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Summary

I enjoy every step of the problem-solving process, from 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: 2-player no-limit Texas hold 'em agent Tartanian7 that I created won the Computer Poker Competition, and Claudico competed against top human specialists in the Brains vs. Artificial Intelligence competition. I also developed approaches for games with more than two players, robustly exploiting suboptimal opponents, and computing strategies that are human understandable.

Interests: artificial intelligence, game theory.

Education

- Post-Master's Certificate, Applied and Computational Mathematics, Johns Hopkins University, 2025
- Graduate Certificate, Artificial Intelligence, Stanford University, 2023
- Graduate Certificate, Statistics, Stanford University, 2022
- 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: 3.9; President of club tennis team for 3 years; Co-founder of bridge club

Awards

- Best Paper Award, "Computing Equilibria in Multiplayer DAG-Structured Stochastic Games with Persistent Imperfect Information" at *Conference on Decision and Game Theory for Security (GameSec)*.
- 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

- Founder, Ganzfried Research, 2015–present
  - Conducting research and building technology in artificial intelligence and game theory with applications including poker, education, medicine, socialization, and hurricane prediction.
- Independent consultant and principal investigator on contract for DARPA grant, 2018–2020
  - "Serial Interactions in Imperfect Information Games Applied to Complex Military Decision Making."
- Assistant Professor, Florida International University, Computer Science, 2016–2018, Miami, FL
- Quantitative Trader, Tower Research Capital LLC, 2005–2006, New York, NY
  - Designed, implemented, and deployed high-frequency trading algorithms.
- 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 14, 2017.
- "Turing and the Poker Endgame," PokerNews online article, August 30, 2016.
- "Poker-playing AI 'bot' carries long-range impact," Pittsburgh Tribune-Review, August 26, 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 11/19–20/16 and commentated on 3/11/17.

Publications

- Sam Ganzfried. Empirical Analysis of Fictitious Play for Nash Equilibrium Computation in Multiplayer Games. 2023. arXiv:2001.11165 [cs.GT]. Subsumes:
    - Random Initialization Solves Shapley's Fictitious Play Counterexample. 2022. arXiv:2209.02154.
    - Fictitious Play Outperforms Counterfactual Regret Minimization. 2020. arXiv:2001.11165.
- Sam Ganzfried. Nonparametric Strategy Test. 2023. arXiv:2312.10695 [stat.ME].
- Sam Ganzfried, Kevin A. Wang, and Max Chiswick. Opponent Modeling in Multiplayer Imperfect-Information Games. 2022. arXiv:2212.06027 [cs.GT].
- Sam Ganzfried. Observable Perfect Equilibrium. *Conference on Decision and Game Theory for Security*, 2023.
- Sam Ganzfried. Stable Relationships. *Journal of Social Mathematical & Human Engineering Sciences*, 2024.
- Sam Ganzfried. Best Response Computation in Multiplayer Imperfect-Information Stochastic Games. *Florida Artificial Intelligence Research Society Conference (FLAIRS)*, 2022.
- Sam Ganzfried. Fictitious Play with Maximin Initialization. *IEEE Conference on Decision and Control (CDC)*, 2022.
- Sam Ganzfried. Safe Equilibrium. *IEEE Conference on Decision and Control (CDC)*, 2023.
- Sam Ganzfried. Human Strategic Decision Making in Parametrized Games. *Mathematics* special issue "Game Theory and Artificial Intelligence," 2022, 10(7), 1147.
- Sam Ganzfried. Computing Equilibria in Multiplayer DAG-Structured Stochastic Games with Persistent Imperfect Information. *Conference on Decision and Game Theory for Security (GameSec)*, 2021.
- Sam Ganzfried. Algorithm for Computing Approximate Nash equilibrium in Continuous Games with Application to Continuous Blotto. *Games* special issue "Economics of Conflict and Terrorism," 2021, 12(2), 47.
- Sam Ganzfried. Fast Complete Algorithm for Multiplayer Nash Equilibrium. *Conference on Game Theory and AI for Security (GameSec)*, 2024.
- Sam Ganzfried, Conner Laughlin, and Charles Morefield. Parallel Algorithm for Approximating Nash Equilibrium in Multiplayer Stochastic Games with Application to Naval Strategic Planning. *International Conference on Distributed Artificial Intelligence (DAI)*, 2020.
- Max Chiswick and Sam Ganzfried. Prediction of Bayesian Intervals for Tropical Storms. *Florida Artificial Intelligence Research Society Conference (FLAIRS)*, 2020.
    - Early version at *ICLR Workshop Tackling Climate Change with Machine Learning*, 2020.
- Sam Ganzfried and Max Chiswick. Most Important Fundamental Rule of Poker Strategy. *Florida Artificial Intelligence Research Society Conference (FLAIRS)*, 2020.
- Sam Ganzfried. Mistakes in Games. *International Conference on Distributed Artificial Intelligence (DAI)*, 2019.
- Sam Ganzfried, Austin Nowak, Joannier Pinales. Successful Nash Equilibrium Agent for a 3-Player Imperfect-Information Game. Invited feature paper at *Games*, 2018, 9(2), 33.
- Sheila Alemany, Jonathan Beltran, Adrian Perez, and Sam Ganzfried. Predicting Hurricane Trajectories using a Recurrent Neural Network. *AAAI Conference on Artificial Intelligence (AAAI)*, 2019.
- Sam Ganzfried and Farzana Yusuf. Optimal Weighting for Exam Composition. *Education Sciences* special issue "Artificial Intelligence and Education," 2018, 8(1), 36.
- Sam Ganzfried and Farzana Yusuf. Computing Human-Understandable Strategies: Deducing Fundamental Rules of Poker Strategy. Invited feature paper at *Games*, 2017, 8(4), 49.
- Sam Ganzfried and Farzana Yusuf. Optimal Number of Choices in Rating Contexts. *Big Data and Cognitive Computing* special issue "Computational Models of Cognition and Learning," 2019, 3(3), 48.
    - Early version at *NIPS 2016 Workshop on Imperfect Decision Makers: Admitting Real-World Rationality*.
- Sam Ganzfried and Qingyun Sun. Bayesian Opponent Exploitation in Imperfect-Information Games. *Conference on Computational Intelligence and Games (CIG)*, 2018.
- Sam Ganzfried. Reflections on the First Man vs. Machine No-Limit Texas Hold 'em Competition. AI Magazine, Volume 48, Number 2, summer 2017.
    - Feature article in SIGecom Exchange Newsletter, Volume 14.2, 2015.
- 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.
    - 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.
- 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.
- 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.
- Sam Ganzfried and Tuomas Sandholm. Potential-Aware Imperfect-Recall Abstraction with Earth Mover's Dis-

tance in Imperfect-Information Games. *AAAI Conference on Artificial Intelligence (AAAI)*, 2014.

- 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.
- 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.
- 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.
- Sam Ganzfried. Computing Strong Game-Theoretic Strategies in Jotto. *Conference on Advances in Computer Games (ACG)*, 2011.
- 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.
- Sam Ganzfried and Tuomas Sandholm. Computing Equilibria by Incorporating Qualitative Models. *International Conference on Autonomous Agents and Multiagent Systems (AAMAS)*, 2010.
- Sam Ganzfried and Tuomas Sandholm. Computing Equilibria in Multiplayer Stochastic Games of Imperfect Information. *International Joint Conference on Artificial Intelligence (IJCAI)*, 2009.
- 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.
- Sam Ganzfried. A New Algorithm for Knight's Tours. Proceedings of the *Research Experiences for Undergraduates (REU) Program in Mathematics*, 2004.

Other presentations

- "Game Theory Solution Concepts for An Age of High-Stakes Multiagent Decision-Making" 3/29/24, keynote talk at Poker AI Competition hosted by CMU Data Science and Poker Club.
- "Grady: AI System for Robust Transparent Grading" 10/22/21, FIU KFSCIS computer science seminar.
- "Successful Nash Equilibrium Agent for a 3-Player Imperfect-Information Game"
  – Princeton University, 5/1/18, organized by Princeton Poker Club.
  – MIT, 5/3/18, organized by MIT Poker Club.
- "Optimal Number of Choices in Rating Contexts" 4/20/2018, FIU Department of Mathematics and Statistics Annual Mini-Conference in Statistical Methods and Mentoring.
- "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.
- Three-part guest lecture on computer poker at Tsinghua University game theory class, 5/8/17.
- "Endgame Solving: The Surprising Breakthrough that Enabled Superhuman Two-Player No-Limit Texas Hold 'em Play"
  – Princeton University, 3/13/17, organized by Princeton Poker Club.
  – Tsinghua University, 5/7/17.
  – Microsoft Research Asia Lab, 5/11/17.
- "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

- Guest editor: *Mathematics* journal special issue on "Game Theory and Artificial Intelligence" (2022).
- Organizer: Tutorial on Computer Poker at Conference on Economics and Computation (2016) and AAAI (2017).
- Organizer: AAAI Workshop on Computer Poker and Imperfect Information (2014, 2015).
- Program committees: AAAI (2012, 2014–2018), AAMAS (2014, 2016, 2021), ECAI (2023), IJCAI (2013, 2015, 2016, 2022, 2023), NeurIPS (2021), WWW (2018, 2019).

Teaching

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

Mentoring

- Farzana Yusuf, PhD student at FIU. Areas: artificial intelligence, machine learning.
- Sheila Alemany, Undergraduate CS student at FIU. Areas: artificial intelligence, machine learning.
  – Finalist for CRA Outstanding Undergraduate Research Award.
- Max Chiswick, MSc in electrical engineering from Technion. Areas: artificial intelligence, machine learning.
- Worked with Princeton undergraduate student Bradley Snider on his thesis in mathematics (2017).
- Worked with Stanford mathematics PhD student Qingyun Sun on opponent exploitation algorithms.
- Worked with Harbin Institute of Technology MS student Kailiang Hu on game-theoretic algorithms.