

Wei-Lin Wu

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SUMMARY

Research Scientist in formal methods at IAIC, A*STAR, with a Ph.D. in Computer Science: interactive theorem proving (HOL4, Lean), constraint solving via pseudo-Boolean proof-certifying encoders, and working familiarity with SMT solvers (Z3, cvc5). Complementary Ph.D. background in mathematical logic and finite model theory from UC Santa Cruz.

RESEARCH INTERESTS

Automated Reasoning, Formal Verification, Constraint Programming, Theorem Proving, Proof Logging & Certification (Pseudo-Boolean), Mathematical Logic, Finite Model Theory, Graph Theory, Algorithm Design

THEOREM PROVERS AND COMPUTER LANGUAGES

HOL4, Lean, Agda (interactive theorem provers), Z3, cvc5 (SMT solvers), Standard ML (ML/OCaml family), Haskell, C/C++, Python, Java, Objective-C, Prolog

RESEARCH EXPERIENCE

- **Research Scientist, Agency for Science, Technology and Research (A*STAR), Singapore** 03/2025-present
Supervisor: Yong Kiam Tan
 - Contributed the verified constraint-programming-to-pseudo-Boolean (CP-to-PB) encoding front end of a trustworthy constraint-solving pipeline, open-sourced in the CakeML verified-compiler ecosystem (repo): formalized the semantics of constraint-satisfaction, -optimization, and -enumeration problems in HOL4, and proved soundness/completeness of the constraint-to-pseudo-Boolean encoders — closing a previously unverified trust gap in the pipeline’s pseudo-Boolean (VeriPB, SAT/SMT-adjacent) proof certification; work recently submitted for publication (see Publications)
 - Leading a study group for the online learning material Logic and Mechanized Reasoning, covering Lean programming and theorem-proving as well as SMT solving (Z3, cvc5), and hosting weekly meetings
 - Co-supervised undergraduate students at Nanyang Technological University for URECA (Undergraduate Research Experience on Campus) research projects on mathematical logic and graph homomorphisms
- **Research Assistant, University of California, Santa Cruz, Santa Cruz, CA, USA** 04/2020-06/2023
Advisor: Phokion G. Kolaitis
 - Investigated the expressive power of homomorphism counts in characterizations of various equivalence relations that are relaxations of isomorphism and in query algorithms for isomorphism-invariant property-testing of graphs and relational databases (see Publications)
 - Formulated encoding techniques of common arithmetical operations within monadic second-order logic, investigated the almost-everywhere equivalence between its existential and universal fragments
- **Research Assistant, Institute of Information Science, Academia Sinica, Taipei, Taiwan** 10/2016-07/2017
Advisors: Shin-Cheng Mu & Tony Tan
 - Assisted research on formal methods of process calculi/session types and research on algorithmic problems and complexity of the two-variable fragment of first-order logic with counting
- **Research Assistant, Institute of Information Science, Academia Sinica, Taipei, Taiwan** 11/2010-12/2011
Advisor: Shin-Cheng Mu
 - Derived formal proofs of set-theoretic theorems using the theorem prover Agda, and gave tutorials on functional programming (mainly Haskell and Agda) and on formalization of proofs in intuitionistic logic and foundational mathematics
- **Student Researcher, National Taiwan University, Taipei, Taiwan** 09/2007-06/2009
Advisor: Kun-Mao Chao
 - Investigated mathematical logic and the definability issue of Hamiltonian path in second-order logic
- **Student Researcher, National Cheng Kung University, Tainan, Taiwan** 04/2004-08/2006
Advisor: Kuo-Yung Yen
 - Derived a new and elementary proof of the existence of π as defined via differential equations of sine and cosine functions, and led a study group of foundational mathematics and construction of number systems

EDUCATION

- **University of California, Santa Cruz, Santa Cruz, CA** 12/2023
 - Ph.D. in Computer Science (GPA: 3.96/4.00)
 - Dissertation: A Study of the Expressive Power of Homomorphism Counts
 - Relevant Courses: Programming Language Theory (and Verification using Dafny), Logic in Computer Science, Machine Learning, Data Science, Database Principles, Information Theory, Combinatorial Algorithms

- Courses Taught as a TA: Automata Theory and Computability (8 terms), Analysis of Algorithms, Introduction to Java, Comparative Programming (Python, Haskell, Prolog, Scala)
- **National Taiwan University**, Taipei, Taiwan 06/2009
 - M.S. in Computer Science and Information Engineering
 - Thesis: A Study on Expressing the Hamiltonian Path Problem in Second-Order Logic with Some Additional Predicate Symbols
 - Selected Project: A Finance Calculator implemented in C++ to price barrier options using a lattice model, and to evaluate the risk-neutral value of derivatives with early-exercise features (e.g., Bermudan or American style options) using least-squares Monte Carlo and lattice methods
- **National Cheng Kung University**, Tainan, Taiwan 06/2007
 - B.S. in Electrical Engineering
 - Selected Project: A Simulator for a Simplified MIPS Architecture implemented in C++ for a RISC computer architecture, using a linked-list data structure for space efficiency, with analysis reports of time efficiency

PROJECTS

- RIPEMD-160 Program – an implementation of RIPEMD-160 (a family of cryptographic hash functions) together with machine-checked correctness proofs in the HOL4 ecosystem; merged as an open-source contribution to the official HOL4 theorem-prover distribution. GitHub: <https://github.com/HOL-Theorem-Prover/HOL/tree/develop/examples/Crypto/RIPEMD>
- Annotations to “Mathematical Logic” – a textbook (2nd edition, Springer) by H.-D. Ebbinghaus, J. Flum, W. Thomas – with a complete solutions manual. GitHub: <https://github.com/Linisac/Mathematical-Logic-EFT->

AWARD

- **Regents’ Fellowship**, University of California, Santa Cruz 2017

PUBLICATIONS

Alphabetical authorship by the convention of theoretical computer science

- [**Anonymous Submission, Under Review**] Title withheld pending review (working area: formally verified pseudo-Boolean encodings and proof logging for certified constraint-programming solvers). With colleagues at A*STAR (Singapore) and collaborators at Chalmers University of Technology, Lund University (Sweden), University of Copenhagen (Denmark), University of Glasgow (Scotland)
- [**ICDT**] Balder ten Cate, Víctor Dalmau, Phokion G. Kolaitis, and **Wei-Lin Wu**: When Do Homomorphism Counts Help in Query Algorithms?. In *27th International Conference on Database Theory (ICDT 2024)*, LIPIcs, Volume 290, pages 8:1-8:20, Mar 25-28, 2024
- [**ICALP-affiliated SmP Workshop**] **Wei-Lin Wu**: Query Algorithms Based on Homomorphism Counts. In *Structure Meets Power Workshop ICALP 2022 (Extended Abstract)*, pages 24-26, Jul 4-8, 2022
- [**LICS**] Albert Atserias, Phokion G. Kolaitis, and **Wei-Lin Wu**: On the Expressive Power of Homomorphism Counts. In *36th Annual ACM/IEEE Symposium on Logic in Computer Science*, pages 1-13, Jun 29-Jul 2, 2021

TALKS & PRESENTATION

- [**Invited Talk**] A Study of the Expressive Power of Homomorphism Counts. In *Logic in Computer Science Special Session of the 2024 ASL Annual Meeting*, Iowa State University, Iowa, USA, 2024
- [**Contributed Talk**] Query Algorithms Based on Homomorphism Counts. In *Structure Meets Power Workshop ICALP 2022*, Paris, France (participated virtually via Zoom), 2022
- [**Contributed Talk**] On Capturing Some Equivalence Relations by Homomorphism Counts. In *Finite and Algorithmic Model Theory Seminar 22051*, Schloss Dagstuhl, Germany (invited participant), 2022
- [**Presentation**] On the Expressive Power of Homomorphism Counts. In *36th Annual ACM/IEEE Symposium on Logic in Computer Science*, Rome, Italy (participated virtually via Zoom), 2021

JOURNAL REVIEW

- 2026 Elsevier Information and Computation
- 2025 ACM Transactions on Computation Theory

INDUSTRY EXPERIENCE

- Software Engineer, **Fonestock Technology Inc.**, Taipei, Taiwan 05/2016-09/2016
 - Performed supportive work in maintenance, restructured source code (in Objective-C) of iOS apps for stock investments, improved app performance by implementing optimal sorting and searching algorithms, and resolved issues of app crashes and database inconsistency