Csenge Petak

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Research Statement

I am a recent PhD graduate with a deep-rooted interest in fundamental laws governing biology. I have experience in building computational models of development and evolution, specifically, I have worked on models of gene regulatory networks to investigate their dynamics and evolution, and their influence on developmental patterning and evolvability.

Education

- **PhD in Biology**
  University of Vermont, Burlington, VT, USA *2019 - 2025*

  Adaptation to variable environments using sea urchins and simulations. Involved the building and analysis of computational models of gene regulatory networks and their evolution, fitness landscape analysis, and the generation of target spatial-temporal developmental patterning generated by cellular automata rules.

- **Complex Systems and Data Science Graduate Certificate**
  Vermont Complex Systems Institute, Burlington, VT, USA *2020 - 2022*

  Training in computational and mathematical techniques to describe and understand complex natural and sociotechnical systems. Classes taken: Principles of Complex Systems, Modelling Complex Systems, Evolutionary Computation, Data Science I, Data Lab. GPA: 4.0

- **BSc in Biology**
  University of Southampton, Southampton, UK *2016 - 2019*

  Undergraduate degree with special focus on evolutionary, developmental, and molecular biology. First-Class Honours and Dean's List Award.

Extra courses

- **PH526x: Using Python for Research**
  HarvardX certificate *2018*

- **CS50's Introduction to Computer Science**
  HarvardX certificate *2016 - 2017*

Research experience

- **Research Assistant - Phyllotaxis Computational Modelling**
  University of Cambridge, Cambridge, UK *2023*

  lead by Dr. Renske Vroomans at the Sainsbury Laboratory Cambridge University (SLCU). I investigated different models of stripe formation and the ways in which plant morphogens influence development when evolved to produce different patterns.

- **Research Trainee - Biological Data Science**
  University of Vermont, Burlington, VT *2019 - 2025*

  Graduate Training Program - formerly known as the Quantitative Evolutionary STEM Training program, funded by the National Science Foundation.

- **Wellcome Trust Biomedical Vacation Scholarship**
  University of Southampton, Southampton, UK *2018*

  Applied and received funds for examining the role of alginate in the attachment of *Pseudomonas aeruginosa* on urinary catheters by comparing biofilm formation-defective mutant strains.

- **Undergraduate Research Assistant**
  University of Southampton, Southampton, UK *2017*

  Assisted with research on speciation through homoploid hybridisation in *Argyranthemum* in an Evolutionary Genomics and Transcriptomics lab.

Notable Projects

- **Modularity in complex contagion models**
  Python simulation *2019*

  Investigated the emergence and function of modularity in grown networks with threshold-based activation functions. Collaborators: Dr. Lapo Frati and Karl Dejong Kaiser.

- **Computational model of mutation rate evolution**
  Python simulation *2018*

  Explored the indirect evolution of mutation rates in a population of food-seeking agents moving on a toroidal lattice. Collaborators: Dr. Lapo Frati and Dr. Richard A. Watson.

Publications and preprints

- **Petak, C.**, Frati, L., Vroomans, R. M., Pespeni, M. H., and Cheney, N. (2025). The variability of evolvability: properties of dynamic fitness landscapes determine how phenotypic variability evolves. bioRxiv, 2025-07.
- Weinreich, D. M., Sgouros, T., Raynes, Y., Burtsev, H., Chang, E., Rajakumar, S., Bravo, I.G. and **Petak, C.** (2025). The Population Genetics of Biological Noise. bioRxiv, 2025-01.
- Frati, L., **Petak, C.**, and Cheney, N. (2024). Networks of Binary Necklaces Induced by Elementary Cellular Automata Rules. Proceedings of the 2024 Artificial Life Conference. (pp. 117). ASME.
- **Petak, C.**, Frati, L., Brennan, R. S., and Pespeni, M. H. (2023). Whole-Genome Sequencing Reveals That Regulatory and Low Pleiotropy Variants Underlie Local Adaptation to Environmental Variability in Purple Sea Urchins. The American Naturalist, 202(4), 571–586.
- **Petak, C.**, Frati, L., Pespeni, M. H., and Cheney, N. (2023). Coping with seasons: evolutionary dynamics of gene networks in a changing environment. Proceedings of the Companion Conference on Genetic and Evolutionary Computation, 163–166.
- Bunford, N., Csibra, B., **Peták, C.**, Ferdinandy, B., Miklósi, Á., and Gácsi, M. (2019). Associations among behavioral inhibition and owner-rated attention, hyperactivity/impulsivity, and personality in the domestic dog (*Canis familiaris*). *Journal of comparative psychology*, 133(2), 233.

Awards

University of Vermont Computer Science Fair	3^{rd} place	*2023*
Graduate Student Senate Most Innovative Research Award	1^{st} place	*2021*
University of Southampton Faculty Merit Award	1^{st} place	*2018*

Graduate College Conference and Chair's Award	$900	*2024*
Quantitative Evolutionary STEM Training program	$10,500	*2023*
Dr. Roberto Fabri Fialho Research Award	$1,850	*2022*
John Wheeler Graduate Student Research and Development Award	$1,600	*2021*
Wellcome Trust Biomedical Vacation Scholarship	£2,000	*2018*
	$17,500	

Technical skills

- **Programming languages**: Python, R, C++, LaTeX, Bash
- **Computational modelling**: Building computational models of complex systems, systems of ordinary differential equations, agent-based computing, network dynamics, cellular automata, genetic algorithms, training and using artificial neural networks.
- **Computational tools**: Data science techniques for statistics and visualization of high dimensional data and networks. Scheduling and running jobs in parallel on high-performance computing clusters, using virtual environments for package management, making basic websites with Quarto, and version control with git.
- **Wet lab skills**: DNA extraction, primer design, PCR amplification and purification of product, gel electrophoresis, molecular cloning, microinjection of live egg cells, heat-shock transformation, inoculation of agar plates and broths, fluorescent staining, using epifluorescence confocal microscope.

Conferences and talks

- **Artificial Life Conference (Alife)**
  Attended, Co-Author *2024*
  Title: Networks of Binary Necklaces Induced by Elementary Cellular Automata Rules.
- **The Allied Genetics Conference (TAGC)**
  Presenter *2024*
  Title: Non-heritable yet evolvable: increased developmental noise can be selected for despite average negative effect
- **The Genetic and Evolutionary Computation Conference (GECCO)**
  Presenter *2023*
  Title: Coping with seasons: evolutionary dynamics of gene networks in a changing environment
- **Developmental Biology of Sea Urchins and other Marine Invertebrates XXVI**
  Presenter *2022*
  Title: Whole-genome sequencing shows the role of gene regulation in local adaptation to environmental variability in purple sea urchins
- **SSE, SSB, ASN joint Evolution Conference**
  Presenter *2021*
  Title: Local adaptation to environmental variability through the evolution of gene regulation in a heterogeneous seascape
- **University of Vermont Student Research Conference**
  Presenter *2021 - 2024*
- **Evolutionary Systems Biology**
  Attended *2020, 2022*
- **University of Southampton Natural History Society Symposium**
  Invited speaker *2018*

Teaching experience

- **Graduate Teaching Assistant**
  Vermont Complex Systems Institute, Burlington, VT, USA *2022 - 2025*

  Graduate courses: Data Science I, Evolutionary Computation, Modelling Complex Systems
  Undergraduate courses: Introduction to Programming

- **Graduate Teaching Assistant**
  University of Vermont Biology Department, Burlington, VT, USA *2019 - 2023*

  Graduate courses: Ecological Genomics
  Undergraduate courses: Genetics, Ecology and Evolution, Comparative Physiology

Service

- **Reviewer** for the Conference on Artificial Life and the American Naturalist.
- **Mentor** for undergraduate researchers Mackenzie E. Kerner, Julia Footh, Kolding Rasmussen, Meg Hall and Cora Deininger.
- **Program support advisor** for the Thermofly 2022 Summer Undergraduate Research Experience
- **Member** of the QuEST Evolutionary Genomics Interest Group Network
- **Demonstrator** at the Southampton Science and Engineering Day - evolutionary biology/fossils booth
- **Member** of the Darwin Journal Club at the University of Southampton
- **Current and Past Memberships** of the following societies: Society for the Study of Evolution (SSE), Society for Molecular Biology and Evolution (SMBE), EchinoClub, Genetics Society of America

Extra-curricular activities

Rock climbing, hiking, geocaching

References

Name: Dr. Melissa Pespeni
Position: Associate Professor
Institution: University of Vermont
Email Address: Melissa.Pespeni@uvm.edu
Reference Description: PhD advisor 2019 - 2025

Name: Dr. Daniel Weinreich
Position: Professor
Institution: Brown University
Email Address: Daniel_Weinreich@brown.edu
Reference Description: PhD committee member and collaborator since 2019

Name: Dr. Nick Cheney
Position: Associate Professor
Institution: University of Vermont
Email Address: ncheney@uvm.edu
Reference Description: PhD committee member and collaborator since 2021