

# Hongwei WANG

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## EDUCATION BACKGROUND

**Xi'an Jiaotong Liverpool University (XJTLU), China**  
BSc Mathematics and Applied Mathematics

09/2022 – 05/2026

**Westlake University, China**  
Visiting Scholar of Institute for Theoretical Sciences

09/2025 – 03/2026

## PURE MATH STUDY

### Categorical Algebra and Homotopy Theory

**Research Assistant | Advisor: Prof. Alastair Darby, XJTLU**

09/2025 – in progress

- Explored algebraic topology and homotopy theory
- Solid command of algebraic topology built through systematic study. Core competencies include fundamental groups and groupoids, covering spaces, simplicial homology, and homotopy theory
  - Investigated algebraic topology through category theory, framing core concepts to motivate the study of homotopy theory. Detailed work includes proving the equivalence between the van Kampen theorem of the fundamental group and the groupoid under its formulation via categorical colimits; discussing the Galois theory of covering spaces categorically, finding a bridge between topology and algebra. Significantly deepened categorical understanding of algebraic topology and built a unified perspective on mathematics
  - Motivated by the deep connections between homotopy theory and type theory, studied the fundamentals of dependent type theory and used Lean theorem prover to formalize core theorems of algebraic topology: completed a full formalization proving that the fundamental group of the circle  $S^1$  is isomorphic to the integers

### Visiting Scholarship in Westlake University on Algebraic Topology and Homotopy Theory

**Visiting Scholar | Advisor: Prof. Xing Gu, Westlake University**

9/2025 – in progress

- Systematically studied homotopy theory under the guidance of Professor Gu Xing and conducted undergraduate thesis research at Westlake University
- Visited Westlake University once a week to attend Professor Gu Xing's algebraic topology course alongside graduate students, significantly deepening my understanding and professionalizing my knowledge in the field
  - Conducted a rigorous, self-directed study of modern algebraic topology through Haynes Miller's *Lectures on Algebraic Topology*; including simplicial homology theory and homotopy theory, moving beyond computational techniques to understand their categorical meaning

### Undergraduate Category Theory Seminar

**Organizer & Lecturer | Advisor: Prof. Adam-Christiaan von, XJTLU**

02/2025 – 05/2025

- Organized and led a reading seminar on Tom Leinster's *Basic Category Theory* and delivered core lectures to introduce basic category theory
- Had a thorough grasp of category structure knowledge, including categories, functors, natural transformations, limits, representable functors, and the Yoneda lemma, among other contents
  - As a student lecturer, gave a special lecture on core concepts such as representable functors and the Yoneda lemma, and explained the abstract constructions by using specific examples from algebra and topology, such as set representations, group actions, and the category of presheaves
  - Organized group discussions on exercises and proofs to deepen students' theoretical understanding of the parallel structures between different fields to cultivate a cohesive mathematical worldview and comprehend the unifying language of higher and  $\infty$ -categories

### XJTLU Winter Pure Mathematics Seminar

**Organizer & Lecturer | Organizer: Stud. Hongwei Wang, XJTLU**

12/2024 – 01/2025

- Initiated and hosted the Winter Pure Mathematics Symposium at XJTLU, aiming to promote knowledge sharing, interdisciplinary communication, academic progress, and collaborative learning among the pure math students
- Independently presented a seminar on Galois theory from Galois correspondence to the unsolvability of the quintic, and recruited a team of student speakers covering areas such as algebra, analysis, topology, number theory, geometry, and mathematical physics. Received formal recognition from the school
  - Organized a series of well-defined seminars and reports over a period of 15 days; the schedule and topics were carefully arranged to balance diversity and coherence
  - Utilized online platforms and social media for event promotion and information dissemination, achieving over 8,000 views in a single week

### Prime Distribution Visualization and Analytic Number Theory Study

**Summer Undergraduate Research Fellowships in XJTLU | Advisor: Prof. Pietro Sgobba, XJTLU** 06/2024 – 09/2024

- Conducted visual analyses of prime distribution using classical spiral models, integrated elementary analytic

number theory to explore large-scale patterns and systematically studied the theoretical foundations

- Systematically studied *Introduction to Analytic Number Theory* by Tom M. Apostol; mastered core concepts, including arithmetical functions, Chebyshev estimates, and elementary forms of the Prime Number Theorem
- Wrote a review paper entitled *Arithmetical Functions and Elementary Theorems on the Distribution of Primes*.
- Generated classic large-scale prime number spirals such as the Ulam Spiral, Klauber Triangle, and Sacks Spiral through Python; studied prime-rich polynomials

### Global Mathematics Students' Summer School at Westlake University

*Student | Organizer: Prof. Huayi Chen, Westlake University*

06/2025 – 07/2025

- Participated in an intensive summer academic research program led by Professor Huayi Chen
- Participated in four mathematics discussion sessions daily, delving into fundamental structures of information geometry, algebraic geometry, algebraic number theory, regularity theory of elliptic PDEs, and the analytic and arithmetic properties of modular forms
- Sorted out the core theorems and classic proof paths for each topic, organized discussion notes, and created phased summary materials, thereby assisting in the construction of a cross-disciplinary knowledge framework
- Collaborated with fellow participants from international institutions to prepare and deliver a group presentation on the conjecture regarding the relationship between the lower bound of the Hausdorff dimension in fractal geometry and the order of its generating group, receiving constructive feedback from professors

## EXTRA STUDY

### Exploring the Substantive Role of AI like ChatGPT in Mathematics Learning

*Research Assistant | Advisor: Prof. Jinsong Xu, XJTLU*

10/2024 – 04/2025

- Explored the supportive role of generative artificial intelligence in advanced undergraduate mathematics education.
- Designed and led a six-month empirical study applying generative programming to pure math subjects, including complex analysis, abstract algebra, and topology
- Developed three interactive learning programs: (1) A machine-learning proof of a simple case of Ramsey's Theorem: Through computer self-play optimization, it was verified that in the game on the complete graph K5, the first player has a winning strategy - namely, to force the opponent to be the first to complete a monochromatic C3 triangle. (2) A visualization tool for conformal mappings of analytic functions on the complex plane, with the automatic detection of singularities; (3) A scalar field visualization program that automatically computes and plots the corresponding gradient vector
- Wrote and presented a research report titled *AI-Driven Python Code Generation for Solving Specific Mathematics Problems*, receiving positive feedback from faculty and peers

### Data-Driven Analysis of Stellar Cluster Formation and Evolution

*Research Assistant | Advisor: Prof. Xiaoying Pang XJTLU*

10/2022 – 06/2023

- Performed a data-driven analysis on stellar cluster formation and evolution based on Gaia DR3 catalog data
- Utilized Python to conduct data cleaning and dimensionality reduction in the high-dimensional parameter space of the Gaia DR3 star catalog.
- Constructed a multi-dimensional Gaussian Mixture Model (GMM) to initially screen the member stars of the Beehive Cluster; ultimately identified 387 high-confidence member stars (with confidence > 90%) and plotted a clear color-magnitude diagram (CMD)
- Innovatively introduced the Self-Organizing Map (SOM) for unsupervised clustering analysis

## STUDY REPORT

- Wang, Hongwei, *Arithmetical Functions of Elementary Theorems on the Distribution of Primes* 07/2024
- Wang, Hongwei, *Introduction to Commutative Algebra - Rings and Ideals,* 08/2024
- Wang, Hongwei, *Futurama Theorem: Group and Permutations in Body Changing Problem,* 03/2025
- Wang, Hongwei, *Upperbound for Hausdorff Dimension of Fractals under Symmetry Group* 04/2025
- Wang, Hongwei, *AI-Driven Python Code Generation for Solving Specific Mathematics Problems* 05/2025
- Wang, Hongwei, *Concise Categorical Algebra and Homotopy Theory* 09/2025

## AWARDS AND HONORS

- Outstanding Student Representative, XJTLU 05/2025
- Outstanding Pure Mathematics TA, XJTLU 05/2025
- Outstanding Student Ambassador, XJTLU 07/2023
- Best Academic Social Practice, XJTLU 03/2023
- Excellent Student Lecturer, XJTLU 03/2023

## SKILLS

Java | Python | LaTeX | Lean