# Reca Daetwyler Sarfati

in *www.linkedin.com/in/reca-sarfati*
✉ *sarfati@mit.edu*
⬏ *www.recasarfati.com*
○ *www.github.com/rsarfati*

## Education

Aug. 2020 - **Massachusetts Institute of Technology (MIT)**, *Ph.D., Economics.*
▸ National Science Foundation Graduate Research Fellowship, MIT Graduate Fellowship

2014 - 2018 **Brown University**, *Sc.B., Mathematics and Computer Science.*
Phi Beta Kappa, Sigma Xi, magna cum laude
▸ *Senior Capstone:* "Strategic Bidding and Value Querying in Ascending Combinatorial Auctions"
*Advisor:* Professor Amy Greenwald, Computer Science

2018 - 2020 **New York University**, *Graduate Coursework in Mathematics and Economics.*

## Personal

Citizenship United States, Switzerland.

Interests Macroeconomics, Theory, Inequality, Labor, Development, Trade, Market Design, Computation.

## Publications

Sep. 2020 [Online Estimation of DSGE Models](), ***The Econometrics Journal***, with Michael Cai, Marco Del Negro, Edward Herbst, Ethan Matlin, and Frank Schorfheide.

This paper illustrates the usefulness of sequential Monte Carlo (SMC) methods in approximating DSGE model posterior distributions. We show how the tempering schedule can be chosen adaptively, explore the benefits of an SMC variant we devise termed generalized tempering for "online" estimation, and provide examples of multimodal posteriors well-captured by SMC methods. We then use our online estimation technique to compute pseudo-out-of-sample density forecasts of DSGE models with and without financial frictions, documenting the benefits of conditioning DSGE model forecasts on nowcasts of macroeconomic variables and interest rate expectations.

▸ *Presented*: European Seminar on Bayesian Econometrics (St. Andrews, Scotland, Sep. 3-4, 2019), System Committee on Econometrics (Philly Fed, Sep. 25-26, 2019), Forecasting at Central Banks Conference (Bank of Canada, Oct. 3-4, 2019), Conference on Computational and Financial Econometrics (University of London, Dec. 14-16, 2019).

## Working Papers

Mar. 2019 **Estimating HANK: Macro Time Series and Micro Moments**, with Sushant Acharya, Michael Cai, Marco Del Negro, Keshav Dogra, and Ethan Matlin.

We show how to use sequential Monte Carlo methods to estimate a heterogeneous agent New Keynesian (HANK) model featuring both nominal and real rigidities. We demonstrate how the posterior distribution may be specified as the product of the standard macro time series likelihood and a prior enforcing several steady state distributional moments, including the average marginal propensity to consume (MPC) and fraction of agents with zero liquid wealth. Using this framework, we ask whether there exists a tension between fitting macroeconomic time series and distributional moments of interest, ultimately finding there is none. For instance, even after relaxing the prior, the posterior based solely on macro time series features an MPC well below one, broadly in line with existing micro evidence.

▸ *Presented*: Society for Economic Dynamics 2020 (Barcelona, Spain, Jun. 21-23, 2021), The Econometric Society and Bocconi University World Congress (Virtual, Aug 17 - 21, 2020), 20th IWH Macroeconometric Workshop (Halle, Germany on Oct. 29-30, 2019), New York Fed/Hong Kong Monetary Authority Conference on "Monetary Policy and Heterogeneity" (Hong Kong, May 23-24, 2019).

Jan. 2019 **Learning Correlated Equilibria in Extensive-Form Games**, with Amy Greenwald.

We formalize an efficient class of counterfactual regret minimization algorithms exploiting the "sequence form" to compute "$\Phi$-equilibria" – a generalized class of equilibrium concepts defined within general-sum extensive-form games of imperfect information. We develop increasingly strong notions of no-regret, mapping those notions directly onto concepts of interest, such as agent- and extensive-form correlated and coarse correlated equilibria.

▸ *Presented*: 34th AAAI Conference on Artificial Intelligence, *Reinforcement Learning in Games* (Feb. 8, 2020).

## Working Papers in Computer Science

Sep. 2020 **Hindsight and Sequential Rationality of Correlated Play**, *in submission to 35th AAAI Conference on Artificial Intelligence*, Dustin Morrill, Ryan D'Orazio, Reca Sarfati, Marc Lanctot, Michael Bowling, Amy Greenwald, James Wright.

Driven by recent successes in two-player, zero-sum game solving and playing, artificial intelligence work on games has increasingly focused on algorithms that produce equilibrium-based strategies. However, this approach has been less effective at producing competent players in general-sum games or those with more than two players. An appealing alternative is to consider adaptive algorithms that ensure strong performance in hindsight relative to what could have been achieved with modified behavior. This approach also leads to a game-theoretic analysis, but in the correlated play that arises from learning dynamics rather than factored equilibrium behavior. We develop and advocate for this *hindsight rationality* framing of learning in general sequential decision-making settings. To this end, we re-examine mediated equilibrium and deviation types in extensive-form games, thereby gaining a more complete understanding and resolving past misconceptions. We present a set of examples illustrating the distinct strengths and weaknesses of each type of equilibrium in the literature, and proving that none subsumes all others. This line of inquiry culminates in the definition of the deviation and equilibrium classes that correspond to algorithms in the counterfactual regret minimization (CFR) family, relating them to all others in the literature. Examining CFR in greater detail further leads to a new recursive definition of rationality in correlated play that extends sequential rationality in a way that naturally applies to hindsight evaluation.

Sep. 2020 **Rational Learning Algorithms for Extensive-Form Games**, Dustin Morrill, Ryan D'Orazio, Marc Lanctot, Reca Sarfati, Michael Bowling, Amy Greenwald, James Wright.

Recent and parallel lines of work have made progress toward the computation of mediated equilibria and on clarifying the desirable properties of learning algorithms in sequential, general-sum, multi-agent environments. Taking the viewpoint that learning algorithms should behave rationally in hindsight, we investigate extensions to the counterfactual regret minimization (CFR) framework that has yielded major successes in extensive-form game (EFG) playing and solving. This paper describes how time selection regret minimization can be used to construct an elementary CFR variant that is subjectively sequentially rational in hindsight with respect to partial sequence deviations, a new class of deviations that subsumes all of the EFG-specific deviation concepts in the literature. This algorithm can thereby take advantage of the different strengths of each EFG deviation type. We show experimentally how this extension improves on previous CFR variants in online learning tasks. Additionally, we present the idea of a behavioral deviation, a natural unifying class of extensive-form deviations that encompasses even partial sequence deviations, along with a recipe for deriving a CFR-based algorithm for any subclass.

## Speaking and Presentations

Jun. 2019 **JuliaCon 2019**, *Heterogeneous Agent Dynamic Stochastic General Equilibrium (DSGE) Models in Julia at the Federal Reserve Bank of New York*, University of Maryland, Baltimore.
▶ Watch
Invited and awarded full funding to present at annual conference for developers in the Julia programming language. Delivered 30-minute talk on my team's work implementing tools for the solution and estimation of heterogeneous agent models to an audience of academics and practitioners from a range of computational disciplines.

Jul. 2019 **Federal Reserve Bank of New York**, *Intro to Git and Version Control; Intro to Database Management and SQL; Coding Best Practices; Intro to Julia.*

## Authored Software

Summer 2019 **Sequential Monte Carlo**, *Package (Julia).*
Coauthored Julia-licensed package, SMC.jl, implementing sequential Monte Carlo sampling methods for the approximation of posterior distributions. Optimized memory allocation to rival Fortran speeds for distributed computation.

Spring 2019 **Sparse Automatic Differentiation**, *Package (Julia).*
Wrote extension to Julia package, ForwardDiff.jl, to exploit sparsity of data structures during forward automatic differentiation (useful for differentiation of functions $f : \mathbb{R}^n \to \mathbb{R}^m$ when $n << m$). This modification more than halves the runtime of solution algorithms for various continuous-time HANK models.

Spring 2018 **Extensive-Form Games**, *Library (Python).*
Developed library in Python for specification and conversion of games between normal, extensive, and sequence form representations. Implemented reinforcement learning algorithms to compute various correlated equilibrium concepts.

Summer 2017 **Tempered Particle Filter**, *Package (Julia).*
Implemented self-tuning tempered particle filter from Herbst and Schorfheide, (2017) for likelihood evaluation of non-linear models with non-Gaussian innovations. Integrated code into the NY Fed's package of filtering and smoothing routines for state-space models, StateSpaceRoutines.jl.

## Blog Articles

Jun. 19, 2020    **Liberty Street Economics**, *The New York Fed DSGE Model Forecast: June 2020*, with William Chen, Marco Del Negro, and Ethan Matlin.

Jun. 19, 2020    **Liberty Street Economics**, *The New York Fed DSGE Model Forecast: March 2020*, with Ozge Akinci, William Chen, Marco Del Negro, and Ethan Matlin.

Dec. 20, 2019    **Liberty Street Economics**, *The New York Fed DSGE Model Forecast: December 2019*, with William Chen, Marco Del Negro, Ethan Matlin, and Andrea Tambalotti.

Sep. 30, 2019    **Liberty Street Economics**, *The New York Fed DSGE Model Forecast: September 2019*, with Ozge Akinci, William Chen, Marco Del Negro, and Ethan Matlin.

Sep. 4, 2019    **Liberty Street Economics**, *Online Estimation of DSGE Models*, with Michael Cai, Marco Del Negro, Ethan Matlin, and Frank Schorfheide.

Jun. 21, 2019    **Liberty Street Economics**, *The New York Fed DSGE Model Forecast: June 2019*, with Sushant Acharya, Michael Cai, Marco Del Negro, and Ethan Matlin.

Feb. 8, 2019    **Liberty Street Economics**, *The New York Fed DSGE Model Forecast: January 2019*, with Marco Del Negro, Michael Cai, and Ethan Matlin.

Oct. 24, 2018    **Liberty Street Economics**, *The New York Fed DSGE Model Forecast: October 2018*, with Marco Del Negro, Argia Sbordone, Michael Cai, and Ethan Matlin.

## Research Experience

2018 - 2020    **Federal Reserve Bank of New York**, *Senior Research Analyst, Macroeconomic and Monetary Studies*.
Assisted the dynamic stochastic general equilibrium (DSGE) team with research, policy analysis, forecasting, and model development. Extended and maintained the DSGE.jl package (in the Julia programming language) for solving, estimating, and forecasting DSGE models. (Julia, MATLAB, Fortran, Stata)

- ▶ Coauthored two academic papers with NY Fed economists exploring the application of sequential Monte Carlo (SMC) methods to the estimation of representative and heterogeneous agent New Keynesian (HANK) models.
- ▶ Studied and developed code for insertion of Hamiltonian Monte Carlo sampling in the place of random-walk Metropolis-Hastings during the "mutation" step of SMC, with an eye toward the efficient estimation of DSGE models with many state variables.

2017 - 2020    **Research Assistant for Amy Greenwald**, *Brown University Computer Science Department*.
Devised no-regret learning algorithms for efficient computation of various Bayes correlated equilibrium concepts in extensive-form, imperfect-information games. Researched application of innovations in reinforcement learning to the computation of correlated equilibria, wrote package for running simulations, derived proofs of empirical convergence.

2017 - 2018    **Research Assistant for Jesse Shapiro**, *Brown University Economics Department*.
Developing quantitative index of national freedom of assembly. Explored use of machine learning classifiers (SVM, Naïve Bayes, and logistic regression) to construct implied measures of "predictability" of protests. Algorithmically automated web-scraping of news articles to match, augment, and re-classify protest data in Social Conflict Analysis Database (SCAD). Studied effects of protests against the state on financial variables in Egypt, Mexico, and South Africa. (Python, Stata, SQL)

2016 - 2017    **Research Assistant for Louis Putterman**, *Brown University Social Science Experimental Laboratory*.
Implemented and designed graphical user interface for 24-subject game in z-Tree to model social incentives for civic engagement in a setting with moral hazard. Extended base z-Tree functionality to handle thread-safe distributed computation. Administered sessions, cleaned and interpreted the collected data. Results from implementation may be found in the working paper Kamei, Putterman, and Tyran (2019). (z-Tree, VBA)

2015    **U.S. Consulate Guangzhou, China**, *Summer Analyst in Foreign Commercial Service, Consular Sections*.
Assembled and cleaned database of over 60,000 observations of past visa applicants. Performed logistic regression analysis to discern attributes correlated with future visa fraud. Compiled and analyzed summary statistics of high-tech direct investment trends from major Guangdong businesses. Performed sentiment analysis of Chinese news reporting on American global activity, coauthored weekly South China Media Reaction Report. (SQL, MATLAB)

## Teaching Experience

Fall 2017    **Design and Analysis of Algorithms**, *Teaching Assistant*, Brown Computer Science Department.
*CSCI 1570* : Led sections, held office hours, and graded projects, exams, and homework assignments for advanced proof-based course spanning data structures, linear programming, optimization, online and competitive analysis, dynamic programming, NP-Hardness, information theory, parallel computing, and graph algorithms.

| | |
|---|---|
| Spring 2017 | **Algorithms and Data Structures**, *Teaching Assistant*, Brown Computer Science Department. |
| | *CSCI 0160* : Taught section of 20 students, held office hours, wrote assignment stencil code in Java, and implemented auto-grading functionality for programming assignments. Course spanned complexity analysis, data structures, sorting, and search algorithms, as well as fundamental Python and Java. |
| Summer 2016 | **{Statistics, Economics} for Public Policy (MPA)**, *Economics Tutor*, Brown Economics Department. |
| | *PLCY 2455, 2460* : Tutored masters students in quantitative methods and microeconomics for public policy. |

## Honors and Grants

| | |
|---|---|
| 2020 - 2025 | **National Science Foundation**, *Graduate Research Fellowship*. |
| 2020 - 2025 | **Massachusetts Institute of Technology (MIT)**, *Graduate Fellowship*. |
| Mar. 2019 | **National Science Foundation**, *XSEDE Research Allocation Grant, SES #190003*. |
| | ▸ "Estimating Heterogeneous Agent Dynamic Stochastic General Equilibrium Models using Sequential Monte Carlo" |
| Mar. 2019 | **Vault Recognition Award**, *Federal Reserve Bank of New York*. |
| 2016 - 2018 | **JPMorgan Chase Research Assistantship Award for Research in Economics**, *Brown University*. |
| Dec. 2017 | **Women of Computer Science '84 Undergraduate Teaching Assistant Award**, *Brown University*. |
| May 2018 | **Phi Beta Kappa**, *Brown University*. |
| May 2018 | **Sigma Xi**, *Brown University*. |
| May 2018 | **Magna cum laude**, *Brown University*. |

## Other Awards and Experience

| | |
|---|---|
| Aug. 2020 - | **Harvard College Debating Union**, *Debate Coach*. |
| | Coaching top-ranked national collegiate debate team in American and British Parliamentary formats. |
| May 2018 | **4th Place, American Parliamentary Debate National Championships**, *Johns Hopkins University*. |
| | Ranked 4th in the nation at the National Championships for American parliamentary debate. |
| Jan. 2018 | **Top 6% Speaker, World Universities Debating Championships**, *Mexico City, Mexico*. |
| | Ranked 36/629 globally for individual performance in world's largest, most prestigious debating tournament. |
| May 2017 | **The Ratcliffe Hicks Prize for Excellence in Debate**, *Brown University*. |
| | Awarded annually for extraordinary performance in and commitment to collegiate debate. (val. $2,500) |
| 2014 - 2018 | **Brown Debating Union**, *Vice President of Operations, Vice President of Finance, Varsity Debater*. |
| | Managed logistics and budget of over $20,000 for 2nd-ranked (2016-2018) debating union in the nation. Extensively researched and edited 1500-word arguments for use on national circuit. Competed weekly. (35+ hours/week) |

## Select Coursework

○ Economics: *(Ph.D.)* International Economics I, Microeconomic Theory {I, II}, Economic Growth, Dynamic Optimization with Applications, Bayesian Macroeconometrics, Applied Econometrics, Statistical Methods in Economics; *(M.Sc.)* Advanced Econometric Modeling and Big Data, Algorithmic Game Theory; *(Sc.B.)* Advanced Macroeconomics: Monetary, Fiscal, and Stabilization Policies, International Trade, Economic Development, Econometrics I (Adv.), Intermediate {Macroeconomics, Microeconomics}, International Political Economy, Comparative Politics of Finance.

○ Computer Science: Advanced Probabilistic Algorithms (Ph.D.), Data Science (M.Sc.), Machine Learning, Design and Analysis of Algorithms, Design and Implementation of Programming Languages, Computer Systems, Object-Oriented Programming, Intro to Algorithms and Data Structures.

○ Math: Intro Analysis II: Lebesgue Integral and Measure Theory (M.Sc.), Analysis: Functions of Several Variables, Analysis: Functions of One Variable, Abstract Algebra, Graph Theory, Ordinary Differential Equations, Dynamics and Vibrations, Discrete Structures and Probability, Statistical Inference I, Linear Algebra, Multivariate Calculus, Logic.

## Certifications

○ **Columbia University:** Causal Inference I 🏛, II 🏛.

○ **Stanford University:** Social and Economic Networks 🏛.

○ **University of Pennsylvania:** Inferring Causal Effects from Observational Data 🏛.

## Technical Skills

- **Programming Languages:** *Expert:* Julia, MATLAB, Python, Java, SQL, z-Tree. *Extensive Use:* C/C++, Fortran, R, Stata, Lisp, Racket. *Familiar:* EViews, Visual Basic, x86-64.
- **Scripting/Typesetting Languages:** Shell Script, JavaScript (incl. D3.js, Node.js), HTML, Pyret, Markdown, LaTeX.
- **Computing Skills:** Git, high performance distributed computing and parallel processing (MPI, SGE, Slurm), GPU programming, sparse numerical techniques, Arduino Robotics.
- **Clusters:** NY Fed Research Access Network, UT Dallas BigTex, Bridges PSC, Indiana/TACC Jetstream (XSEDE).
- **Operating Systems/Software:** Linux, Mac OS, Windows, Maya, SolidWorks, CAD.

## Personal

- **General Interests:** Oration, programming language design, classical violin, oil painting, modernist literature, rugby.
- **Places Lived:** Seoul, South Korea; Manila, Philippines; Vienna, Austria; Kingston, Jamaica; Düsseldorf, Germany; Guangzhou, China; Sydney, Australia.
- **Born:** Berkeley, CA.

Last updated: November 6, 2020