Overview of 2022 CAD Contest at ICCAD

(Invited Paper)

Yu-Guang Chen†
Department of EE
National Central University
Taoyuan, Taiwan
andyygchen@ee.ncu.edu.tw

Chun-Yao Wang
Department of CS
National Tsing Hua University
Hsinchu, Taiwan
wcyao@cs.nthu.edu.tw

Tsung-Wei Huang
Department of ECE
University of Utah
Salt Lake, USA
tsung-wei.huang@utah.edu

Takashi Sato
Department of EE
Kyoto University
Kyoto, Japan
takashi@i.kyoto-u.ac.jp

ABSTRACT

The "CAD Contest at ICCAD" is a challenging, multi-month, research and development competition, focusing on advanced, real-world problems in the field of electronic design automation (EDA). Since 2012, the contest has been publishing many sophisticated circuit design problems, from system-level design to physical design, together with industrial benchmarks and solution evaluators. Contestants can participate in one or more problems provided by EDA/IC industry. The winners will be awarded at an ICCAD special session dedicated to this contest. Every year, the contest attracts more than a hundred teams, fosters productive industry-academia collaborations, and leads to hundreds of publications in top-tier conferences and journals. The 2022 CAD Contest has 166 teams from all over the world. Moreover, the problems of this year cover state-of-the-art EDA research trends such as circuit security, 3D-IC, and design space exploration from well-known EDA/IC companies. We believe the contest keeps enhancing impact and boosting EDA researches.

KEYWORDS

CAD Contest, electronic design automation, computer-aided design, integrated circuits, circuit security, 3D-IC, design space exploration

1 Introduction

With rapid technology advancement and stringent specification requirements of modern electronic systems, the IC design complexity has grown dramatically during the past decades. Electronic Design Automation (EDA), or Computer-Aided Design (CAD), is not only a category of software tools for designing electronic systems but also plays an extremely important role to tackle various design challenges, reduce design cycles, and achieve the best trade-off among performance, power, area, reliability, and cost. In order to boost EDA research, the *CAD Contest at ICCAD* [1] offers a platform for industrial companies to share various design problems and design cases while it encourages researchers in academia to study state-of-the-art IC design challenges and advance problem-solving techniques. The contest is a multi-month, research and development international competition, focusing on solving advanced, real-world problems from the industry with both theoretical solutions and practical software.

ICCAD '22, October 30-November 3, 2022, San Diego, CA, USA

ACM ISBN 978-1-4503-9217-4/22/10.
https://doi.org/10.1145/3508352.3561106

The CAD Contest was originated as a domestic contest in Taiwan in 1999. It had been a successful annual competition activity, sponsored by Ministry of Education (MOE), Taiwan, for cultivating talented young professionals in the EDA field while contributing to the semiconductor industry. Since 2012, the CAD Contest has been presented at IEEE/ACM International Conference on Computer-Aided Design (ICCAD) [2] – [11], under joint sponsorships of ACM SIGDA [12], IEEE CEDA [13], MOE of Taiwan [14], and other industrial companies, including Cadence Design Systems, Inc. [15] and Synopsys, Inc. [16], while the contest environment, including both hardware and software, is supported by Taiwan Semiconductor Research Institute (TSRI) [17]. The contest has already been publishing many sophisticated circuit design problems [18] – [47], from system-level design to physical design, together with industrial benchmarks and evaluators.

Contestants from all over the world can participate in one or more problems provided by the industry. The winners will be awarded at an ICCAD special session dedicated to this contest. Every year, the contest attracts more than a hundred teams, fostering productive industry-academia collaborations, and leading to hundreds of publications in top-tier conferences and journals. The contest keeps enhancing its impact and boosting EDA research.

2 Contest Problems

The ICCAD-2022 CAD contest features the following three critical problems provided by Cadence Design Systems, Inc., Synopsys, Inc., and Alibaba DAMO Academy, respectively.

- **Problem A "Learning Arithmetic Operations from Gate-Level Circuit"** provides a datapath learning and extraction problem which encourage contestants to develop programs that can extract circuit functionality from a gate-level netlist for the purpose of verification, Engineering Change Order (ECO), and hardware security [45].
- **Problem B "3D Placement with D2D Vertical Connections"** introduces a multi-die netlist partitioning and placement problem which addresses the challenges of netlist partitioning, cell placement, and locations of

die-to-die inter-connection terminals in the chiplet era [46].

- **Problem C "Microarchitecture Design Space Exploration,"** gives a design space exploration problem on microarchitecture processors with the challenges of enhancing the chip design ability by efficiently trade-off different degrees w.r.t. performance, power, and area in a short time [47].

It is worth to mention that the three problems align the research trends in the EDA field nowadays and we believe the three valuable problems can not only incubate novel ideas and techniques but also attract more talents to join EDA-related research.

3 Contest Schedule

The contest starts in February and ends in November. The contestants need to carefully read the problem descriptions as well as reference reading from February, register for the contest by the mid of May, submit their works for alpha, beta, and final stage at June, July, and August, respectively. The final evaluation will take place after the final submission and the winners will be awarded at an ICCAD special session dedicated to this contest. The detailed schedule is shown in Figure. 1.

Figure 1. The contest schedules.

4 Registration Statistics

The contest this year receives 166 registered teams from 8 countries/regions, including Taiwan, Mainland China, Hong Kong, United States of America (USA), Korea, India, Swiss, and Germany. Moreover, 3 teams are transnational. Figure 2 shows the numbers of registered teams and Figure 3 presents the countries/regions where the contestants resides in from 2012 to 2022.

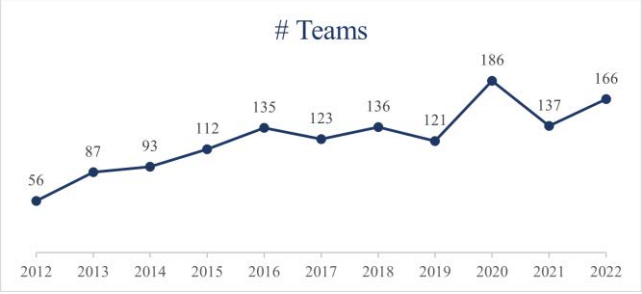

Figure 2. The numbers of registered teams where the contestants reside in from 2012 to 2022.

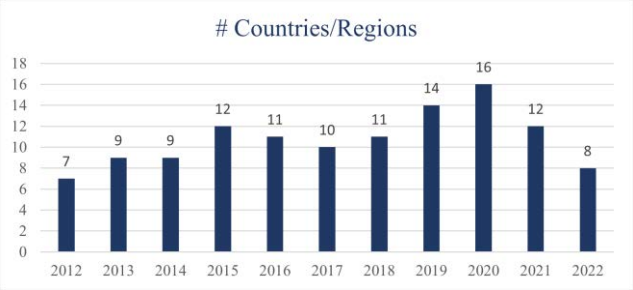

Figure 3. The numbers of countries/regions where the contestants reside in from 2012 to 2022.

5 Award Ceremony

The award ceremony is held at an ICCAD-2022 special session. The session will give an overview of the 2022 CAD Contest, introduce the three contest problems to the community, announce the contest results, and present the awards to the winners. The video clips made by contestants, which introduce key ideas and algorithms to the contest problems, will also be played and demonstrated. The Design Automation Technical Committee (DATC) of IEEE CEDA will finally present the expanding research foundations for IC physical design and ML-enabled EDA. It is worth to mention that the award ceremony in 2020 and 2021 is held as a virtual event due to the serious covid-19 pandemic situation. In this year, the award ceremony is held as a hybrid event where the winner can participate either in-person or on-line.

6 Conclusions

The CAD contests at ICCAD have presented critical problems and industrial benchmarks to the academic community resulting in research breakthroughs and industry-academia collaborations since 2012. The contest has become one of the largest world-wide academic competitions, and attracted over 1100 international teams during 2012–2022. The published industrial benchmarks have been widely adopted by academia, resulting in numerous publications. The contest keeps enhancing its impact and boosting EDA research.

Acknowledgement

The contest organizers would like to thank ACM SIGDA, IEEE CEDA, Cadence Design Systems, Inc., Synopsys Taiwan Co., Ltd., Taiwan, and Ministry of Education (MOE), Taiwan, for the generous financial sponsorship. In addition to the financial sponsors, the organizers would also like to thank Taiwan IC Design Society (TICD) and Taiwan Semiconductor Research Institute (TSRI) for technical consulting and enablement of required computing environments.

REFERENCES

[1] CAD Contest at ICCAD, [Online]. Available: http://iccad-contest.org/.

[2] I. H. Jiang, Z. Li and Y. Li, "Opening: Introduction to CAD contest at ICCAD 2012: CAD contest," Proc. ICCAD, 2012, pp. 341–341.

[3] I. H. Jiang, Z. Li, H. Wang and N. Viswanathan, "The overview of 2013 CAD contest at ICCAD," Proc. ICCAD, 2013, pp. 264–264.

[4] I. H. Jiang, N. Viswanathan, T. Chen and J. Li, "The overview of 2014 CAD contest at ICCAD: Special session paper: CAD contest," Proc. ICCAD, 2014, pp. 356–356.

[5] N. Viswanathan, S. Huang, R. Lin and M. Kim, "Overview of the 2015 CAD contest at ICCAD," Proc. ICCAD, 2015, pp. 910–911.

[6] S. Huang, R. Lin, M. Kim and S. Nakatake, "Overview of the 2016 CAD contest at ICCAD," Proc. ICCAD, 2016, pp. 1-2.

[7] M. Kim, S. Huang, R. Lin and S. Nakatake, "Overview of the 2017 CAD contest at ICCAD: Invited paper," Proc. ICCAD, 2017, pp. 855–856.

[8] M. P.-H. Lin, I.-C. Lin, S. Nakatake, and U. Schlichtmann, "The 2018 CAD Contest," [Online]. Available: http://iccad-contest.org/2018/.

[9] U. Schlichtmann, S. Das, I.-C. Lin, and M. P.-H. Lin, "Overview of 2019 CAD Contest at ICCAD," Proc. ICCAD, 2019.

[10] I.-C. Lin, U. Schlichtmann, T.-W. Huang, and M. P.-H. Lin, "Overview of 2020 CAD Contest at ICCAD," Proc. ICCAD, 2020.

[11] T.-W Huang, Y.-G Chen, C.-Y Wang, and T. Sato, "Overview of 2021 CAD Contest at ICCAD," Proc. ICCAD, 2021.

[12] ACM Special Interested Group on Design Automation (ACM SIGDA), [Online]. Available: https://www.sigda.org.

[13] IEEE Council on Electronic Design Automation (IEEE CEDA), [Online]. Available: https://ieee-ceda.org.

[14] Ministry of Education, Republic of China (Taiwan), [Online]. Available: https://english.moe.gov.tw/

[15] Cadence Design Systems, Inc., [Online]. Available: https://www.cadence.com.

[16] Synopsys, Inc., [Online]. Available: https://www.synopsys.com.

[17] Taiwan Semiconductor Research Institute, [Online]. Available: https://www.tsri.org.tw/en/

[18] W. Jong, H. Wang, C. Hsieh and K. Khoo, "ICCAD-2012 CAD contest in finding the minimal logic difference for functional ECO and benchmark suite: CAD contest," Proc. ICCAD, 2012, pp. 342–344.

[19] N. Viswanathan, C. Alpert, C. Sze, Z. Li and Y. Wei, "ICCAD-2012 CAD contest in design hierarchy aware routability-driven placement and benchmark suite," Proc. ICCAD, 2012, pp. 345–348.

[20] J. A. Torres, "ICCAD-2012 CAD contest in fuzzy pattern matching for physical verification and benchmark suite," Proc. ICCAD, 2012, pp. 349–350.

[21] C. Hsu, W. Lin, H. Wang, F. Lu and K. Khoo, "ICCAD-2013 CAD contest in technology mapping for macro blocks and benchmark suite," Proc. ICCAD, 2013, pp. 265–267.

[22] M. Kim, N. Viswanathan, Z. Li and C. Alpert, "ICCAD-2013 CAD contest in placement finishing and benchmark suite," Proc. ICCAD, 2013, pp. 268–270.

[23] S. Banerjee, Z. Li and S. R. Nassif, "ICCAD-2013 CAD contest in mask optimization and benchmark suite," Proc. ICCAD, 2013, pp. 271–274.

[24] C. Hsu, W. Lin, C. Wu and K. Khoo, "ICCAD-2014 CAD contest in simultaneous CNF encoder optimization with SAT solver setting selection and benchmark suite: Special session paper: CAD contest," Proc. ICCAD, 2014, pp. 357–360.

[25] M. Kim, J. Huj and N. Viswanathan, "ICCAD-2014 CAD contest in incremental timing-driven placement and benchmark suite: Special session paper: CAD contest," Proc. ICCAD, 2014, pp. 361–366.

[26] R. O. Topaloglu, "ICCAD-2014 CAD contest in design for manufacturability flow for advanced semiconductor nodes and benchmark suite," Proc. ICCAD, 2014, pp. 367–368.

[27] A. Sridhar, M. M. Sabry and D. Atienza, "ICCAD 2015 contest in 3D interlayer cooling optimized network," Proc. ICCAD, 2015, pp. 912– 915.

[28] C. Hsu, C. Wu, W. Lin and K. Khoo, "ICCAD-2015 CAD contest in large-scale equivalence checking and function correction and benchmark suite," Proc. ICCAD, pp. 916–920.

[29] M. Kim, J. Hu, J. Li and N. Viswanathan, "ICCAD-2015 CAD contest in incremental timing-driven placement and benchmark suite," Proc. ICCAD, pp. 921–926.

[30] T. Wei and L. Lin, "ICCAD-2016 CAD contest in large-scale identical fault search," Proc. ICCAD, 2016.

[31] C. Wu, C. Hsu and K. Khoo, "ICCAD-2016 CAD contest in non-exact projective NPNP boolean matching and benchmark suite," Proc. ICCAD, 2016.

[32] R. O. Topaloglu, "ICCAD-2016 CAD contest in pattern classification for integrated circuit design space analysis and benchmark suite," Proc. ICCAD, 2016.

[33] C. Huang, C. Hsu, C. Wu and K. Khoo, "ICCAD-2017 CAD contest in resource-aware patch generation," Proc. ICCAD, 2017, pp. 857–862.

[34] K. Hu, M. Yang, Y. Huang, B. Wong and C. Shen, "ICCAD-2017 CAD contest in net open location finder with obstacles: Invited paper," Proc. ICCAD, 2017, pp. 863–866.

[35] N. K. Darav, I. S. Bustany, A. Kennings and R. Mamidi, "ICCAD-2017 CAD contest in multi-deck standard cell legalization and benchmarks," Proc. ICCAD, 2017, pp. 867–871.

[36] C.-Y. Huang, C.-A. Wu, T.-Y. Lee and C.-J. Hsu, "2019 CAD contest: Logic regression on high dimensional boolean space," Proc. ICCAD, 2019.

[37] Y.-H. Su, E. Huang, H.-H. Lai and Y.-C. Zhao, "2019 CAD contest: System-level FPGA routing with timing division multiplexing technique," Proc. ICCAD, 2019.

[38] A. Volkov, S. Dolgov, L. Wang and B. Xu, "2019 CAD contest: LEF/DEF based global routing," Proc. ICCAD, 2019.

[39] C.-J. Hsu, C.-A. Wu, and C.-Y. Huang, "2020 CAD contest: X-value Equivalence Checking," Proc. ICCAD, 2020.

[40] K.-S. Hu and M.-J. Yang, "2020 CAD contest: Routing with Cell Movement," Proc. ICCAD, 2020.

[41] Y. Zhang, H. Ren, B. Keller, and B. Khailany, "2020 CAD contest: GPU Accelerated Logic Re-simulation," Proc. ICCAD, 2020.

[42] Y.-C Fang, S.-L Huang, C.-A. (Rocky) Wu, C.-H Chou, C.-J (Jacky) Hsu, W.-T (Wells) Jong, and K.-Y. Khoo, "2021 ICCAD CAD Contest Problem A: Functional ECO with Behavioral Change Guidance and Benchmark Suite," Proc. ICCAD, 2021

[43] K.-S. Hu, T.-C. Yu, M.-J. Yang, and C.-F. Cindy Shen,"2021 ICCAD CAD Contest Problem B: Routing with Cell Movement Advanced" Proc. ICCAD, 2021

[44] G. Pasandi, S. Pratty, D. Brown, Y. Zhang, H. Ren, and B. Khailany, "2021 ICCAD CAD Contest Problem C: GPU Accelerated Logic Rewriting" Proc. ICCAD, 2021

[45] C.-H. Chou, C.-J. (Jacky) Hsu, C.-A. (Rocky) Wu, and K.-H. Tu, "2022 ICCAD CAD Contest Problem A: Learning Arithmetic Operations from Gate-Level Circuit," Proc. ICCAD, 2022

[46] K.-S. Hu, I-J. Lin, Y.-H. Huang, H.-Y. Chi, Y.-H. Wu, and C.-F. Cindy Shen "2022 ICCAD CAD Contest Problem B: 3D Placement with D2D Vertical Connections," Proc. ICCAD, 2022

[47] S. Li, C. Bai, X. Wei, B. Shi, Y.-K. Chen, and Y. Xie, "2022 ICCAD CAD Contest Problem C: Microarchitecture Design Space Exploration," Proc. ICCAD, 2022