

James Holehouse

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Biography

■ I'm a postdoc at the Santa Fe Institute (SFI) and I completed my PhD in Mathematical Biology at the University of Edinburgh. I obtained a first-class honors degree in Theoretical Physics (MPhys) from the University of Edinburgh. My main interests span several aspects of complexity science and statistical physics:

- Stochasticity and its non-intuitive consequences.
- The effects of randomness on gene expression.
- Rules and regulations across different complex systems.
- Social choice and complexity economics.

Examples of these interests include work on time-dependent solutions of master equations in mathematical biology and economics, and recent work on the evolution of rules and regulations in documents such as the US Code. I actively engage in teaching and mentoring and have trained in a variety of mathematical, physical and biological topics.

Employment History

October 2022 – Present

■ **Postdoc at the Santa Fe Institute.**

Working alongside Sidney Redner, Chris Kempes, Geoffrey West, Vicky Chuqiao Yang and Hyejin Youn.

- I am the current Curriculum Director of the Undergraduate Complexity Researcher program (an REU program).
- In both 2023 and 2024 I organized the annual SFI postdoc retreat.
- Co-organized a series of talks at St. Johns College from SFI postdocs.
- I was a core member of the SFI postdoc selection process for 2023.

May 2021 – October 2021

■ **Economic Modeling Intern at Cambridge Econometrics.**

An industrial internship in complexity economics alongside Hector Pollitt.

Feb 2021 – Feb 2022

■ **Tutor at MyTutor.**

I tutored GCSE and A-level Mathematics and Physics to high school students during the pandemic.

Sept 2019 – June 2021

■ **Teaching Assistant at the University of Edinburgh.**

I taught Python programming to 1st year Biology students.

June 2017 – Aug 2017






■ **NERC Summer Researcher at the University of Edinburgh.**

A climate science summer internship supervised by Simon Tett.

pre 2017

■ I worked at various positions in hospitality including, working at a hostel and as a cook in a restaurant.

Education

- 2018 – 2022  **PhD, the University of Edinburgh** in *Mathematical Biology*.
Studying stochastic models of gene expression with Prof. Ramon Grima. I organized and instantiated *stochastic problem solving days* and groups retreats in our research group.
I was the winner of the Reinhart Heinrich award from the European Society for Mathematical Biology (2022) for the best thesis in mathematical biology.
- 2021  **TensorFlow Certificates** in *Coursera*.
Achieved 99% in courses on *Introduction to TensorFlow for Artificial Intelligence, Machine Learning, and Deep Learning* and *Convolutional Neural Networks in TensorFlow*.
- 2020 – 2021  **Centre for Open Learning, the University of Edinburgh** *Introduction to Philosophy*.
I completed a night-school Philosophy course during my PhD studies.
- 2014 – 2018  **MPhys, the University of Edinburgh** in *Theoretical Physics*.
I achieved a First Class Honors degree (1:1) and did my Masters project alongside Prof. Richard Blythe. My course choices were tailored to mathematical and statistical physics modules.
- 2012 – 2014  **A-Levels, Scarborough Sixth Form College**.
Obtained A*A*A in Mathematics, Physics and Chemistry respectively (A* is top grade), and AS-Levels AA in Further Mathematics and Biology (A is top grade).

Publications

Published Articles

- 1 **Holehouse, J.** (2024b). Thesis summary: Model reduction, mechanistic modelling and transience in models of stochastic chemical kinetics. *European Communications in Mathematical and Theoretical Biology*, 26, 6–14.
- 2 **Holehouse, J., & Redner, S.** (2024). First passage on disordered intervals. *Physical Review E*, 109(3), L032102. **Corresponding author paper.**
- 3 Wu, B., **Holehouse, J.**, Grima, R., & Jia, C. (2024). Solving the time-dependent protein distributions for autoregulated bursty gene expression using spectral decomposition. *The Journal of Chemical Physics*, 160(7).
- 4 **Holehouse, J.** (2023). Recurrence and eigenfunction methods for non-trivial models of discrete binary choice. *Entropy*, 25(7), 996.
- 5 Weidemann, D. E., **Holehouse, J.**, Singh, A., Grima, R., & Hauf, S. (2023). The minimal intrinsic stochasticity of constitutively expressed eukaryotic genes is sub-poissonian. *Science Advances*, 9(32), eadh5138.
- 6 **Holehouse, J., & Moran, J.** (2022). Exact time-dependent dynamics of discrete binary choice models. *Journal of Physics: Complexity*. **Corresponding author paper.**
- 7 **Holehouse, J., & Pollitt, H.** (2022). Non-equilibrium time-dependent solution to discrete choice with social interactions. *PLoS ONE*. **Corresponding author paper.**
- 8 Braichenko, S., **Holehouse, J.**, & Grima, R. (2021). Distinguishing between models of mammalian gene expression: Telegraph-like models versus mechanistic models. *Journal of the Royal Society Interface*. **Joint first author publication.**
- 9 **Holehouse, J.**, Cao, Z., & Grima, R. (2020). Stochastic modeling of autoregulatory genetic feedback loops: A review and comparative study. *Biophysical journal*, 118(7), 1517–1525.

- 10 **Holehouse, J.,** Gupta, A., & Grima, R. (2020). Steady-state fluctuations of a genetic feedback loop with fluctuating rate parameters using the unified colored noise approximation. *Journal of Physics A: Mathematical and Theoretical*, 53(40), 405601.
- 11 **Holehouse, J.,** Sukys, A., & Grima, R. (2020). Stochastic time-dependent enzyme kinetics: Closed-form solution and transient bimodality. *The Journal of Chemical Physics*, 153(16), 164113.
- 12 **Holehouse, J.,** & Grima, R. (2019). Revisiting the reduction of stochastic models of genetic feedback loops with fast promoter switching. *Biophysical journal*, 117(7), 1311–1330.
- 13 **Holehouse, J.,** & Cameron, B. (2017). Meteorological visibility observations: A user's guide. *Times Educational Supplement*.


Other and In Progress

- 1 **Holehouse, J.** (2024a). Principles of bursty mRNA expression and irreversibility in single cells and extrinsically varying populations. arXiv preprint arXiv:2405.12897.
- 2 **Holehouse, J.** (2022). Model reduction, mechanistic modelling and transience in models of stochastic chemical kinetics. PhD thesis. *The University of Edinburgh*.
- 3 **Holehouse, J.,** & Blythe, R. A. (2018). Cross-situational learning of large lexicons with finite memory. arXiv preprint arXiv:1809.11047.





Seminars, Posters and Invited Talks

- 2024
 - **Plenary talk** at the European Conference for Mathematical and Theoretical Biology 2024 in Toledo.
Breaking steady state assumptions in models of stochastic chemical kinetics.
 - **Contributed talk** at the European Conference for Mathematical and Theoretical Biology 2024 in Toledo.
The statistical physics of transcription and mRNA expression heterogeneity.
 - **Contributed talk** at the 10th International Conference on Computational Social Science (IC²S²) in Philadelphia.
Scaling of diversity and specialization across socioeconomic and biological complex systems.
 - **Invited talk** at the University of California Berkeley at the lab of Prof. Hernan Garcia.
What are the benefits of bursty transcription?
 - **Invited talk** at St. Johns College, Santa Fe.
A complexity approach to rules, regulations and bureaucracy. This is part of the ongoing seminar series I am co-organizing.
- 2023
 - **Workshop talk** at the Santa Fe Institute.
A unified mechanistic model of diversity in cities, cells and companies.
- 2022
 - **Poster presentation** at the European Conference for Mathematical and Theoretical Biology 2022 in Heidelberg.
Analytics and Bimodality in Transient Michaelis-Menten Kinetics.
 - **Seminar** at Cambridge Econometrics.
Stochastic methods for binary decision models.
 - **Seminar** at Scuola Superiore Sant'Anna.
Stochastic methods for binary decision models.
 - **Invited talk** at the Santa Fe Institute.
Time-dependent solutions to master equations in chemical kinetics and opinion formation.
- 2021
 - **Seminar** at the University of St. Andrews.
Stochastic time-dependent enzyme kinetics: Closed-form solution and transient bimodality.





Seminars, Posters and Invited Talks (continued)

- 2019  **Invited talk** at the University of Edinburgh.
Using moment-based maximum likelihood inference to infer parameters from experimental data.

Mentoring







- 2023–present  **Anish Pandya (The University of Texas at Austin)** at the Santa Fe Institute.
Volume-dependence in stochastic gene expression—presented at the Bulletin of the American Physical Society in Austin, TX.
Causation does not imply correlation: non-intuitive insights from a simple genetic mechanism.
- 2023  **Nathan Hasegawa (Harvey Mudd College)** at the Santa Fe Institute.
Island growth models with preferential attachment.
- 2024  **Shloka Janapaty (Columbia University)** at the Santa Fe Institute.
Reaction-diffusion equations of biocrust growth.
-  **Elena Parkerson (Carleton College)** at the Santa Fe Institute.
Finite state projection and stochastic simulation for viral infections.

Grants




- 2020  **Scottish Mathematical Biology Forum (SMBF) 2020 Research Collaboration Prize** for £500 alongside Jochen Kursawe (University of St. Andrews).
The physical meaning and application of Hill functions in gene regulatory networks.
- 2023  **Lou Schuyler Grant** for \$14,640 from the Santa Fe Institute.
Understanding the trade-offs between diversity, robustness and performance across the tree of life.
- 2024  **SFI working group** for \$6,104 alongside Asher Leeks (Yale University). Participants: Brandon Schlomann and William DeWitt.
Modeling the evolutionary dynamics of cheating in natural viral infections.
-  **SFI working group** for \$4,536. Participants: Augustinas Sukys and Kaan Öcal.
On the origins of transient bimodality.

Service and Skills

Journal Reviewing

- 2020–present  **Reviewer** for Mathematical Biosciences.
- 2021–present  **Reviewer** for PLoS One.
-  **Reviewer** for Physical Review E.
- 2023–present  **Reviewer** for Physical Review Letters.
-  **Reviewer** for Biophysical Journal.
- 2024–present  **Reviewer** for Chaos: An Interdisciplinary Journal of Nonlinear Science.

Programming Languages

- Julia  Very proficient, preferred language.
- Mathematica  Very proficient, preferred language.
- Python  Very proficient.

References

Please reach out to request references from: Ramon Grima (ramon.grima@ed.ac.uk), Chris Kempes (ckempes@gmail.com), Geoffrey West (gbw@santafe.edu), Sidney Redner (redner@santafe.edu) and Hyejin Youn (hyejin.youn@kellogg.northwestern.edu).