SAM GANZFRIED

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Summary

I enjoy every step of the problem-solving process, from the design and theoretical analysis of new algorithms to implementation in large-scale systems. For my PhD research, I developed scalable approaches for computing game-theoretic solution concepts and learning in imperfect-information games. I have applied several of these techniques to the domain of poker: the two-player no-limit Texas hold 'em agent Tartanian7 that I created came in first place in the 2014 AAAI Computer Poker Competition, and Claudico lost against the strongest human specialists in the Brains vs. Artificial Intelligence competition in 2015.

Interests: artificial intelligence, game theory, multiagent systems, multiagent learning, large-scale optimization, large-scale data analysis and analytics, knowledge representation.

Education

- Ph.D., Computer Science, Carnegie Mellon University, 2015
  - Thesis: "Computing Strong Game-Theoretic Strategies and Exploiting Suboptimal Opponents in Large Games"
- M.S., Computer Science, Carnegie Mellon University, 2009
- A.B., Mathematics, Harvard University, 2005
  - Concentration GPA: 3.92

Awards

- Paper "Reflections on the First Man vs. Machine No-Limit Texas Hold 'em Competition" selected to be feature article in SIGecom Exchange Newsletter for ACM Interest Group on Electronic Commerce.
- First place, Annual Computer Poker competition, two-player no-limit Texas hold 'em bankroll instant run-off and total bankroll divisions, at the *AAAI Conference on Artificial Intelligence (AAAI)*, 2014 (with Noam Brown and Tuomas Sandholm). Our agent beat each opponent with statistical significance.
- Paper "Safe Opponent Exploitation" from *ACM Conference on Electronic Commerce* invited to "Best of EC" special issue of journal *ACM Transactions on Economics and Computation* (with Tuomas Sandholm).
- Finalist, Best Student Paper Award, "Computing an Approximate Jam/Fold Equilibrium for 3-Player No-Limit Texas Hold'em Tournaments" at *International Conference on Autonomous Agents and Multiagent Systems* (with Tuomas Sandholm).
- United States Presidential Scholar.
- National Merit Scholar.

Employment

- Assistant Professor, Florida International University, Computer Science, 2016–present, Miami, FL
  - Director of Strategic Adversarial Multiagent Artificial Intelligence Laboratory (SAM AI).
- Founder, Ganzfried Research, 2015–present, New York, NY and Miami, FL
  - Conducting research and building technology in artificial intelligence and game theory with applications including poker, education, medicine, socialization, and hurricane prediction.
- Quantitative Trader, Tower Research Capital LLC, 2005–2006, New York, NY
  - Designed, implemented, and deployed high-frequency trading algorithms. I was compensated for several months after I returned to graduate school due to high profitability of the strategies.
- Director's Summer Program, National Security Agency, Summer 2005
- Research Experiences for Undergraduates, Mathematics, Oregon State University, Summer 2004

Media

- "Meet the FIU professor who created program that can beat the poker pros," Miami Herald, front page of "Tropical Life" section, March 2017.
- "Poker-playing AI 'bot' carries long-range impact," Pittsburgh Tribune-Review, August 2016.
- Played in high-stakes poker game for the television series "Poker Night in America," November 2015.
  - Season 4 episodes 17 and 18, aired in October 2016 on CBS Sports Network.
  - Commentated for and played on the show again November 19–20, 2016.
  - Also commentated on March 11, 2017.

Publications

- Sam Ganzfried. Algorithm for Evolutionarily Stable Strategies Against Pure Mutations. 2018. Working paper.
- Sheila Alemany, Jonathan Beltran, Adrian Perez, and Sam Ganzfried. Predicting Hurricane Trajectories using a Recurrent Neural Network. 2018. Working paper.
- Sam Ganzfried and Farzana Yusuf. Optimal Weighting for Exam Composition. 2018. *Education Sciences* special issue "Artificial Intelligence and Education."
- Sam Ganzfried and Kailiang Hu. Midgame Solving: A New Weapon for Efficient Large-Scale Equilibrium Approximation. 2017. *International Conference on Tools with Artificial Intelligence*. Short paper.
- Sam Ganzfried. What is the Right Solution Concept for No-Limit Poker? *International Conference on Game Theory*, 2017. Oral presentation.
- Sam Ganzfried. Endgame Solving: The Surprising Breakthrough that Enabled Superhuman Two-Player No-Limit Texas Hold 'em Play. *International Conference on Game Theory*, 2017.
- Sam Ganzfried and Farzana Yusuf. Computing Human-Understandable Strategies: Deducing Fundamental Rules of Poker Strategy. Invited feature paper at *Games*, 2017.
    – Oral presentation at *AAAI Workshop on Computer Poker and Imperfect Information Games*, 2017.
- Sam Ganzfried and Farzana Yusuf. Optimal Number of Choices in Rating Contexts. arXiv:1605.06588.
    – Oral presentation at INFORMS 2017 in Decision Support Systems track. (Finalist at 2016 INFORMS poster competition.)
    – Accepted as extended abstract at *AAMAS*, 2017 (acceptance rate 48%) (declined).
    – Proceedings of Machine Learning Research, 2016, Volume 58.
    – Poster and spotlight presentation at *NIPS* Workshop on Imperfect Decision Makers: Admitting Real-World Rationality.
- Sam Ganzfried and Qingyun Sun. Bayesian Opponent Exploitation in Imperfect-Information Games.
    – Oral presentation at AAAI Spring Symposium on Learning, Inference, and Control of Multi-Agent Systems, 2018.
    – Oral and poster presentation at *AAAI* Workshop on Computer Poker and Imperfect Information Games, 2016.
    – Oral presentation at INFORMS, 2016.
    – Oral presentation at UECE Lisbon Meetings in Game Theory and Applications, 2016.
    – Poster presentation at 2016 New York Computer Science and Economics Day.
    – Poster presentation at ACM Conference on Economics and Computation (*EC*), 2016.
- Sam Ganzfried. Reflections on the First Man vs. Machine No-Limit Texas Hold 'em Competition. Feature article in SIGecom Exchange Newsletter, Volume 14.2, 2015. arXiv:1510.08578 [cs.GT].
    – AI Magazine, Volume 48, Number 2, summer 2017.
    – Oral presentation at 2016 New York Computer Science and Economics Day.
    – Oral presentation at 2016 World Congress of the Game Theory Society (GAMES).
- Sam Ganzfried. Computing Strong Game-Theoretic Strategies and Exploiting Suboptimal Opponents in Large Games. PhD dissertation, 2015, available as CMU technical report CMU-CS-15-104.
- Sam Ganzfried and Tuomas Sandholm. Endgame Solving in Large Imperfect-Information Games. *International Conference on Autonomous Agents and Multiagent Systems (AAMAS)*, 2015. Full paper, acceptance rate 25%. Oral and poster presentation.
    – Also presented at the *Workshop on Computer Poker and Imperfect Information* at *AAAI*, 2015, oral and poster presentation.
    – Poster presentation at ACM Conference on Economics and Computation, 2015.
    – Oral presentation at INFORMS, 2015.
    – Early version appeared as "Improving Performance in Imperfect-Information Games with Large State and Action Spaces by Solving Endgames" at the *Workshop on Computer Poker and Imperfect Information* at *AAAI*, 2013, oral and poster presentation, and was also presented at the *Workshop on Computer Games* at *IJCAI*, 2013.
- Noam Brown*, Sam Ganzfried*, and 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. Full paper, acceptance rate 25%. Oral and poster presentation. *Listed alphabetically.
    – Also presented at the *Workshop on Computer Poker and Imperfect Information* at *AAAI*, 2015. Oral and poster presentation.
    – Short version "Tartanian7: A Champion Two-Player No-Limit Texas Hold'em Poker-Playing Program" in Demonstrations Program at *AAAI*, 2015.
- Sam Ganzfried and Tuomas Sandholm. Safe Opponent Exploitation. *ACM Transactions on Economics and Computation (TEAC)*, 2015. Special issue on selected papers from EC-12.
    – Early version appeared in *ACM Conference on Electronic Commerce (EC)*, 2012. Acceptance rate 33%; 11% for plenary track. Talk in plenary (non-parallel) track. Also presented at poster session.
    – Shorter version presented at *AAMAS* Workshop on Adaptive and Learning Agents, 2012.
    – Oral presentation at INFORMS, 2012.
- Sam Ganzfried and Tuomas Sandholm. Potential-Aware Imperfect-Recall Abstraction with Earth Mover's Distance in Imperfect-Information Games. *AAAI Conference on Artificial Intelligence (AAAI)*, 2014. Acceptance 28%.
    – Also presented at the *Workshop on Computer Poker and Imperfect Information* at *AAAI*, 2014. Oral and poster presentation.
- Sam Ganzfried and Tuomas Sandholm. Action Translation in Extensive-Form Games with Large Action Spaces: Axioms, Paradoxes, and the Pseudo-Harmonic Mapping. *International Joint Conference on Artificial Intelligence (IJCAI)*, 2013. Acceptance rate 28%. Oral and poster presentation.
    – Also appeared as a poster presentation at the *Workshop on Computer Poker and Imperfect Information* at *AAAI*, 2013.

- Sam Ganzfried and Tuomas Sandholm. Tartanian5: A Heads-Up No-Limit Texas Hold'em Poker-Playing Program. *Computer Poker Symposium* at the *AAAI Conference on Artificial Intelligence (AAAI)*, 2012. Oral and poster.
- Sam Ganzfried, Tuomas Sandholm, and Kevin Waugh. Strategy Purification and Thresholding: Effective Non-Equilibrium Approaches for Playing Large Games. *International Conference on Autonomous Agents and Multiagent Systems (AAMAS)*, 2012. Full paper, acceptance rate 20%. Oral and poster.
    - Early version "Strategy Purification" in *AAAI* Workshop on Applied Adversarial Reasoning and Risk Modeling, 2011.
    - Extended abstract in *AAMAS*, 2011 (acceptance rate 45%).
    - Oral presentation at INFORMS, 2012.
    - Poster presentation at ACM Conference on Electronic Commerce (*EC*), 2012.
- Sam Ganzfried. Computing Strong Game-Theoretic Strategies in Jotto. *Conference on Advances in Computer Games (ACG)*, 2011. Oral presentation. arXiv:1107.3342 [cs.GT].
- Sam Ganzfried and Tuomas Sandholm. Game Theory-Based Opponent Modeling in Large Imperfect-Information Games. *International Conference on Autonomous Agents and Multiagent Systems (AAMAS)*, 2011. Full paper, acceptance rate 22%. Oral and poster presentation.
    - Also presented at INFORMS, 2011.
    - Poster presentation for the Annual Computer Poker Competition at *AAAI*, 2010.
- Sam Ganzfried and Tuomas Sandholm. Computing Equilibria by Incorporating Qualitative Models. *International Conference on Autonomous Agents and Multiagent Systems (AAMAS)*, 2010. Full paper, acceptance rate 24%. Oral and poster presentation. Extended version as tech. report CMU-CS-10-105.
    - Also presented at INFORMS, 2010.
    - Oral presentation at *Brazilian Workshop of the Game Theory Society*, 2010.
- Sam Ganzfried and Tuomas Sandholm. Computing Equilibria in Multiplayer Stochastic Games of Imperfect Information. *International Joint Conference on Artificial Intelligence (IJCAI)*, 2009. Full paper, acceptance rate 25.7%.
    - Also presented at INFORMS, 2008.
- Sam Ganzfried and Tuomas Sandholm. Computing an Approximate Jam/Fold Equilibrium for 3-Player No-Limit Texas Hold'em Tournaments. *International Conference on Autonomous Agents and Multiagent Systems (AAMAS)*, 2008. Full paper, acceptance rate 22%. Oral and poster presentation.
    - Also presented as poster presentation at *International Congress of the Game Theory Society*, 2008.
- Sam Ganzfried. A New Algorithm for Knight's Tours. Proceedings of the *Research Experiences for Undergraduates (REU) Program in Mathematics*, 2004.

Other presentations
- "Artificial Intelligence: From Poker Agents to Hurricane Prediction" 9/30/2017, FIU ShellHacks hackathon.
- "Strong Game-Theoretic Strategies: Beyond Two Agents" 9/15/2017, MIT, organized by MIT Poker Club.
- "Endgame Solving: The Surprising Breakthrough that Enabled Superhuman Two-Player No-Limit Texas Hold 'em Play"
    - Microsoft Research Asia Lab, 5/11/17.
    - Tsinghua University, 5/7/17.
    - Princeton University, 3/13/17, organized by Princeton Poker Club.
- "First Man vs. Machine No-Limit Texas Hold 'em Competition" 2/1/17, Stanford University.
- "Computing Strong Game-Theoretic Strategies in Large Games" 3/24/16, Princeton University Poker Club.
- "Reflections on the First Man vs. Machine No-Limit Texas Hold 'em Competition" 3/18/16, Susquehanna International Group.

Professional service
- Organizer: Tutorial on Computer Poker at AAAI Conference on Artificial Intelligence (AAAI) (2017).
- Organizer: First Tutorial on Computer Poker at Conference on Economics and Computation (2016).
- Organizer: AAAI Workshop on Computer Poker and Imperfect Information (2014, 2015).
- Program committees: AAAI (2012, 2014–2018), AAMAS (2014, 2016), IJCAI (2013, 2015, 2016), WWW (2018), AAAI Workshop on Computer Poker and Imperfect-Information Games (2017).
- Additional conference reviewing: AAAI (2010), AAMAS (2013), EC (2013), NIPS (2016).
- Journal reviewing: Artificial Intelligence ('10–'14,'18), Computational Intelligence ('10), Games ('14, '18), Transactions on Computational Intelligence and AI in Games ('14,'15,'17), Sensors ('17).

Teaching
- Instructor, Game Theory, new graduate course at FIU (2017), www.bestgametheoryclass.com.
- Instructor, Artificial Intelligence, new undergraduate course at FIU, www.ultimateaiclass.com.

Mentoring
- Farzana Yusuf, PhD student at FIU, 9/2016–present. Areas: artificial intelligence, machine learning.
- Sheila Alemany, Undergraduate CS student at FIU, 9/17–present. Area: artificial intelligence.
    - Finalist for CRA Outstanding Undergraduate Research Award.
- Working with Stanford mathematics PhD student Qingyun Sun on opponent exploitation algorithms.
- Working with Harbin Institute of Technology MS student Kailiang Hu on game-theoretic algorithms.