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Proposed Dissertation Title: Disjoint NP Pairs
Proposed Dissertation Abstract:

A disjoint NP pair is a pair of sets (A,B) where $A\cap B=\emptyset$ and both A and B are in NP - the complexity class that consists of languages that have polynomial time verification algorithms. A separator of a disjoint NP pair is a set S where $A\subseteq S\subseteq \overline{B}$. Two central problems in this area of research is how hard it is to separate disjoint NP pairs and what's the relation between the hardness of disjoint NP pairs and some properties of certain complexity classes (NP,co-NP).
Another interesting aspect in this area of research is the study of reducibilities (many-one, Turing, etc) between disjoint NP pairs and existence of complete disjoint NP pairs under various reductions. As for other complexity classes, it is interesting to study the separation of different reductions between disjoint NP pairs.

An unsolved conjecture states that there are no NP-hard disjoint NP pairs, which the non-existence of secure public-key cryptosystems. This is one of the motivations for this area of research. The other motivation comes from proof theory. It's known that the existence of optimal proof systems implies the existence of completet disjoint NP pairs under many-one reductions. But it's not known yet if the converse holds even though we know it will not have a easy proof if it holds. So if we can show the non-existence of many-one complete disjoin NP pairs, it will solve a very important problem in proof theory: optimal proof systems do not exist.

My research will mainly focus on the hardness of disjoint NP pairs and separation of reductions between disjoint NP pairs.