Hanlin Ren

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Employment

Sep 2025 – present **Institute for Advanced Study**
Postdoctoral member

Education

Oct 2021 – Sep 2025 **University of Oxford, UK**
DPhil in computer science
Advisor: Prof. Rahul Santhanam

Aug 2016 – Jun 2021 **Tsinghua University, China**
Bachelor of engineering
Major: computer science (Special Pilot CS Class, a.k.a Yao Class)

Selected Publications

(Note: in theoretical computer science, the list of authors are usually sorted in alphabetical order.)

- **Polynomial-Time Pseudodeterministic Construction of Primes.** FOCS 2023.
  Lijie Chen, Zhenjian Lu, Igor C. Oliveira, Hanlin Ren, and Rahul Santhanam

  Summary: We present an unconditional pseudodeterministic algorithm that for infinitely many input lengths n, outputs an n-bit prime number in $\mathrm{poly}(n)$ time. Here, "pseudodeterministic" means that although our algorithm is randomized, it outputs a fixed canonical prime number with high probability. In fact, we present pseudodeterministic algorithms for a broad family of search problems, namely those "dense properties in $\mathbf{P}$."

- **On the Range Avoidance Problem for Circuits.** FOCS 2022.
  Hanlin Ren, Rahul Santhanam, and Zhikun Wang.

  Summary: We study the *range avoidance* problem for restricted circuit classes. Among other results, we provide an "Algorithmic Method" for the range avoidance problem, generalizing the famous Algorithmic Method for proving circuit lower bounds initiated by Ryan Williams. This framework has been useful in obtaining explicit construction results that generalize the state-of-the-art circuit lower bounds proven by the Algorithmic Method.

Full Publications

- **Finding Bugs in Short Proofs: The Metamathematics of Resolution Lower Bounds.** STOC 2026.
  Jiawei Li, Yuhao Li, and Hanlin Ren
- **The Weak Rank Principle: Lower Bounds and Applications.** STOC 2026.
  Michal Garlík, Svyatoslav Gryaznov, Hanlin Ren, and Iddo Tzameret
- **Hardness of Range Avoidance and Proof Complexity Generators from Demi-Bits.** ITCS 2026.
  Hanlin Ren, Yichuan Wang, and Yan Zhong
  Best student paper award.

Full Publications (Continued)

- **Total Search Problems in** ZPP**.** ITCS 2026.
  Noah Fleming, Stefan Grosser, Siddhartha Jain, Jiawei Li, Hanlin Ren, Morgan Shirley, and Weiqiang Yuan
- **New Algebrization Barriers to Circuit Lower Bounds via Communication Complexity of Missing-String.** ITCS 2026.
  Lijie Chen, Yang Hu, and Hanlin Ren
- **On the Complexity of Avoiding Heavy Elements.** FOCS 2024.
  Zhenjian Lu, Igor C. Oliveira, Hanlin Ren, and Rahul Santhanam
- **Symmetric Exponential Time Requires Near-Maximum Circuit Size.** STOC 2024, JACM 2025.
  Lijie Chen, Shuichi Hirahara, and Hanlin Ren
- **Polynomial-Time Pseudodeterministic Construction of Primes.** FOCS 2023.
  Lijie Chen, Zhenjian Lu, Igor C. Oliveira, Hanlin Ren, and Rahul Santhanam
- **Bounded Relativization.** CCC 2023.
  Shuichi Hirahara, Zhenjian Lu, and Hanlin Ren
- **Range Avoidance, Remote Point, and Hard Partial Truth Table via Satisfying-Pairs Algorithms.** STOC 2023.
  Yeyuan Chen, Yizhi Huang, Jiatu Li, and Hanlin Ren.
- **NP-Hardness of Approximating Meta-Complexity: A Cryptographic Approach.** STOC 2023, SICOMP 2025.
  Yizhi Huang, Rahul Ilango, and Hanlin Ren
- **On the Range Avoidance Problem for Circuits.** FOCS 2022.
  Hanlin Ren, Rahul Santhanam, and Zhikun Wang.
- **Maintaining Exact Distances under Multiple Edge Failures.** STOC 2022.
  Ran Duan and Hanlin Ren.
- **Robustness of Average-Case Meta-Complexity via Pseudorandomness.** STOC 2022.
  Rahul Ilango, Hanlin Ren, and Rahul Santhanam.
- **A Relativization Perspective on Meta-Complexity.** STACS 2022.
  Hanlin Ren and Rahul Santhanam.
- **Hardness of** KT **Characterizes Parallel Cryptography.** CCC 2021.
  Hanlin Ren and Rahul Santhanam.
  Invited to the ToC special issue for CCC 2021.
- **Constructing a Distance Sensitivity Oracle in** $O(n^{2.5794}M)$ **Time.** ICALP 2021.
  Yong Gu and Hanlin Ren.
- **Approximate Distance Oracles Subject to Multiple Vertex Failures.** SODA 2021.
  Ran Duan, Yong Gu, and Hanlin Ren.
- **Improved Distance Sensitivity Oracles with Subcubic Preprocessing Time.** ESA 2020, JCSS 2022.
  Hanlin Ren.
  Invited to the JCSS special issue for ESA 2020.
- **Strong Average-Case Circuit Lower Bounds from Non-trivial Derandomization.** STOC 2020, SICOMP 2022.
  Lijie Chen and Hanlin Ren.
  Invited to the SICOMP special issue for STOC 2020.

Full Publications (Continued)

- **Approximating All-Pair Bounded-Leg Shortest Path and APSP-AF in Truly-Subcubic Time.** ICALP 2018.
  Ran Duan and Hanlin Ren.

Academic Talks

- **Weak Rank Principle: Lower Bounds and Applications (II).**
  Oxford proof complexity workshop. Aug 2025
- **Hardness of Range Avoidance and Proof Complexity Generators from Demi-bits.**
  Complexity Network: 6-th in-person meeting. Jun 2025
  Logic seminar, Institute of Mathematics, Czech Academy of Sciences (online). Jan 2026
  ITCS 2026. Jan 2026
- **Metamathematics of Resolution Lower Bounds: A TFNP Perspective.**
  NII Algorithm Lunch Seminar. Jul 2024
  Oxford-Warwick-Imperial Complexity Network. Jul 2024
  Shanghai Jiao Tong University. Aug 2024
  Oxford proof complexity workshop. Sep 2024
  Logic seminar, Institute of Mathematics, Czech Academy of Sciences. Jan 2025
- **Symmetric Exponential Time Requires Near-Maximum Circuit Size.**
  Tsinghua University. Dec 2023
  Peking University. https://b23.tv/BV1Cj411J7CB Dec 2023
  ICT, Chinese Academy of Sciences. Jan 2024
  STOC 2024 (with Zeyong Li). https://youtu.be/yVBSU1_0i2o Jun 2024
  Fudan University. Aug 2024
- **The Iterative Win-Win Method, and Explicit Constructions (without) Using It.**
  A series of two talks at the CSDM Seminar, Institute for Advanced Study. https://youtu.be/uxyN2eVYKic Nov 2023
- **Polynomial-Time Pseudodeterministic Construction of Primes.**
  DIMAP Seminar, University of Warwick. Jun 2023
  TCS+. https://youtu.be/yalaX02fVow Sep 2023
  Algorithms and Complexity Theory Seminars, University of Oxford. Oct 2023
  FOCS 2023. Nov 2023
  Recent Developments in Explicit Constructions, FOCS 2023 Workshop. Nov 2023
  UIUC Theory Seminar. Jan 2024
  Meta-Complexity 2023 Reunion, Simons Institute. Apr 2024
  Workshop on Algebraic Complexity, Geometry, and Representations, University of Warwick. Mar 2025
- **NP-Hardness of Approximating Meta-Complexity: A Cryptographic Approach.**
  Minimal Complexity Assumptions for Cryptography, Meta-Complexity 2023, Simons Institute. https://youtu.be/v9JiEf2WH58 May 2023
  ICT, Chinese Academy of Sciences (online). May 2023
  STOC 2023. https://youtu.be/DtJQ5-3zptE Jun 2023
- **Robustness of Average-Case Meta-Complexity.**
  Seminar at Meta-Complexity 2023, Simons Institute. Mar 2023
- **Bounded Relativization.**
  Student Seminar, Meta-Complexity 2023, Simons Institute. Feb 2023
  CCC 2023. https://youtu.be/gPqcSXNU0ms Jul 2023
  Warwick complexity meetings (online). Nov 2023

Academic Talks (Continued)

- **Range Avoidance, Remote Point, and Hard Partial Truth Table via Satisfying-Pairs Algorithms.**
  Lower Bounds, Learning, and Average-Case Complexity, Meta-Complexity 2023, Simons Institute. https://youtu.be/pd45Av1iTlw — Feb 2023
  STOC 2023. — Jun 2023
- **Recent Advances in the Range Avoidance Problem.**
  Yaoclass Seminar (online). — Dec 2022
- **Range Avoidance Part II: Beyond Circuit Lower Bounds.**
  New Directions in Derandomization, FOCS 2022 Workshop. https://vimeo.com/user39621409/review/772183410/1201f3a1d4 — Nov 2022
- **On the Range Avoidance Problem for Circuits.**
  ICMS workshop on Mathematical Approaches to Lower Bounds: Complexity of Proofs and Computation. — Jul 2022
  Warwick complexity meetings (online). — Aug 2022
  FOCS 2022. https://vimeo.com/user39621409/review/771296149/46488425a3 — Nov 2022
- **Maintaining Exact Distances under Multiple Edge Failures.**
  STOC 2022. http://youtu.be/B1wMXgTCy8o — Jun 2022
- **A Relativization Perspective on Meta-Complexity.**
  STACS 2022 (online). — Mar 2022
- **Faster Algorithms for Distance Sensitivity Oracles.**
  IJTCS 2021 (hybrid). — Aug 2021
  Yaoclass Seminar. — Nov 2021
- **Constructing a Distance Sensitivity Oracle in $O(n^{2.5794}M)$ Time.**
  ICALP 2021 (online). http://youtu.be/uIFoucab6d4 — Jul 2021
- **Hardness of KT Characterizes Parallel Cryptography.**
  DIMACS workshop on meta-complexity, barriers, and derandomization. http://youtu.be/hZZaEuumtTY — Apr 2022
  CCC 2021 (online). http://youtu.be/esFxj1cNLCE — Jul 2021
  Yaoclass Seminar. — Apr 2021
  Oxford-Warwick complexity meetings (online). — Apr 2021
- **Approximate Distance Oracles Subject to Multiple Vertex Failures.**
  SODA 2021 (online). https://player.vimeo.com/video/496602190. — Jan 2021
  Yaoclass Seminar. — Dec 2020
- **Improved Distance Sensitivity Oracles with Subcubic Preprocessing Time.**
  ESA 2020 (online). https://youtu.be/2Z46AybFkJ8. — Sep 2020
- **Strong Average-Case Circuit Lower Bounds from Non-trivial Derandomization.**
  STOC 2020 (online). https://youtu.be/xWDQ4LefOVs. — Jun 2020
  SIGMA, ICT, Chinese Academy of Sciences (online). — Mar 2020
- **Approximating All-Pair Bounded-Leg Shortest Path and APSP-AF in Truly-Subcubic Time.**
  ICALP 2018. — Jul 2018

Special Issue Invitation

- STOC 2020, ESA 2020, CCC 2021

Teaching Experience

2020 Fall — **Design and Analysis of Algorithms** (graduate level)
Instructor: Prof. Ran Duan
Teaching assistant

2021 Spring — **Theory of Computation** (undergraduate level)
Instructor: Prof. Ran Duan
Teaching assistant

2022 Michaelmas Term — **Advanced Complexity Theory** (Part C)
Instructor: Prof. Rahul Santhanam
Marker and tutor

Selected Awards

2021 Clarendon Scholarship
2019 Yao Award, bronze prize
2018 Evergrande Scholarship
2017 Baidu "Future Star" Scholarship
2015 Gold medal (15th place) in Chinese National Olympiad in Informatics (NOI)

In the Media

- How to build a big prime number — Quanta magazine
  https://www.quantamagazine.org/how-to-build-a-big-prime-number-20230713/
- Finding Primes Pseudodeterministically — Computational Complexity Blog
  https://blog.computationalcomplexity.org/2023/05/finding-primes-pseudodeterministically.html
- Half-Exponential No More — Computational Complexity Blog
  https://blog.computationalcomplexity.org/2023/09/half-exponential-no-more.html