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Avi Wigderson* (avi@ias.edu). *Proving algebraic identities.*

In numerous mathematical settings, an object typically has several representations. The word (or isomorphism) problem asks: when are two given representations equivalent? Such problems have driven much structural and algorithmic research across mathematics.

We focus on the algebraic setting: our objects are polynomials and rational functions in many variables, represented by arithmetic formulae. Here the word problem is proving algebraic identities. I will describe the history, motivation and the status of this problem in two settings: when the variables commute, and when they do not.

For commuting variables, a probabilistic polynomial time algorithm was known, and a major open problem is to find a deterministic counterpart. To explain this we'll visit the VP versus VNP problem, permanents vs. determinants and more.

For non-commuting variables, I will describe a recent deterministic polynomial time algorithm based on the ideas of the first lecture, appealing to the theory of free skew fields and to degree bounds on invariant rings of linear group actions.

Finally, we'll see how the two settings are related!

This talk is self-contained, and requires no special background. The new material covered is taken mostly from <https://arxiv.org/abs/1511.03730>

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