Seokhwan Moon

Curriculum Vitae

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Education

B.S. **Pohang University of Science and Technology (POSTECH)**, Mathematics — Feb 2019 – Present, Pohang, ROK

- GPA: 3.93/4.30 (Expected to graduate in Feb 2025 with *Summa Cum Laude*)
- Absence due to mandatory military service (Feb 2021 – Nov 2022)
- Senior Thesis : "Exponential ergodicity of one-dimensional stochastic reaction networks", advised by Jinsu Kim. Link

University of Illinois, Urbana-Champaign (UIUC), Mathematics — Jan 2024 – May 2024, Urbana, USA

- Exchange student with approximately $5,000 funding from POSTECH

H.S. **Gwangju Science Academy for the Gifted** — Mar 2016 – Feb 2019, Gwangju, ROK

- High school for the gifted in mathematics and science

Research Interest

Mathematical Interest : Mathematical biology, Probability and Stochastic Process, Evolutionary Game Theory

Biological Interest : Systems Biology, Evolutionary Dynamics, Pattern Formation

Publications/Preprints

† : (co-) first author (for interdisciplinary journals), * : (co-) corresponding author

1. Hyukpyo Hong†, **Seokhwan Moon**†, Yuji Hirono†, and Jae Kyoung Kim*. Topological criterion for robust perfect adaptation of reaction fluxes in biological networks. Under review in *Cell Systems*. Link
2. **Seokhwan Moon**, Chenning Xu, Tianyong Yao, and Daniel Cooney*. Agent-Based and PDE Models for Evolutionary Games with Payoff-Driven Motion. *In preparation*.
3. Dongju Lim†, **Seokhwan Moon**†, Yun Min Song, Jinsu Kim*, and Jae Kyoung Kim*. Variance controller for biochemical reaction networks . *In preparation*.

Research Experience

Exponential ergodicity for 1D stochastic reaction networks [Senior Thesis] — Dec 2023 – Ongoing

- Co-worked with Minjoon Kim and Prof. Jinsu Kim.
- Provied that ergodic one-dimensional stochastic reaction network is always exponential ergodic.
- Studied about the exponential ergodicity of continuous-time Markov chains, mixing time of Markov chains.

Noise controller for stochastic reaction networks [Paper 3] — Sep 2023 – Ongoing

- Co-work with Dongju Lim, Yun Min Song, Prof. Jinsu Kim, and Jae Kyoung Kim.
- Worked as an undergraduate research intern in the Biomedical Mathematics Group, Institute for Basic Science.
- Proposed a noise controller which controls the mean and variance of stationary distribution.
- Studied about the ergodicity and stationary distribution of continuous-time Markov chains, and constructing a Lyapunov function.

Spatial Models of Evolutionary Dynamics [Paper 2] Jan 2024 – Sep 2024

- Co-worked with Prof. Daniel Cooney as an undergraduate research scholar in Illinois Mathematics Lab.
- Formulated a PDE model describing the evolutionary game with spatial dynamics, and analyze spatial patterns.
- Studied evolutionary dynamics, game theory, partial differential equations, and linear/nonlinear stability analysis.

Robust perfect adaptation of reaction fluxes [Paper 1] Jun 2023 – Nov 2023

- Co-worked with Hyukpyo Hong, Prof. Yuji Hirono, and Prof. Jae Kyoung Kim.
- Worked as an undergraduate research intern in the Biomedical Mathematics Group, Institute for Basic Science.
- Identified the structural conditions for the robust perfect adaptation (RPA) of fluxes, and found its biological examples.
- Studied RPA, reaction networks, and how to apply mathematics to biology.

Moment closure method for stochastic reaction networks Jan 2023 – Sep 2023

- Advised by Prof. Jinsu Kim.
- Applied various moment closure approximation to stochastic reaction networks.
- Studied chemical reaction network theory, moment closure approximation, and stationary distribution of reaction network.
- Notes for this project is available here.

Presentations

Contributed Talk

Exponential ergodicity of stochastic chemical reaction networks with a single species Jul 2024
2024 Society for Mathematical Biology Annual Meeting, Seoul, ROK

Poster presentation

Topological criterion for robust perfect adaptation of reaction fluxes in biological networks Jun 2024
2024 SMB Satellite Workshop : Recent Advances in Methods for Biomedical Mathematics, Daejeon, ROK

Spatial models of evolutionary dynamics Apr 2024
2024 UIUC Undergraduate Research Symposium, Urbana, USA

Robust perfect adaption of reaction fluxes ensured by network topology Aug 2023
ICIAM 2023 Satellite Workshop : Stochastic Modeling and Data Analysis for Biological Systems, Daejeon, ROK

Seminars

Journal Club for stochastic analysis of biochemical systems, POSTECH Oct 2024
Lestas, Ioannis, Glenn Vinnicombe, and Johan Paulsson. "Fundamental limits on the suppression of molecular fluctuations." Nature 467.7312 (2010): 174-178.

Reading Group on PDE Models in Mathematical Biology, UIUC Apr 2024
Woolley, Thomas E. "Boundary conditions cause different generic bifurcation structures in Turing systems." Bulletin of Mathematical Biology 84.9 (2022): 101.

Reading Group on PDE Models in Mathematical Biology, UIUC Feb 2024
Hillen, Thomas, and Kevin J. Painter. "A user's guide to PDE models for chemotaxis." Journal of Mathematical Biology 58.1-2 (2009): 183-217.

Journal Club for stochastic analysis of biochemical systems, POSTECH — Nov 2023
Briat, Corentin, Ankit Gupta, and Mustafa Khammash. "Antithetic proportional-integral feedback for reduced variance and improved control performance of stochastic reaction networks." Journal of The Royal Society Interface 15.143 (2018)

Journal Club, IBS Biomedical Mathematics Group — Aug 2023
Ankit Gupta, and Mustafa Khammash. "The Internal Model Principle for Biomolecular Control Theory", IEEE Open Journal of Control Systems 2 (2023): 63-69

POSTECH SIAM Student Chapter, POSTECH — May 2023
What is the chemical master equation, and how to solve it?

Journal Club for stochastic analysis of biochemical systems, POSTECH — Mar 2023
Lee, Chang Hyeong, Kyeong-Hun Kim, and Pilwon Kim. "A moment closure method for stochastic reaction networks." The Journal of Chemical Physics 130.13 (2009)

Scholarships/Awards

Dean's List, POSTECH Mathematics (Top 3% in the department) — Fall 2023, Spring 2023

National Science & Engineering Scholarship, Korea Student Aid Foundtaion (Full Tuition) — 2023 – 2024

Jigok Scholarship, POSTECH (Full Tuition) — 2019 – 2020

Teaching/Mentoring

Student Mentoring Program, POSTECH Mathematics — Fall 2023, Spring 2020
Tutor for MATH203 *Applied Linear Algebra*

Student Advisor, POSTECH Mueunjae School of Undergraduate studies — Fall 2023, Spring 2023
Teaching Assistant for MSUS102, MSUS103 *Future Planning for College Life I, II*

Educational Outreach Organization, POSTECH — Fall 2023, Spring 2023, Fall 2019
Visited local children's center weekly to teach mathematics and science

1st Pohang Academy of AI and Mathematics, POSTECH Mathematical Institute for Data Science — Jan 2021 – Feb 2021
Teaching Assistant for the practice section using Python

2019 Summer Educational Outreach Science Camp, POSTECH — Jul 2019 – Aug 2019
Invited middle school students to campus, taught scientific program, and lead the students

Conferences attended

Workshop on chemical reaction network theory: satellite workshop of SMB 2024 — Jul 2024
Pohang, ROK

2023 KSIAM (Korean Society for Industrial and Applied Mathematics) Annual Meeting — Nov 2024
Gwangju, ROK

The 8th CIJK Conference on Mathematical and Theoretical Biology — Jun 2023
Jeju, ROK

2023 KSIAM-NIMS School on Biomathematics : Statistical Tools for Mathematical Modeling — Jun 2023
Jeju, ROK

2023 KMS (Korean Mathematical Society) Spring Meeting — Apr 2023
Daejeon, ROK

Extracurricular Activities

Educational Outreach Organization Jul 2019 – Ongoing

- Helped local student of grade 5-9 studying mathematics and science
- Provided class, helped homework and provided counseling

Signal Intelligence Soldier at ROK Defense Security Agency Feb 2021 – Nov 2022

- Mandatory military service in the Republic of Korea
- Worked with US Air Force 303rd Intelligence Squadron at the OSAN Air Base

POSTECH Baseball Club (Tachyons) Spring 2019 – Fall 2023

- Played as a 1st and 3rd Basemen
- Played as a POSTECH representative player in official events

POSTECH Freshmen Student Council Fall 2019 – Spring 2020

- Worked as a member of the Design force

Skills/Languages

Korean, English, C, Python, Matlab, LaTeX, Julia, Mathematica, Adobe Illustrator & Photoshop

References

Prof. Jinsu Kim, jinsukim@postech.ac.kr

- *Assistant Professor* at Department of Mathematics, POSTECH

Prof. Jae Kyoung Kim, jaekkim@kaist.ac.kr

- *Associate Professor* at Department of Mathematical Sciences, KAIST.
- *Chief Investigator* at BIomedical MAthematics Group (BIMAG), Center for Mathematical and Computational Sciences, Institute for Basic Sciences (IBS)

Prof. Daniel Cooney, dbcoone2@illinois.edu

- *Assistant Professor* at Department of Mathematics, University of Illinois, Urbana-Champaign