Publications of Katrin Casel

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Journal articles


Classical clustering problems search for a partition of objects into a fixed number of clusters. In many scenarios, however, the number of clusters is not known or necessarily fixed. Further, clusters are sometimes only considered to be of significance if they have a certain size. We discuss clustering into sets of minimum cardinality $k$ without a fixed number of sets and present a general model for these types of problems. This general framework allows the comparison of different measures to assess the quality of a clustering. We specifically consider nine quality-measures and classify the complexity of the resulting problems with respect to $k$. Further, we derive some polynomial-time solvable cases for $k = 2$ with connections to matching-type problems which, among other graph problems, then are used to compute approximations for larger values of $k$.


This paper studies Upper Domination, i.e., the problem of computing the maximum cardinality of a minimal dominating set in a graph with respect to classical and parameterised complexity as well as approximability.


A vertex $v \in V(G)$ is said to distinguish two vertices $x, y \in V(G)$ of a graph $G$ if the distance from $v$ to $x$ is different from the distance from $v$ to $y$. A set $W \subseteq V(G)$ is a total resolving set for a graph $G$ if for every pair of vertices $x, y \in V(G)$, there exists some vertex $w \in W - \{x, y\}$ which distinguishes $x$ and $y$, where $W$ is a weak total resolving set if for every $x \in V(G) - W$ and $y \in W$, there exists some $w \in W - \{y\}$ which distinguishes $x$ and $y$. A weak total resolving set of minimum cardinality is called a weak total metric basis of $G$. Our main contributions are the following ones: (a) Graphs with small and large weak total metric bases are characterised. (b) We explore the (tight) relation to independent 2-domination. (c) We introduce a new graph parameter, called weak total adjacency dimension and present results that are analogous to those presented for weak total dimension. (d) For trees, we derive a characterisation of the weak total (adjacency) metric dimension. Also, exact figures for our parameters are presented for (generalised) fans and wheels. (e) We show that for Cartesian product graphs, the weak total (adjacency) metric dimension is usually pretty small. (f) The weak total (adjacency) dimension is studied for lexicographic products of graphs.

Conference papers


This paper considers the effect of non-metric distances for lower-bounded clustering, i.e., the problem of computing a partition for a given set of objects with pairwise distance, such that each set has a certain minimum cardinality (as required for anonymisation or balanced facility location problems). We discuss lower-bounded clustering with the objective to minimise the maximum radius or diameter of the clusters. For these problems there exists a 2-approximation but only if the pairwise distance on the objects satisfies the triangle inequality, without this property no polynomial-time constant factor approximation is possible. We try to resolve or at least soften this effect of non-metric distances by devising particular strategies to deal with violations of the triangle inequality ("conflicts"). With parameterised algorithms, we find that if the number of such conflicts is not too large, constant factor approximations can still be computed efficiently. In particular, we introduce parameterised approximations with respect to not just the number of conflicts but also for the vertex cover number of the "conflict graph" (graph induced by conflicts). Interestingly, we salvage the approximation ratio of 2 for diameter while for radius it is only possible to show a ratio of 3. For the parameter vertex cover number of the conflict graph this worsening in ratio is shown to be unavoidable, unless FPT=W[2]. We further discuss improvements for diameter by choosing the (induced) $P_3$-cover number of the conflict graph as parameter and complement these by showing that, unless FPT=W[1], there exists no constant factor parameterised approximation with respect to the parameter split vertex deletion set.


Unit square (grid) visibility graphs (USV and USGV, resp.) are described by axis-parallel visibility between unit squares placed on integer grid coordinates in the plane. We investigate combinatorial properties of these graph classes and the hardness of variants of the recognition problem, i.e., the problem of representing USGV with fixed visibilities within small area and, for USV, the general recognition problem.
This paper studies Upper Domination, i.e., the problem of computing the maximum cardinality of a minimal dominating set in a graph, with a focus on parameterised complexity. Our main results include \( W[1]\)-hardness for Upper Domination, contrasting \( \text{FPT} \) membership for the parameterised dual Co-Upper Domination. The study of structural properties also yields some insight into Upper Total Domination. We further consider graphs of bounded degree and derive upper and lower bounds for kernelisation.

In this paper, we survey and supplement the complexity landscape of the domination chain parameters as a whole, including classifications according to approximability and parameterised complexity. Moreover, we provide clear pointers to yet open questions. As this posed the majority of hitherto unsettled problems, we focus on Upper Irredundance and Lower Irredundance that correspond to finding the largest irredundant set and resp. the smallest maximal irredundant set. The problems are proved \( \text{NP}\)-hard even for planar cubic graphs. While Lower Irredundance is proved not \( \log(n)\)-approximable in polynomial time unless \( \text{NP} \subseteq \text{DTIME}(n^{\log \log n}) \), no such result is known for Upper Irredundance. Their complementary versions are constant-factor approximable in polynomial time. All these four versions are \( \text{APX}\)-hard even on cubic graphs.

It is shown that the shortest-grammar problem remains \( \text{NP}\)-complete if the alphabet is fixed and has a size of at least 24 (which settles an open question). On the other hand, this problem can be solved in polynomial-time, if the number of nonterminals is bounded, which is shown by encoding the problem as the problem on graphs with interval structure. Furthermore, we present an \( \text{O}(3^n)\) exact exponential-time algorithm, based on dynamic programming. Similar results are also given for 1-level grammars, i.e., grammars for which only the start rule contains nonterminals on the right side (thus, investigating the impact of the "hierarchical depth" on the complexity of the shortest-grammar problem).

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This paper discusses a problem arising in the field of privacy-protection in statistical databases: Given a \( n \times m \) \( \{0,1\}\)-matrix \( M \), is there a set of mergings which transforms \( M \) into a zero matrix and only affects a bounded number of rows/columns. "Merging" here refers to combining adjacent lines with a component-wise logical AND. This kind transformation models a generalization on OLAP-cubes also called global recoding. Counting the number of affected lines presents a new measure of information-loss for this method. Parameterized by the number of affected lines \( k \) we introduce reduction rules and an \( \text{O}^{\ast}(2.618^k)\)-algorithm for the new abstract combinatorial problem LMAL.