

Noam Brown

Computer Science Department
Carnegie Mellon University
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EDUCATION

- PhD Computer Science** 2014–Present
Carnegie Mellon University
Advisor: Tuomas Sandholm
- MS Robotics** 2012–2014
Carnegie Mellon University
Advisor: Tuomas Sandholm
- BA Mathematics and Computer Science** 2005–2008
Rutgers University
Summa Cum Laude
Rutgers College Honors Program

WORK EXPERIENCE

- Research Assistant** 2012–Present
Carnegie Mellon University
- Applying computational game theory to produce artificial intelligence capable of strategic reasoning in large imperfect-information multi-agent interactions
- Research Assistant** 2010–2012
Federal Reserve Board of Governors
- Conducted research on the impact of algorithmic trading on liquidity, volatility, and triangular arbitrage in the foreign exchange market
 - Analyzed tick data to determine the effects of imposing a minimum quote life on algorithmic trading in foreign exchange markets
 - Applied machine learning to classify the cause of price movements in the crude oil market based on news articles
- Algorithmic Trading Engineer** 2006–2010
MJM Trading Group
- Developed algorithmic trading programs focused on equity markets
 - Created programs to interpret breaking news headlines and corporate SEC filings in order to place trades immediately before other market participants could react

INTERNSHIPS

Research Intern Summer 2017
Google DeepMind

Software Engineer Intern Summer 2012
Freshplum

Technology Analyst Intern Summer 2008
Merrill Lynch

PUBLICATIONS

Journal Papers

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

Preprints

- Noam Brown, Adam Lerer, Sam Gross, Tuomas Sandholm, [Deep Counterfactual Regret Minimization](#). *Preprint*, 2018.

Highly Refereed Conference Papers

- Noam Brown and Tuomas Sandholm, [Solving Imperfect-Information Games via Discounted Regret Minimization](#). *AAAI Conference on Artificial Intelligence (AAAI)*, 2019. **Outstanding Paper Honorable Mention**.
- Noam Brown, Tuomas Sandholm, Brandon Amos, [Depth-Limited Solving for Imperfect-Information Games](#). *Neural Information Processing Systems (NeurIPS)*, 2018.
- Noam Brown and Tuomas Sandholm, [Safe and Nested Subgame Solving for Imperfect-Information Games](#). *Neural Information Processing Systems (NIPS)*, 2017. **Best Paper Award**.
- Noam Brown and Tuomas Sandholm, [Reduced Space and Faster Convergence in Imperfect-Information Games via Pruning](#). *International Conference on Machine Learning (ICML)*, 2017.
- Noam Brown, Christian Kroer, Tuomas Sandholm, [Dynamic Thresholding and Pruning for Regret Minimization](#). *AAAI Conference on Artificial Intelligence (AAAI)*, 2017.
- Noam Brown and Tuomas Sandholm, [Strategy-Based Warm Starting for Regret Minimization in Games](#). *AAAI Conference on Artificial Intelligence (AAAI)*, 2016.
- Noam Brown and Tuomas Sandholm, [Regret-Based Pruning in Extensive-Form Games](#). *Neural Information Processing Systems (NIPS)*, 2015.

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

Refereed Demonstrations

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

INVITED TALKS

- **Deep Counterfactual Regret Minimization.**
Deep Reinforcement Learning Workshop at NeurIPS Oral Presentation. December 2018.
- **AI for Large Imperfect-Information Games: Beating Top Humans in No-Limit Poker.**
Microsoft Research. October 2018.
Google Brain. July 2018.
OpenAI. July 2018.
Facebook AI Research. June 2018.
- **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.
Jane Street Capital. January 2018.
Facebook AI Research. May 2017.
Rutgers University. October 2017.
Princeton University. October 2017.
Cubist Systems. October 2017.
Harvard University. September 2017.
MIT. September 2017.
Hertz Fellowship Retreat. September 2017.
DeepMind. May 2017.
University of Michigan. April 2017.
Carnegie Mellon University. April 2017.
OpenAI. February 2017.
AAAI Workshop on Computer Poker and Imperfect-Information Games. February 2017.
- **Safe and Nested Subgame Solving for Imperfect-Information Games.**
NIPS Oral Presentation. December 2017.
- **Super-Human AI for Strategic Reasoning: Beating Top Pros in Heads-Up No-Limit Texas Hold'em.**
TNG Big Tech Day. Keynote. June 2017.
- **Reduced Space and Faster Convergence in Imperfect-Information Games via Pruning.**
ICML Oral Presentation. August 2017.
Carnegie Mellon University. September 2016.
- **Strategy-Based Warm Starting for Regret Minimization in Games.**
AAAI Workshop on Computer Poker and Imperfect-Information Games, 2016.
- **Simultaneous Abstraction and Equilibrium Finding in Games.**
AAAI Workshop on Computer Poker and Imperfect-Information Games, 2016.
INFORMS Annual Conference, 2015. Optimization cluster.
IJCAI Oral Presentation, 2015.
- **Regret Transfer and Parameter Optimization.**
AAAI Workshop on Computer Poker and Imperfect Information, 2014.
AAAI Oral Presentation, 2014.

AWARDS

- 2019 Marvin Minsky Medal for Outstanding Achievements in AI (with Tuomas Sandholm)
- AAAI 2019 Outstanding Paper Honorable Mention (one of four papers receiving special recognition out of 7,095 submissions and 1,150 accepted papers)
- 2018 Open Philanthropy AI Fellowship (one of seven recipients)
- 2018 Tencent AI Lab Fellowship (one of five recipients)

- NIPS 2017 Best Paper Award (one of three out of 3,240 submissions and 678 accepted papers)
- 2017 Allen Newell Award for Research Excellence (with Tuomas Sandholm)
- *Libratus* (together with University of Alberta's *DeepStack*) selected as one of 12 candidates 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 and 2018
- 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, 2016 (there was no 2015 competition)
- 1st place in the Annual Computer Poker Competition No-Limit Texas Hold'em Total Bankroll Event, 2016 (there was no 2015 competition)
- 1st place in the Annual Computer Poker Competition No-Limit Texas Hold'em Instant Runoff Event, 2014
- 1st place in the Annual Computer Poker Competition No-Limit Texas Hold'em Total Bankroll Event, 2014
- NSF Graduate Research Fellowship Honorable Mention
- Rutgers Computer Science Department Highest Honors
- Rutgers College Scholarship Recipient

TEACHING

Carnegie Mellon University

Teaching Assistant	Artificial Intelligence	Fall 2017
Teaching Assistant	Artificial Intelligence	Fall 2014

Rutgers University

Instructor	Young Scholars Program: Game Theory	Summer 2018
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

Creative Technologies Nights
Carnegie Mellon University

2015 – Present

- 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.

Young Scholars Programs
Rutgers University

Summers 2009 – *Present*

- Presented lessons on game theory to gifted high school students.

FedEd
Federal Reserve Board of Governors

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
Rutgers University

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.

ACADEMIC SERVICE

(Co-)Chair

- Workshop on AI for Imperfect-Information Games at AAAI 2018

Journal Reviewing

- Journal of Artificial Intelligence Research (JAIR) 2017
- Cognitive Science 2015, 2018
- Artificial Intelligence Journal (AIJ) 2014

Conference Reviewing

- Neural Information Processing Systems (NIPS/NeurIPS) 2017, 2018
- AAAI Conference on Artificial Intelligence (AAAI) 2018
- International Conference on Autonomous Agents and Multiagent Systems (AAMAS) 2016
- International Joint Conference on Artificial Intelligence (IJCAI) 2015, 2016

Workshop Reviewing

- Workshop on Reinforcement Learning in Games at AAAI 2019
- Deep Reinforcement Learning Workshop at NeurIPS 2018
- Workshop on Computer Poker and Imperfect-Information Games at AAAI 2017

Departmental Service

- Computer Science Department Immigration Course 2014, 2015, 2016, 2017, 2018
- Computer Science Department Open House 2015, 2016, 2017, 2018
- Computer Science Department Speakers Club 2017, 2018

SELECTED MEDIA COVERAGE

- The “Brains vs AI: Upping the Ante” 2017 man-machine poker competition and our poker AI *Libratus* were covered in HBO VICE News (including a TV segment), La Vanguardia (leading Spanish TV), ABC (leading Spanish TV), Discovery Channel Canada (TV), Bloomberg Businessweek, The Washington Post (3 articles), The Wall Street Journal (3 articles), Wired (4 articles), MIT Technology Review (3 articles), Time, IEEE Spectrum (3 articles), Engadget (2 articles), Quartz, PBS Newshour, The Verge (2 articles), New Scientist, Mashable, Quanta Magazine, Science News, FiveThirtyEight, Business Insider (5 articles), Fox News, CNN Money, Slate, The Guardian (2 articles), Financial Times, The Economist, Reuters (New York Times), BBC News, BBC Radio 4, Der Spiegel, Westdeutscher Rundfunk, a YouTube commercial by HPE (31 million views), a Facebook video by CNN’s Great Big Story (1 million views), other YouTube videos (1 million views), and many other articles.
- The man-machine poker competition in Haikou, China in April 2017 between our poker AI *LeNgpuDashi* and six Chinese poker pros received over 50 million views and was covered extensively by the Chinese media, as well as Bloomberg, MIT Technology Review (2 articles), Engadget, and many others.
- The “Brains vs AI” 2015 man-machine poker competition and our poker AI *Claudico* were covered by the BBC, PBS, NBC, CBS, Der Spiegel, New York Times, LA Times, IEEE Spectrum (3 articles), Wired, ABC News, Christian Science Monitor, Daily Mail, Fox News, New Scientist (2 articles), Science Times, Motherboard, Poker News, and many others.
- “Carnegie Mellon ‘Baby Tartanian8’ Pokerbot Sweeps Annual Competition.” UCSD News Center, 8/31/2016.
- “Heads-Up Bots Will Be Stronger Than Humans; No-Limit Hold’em May Never Be Solved”. PokerNews.com, 3/16/2016.
- “Championship Poker Bot: ‘A Nuclear Weapon For Poker’”. Card Player Magazine, 9/24/2014.