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Formalization of geometry, automated and interactive geometric reasoning

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Preface

This special issue of *Annals of Mathematics and Artificial Intelligence*, under the title *Formalization of Geometry, Automated and Interactive Geometric Reasoning*, is devoted to advances in different subareas of computer-supported reasoning in geometry.

As far back as the 1950's, computer-supported reasoning in geometry was one of the popular and challenging areas of artificial intelligence. Ideas in automated reasoning in geometry often promoted, introduced, or anticipated significant ideas applicable in much wider domains. This is still so with, for instance, new machine-learning approaches being applied to geometry. The importance of computer-supported reasoning in geometry comes also from applications in mathematical education and industrial applications like robotics.

The six articles in this special issue address various problems in computer-supported reasoning in geometry, ranging from discovering new theorems in Euclidean geometry, to solving construction problems in hyperbolic geometry. Parts of the work presented in some of these papers were introduced in earlier form at the 13th International Conference on Automated Deduction in Geometry (held online in Hagenberg in 2021).

- In the article *Automated discovery of angle theorems*, Philip Todd presents a new method, based on a suitable graph representation, for automated discovery of geometry theorems whose premises and statements comprise a set of bisector conditions.
- Philip Todd contributes another paper *A program to create new geometry proof problems* in which he describes a program that creates new geometry proof problems. Its central algorithm takes as input a sparse rank deficient matrix corresponding to a set of angle bisector conditions, and outputs a collection of geometry problems, each incorporating diagram and problem description.
- In the article *Automated generation of illustrated proofs in geometry and beyond*, Predrag Janičić and Julien Narboux propose a new approach and a tool for automated generation of proofs along with illustrations. The tool is built upon a theorem prover for coherent

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logic and can be used not only for geometry, but also for other mathematical fields which can have useful visualizations.

- In the paper *Automated triangle constructions in hyperbolic geometry*, Vesna Marinković, Tijana Šukilović and Filip Marić describe a system for automated ruler and compass triangle constructions in hyperbolic geometry. They discuss key differences between constructions in Euclidean and hyperbolic settings, compile a list of primitive constructions and lemmas used for constructions in hyperbolic geometry, build an automated system for solving construction problems, and test it on a corpus of triangle-construction problems.
- In the work *Towards a geometry deductive database prover*, Pedro Quaresma and Nuno Baeta report on their work on a prover based on geometry deductive database method, that aims to be efficient, flexible, open-source, and capable of generating readable proofs and corresponding visualization.
- In the paper *Local critical analysis of inequalities related to the sum of distances between n points on the unit hemisphere for* $n = 4, 5$, the authors Zhenbing Zeng, Yaochen Xu, Jian Lu, Yuzheng Wang, and Liangyu Chen study a geometrical inequality conjecture which states that for any four points on a hemisphere with the unit radius, the largest sum of distances between the points is $4 + 4\sqrt{2}$, and for any five points, the largest sum is $5\sqrt{5 + 2\sqrt{5}}$.

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