Jineon Baek

"When we invented the personal computer, we created a new kind of bicycle. . . a new man-machine partnership. . . a new generation of entrepreneurs." - Steve Jobs

Education

2016–2017 **Ph.D., Mathematics**, *University of Michigan*, *Ann Arbor, MI*
2021–present Leave of Absence from June 2017 to July 2021 due to military service and pandemic.
2012–2016 **B.S., Mathematics**, *POSTECH*, *Pohang, Korea*

Skills

I collaborate with computers on a cognitive level to solve challenges in academia and industry.

Mathematics

Algorithms, Combinatorics, Discrete Geometry, Experimental Mathematics

Computer Science

Fields Artifical Intelligence, Data Analysis, Neural Networks, Formal Proofs
Languages C++, Python, Mathematica (Working/Proficient), Haskell, Scala, Lean (Novice)
Tools Pandas, NumPy, PyTorch, Google OR-Tools, SAT Solvers (Kissat/CaDiCaL), CGAL

Research

Present **A computer-assisted resolution of the moving sofa problem**, *Ongoing*
- Resolution of the decades-old moving sofa problem with computer assistance.
- The proof incorporates techniques from both:
  - Mathematics: Convex Geometry, Analysis, Convex Optimization.
  - Computer Science: Branch-and-bound, Quadratic Programming, Parallelization.

2022 **On the Erdős-Tuza-Valtr Conjeture**, *Preprint*
- Proved a new case of a generalization of the Erdős-Szekeres conjecture in combinatorics.
- Incorporated *Google OR-tools*, a combinatorial optimization solver, intensively to find the right definitions to use and theorems to prove.
- The result is formally verified with *Lean 3*.

2019 **Unpaired image denoising using a GAN in X-ray CT**, *IEEE Access*
(with H. Park)

2019 **Johnson's bijections and their application to counting simultaneous core partitions**, *European Journal of Combinatorics*
(with H. Nam and M. Yu)

2018 **A bijective proof of Amdeberhan's conjecture on the number of (s, s + 2)-core partitions with distinct parts**, *Discrete Mathematics*
(with H. Nam and M. Yu)
- Used *Mathematica* sessions and the *OEIS* database to find the right proof strategy.

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Experience

Military Service

I gained industrial experiences in artificial intelligence, data analysis and software development during my military service from June 2017 to July 2021 in Korea

Aug 2019 –Jul 2021 **Riiid! Inc.**, *AI Research Scientist*, *Seoul, Korea*

- Organized an AAAI'21 workshop on Artificial Intelligence in Education and a paired Kaggle challenge on student performance prediction.
- Collaboratively developed and deployed a student performance prediction model serving more than 3 million users worldwide.
- Sped up inference of a prediction Transformer model by a factor of ∼100 by algorithmically optimizing tensor calculations.
- Improved the performance of a Transformer prediction model with a classical model, and showed rigorously that it satisfies a desirable property for interactive education.

Jun 2017 –Jul 2019 **National Institute for Mathematical Sciences**, *Research Scientist*, *Daejeon, Korea*

- Proposed a GAN framework that improves the quality of medical CT images.
- Unlike previous models that require paired low-quality/high-quality image database, the model is able to learn from unpaired low-quality/high-quality image database, making it trainable from actual medical dataset.

Teaching

2016–2017 2021–present **University of Michigan**, *Graduate Student Instructor*, *Ann Arbor, MI*

- Math 105 (Precalculus), 115 (Calculus I), 116 (Calculus II) and 216 (Differential Equations)

Freelance

Jun 2017 –present **Donga Science**, *Freelancer*, *Seoul, Korea*

- Proposing monthly challenging math problems to *Mathematics Donga*, a Korean math magazine for teenagers.
- A problem is designed to be not solved by anyone within two weeks to encourage collaboration and discussion of talented students.

Jul 2022 –Aug 2022 **Cryptolab Inc.**, *Research Engineer*, *Seoul, Korea*

- Homomorphic encryption of matrix operations and ONNX neural network models.

Dec 2020 –Feb 2021 **Team Samoyed**, *Freelancer*, *Seoul, Korea*

- Developed an enemy AI for *Teamfight Managers*, an e-sports team simulation game.
- Designed neural networks with a custom combinatorial loss function suited for many-to-many combat situations.
- Users reported a steep increase in difficulty, making the game even challenging to most experienced players.