# Summary

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**Summary** My main research interests lie in the field of complexity theory. Specifically, I'm interested in constructing efficient algorithms for NP-hard problems and proving lower and upper bounds on the circuit size of explicit Boolean functions. Since it is still unknown whether the complexity classes P and NP are equal or not we currently have no polynomial time algorithms for NP-hard problems nor a proof that such algorithms do not exist. Moreover, for some problems the best known algorithm is just a brute force search for all potential solutions. At the same time known lower bounds on computation complexity of many problems are just trivial. The best known lower bound $3n - o(n)$ on the circuit size of an explicit function $f: \{0,1\}^n \to \{0,1\}$ was proved by Blum more than 30 years ago.

**Past research** In the field of circuit complexity we gave, together with several coauthors, much more simpler proofs of the best known lower bound $3n - o(n)$ and $5n - o(n)$ for circuit over the full binary basis $B_2$ and the basis $U_2 = B_2 \setminus \{\equiv, \oplus\}$. In our proofs, the bound $3n - o(n)$ is given for an affine disperser for sublinear dimension, while the bound $5n - o(n)$ is proved for a simple linear function. We get an elementary proof of a $7n/3$ lower bound for a wide class of Boolean functions of high degree. We showed why some natural extensions of Khrapchenko's method do not allow to get stronger than quadratic lower bounds on de Morgan formula size. We also improved known upper bounds for circuit complexity of symmetric Boolean functions. In particular, we improved the $5n$ upper bound to $4.5n$. In the field of algorithms for NP-hard problems we improved known upper bounds for several NP-hard problems including the maximum cut problem, the maximum satisfiability problem, the satisfiability problem, the graph coloring problem, the traveling salesman problem, the shortest common superstring problem.

**Future research plans** At the moment I continue doing research on both strands. In the field of circuit complexity I'm trying to improve known lower bounds on circuit complexity. One possible approach is to construct a function that survives under not only linear substitutions but also short quadratic substitutions. I'm also trying to improve the upper bound $4.5n$ for all symmetric functions. In the field of algorithms for NP-hard problems I'm currently working on the complexity of graph homomorphism problem and the shortest common superstring problem. We are going to prove stronger upper bounds for special cases and prove lower bounds for the general case of the homomorphism problem under the Exponential Time . For the problem of the shortest common superstring we are investigating both exact and approximation algorithms.