Salvador Buse
Bioengineering PhD Student at Caltech

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Education

California Institute of Technology (Caltech) *Pasadena, California*
PhD in Bioengineering *Sep 2020 -*

- Theoretical and experimental study of pattern formation, artificial and biochemical neural networks, and synthetic biology
- Funding 1st year: full graduate research fellowship from Caltech
- Funding 2nd year on: OpenPhilanthropy Biosecurity Fellowship, covering stipend and fees for the remainder of my degree
- Courses 1st year: data analysis and statistical inference in Python, biomolecular computation, mathematical biology
- Courses 2nd year: networks of relations, probability and stochastic processes, machine learning theory, physical biology of the cell

University of Cambridge, Trinity College *Cambridge, UK*
BA and MSci in Natural Sciences – First Class, 76% *Oct 2016 - Jul 2020*

- Part III in Systems Biology (courses in mathematical modelling, biological networks, and synthetic and executable biology)
- Part II in Chemistry (courses in organic, biological, theoretical, and physical chemistry, molecular biology, and mathematics)

Research Experience

California Institute of Technology (Caltech) *Pasadena, California*
PhD Student, Erik Winfree Lab *Sep 2020 -*

- My main interests are in pattern formation and collective decision-making. I research self-assembly and morphogenesis in neural reaction-diffusion systems and cellular automata, using simulation in TensorFlow and PyTorch. I also study the phase separation of DNA droplets as a model for spatial organisation. My work so far has been theoretical and computational. [*Computational.*]

MRC Laboratory of Molecular Biology *Cambridge, UK*
Master's Thesis Student, Jason Chin Lab *Nov 2019 - Apr 2020*

- To enable bacteria to make proteins containing unnatural amino acids, the Chin lab built 'Syn61', an *E. coli* whose genome uses only 61 of 64 codons, and is the largest yet synthesised. This works by 'recoding': synonymously replacing all instances of certain codons. I found that Syn61 still contains some recoded codons, and studied their implications for future recoded genomes. [*Wet Lab and Computational.*]

Medical Research Council Fellowship Student, Jason Chin Lab *Jun 2019 - Sep 2019*

- In Syn61, recoded codons are 'blank': they do not encode natural amino acids, so can be assigned to unnatural amino acids. To enable this, I deleted the tRNAs recognising the recoded codons and found the new Syn61 strain to be viable, but less fit. [*Wet Lab.*]

Stanford University, Chemical and Systems Biology *Palo Alto, California*
Summer Research Intern, Jim Ferrell Lab *Jun 2018 - Aug 2018*

- Studied the role of an APC/C subunit in cell cycle regulation. [*Wet Lab.*]

University of Cambridge, Physiology Department *Cambridge, UK*
Summer Research Intern, Bill Harris Lab *Jul 2017 - Sep 2017*

- Collected data and wrote code to study the role of nuclear migration in retinal development. [*Computational.*]

Teaching Experience

Teaching Assistant: Caltech BE / CS 191 a and b, Biomolecular Computation *Jan 2022 - Jun 2022*

- This course is taught by Erik Winfree and explores models of computation, from Turing machines to DNA computers. The emphasis is on understanding how chemical reactions can compute, and how we can use this to explain natural processes and design algorithms. Part b of the class focused on neural computation in chemical systems. I held office hours, led discussions, and graded assignments.

Teaching Fellow: Harvard Mini-Course on Computation *Jan 2022*

- Chi-Ning Chou, a PhD student, arranged this open-access bootcamp as an introduction to theoretical computer science, with three daily lectures over two weeks. The three modules explored mathematical, physical, and biological models of computation. I helped to answer student questions, and gave a talk on computing with chemistry, recorded here.

Leadership and Mentoring Experience

Mentor: Caltech Summer Undergraduate Research Fellowships *Jun 2022 - Sep 2022*

- Inhoo Lee: project on chemical Boltzmann machines and energy-based probabilistic inference.
- Mohini Misra: project on constraint satisfaction problems in surface-based chemical networks.
- JS Paul: project on constraint satisfaction problems in surface-based chemical networks.

Mentor: Caltech Summer Undergraduate Research Fellowships *Jun 2021 - Sep 2021*

- Pippa Richter: project on constraint satisfaction problems in well-mixed chemical networks.

October 4, 2022

Cambridge University Scientific Society *Cambridge, UK*

Co-President *Mar 2018 - Mar 2019*

- Arranged a weekly lecture series of 15 scientists, and co-chaired a research internships event. Helped to renew our relationship with Oxford's Science Society, and jointly arranged a formal dinner in Cambridge and a field trip to the London Natural History Museum.

Trinity College Science Society *Cambridge, UK*

President *Mar 2017 - Mar 2018*

- Arranged a weekly lecture series of 17 scientists, which featured Sir Paul Nurse & Dame Ottoline Leyser. Organised a research internships event, which now occurs annually, and a symposium showcasing research at Trinity.

Publications

- Robertson W., Funke L., De La Torre D., Fredens J., Elliot T., Spink M., Christova Y., Cervettini D., Boge F., Liu K., **Buse S.**, Maslen S., Salmond G., Chin J. (Jun 2021). Sense codon reassignment enables viral resistance and encoded polymer synthesis. Science. DOI: 10.1126/science.abg3029

- Azizi A., Herrmann A., Wan Y., **Buse S.**, Keller P. J., Goldstein R., & Harris W. A. (Oct 2020). Nuclear crowding and nonlinear diffusion during interkinetic nuclear migration in the zebrafish retina. eLife. DOI: 10.7554/eLife.58635

Programming Languages

- Confident: Python. Have used this extensively, including frameworks such as TensorFlow and JAX, packages such as NumPy and Numba, and data visualisation tools such as MatPlotLib and Bokeh.

- Capable: Mathematica, MATLAB. Have used these in my research, as well as in university assignments.

- Other: LaTeX, some experience with git, R, and html.

Profile

I'm interested in using synthetic biology to understand life and build technologies which benefit humanity. I consider myself to be part of the effective altruism community, and care a great deal about our long-term future. I believe that the misuse of synthetic biology could pose an existential threat, and hope to use my career to help mitigate that risk. I won a Silver Medal at the International Biology Olympiad in 2016, and Gold Medals in the national Physics, Chemistry, and Biology Olympiads in 2015 & 16. I love to travel and am fascinated by world history, and am lucky enough to have visited more than 40 countries.