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Guest Editorial for "Group Testing: models and applications"

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The search model known as group testing has recently seen a new raising interest in several areas of computer science with new applications in pattern matching, data structures for static membership, communication protocols and more. Group testing and group testing like models have also proved useful in furthering new fertile fields like streaming computation and compressed sensing. The use of randomness extraction structures for group testing has provided new stimulus in the field.

The basic group testing problem is about identifying a set of positive elements in a given search space by means of tests or queries asking whether a certain subset includes at least one of the positive elements. In a broad sense we can rephrase group testing as the problem of determining some special substructure within a large structure. Due to its foundational characters it is not surprising that the basic structures for group testing are rediscovered in very different scenarios. In this respect, group testing also serves as a perfect ground for cross-fertilization among different fields of research.

This special issue consists of 7 papers focussing on different aspects of group testing and the combinatorial structures at the basis of group testing models.

In "Unbounded Contention Resolution in Multiple-Access Channels," the authors study the problem of resolving the contention arising when a set of users try to use a shared resource which can only be accessed by one user at a time. They prove optimality of two protocols for content resolution in radio networks assuming that the

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users have no collision detection available nor information on the number of possible contenders. The protocols are also evaluated via simulation confirming the tightness of the bounds analyzed and the low complexity of the protocol for many system sizes.

In "Rounds in Combinatorial Search," the author gives a characterization of systems of membership queries such that there exists a $k \geq 3$ for which all the tests have to be asked in order to identify an initially unknown element by only using queries from the systems organized in at most k rounds. The characterization is in terms of traces of the hypergraphs defined by set systems (defined by the membership query system).

In "Two New Perspectives on Multi-Stage Group Testing," optimal group testing strategies are investigated for specific sizes of the search space, in contrast to asymptotic analysis. Analyzing a variant of group testing, called strict group testing, the authors show that, especially for small search spaces, randomized strategies can save many tests on average and, moreover, the only randomization needed is a random permutation of the search space. Tight bounds are also provided for another model of multi-stage group testing where tests in the same stage have to be disjoint.

Efficient two-stage group testing algorithms have been employed in rapid and less-expensive DNA library screening and other large scale biological applications. These types of strategies are studied in "Efficient Two-Stage Group Testing Algorithms for Genetic Screening," where the author focuses on the minimization of the number of individual tests at the second stage of a two-stage disjunctive testing procedure.

Also motivated by analysis of DNA is the model studied in "Synthetic Sequence Design for Signal Location Search". The authors consider a variant of group testing where the positives are assumed to be consecutive elements of a sequence. The new design they provide is used in combination with balanced Gray codes and large scale synthesis for identifying the locations of critical DNA or RNA sequence signals. The efficiency and generality of the new procedure proposed is demonstrated also via experiments in polio and adenovirus.

Many recent advances in the efficient design of non-adaptive group testing schemes were achieved via the exploitation of combinatorial structures for randomness extraction, like expanders, condensers and the like. In "Improved Constructions for Non-adaptive Threshold Group Testing," the author employs state of the art explicit constructions of lossless condensers and achieves best known non-adaptive and noise-resilient strategies for threshold group testing. This is a variant of the group testing model with two additional parameters $0 \leq l \leq u$. A test is positive if it contains at least u positives; it is negative if it contains up to l positives and behaves arbitrarily in the remaining cases.

Group testing has also proven useful in cryptographic applications. The problem of designing an efficient broadcast encryption scheme which is also capable of tracing traitors is addressed in "Black-box Trace and Revoke Codes". Combinatorial objects called (r, s)-disjunct matrices are employed which capture both the traceability of a disjunct matrix and the additional requirement of revocation.

We believe that the selection of papers contained in the special issue represents an excellent example of the variety of research gravitating around this fields and it will also provide an access point to scientists and practitioners involved in other problems where ideas originated in group testing might also be beneficial.