

Curriculum Vitae (May, 2025)

CAI Leizhen

Professor Emeritus

Department of Computer Science and Engineering

The Chinese University of Hong Kong

Hong Kong, China

E-mail: lcai@cse.cuhk.edu.hk

Homepage: <https://www.cse.cuhk.edu.hk/~lcai>

1 Professional Experience

- 22.8 - Professor Emeritus, The Chinese University of Hong Kong
- 03.8 - 22.7 Professor, The Chinese University of Hong Kong
- 07.7 - 10.6 Founding Associate Director
Institute of Theoretical Computer Science and Communications
The Chinese University of Hong Kong
- 07.9 - 07.12 Visiting Professor, Institute for Theoretical Computer Science
Tsinghua University, China
- 97.1 - 03.7 Associate Professor, The Chinese University of Hong Kong
- 94.8 - 96.12 Assistant Professor, The Chinese University of Hong Kong
- 93.9 - 94.8 Assistant Professor, University of Toronto, Canada
- 92.10 - 93.8 Postdoctoral Fellow, University of Saskatchewan, Canada
- 92.5 - 92.9 Postdoctoral Fellow, University of Toronto, Canada
- 91.9 - 91.5 Research Assistant, Simon Fraser University, Canada
- 85.9 - 86.8 Visiting Scholar, Southern Methodist University, USA
- 82.9 - 85.8 Instructor, Zhejiang University, China

2 Education

- 88.9 - 92.4 Ph.D. in Computer Science, University of Toronto, Canada
Thesis: “Tree Spanners: Spanning Trees that Approximate Distances”
Supervisor: Prof. Derek Corneil
- 86.9 - 88.4 M.Sc. in Computer Science, University of Victoria, Canada
Thesis: “The Computational Complexity of Edge Colouring Restricted Graphs”
Supervisor: Prof. John Ellis
- 78.9 - 82.7 B.Sc. in Computer Science, Zhejiang University, China

3 Teaching Experience

CSE Exemplary Teaching Award 2012-2013

The Chinese University of Hong Kong:

Engineering Mathematics (ENGG1410)

Discrete Mathematics (CSC2110)

Discrete Mathematics for Engineers (ENGG2440)

Data Structures (CSC2100)

Design and Analysis of Algorithms (CSCI3160 and Elite Class ESTR3104)

Introduction to Theoretical Computer Science (CSC3640)

Graduate courses: Topics in Graph Algorithms (CSCI5320)

Algorithmic Graph Theory (CSC6160)

Computational Complexity (CSC7120)

University of Toronto: Computability and Complexity (CSC364)

Tsinghua University: Parameterized Complexity (graduate course)

Zhejiang University: Programming in Pascal

Supervised around 6 students every year for their Final Year Projects.

Graduate students:

Su Chong (2019.9 - 2024.3), Ph.D., Partition Problems on Edge-Bicolored Graphs and Beyond.

Pang Ho Lam (2017.9 - 2019.9), M.Phil., Vertex Switching on Edge-Bicolored Graphs.

Ye Junjie (2012.9 - 2016.7), Ph.D., Dual Connectedness of Edge-Bicolored Graphs and Beyond.

Cai Yufei (2010.9 - 2012.5), M.Phil., Polynomial Kernelisation of H -Free Edge Modification Problems.

Guo Chengwei (2008.9 - 2013.2), Ph.D. (co-supervision with Prof. Yao Chi Chih Andrew), Parameterized Complexity of Graph Contraction Problems.

Yang Lin (2007.9 - 2009.6), M. Phil., Efficient Algorithms on Trees.

Xiao Mingyu (2005.9 - 2009.8), Ph.D. (co-supervision with Prof. Yao Chi Chih Andrew), Algorithms for Graph Multiway Partition Problems.

Leung Chi Wai (2002.9 - 2005.5), M.Phil., Fixed-Parameter Tractability of the Maximum k -Vertex Cover Problem on Special Families of Graphs.

Ho Man Lam (2001.9 - 2003.8), M.Phil., Linear Time Algorithms for Graphs Close to Chordal Graphs.

4 Research

Research Area: *Theoretical Computer Science*

Main Interests: *FPT-algorithms, graph algorithms, and graph theory.*

4.1 Major contributions

Indirect certificate (current work): Developing a novel approach to obtain FPT-algorithms based on indirect certificates of NP-hard problems. I have shown that, surprisingly, every graph G with a k -vertex cover has an indirect certificate with at most $k/3$ vertices, which can be used to obtain the following extremely simple $O(kn)$ -time algorithm to find a k -vertex cover in G with probability 2.5199^{-k} , where $N(M)$ denotes the open neighbourhood of marked vertices: *Randomly mark each vertex and output $N(M)$.*

The approach generalizes the well-known random separation method, is orthogonal to the fundamental bounded search tree method, and appears to be a general tool for designing FPT algorithms.

Random separation: Introduced an innovative random separation method for designing FPT algorithms to solve parameterized problems. The method is versatile and powerful, and solves a wide range of parameterized problems for degree-bounded graphs, graphs of bounded degeneracy, and even general graphs.

Parameterized graph families: Set up a general framework for studying the complexity of a problem when its inputs are close to “good inputs” and demonstrated the fruitfulness and usefulness of the framework by a full spectrum of interesting and surprising results for the classical vertex colouring problem. The framework adds a new dimension to the applicability of parameterized complexity.

4.2 Selective Working Papers

1. **L. Cai**, Vertex covers revisited: indirect certificates and FPT algorithms, manuscript (19 pages, revision of arXiv:1807.11339), invited for submission to *J. of Computer and System Sciences*, 2025.
2. **L. Cai**, Harness indirect certificates to design FPT algorithms, manuscript (12 pages), 2025.
3. **L. Cai**, FPT and exact algorithms for the weighted 2-satisfiability problem, manuscript (9 pages), 2024.
4. **L. Cai** and **O.Y. Leung**, Coloured clustering by breaking down alternating paths, manuscript (19 pages), 2022.

4.3 Representative Publications

For publication list, see <https://dblp.org/pid/c/LeizhenCai.html>.

1. **L. Cai** and J. Ye, Two edge-disjoint paths with length constraints, *Theoretical Computer Science* Vol 795, 275-284, 2019.
2. **L. Cai** and Y. Cai, Incompressibility of H -free edge modification problems, invited paper of IPEC 2013, *Algorithmica* 71(3), 731-757, 2015.
3. M. Xiao, **L. Cai** and A.C.C. Yao, Tight approximation ratio of a general greedy splitting algorithm for the minimum k -way cut problem, *Algorithmica* Vol 59, 510-520, 2011.
4. **L. Cai**, Parameterized complexity of cardinality constrained optimization problems, *The Computer Journal* 51(1), 102-121, 2008.
5. **L. Cai**, S.M. Chan and S.O. Chan, Random separation: a new method for solving fixed-cardinality optimization problems, IWPEC 2006, LNCS 4169, pp. 239-250, 2006.
6. **L. Cai**, Parameterized complexity of vertex colouring, *Discrete Applied Mathematics* 127(3), 415-429, 2003.
7. **L. Cai**, Fixed-parameter tractability of graph modification problems for hereditary properties, *Information Processing Letters* 58(4) 171-176, 1996.
8. **L. Cai** and D.G. Corneil, Tree spanners, *SIAM J. Discrete Math.* 8(3), 359-387, 1995.

4.4 Grants

Not much need for my research and I usually apply once every 2-3 years. 8 RGC competitive grants out of 11 applications including the following latest one before my retirement in 2022:

RGC General Research Fund CUHK410409, Tools for Designing FPT Algorithms: From Random Separation to Indirect Certificate, HK\$693,000, 2018-2022.

4.5 Seminars and Talks

Around 100 seminars and conference talks (over 20 invited talks), including

1. CSE CUHK, Harness indirect certificates to design algorithms, Nov 2024.
2. Zhenhai High School, 3 lectures on “Algorithms as the Soul of Computers”, Humanities and Sciences Forum (lecture series 135-137), July 2023.
3. Plenary speaker, FPT Algorithms, National Conference on Theoretical Computer Science, Wuhan, China, 2011.

4.6 Peer Review

Journals: Over 30 journals including ACM Transactions on Algorithms, SIAM Journal on Computing, Algorithmica, Journal of Algorithms, Discrete Applied Mathematics, Journal of Combinatorial Theory(B), and Journal of Graph Theory.

Conferences: Over 20 conferences including FOCS, STOC and SODA.

Grants: NSERC Grants (Canada), Research Grants (Macau) and RGC General Research Grants (Hong Kong)

5 Service

5.1 Service at CUHK

CSE Department: Department Exco Committee, Staff Recruiting Committee, Research Committee, Exam Panel, Graduate Panel, Undergraduate Admission Committee, Curriculum Committee, Final Year Project Committee, Staff-Student Consultation Committee, Student Academic Contest Advisor, and Seminar Coordinator.

Faculty of Engineering: Faculty Disciplinary Committee, and Faculty Library Committee.

Chung Chi College: College Life Committee, and College Coordinator.

Institute of Theoretical Computer Science and Communications: Founding Associate Director.

5.2 External Service

5.2.1 Program Committee

Over 10 conferences including ISAAC, WG, and IWPEC.

5.2.2 External PhD Examiner

University of Hong Kong, City University of Hong Kong, Arizona State University, University of Bergen, and UNSW Sydney.

5.2.3 External Reviewer

The Chinese University of Hong Kong (Shenzhen)