017.
- ***Libratus*: Beating Top Humans in No-Limit Poker.** *Cubist Systems*. October 2017.
- ***Libratus*: Beating Top Humans in No-Limit Poker.** *Harvard University*. September 2017.

- ***Libratus*: Beating Top Humans in No-Limit Poker.** *MIT*. September 2017.
- ***Libratus*: Beating Top Humans in No-Limit Poker.** *Hertz Fellowship Retreat*. September 2017.
- **Super-Human AI for Strategic Reasoning: Beating Top Pros in Heads-Up No-Limit Texas Holdem.** *TNG Big Tech Day. Keynote*. June 2017.
- ***Libratus*: Beating Top Humans in No-Limit Poker.** *DeepMind*. May 2017.
- ***Libratus*: Beating Top Humans in No-Limit Poker.** *University of Michigan*. April 2017.
- ***Libratus*: Beating Top Humans in No-Limit Poker.** *Carnegie Mellon University*. April 2017.
- ***Libratus*: Beating Top Humans in No-Limit Poker.** *OpenAI*. February 2017.
- **Reduced Space and Faster Convergence in Imperfect-Information Games via Regret-Based Pruning.** *Carnegie Mellon University*. September 2016.
- **Simultaneous Abstraction and Equilibrium Finding in Games.** Noam Brown and Tuomas Sandholm. *INFORMS Annual Conference*, 2015. Optimization cluster.
- **Simultaneous Abstraction and Equilibrium Finding in Games.** Noam Brown and Tuomas Sandholm. *IJCAI Oral Presentation*, 2015.
- **Regret Transfer and Parameter Optimization.** Noam Brown and Tuomas Sandholm. *AAAI Oral Presentation*, 2014.

Additional Talks

- **Regret Transfer and Parameter Optimization.** Noam Brown and Tuomas Sandholm. In: *INFORMS Annual Conference*, 2015. Contributed presentations.

HONORS AND AWARDS

- 2019 Marvin Minsky Medal for Outstanding Achievements in AI (shared with Tuomas Sandholm)
- 2018 Open Philanthropy AI Fellowship (one of seven recipients)
- 2018 Tencent AI Lab Fellowship (one of five recipients)
- Best Paper Award at NIPS 2017 (one of three out of 3,240 submissions and 678 accepted papers)
- 2017 Allen Newell Award for Research Excellence (shared with Tuomas Sandholm)
- *Libratus* (together with University of Alberta's *DeepStack*) selected as one of 12 finalists for Science Magazine's Scientific Breakthrough of the Year for 2017
- *Libratus* listed in *La Recherche* as one of the top ten scientific achievements of 2017
- *Libratus* won HPCWire's "Best Use of AI" Award for 2017
- Co-created *Libratus*, the first AI to defeat top humans in no-limit poker
- 1st place in the Annual Computer Poker Competition No-Limit Texas Hold'em Instant Runoff Event, 2014 - 2016
- 1st place in the Annual Computer Poker Competition No-Limit Texas Hold'em Total Bankroll Event, 2014 - 2016
- 3rd place in the Annual Computer Poker Competition No-Limit Texas Hold'em Total Bankroll Event, 2013

- NSF Graduate Research Fellowship Honorable Mention
- Rutgers Computer Science Department Highest Honors
- Rutgers College Scholarship Recipient

WORK EXPERIENCE

<i>Carnegie Mellon University</i> , Pittsburgh, PA Research Assistant, Electronic Marketplaces Lab	August 2012 – <i>Present</i>
<i>Google DeepMind</i> , London, UK Research Intern	Summer 2017
<i>Freshplum</i> , Menlo Park, CA Software Engineer Intern	Summer 2012
<i>Federal Reserve Board of Governors</i> , Washington, DC Research Assistant, International Finance Division	April 2010 – <i>May 2012</i>
<i>MJM Trading Group</i> , Jersey City, NJ Algorithmic Trading Engineer	November 2006 – April 2010
<i>Merrill Lynch</i> , New York, NY Technology Analyst Intern	Summer 2008

TEACHING EXPERIENCE

<i>Carnegie Mellon University</i>		
Teaching Assistant	Artificial Intelligence	Fall 2017
Teaching Assistant	Artificial Intelligence	Fall 2014
<i>Rutgers University</i>		
Recitation Instructor	Calculus I	Spring 2009
Recitation Instructor	Calculus I	Fall 2008
Recitation Instructor	Pre-Calculus	Spring 2008
Recitation Instructor	Pre-Calculus	Fall 2007
Peer Mentor	Calculus II	Spring 2007
Peer Mentor	Calculus II	Fall 2006
Teaching Assistant	Young Scholars Program	Summer 2006

OUTREACH AND SERVICE TO THE ACADEMIC COMMUNITY

Outreach

CMU Creative Technologies Nights	2015 – <i>Present</i>
<ul style="list-style-type: none"> • Introduce middle school girls to various technology-related topics in weekly presentations as part of a program to encourage young women to pursue higher education and careers in STEM fields. 	
Rutgers Young Scholars Programs	Summers 2009 – 2016
<ul style="list-style-type: none"> • Presented lessons on game theory to gifted high school students. 	

Federal Reserve FedEd 2010 – 2012

- Taught financial literacy and monetary policy through guest lectures to D.C.-area public and private high school students.

Douglass Project: Women in STEM 2008 – 2009

- Presented lessons on game theory to gifted high school girls as part of a program to encourage young women to pursue higher education and careers in STEM fields.

(Co-)Chair

AAAI 2018 Workshop on AI for Imperfect-Information Games

Reviewing

Conferences: IJCAI 2015, AAMAS 2016, IJCAI 2016, NIPS 2017, AAAI 2018, NIPS 2018

Journals: Artificial Intelligence, JAIR, Cognitive Science

Departmental Service

Computer Science Department Immigration Course 2014, 2015, 2016, 2017

Computer Science Department Open House 2015, 2016, 2017, 2018

Computer Science Department Speakers Club 2017, 2018