Seungwan **Hong**

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Experience

New York Genome Center — *NY, United States*

Postdoctoral Research Associate — *Mar 2022 - Present*

- At G²Lab, I lead research on privacy-preserving methods for analyzing genomic data using homomorphic encryption, with a joint appointment at Columbia University.

Columbia University — *NY, United States*

Postdoctoral Research Fellow — *Mar 2022 - Present*

Education

Seoul National University — *Seoul, South Korea*

Integrated M.S./Ph.D. in Mathematical Sciences — *Sep. 2016 - Feb. 2022*

- Thesis: Approximation of Multivariate Functions and Homomorphic Data Ordering
- Advisor: Jung Hee Cheon

Seoul National University — *Seoul, South Korea*

B.S. in Mathematical Sciences — *Mar. 2010 - Aug. 2016*

- Honors: *Cum Laude (Major GPA: 3.92/4.3)*

Research Interests

Fully Homomorphic Encryption (FHE)

- Algorithmic optimization of FHE schemes
- Development of algorithms enabling non-arithmetic operations with FHE

Privacy-Preserving Machine Learning (ML) Using FHE

- Adapting ML algorithms to FHE-compatible formats
- Polynomial approximation techniques for privacy-preserving ML applications

Privacy in Genomic Data

- Designing privacy-preserving methodologies for genomic data analysis
- FHE-based frameworks for secure transformation of conventional genomic applications

Functional Encryption

- Developing functional encryption schemes with enhanced efficiency and functionality

Publications

- An asterisk (*) indicates co-first authors and a hash (#) indicates co-corresponding authors.
- A dagger (†) indicates authors listed in alphabetical order, with all authors contributing equally. For more information, see [AMS Statement].

Journal

Ultra-Secure Storage and Analysis of Genetic Data for the Advancement of Precision Medicine
Jacob Blindenbach*, Jiayi Kang*, **Seungwan Hong***#, Caline Karam, Thomas Lehner, and Gamze Grsoy#
Genome Biology (to be published, 2024)

Privacy-preserving model evaluation for logistic and linear regression using homomorphically encrypted genotype data
Seungwan Hong, Yoolim A. Choi, Daniel S. Joo, and Gamze Grsoy
Journal of Biomedical Informatics (2024)

Secure Tumor Classification by Shallow Neural Network Using Homomorphic Encryption
Seungwan Hong, Jai Hyun Park, Wonhee Cho, Hyeongmin Choe, and Jung Hee Cheon
BMC Medical Genomics (2022)

Ultra-Fast Homomorphic Encryption Models Enable Secure Outsourcing of Genotype Imputation
Miran Kim*, Arif Harmanci*, Jean-Philippe Bossuat, Sergiu Carpov, Jung Hee Cheon, Ilaria Chillotti, Wonhee Cho, David Froelicher, Nicolas Gama, Mariya Georgieva, **Seungwan Hong**, Jean-Pierre Hubaux, Duhyeong Kim, Kristin Lauter, Yiping Ma, Lucila Ohno-Machado, Heidi Sofia, Yongha Son, Yongsoo Song, Juan Troncoso-Pastoriza, and Xiaoqian Jiang
Cell Systems (2021)

Efficient Sorting of Homomorphic Encrypted Data with k-way Sorting Network
Seungwan Hong, Seunghong Kim, Jiheon Choi, Younho Lee, and Jung Hee Cheon
IEEE Transactions on Information Forensics and Security (2021)

Privacy-preserving Approximate GWAS Computation Based on Homomorphic Encryption
Duhyeong Kim, Yongha Son, Dongwoo Kim, Andrey Kim, **Seungwan Hong**, and Jung Hee Cheon
BMC Medical Genomics (2020)

A Hybrid of Dual and Meet-in-the-Middle Attack on Sparse and Ternary Secret LWE
† Jung Hee Cheon, Minki Hhan, **Seungwan Hong**, and Yongha Son
IEEE Access (2019)

A Secure SNP Panel Scheme Using Homomorphically Encrypted K-mers Without SNP Calling on the User Side
Sungjoon Park, Minsu Kim, Seokjun Seo, **Seungwan Hong**, Kyoohyung Han, Keewoo Lee, Jung Hee Cheon, and Sun Kim
BMC Genomics (2019)

Conference

Logistic Regression on Homomorphic Encrypted Data at Scale
Kyoohyung Han, **Seungwan Hong**, Jung Hee Cheon, and Daejun Park
Innovative Applications of Artificial Intelligence (IAAI) (2019)

Preprint

Secure and scalable gene expression quantification with pQuant
*Seungwan Hong**, Conor R. Walker*, Annie Y. Choi, Gamze Gürsoy
under review (2024)

Fully Encrypted Machine Learning Protocol using Functional Encryption
† **Seungwan Hong**, Jiseung Kim, Changmin Lee, and Minhye Seo
under review (2024)

Remark on the Security of CKKS Scheme in Practice
† Jung Hee Cheon, **Seungwan Hong**, and Duhyeong Kim
IACR Cryptol. ePrint Arch. (2020)

Honors & Awards

International

Dec. 2020	**First Winner**, HE track - iDASH Competition 2020	*NIH, United States*
Oct. 2019	**Second Winner**, HE track - iDASH Competition 2019	*NIH, United States*

Domestic

Nov. 2019	**Excellent Award ($1,500)**, Korea Cryptography Contest	*KIISC, South Korea*
Sep. 2017	**Awards for Excellence in Teaching**, Teaching Awards: Differential and Integral Calculus	*SNU, South Korea*
Nov. 2015	**Bronze Medal**, University Students Contest for Mathematics	*KMS, South Korea*

Presentations

International

RECOMB 2024 — *MA, United States*
Poster: Ultra-Secure Storage and Analysis of Genetic Data for the Advancement of Precision Medicine — *Apr. 2024*

IDASH Privacy & Security Workshop — *Online*
Talk: Winning Teams' presentation (link) — *Dec. 2020*

Domestic

Korea Institute for Advanced Study (KIAS) — *Seoul, South Korea*
Talk: Introduction to Neural Networks: Theory and Implementation — *Oct. 2023*

Hanyang University — *Seoul, South Korea*
Talk: Homomorphic Encryption and Applications — *Apr. 2023*

Samsung SDS — *Online*
Talk: Private AI and Homomorphic Encryption — *Aug. 2021*

National Tax Service *Sejong, South Korea*

Basics of Homomorphic Encryption *Jul. 2020*

Teaching

- Seoul National University (SNU), Columbia University (CU)

Lecture

CLASS-NAME · CU *2023*

Honor Calculus Practice · SNU *2019*

Differential and Integral Calculus Practice · SNU *2016, 2017, 2018*

Teaching Assistant

Compuatational Number Theory · SNU *2018, 2020*

Introduction to Cryptography · SNU *2019*

Linear Algebra · SNU *2018*

Students Supervised

Daniel Joo · Undergraduate student from CU *2022*

- Project: privacy-preserving neural network evaluation using homomorphic encryption

Other Scientific Activities

Committees

Nov. 2024 **Program Committee,** Genopri *CA, United States*

Reviewer / External Reviewer for

- ACM Transactions on Privacy and Security, IEEE Transactions on Information Forensics and Security, IEEE Transactions on Emerging Topics in Computing, Journal of Supercomputing, IEEE Access
- EUROCRYPT, ASIACRYPT, Public Key Cryptography
- BMC medical Genomics

Extracurricular Activities

NCSOFT *Sungnam, South Korea*

Game AI Development Internship *Jun. 2017 - Aug. 2017*

- Developed and tested AI algorithms to improve PVE matches

Relublic of Korea Army *South Korea*

Surgent *Jan. 2013 - Oct. 2014*

Skills

Programming	Python, Bash, C++, rust, go, LaTeX
Python Libraries	Numpy, Keras, Tensorflow, PyTorch, pandas, matplotlib, seaborn
C++ Libraries	NTL, GMP, Eigen
HE Libraries	HEAAN, SEAL, OpenFHE, Lattigo
Coding practices	Git, Snakemake, Docker, Vim, Slurm
Operating Systems	Linux, MacOS
Languages	Korean, English