CURRICULUM VITAE

WOONG KOOK

September 2021

Professor
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EDUCATION

Ph.D. Mathematics, **Stanford University**, Stanford, CA January 1997
- Advisor: Prof. Gunnar E. Carlsson
- Thesis title: *Categories of acyclic graphs and automorphisms of free groups*

M.A. Mathematics, **Stanford University**, Stanford, CA September 1993

B.A. Mathematics, **Princeton University**, Princeton, NJ: *Magna cum laude* June 1991
- Senior thesis title: *Chern classes of symmetric groups* (advisor: Prof. Gunnar E. Carlsson)

Phillips Exeter Academy, Exeter, NH: *Magna cum laude* June 1987

EMPLOYMENT

Seoul National University, Seoul Korea Sept. 2013-present
Department of Mathematical Sciences: Professor
Institute for Mathematical Data Analytics Research Center: Vice Director June 2017-present

University of Rhode Island, Kingston, RI July 2000 – June 2013
Department of Mathematics: Associate Professor (with tenure since July 2007)
- Member of University Faculty Senate (2006 – 2009, 2012-present)
- Director of Graduate Program in Mathematics since July 2008

George Washington University, Washington, DC August 1998 - June 2000
Department of Mathematics: Visiting Assistant Professor

University of Minnesota, Minneapolis, MN Sept. 1996 - July 1998
School of Mathematics: Visiting Assistant Professor

Interval Research Corp., Palo Alto, CA Aug.- Sept. 1996
Data Compression Group: Summer Postdoctoral Fellow (The Interval Research Corporation was a think tank/ computer R & D firm founded by Paul Allen, a co-founder of Microsoft.)

Stanford University, Stanford, CA Sept.1991 - Aug. 1996
Department of Mathematics: Teaching and Research Assistant in Mathematics

VISITING POSITIONS

Seoul National University, Seoul Korea Jan. 3-Jan. 17, 2012
Department of Mathematical Sciences: Visiting Scholar

Seoul National University, Seoul Korea Jan. 5-Jan. 14, 2011
Department of Mathematical Sciences: Visiting Scholar

Seoul National University, Seoul, Korea Feb.-July 2010
Department of Mathematical Sciences: Visiting Associate Professor (초빙 부교수)

COMMITTEE ACTIVITIES

SNU Dept. of Mathematical Sciences, Chair (2019 Dec.- present)
National Inst. of Math Sciences: member of board of directors (2019 March - present)
INFINITT Healthcare Co., Ltd.: outside director (2021 April ~ 2024 March)
Korean Math Soc.: committee member of Division of Topology (2018 Jan. – 2020. Dec.)
Korean Math Soc.: committee member of Division of Algebra (2015 March – 2018 Feb.)

RESEARCH INTERESTS

Combinatorics: homology of matroids, combinatorial Laplace operators, harmonic space
Algebraic Topology: group cohomology, homological algebra
Commutative Algebra: face ring of simplicial complexes
Network and Data Sciences: simplicial networks, topological data analysis

PUBLICATIONS

Refereed Papers and Proceedings

1. *Categories of acyclic graphs and automorphisms of free groups,*
   Ph.D. Thesis, Stanford University (1997)

2. *A convolution formula for the Tutte polynomial* (coauthors: V. Reiner and D.Stanton),
   Journal of Combinatorial Theory, Series B 76, 297-300 (1999)

3. *Combinatorial Laplacians of matroid complexes* (coauthors: V. Reiner and D. Stanton),
   Journal of the American Mathematical Society 13, No. 1, 129-148 (2000)

4. *Recurrence relations for the spectrum polynomial of a matroid*,
   Discrete Applied Mathematics 143 (2003) 312-317

5. *A formula for an evaluation of the Tutte polynomial of a matroid*,
   Discrete Mathematics 300 (2005) 235-238

6. *On the product of log-concave polynomials*,
   Integers: The Electronic Journal of Combinatorial Number Theory 6 (2006), #A40

7. *The homology of the cycle matroid of a coned graph*,
   European Journal of Combinatorics, Volume 28, Issue 3 (2007) 734-741

8. *Edge-rooted forests and α-invariant of cone graphs*,
   Discrete Applied Mathematics, Volume 155, Issue 8, (2007) 1071-1075

9. *Knowledge Transfer in a Multiple Virtual Communities Network* (coauthor: S. Shin)
   Hawaii International Conference on System Sciences, Proceedings, 5-8 Jan. 2010,
   IEEE Computer Society 2010 (ISBN 978-0-7695-3869-3)

10. *Combinatorial Green's function of a graph and applications to networks*,
    Advances in Applied Mathematics, Volume 46 (Jan. 2011) 417-423
    (Special issue in honour of Dennis Stanton's 60th birthday)
    doi:10.1016/j.aam.2010.10.006

11. *The h-vector of coned graphs,*
    Applied Mathematics Letters, Volume 24, Issue 4 (April 2011) 528-532
    doi: 10.1016/j.aml.2010.11.007

12. *Multicomplex of partially edge-rooted forests*,
European Journal of Combinatorics 33 (May 2012) 505-509
doi: 10.1016/j.ejc.2011.11.006

13. *Can knowledge be more accessible in a virtual network?: Collective dynamics of knowledge transfer in a virtual knowledge organization network* (coauthor: S. Shin),
Decision Support Systems (March 2014),

14. *Logarithmic tree-numbers for acyclic complexes* (co-author: H. Kim),
Electronic Journal of Combinatorics 21(1) #P1.50 (March 10, 2014),

15. *Weighted tree numbers of matroid complexes* (co-author: K. Lee),
Discrete Mathematics and Theoretical Computer Science Proceedings FPSAC' (2015) 709-720

16. A formula for *simplicial tree-numbers of matroid complexes*, (co-author: K. Lee)
European Journal of Combinatorics, Volume 53 (April 2016) 59-65
doi:10.1016/j/ejc.2015.11.001

17. *Path-Intersection matrices and applications to networks*, (co-authors: D. Kho et al.)
Linear Algebra and its Applications 524 (July 2017) 278-292

18. *Harmonic cycles for graphs*, (co-author: Y. Kim)
Linear and Multilinear Algebra (online February 2018)
https://doi.org/10.1080/03081087.2018.1440519

19. *Möbius coinvariants and bipartite edge-rooted forests* (co-author: K. Lee)
European Journal of Combinatorics, Volume 71 C (June 2018) 180-193

20. *A weighted cellular matrix-tree theorem, with applications to complete colorful and cubical complexes* (co-authors: G. Aalipour, A. Duval, K. Lee, J. Martin)
Journal of Combinatorial Theory, Series A, Volume 158 (August 2018) 362-386

21. *Simplicial networks and effective resistance* (co-author: K. Lee)
Advances in Applied Mathematics, Volume 100 (September 2018) 71-86

22. *Topological data analysis can extract subgroups with high rates of Type 2 diabetes*
(co-authors: H. Kim, C. Yi, Y. Kim, U. Park, B. Oh, H. Kim, T. Park)
International Journal of Data Mining and Bioinformatics 22(1):61-74 (April 2019)

23. *High dimensional networks and spanning forests* (co-author: K. Lee)
Topology and its Applications: Proceedings of the Second Pan-Pacific International Conference on Topology and Applications 264 (September 2019) 105-114. (accepted: 8 January 2019)

24. *Investigation of Flash Crash via Topological Data Analysis*
(co-authors: W. Kim, Y. Kim, G. Lee)
Topology and Its Applications: Proceedings of the 3rd Pan-Pacific International Conference on Topology and Applications (available online Dec. 15, 2020)

25. *Tumor spread through air spaces (STAS): prognostic significance of grading in non-small cell lung cancer* (co-authors: J. Jung et al.)
Modern Pathology 34 (published November 2020; appeared March 2021) 549-561

26. *Topological Data Analysis of Coronary Plaques Demonstrates the Natural History of Coronary Atherosclerosis* (co-authors: D. Hwang, H. Kijm, S. Lee, S. Lim et al.)
JACC: Cardiovascular Imaging (available online 13 January 2021)

27. *Effects of catastrophic financial loss on suicide risk: Evidence from Korean stock market crash in October 2008* (co-authors: W. Kim, H. Park, J. Park)
Social Psychiatry and Psychiatric Epidemiology (available online 26 May 2021)

28. *Predicting survival in heart failure: a risk score based on machine-learning and change point algorithm* (co-authors: W. Kim, J. Park, D. Choi)
Clinical Research in Cardiology (published online on 14 July 2021)

29. *Kirchhoff index of simplicial networks* (co-authors: K. Lee)
Linear Algebra and Its Applications 626 (1 October 2021) 1- 19

Submitted Manuscripts

Origin based target bisection to reduce COVID-19 risk in public transportation system (co-authors: W. Kim, B. So) submitted

A clustering using Gaussian Mixture Model for SNP (co-authors: C. Yi, H. Kim, S. Yu, W. Kim) submitted

Preprints

Weighted Laplacians and weighted tree numbers of matroid complexes (co-author: K. Lee) preprint

Cycle intersection matrix, (co-author: C. Phifer) preprint

Monotonicity of complete graphs and symmetric complete bipartite graphs, preprint

Books and Book Chapters

1. "Implications of Electronic Marketplaces in Vertical Market: The case of Korea Fishery Industry"
Authors: Seung Kyoon Shin, Woong Kook, Jong Ho Kang, Hong Suk Jang,
Published by Korea Maritime Institute, and funded by Korea-America Joint Research Center at URI, 2008 (ISBN: 978-89-7998-371-5).

2. A chapter in "Empirical Investigation of The Effects of Korea-EU FTA on Domestic Port Transportation: Network Modeling Approach"
Authors: H.H. Kim, I.Y. Choi, S.H. Park, J.Y. Kim, Seung Kyoon Shin, Woong Kook,
Korean Ministry of Land, Transportation, and Marine Affairs, 2009.

List of Entries in On-Line Encyclopedia of Integer Sequences

A057817: Rank of homology groups for cycle matroid complex for K_n (Feb. 2002).
A072962: Mobius coinvariant for complete bipartite graphs (coauthor: L. Thoma) (May 2002).
A083483: Forests with two components for complete graphs (June 2003).
A071720: Spanning trees in the graph $K_n \setminus e$ (coauthors: N. Eaton and L. Thoma) (Jan. 2004).
A089104: Spanning trees in the graph K_n / e (coauthors: N. Eaton and L. Thoma) (Jan. 2004).
A000918: Edge-rooted forests in a cycle of length n (Sept. 2004).
A100070: Forests with two components in the complete bipartite graph $K_{n,n}$ (Nov. 2004).
A109808: Value of Tutte dichromatic polynomial $T_G(0,1)$ for $G=P_2 \times P_n$ ($n>1$) (Aug. 2005).
A002817: Coefficient of x^{n-3} in the shelling polynomial for the cycle matroid of K_n (Nov. 2006).
A006235: Complexity of Doubled Cycles (Jan. 2009)

RECENT PRESENTATIONS

(* represent invited talks.)

Mathematics Department Seminar*, May 14, 2021, Sungshin Women's University
"Topological Data Analysis and Beyond"

Differential Geometry Seminar* (online), February 24, 2021, Jeju National University
"Mathematics for Artificial Intelligence"

KBRI-KMS-KIAS Workshop*(online), December 21, 2020, KMS
"Simplicial Networks and Harmonic Intelligence"

Symposium for AI and University Level Mathematics II* (online), December 17, 2020, KMS
"University AI Mathematics"

NUBISON Partner's Day & Seminar*, October 15, 2020, SimPlatform, Seoul, Korea
"Mathematics for Industrial AI"

KIAS Workshop on Combinatorial Problems of Algebraic Origin*, July 14-15, 2020
"Tree numbers of rank selected posets" (presented on July 15)

2020 KMS Spring Meeting* (online), 03 July 2020
(Focus Session: Mathematics Education in University:AI)
"Mathematical experiments for deeper learning"

XAIENCE 2019*, Seoul National University, 8 November 2019
"Harmonic data analysis for shape and centrality"

Mathematics Department Colloquium*, Soongsil University, 7 November 2019
"Topological combinatorics and simplicial networks"

Heart Failure Seoul 2019*, Grand Intercontinental Parnas, Seoul, 21 September 2019
The 41st Scientific Conference of the Korean Society of Heart Failure,
"Topological classification of heart failure"

ICIAM 2019*, Valencia, Spain, 16 July 2019
The 9th International Congress on Industrial and Applied Mathematics
(Topological Data Analysis and deep learning: theory and signal applications-Part 3)
"Combinatorial Hodge theory and simplicial networks"

Tutorial Seminar on Topological Data Analysis and Beyond*, Busan, 14 June 2019
"Effective conductance and network decentralization"

International Conference on Matrix Theory with Applications 2019*,
Jeju National University, 24 May 2019
"Harmonic cycles and network decentralization"

2019 KMS Spring Meeting*, Kangwon National University, 20 April 2019
"Combinatorial Perspectives on decentralization"

Mathematics Department Colloquium*, UNIST, Ulsan, 4 April 2019
"Combinatorial Laplacians and Data Analysis"

초청강연*, 제주대학교 수학과, 8 November 2018
"Mathematical data science"

Mathematics Department Colloquium*, Sogang University, 1 November 2018
"Topological combinatorics and data science"

서울대학교 의료빅데이터 연구센터 개소기념 심포지엄 초청강연*
Seoul National University Hospital, 7 September 2018
"위상수학과 조합론에 기반한 데이터 과학"

아주 데이터 사이언스 포럼: 기조강연*
Ajou Universiy, 25 May 2018
"A topological perspective on decentralization"

Conference on Math to Industry: Tutorial Session
Seoul National University, 17 May 2018
"Combinatorial Hodge theory"

Gauss Colloquium* IMDARC, Seoul National University, 27 April 2018
"Topological combinatorics for data analysis"
2018 KMS Spring Meeting, Invited Lecture in Topology*
Kyung Hee University, Seoul, 21 April 2018
"Harmonic cycles and applications to simplicial networks"

2017 Dasan Conference: Mathematical Challenges and Industrial Problem Solving*
Busan, Korea, 1-2 December 2017 (**Program Committee**)
Discussion session (**chair**): Mathematical challenges from industry

Mathematics Concert*
Sungkyunkwan University, Suwon, Korea, 28 November 2017
"Mathematical data analysis for decision making"

The 2nd Pan Pacific International Conference on Topology and Applications: Plenary Talk*
Busan, Korea, 13-17 November 2017, (16 Nov. 2017)
"Simplicial networks and data analysis"

2017 년 제 6 회 Big Data Seminar*
서울대학교병원 의생명연구원 임상의과학정보실, 1 November 2017
"위상수학과 조합론을 이용한 데이터 분석"

AMS Fall Sectional Meeting*
University of St. Thomas, Minneapolis, MN, U.S.A, 29 October 2016
"High-Dimensional Effective Resistance"

SKKU-NIMS Summer School in Data Analysis*
Jeju National University, June 29, 2016
"Information Centrality and Harmonic Classes"

KIAS Combinatorics Workshop Series*
Korea Institute for Advanced Study, Seoul, Korea, June 3, 2016
"Combinatorics of harmonic classes"

Colloquium*, NIMS, May 12, 2016
"Simplicial harmonic classes"

Mathematics Department Seminar*, The Catholic University of Korea, April 22&29, 2016
"Harmonic classes for data analysis 1 & 2

Mathematics Department Colloquium*, Yonsei University, Nov. 19, 2015
"Homological Methods in Combinatorics"

2015 Combinatorics Workshop*, CAMP, NIMS, July 13-16, 2015
"Logarithmic tree numbers for acyclic complex (matroid complexes)"

FPSAC 2015 (Formal Power Series and Algebraic Combinatorics), KAIST, July 6-10, 2015
"Weighted Tree-Numbers of Matroid Complexes"

2014 Combinatorics Workshop*, Ajou University, October 31-November 1
"Topological invariants and tree numbers of matroid complexes"

Mathematics Education Department Colloquium*, Seoul National University, Oct 21, 2014
"Spanning trees and applications to networks"

International Linear Algebra Society*, CMS7. Generalized Laplacian and Green matrices, Seoul, Korea, August 6-9, 2014
"Applications of combinatorial Laplacians"

Math Department Colloquium*, Sungkyunkwan University, June 5, 2014
"Applications of combinatorial Laplacians"

Math Department Colloquium*, Ewha University, May 15, 2014
"Enumeration of tree numbers and applications to networks"

Discrete Math Seminar*, KAIST, May 8, 2014
"Combinatorial Laplacians and high-dimensional tree numbers"

Math Department Colloquium*, Ajou University, April 4, 2014
"Combinatorial Laplacians and high-dimensional tree numbers"

KIAS Combinatorics Workshop Series*
Korea Institute for Advanced Study, Seoul, Korea, November 8, 2013
"Simplicial Tree Numbers for Matroid Complexes"
Math Department Colloquium*, Seoul National University, October 10, 2013
"Combinatorial Laplacians on Acyclic Complexes"

International Linear Algebra Society*, Graphs and Matrices, Providence, June 4, 2013
"Logarithmic tree-numbers for acyclic complexes"

Open Lecture*, Seoul National University, November 27, 2012
"Topics in Topological Combinatorics"

Applied Mathematics Seminar, Seoul National University, January 5, 2012
"High dimensional tree-numbers"

MEG Center Seminar*, Seoul National University Hospital, January 11, 2011
"Information centrality and its applications"

Joint Workshop* of Neurosurgery, Statistics, and Mathematics Departments,
Seoul National University, January 6, 2011
"Information centrality and its applications"

Topology Seminar*, Seoul National University, Seoul, Korea, May 25, 2010
"Homology of acyclic graph complexes"

Algebraic Combinatorics Conference*, POSTECH, Pohang, Korea, May 1, 2010
"Combinatorial Green's Function of a graph and applications to networks"

Joint Meeting of the Korean Association of Mathematical Societies,
Choongnam University, April 25, 2010
"Combinatorial Green's Function of a graph and applications to networks"

Discrete Math Seminar*, KAIST, Daejon, Korea, April 9, 2010
"A Combinatorial formula for information flow in a network"

Math Department Colloquium*, Seoul National University, Seoul Korea, March 18, 2010
"A Combinatorial formula for information flow in a network"

Hawaii International Conference on System Sciences (HICSS), Waikoloa, HI, January 5-8, 2010
"Knowledge Transfer in a Multiple Virtual Communities Network" (with S. Shin)

AMS-KMS Joint Conference, Seoul, Korea, December 16-20, 2009
"A generalization of Temperley's formula and applications in networks"

Seminar Presentations at Seoul National University, Seoul, Korea, July-August 2009
Department of Mathematical Sciences, July 6-7, 2009
"Edge-rooted forest and alpha-invariant of cone graphs"
"A combinatorial interpretation of information flow in a weighted network"
Department of Physics*, August 5, 2009
"Information centrality in a weighted network"

UKC 2008: US-Korea Conference on Science, Technology, and Entrepreneurship
San Diego, CA, Aug. 14-16, 2008
"The symmetric group action on the cycle matroid of complete graphs"

Korea-America Joint Marine Policy Research Workshop
University of Rhode Island, Kingston, RI, Oct. 25, 2007
"Implications of Electronic Marketplaces: The Case of Korea Fishery Industry,"
with Seung Kyoon Shin and Wes McCann.

Workshop on Topological Methods in Combinatorics, MSRI, Berkeley, CA, October 2-6, 2006
"Homology of the cycle matroid of a coned graph"

HONORS AND GRANTS

2020 사회공헌 PLUS 경진대회 전문부문 대상, 서울대학교 글로벌사회공헌단

2016 서울대학교 자연과학대학 우수강의상

Collaboration Grant for Mathematicians by Simons Foundation (July 2012): amount $35,000
Title: Mathematical Contributions by W. Kook since 2007
(This grant was awarded based on my mathematical achievements during the years 2007-2012.)

Industrial Mathematics Initiation Grant (산업수학 점화 프로그램): $200,000 (220,000 천원)
Title: Research and education of the future industrial technology based on mathematics
수학이론 기반 미래 산업기술 연구 및 인재양성

Research Grant from Seoul National University: amount $9000
Title: Applications of combinatorial Laplacians

Research Grant from College of Natural Sciences, Seoul National Univ.: amount $46,000
Title: Topological Methods in Combinatorics
Project for a book chapter in Korea Maritime Institute Technical Report (2009): amount $9,000
Coinvestigator: Prof. S. Shin (Business School at URI)
Title: Investigation of the Effects of Korea-EU FTA on Port Traffic

Joint project of KMI (Korea Marine Institute) and Dept of Environmental and Natural Resource Economics at URI (April 2007-October 2007): amount $39,800
Coinvestigator: Prof. S. Shin (Business School at URI)
Title: Strategic Guidelines for Korea Fishery e-Marketplaces

Faculty Development Fund from URI research office (April 2003): amount $7,000
Title: Discrete Morse Theory and Euler Numbers via Computational Topology

OTHER ACTIVITIES

Reviewer for Zentralblatt MATH
Reviewer for Discrete Mathematics
Reviewer for ASCM(Advanced Studies in Contemporary Mathematics).
Consultant for KORDI (한국해양연구원)
Professional Memberships:
AMS member (American Mathematical Society)
KMS member(Korean Mathematical Society)
KSEA member (Korean-American Scientists and Engineers Association)

PERSONAL

Languages: fluency in English and Korean, knowledge of Japanese, German, and French
Hobbies: classical piano, chamber music (gave numerous solo and chamber concerts.)
Membership: BPAA (Boston Piano Amateurs Association)

REFERENCES

Prof. Gunnar Carlsson	Stanford University, Stanford CA, (650) 723-2224, gunnar@math.stanford.edu
Prof. Brad Osgood	Stanford University, Stanford CA, (650) 723-4002, osgood@isl.stanford.edu
Prof. Donald Kahn	University of Minnesota, Minneapolis MN kahn@math.umn.edu
Prof. Victor Reiner	University of Minnesota, Minneapolis MN, (612) 625-6682 reiner@math.umn.edu
Prof. Dennis Stanton	University of Minnesota, Minneapolis MN stanton@math.umn.edu
Prof. Joseph Bonin	George Washington University, Washington DC, (202) 994-6273 jbonin@gwu.edu
Prof. Thomas Zaslavsky	SUNY, Binghamton University, Binghamton, NY zaslav@math.binghamton.edu
Prof. Art Duval	University of Texas at El Paso, El Paso TX

artduval@math.utep.edu
Prof. Louis Billera Cornell University, Ithaca, NY
billera@math.cornell.edu
Prof. James Baglama University of Rhode Island, Kingston RI, (401) 874-4519
jbaglama@math.uri.edu
Prof. Seung Kyoon Shin University of Rhode Island, Kingston RI, (401) 874-5543
shin@uri.edu
Prof. Hyuk Kim Seoul National University, Seoul, Korea
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