Review of: "SAT is as hard as solving Homogeneous Diophantine Equation of Degree Two"

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The article establishes the NP-completeness of three problems - Monotone Exact XOR 2-SAT (EX2SAT), Zero-One Homogeneous Diophantine Equation (HDE), and Bounded Homogeneous Diophantine Equation (BHDE) - through a chain of polynomial-time reductions from the monotone version of the Not-All-Equal 3-Satisfiability Problem (NAE-3SAT), which is known in the literature to be NP-complete. The author also presents code applying ideas from the above reductions to solving instances of P-Selective SAT through optimization methods.

The main content of the paper (Sections 1-5) appears to be correct, and the introduction provides sufficient background for these sections. The following are some further comments on the details of the article:

- The proof of *Theorem 2* in the paper contains a clash of notation, where c_i is used to denote both the clause as well as a new variable; the new variables can be renamed to d, e, f or a', b', c' to avoid this conflict.
- It would be interesting, though not necessary, to provide motivation in *Theorem 2* for the construction of the clause d_i from c_i.
- The claim that the clause c_i has exactly at least one true literal and at least one false literal if and only if d_i has exactly one unsatisfied clause has been verified by this reviewer using a computer.
- The proof of the reduction in *Theorem 2* crucially rests on the fact that the clauses d_i themselves are unsatisfiable; however, this has not been mentioned or proved in the paper. It would be helpful to include this detail.
- This reviewer was able to build and run the Scala and Julia code in the repository linked the paper (using JDK 8, as mentioned in the README file), with results similar to those mentioned in the README.
- As the author mentions that the code forms an important part of the article, it would be useful to have a dedicated section for it containing more details (instead of including it in the conclusion).
- The P-Selective SAT problem is not defined in the paper when it is mentioned in the conclusion. As literature on this problem appears to be scarce, including a short description on it would help make the paper more self-contained.
- The code appears to be solving instances of NAE-3SAT, produced via instances of SAT, by finding the maximum of a function of the form $\sum_{i=1}^{n}\left((a_i - b_i)^2 + (b_i - c_i)^2 + (a_i - c_i)^2 - 2\right)$ restricted to the unit hypercube in a high-dimensional Euclidean space. This is used to decide which of two input Boolean formulas is satisfiable, given that exactly one of them is, by comparing the maximum values of the functions constructed out of them. Further discussion on the code would be a welcome addition to the article (alternatively, it can be included in the README file or the source-code

comments).

- The article contains a few minor typographic and grammatical errors which can be rectified.

Overall this is an interesting proof of NP-completeness relating homogeneous Diophantine equations to SAT which has been coupled with code for practically solving problems concerning Boolean satisfiability by mapping them to ones involving polynomials.