Preface to Special Issue on Theory and Applications of Graph Searching

This special issue of *Theoretical Computer Science* contains papers selected from, but not limited to, work presented in the *8th International Workshop on Graph Searching: Theory and Algorithms* (GRASTA 2017), which took place in Anogia, Crete, Greece, from April 10 to April 13, 2017. This workshop series has established itself as the main forum on the field of Graph Searching, with a wide participation of researchers in several disciplines in Computer Science and in Mathematics.

In a graph searching game, a number of hiding entities that are sometimes called evaders, or fugitives, or hiders (depending on the application) hide in a domain that can be represented as a graph or a network. A number of seeking entities called searchers or pursuers aim to locate the evaders. In this context, the searchers aim to locate the evaders as efficiently as possible, where the concept of efficiency depends on the specific setting. Several variants of this fundamental game can be defined depending on the characteristics of the evaders and the searchers in terms of parameters such as the relative speed, visibility, sensor capabilities, etc.

Graph searching provides a rigorous framework for modeling concepts such as hiding, pursuing, sense of direction, collaboration and coalition formation. Graph searching thus provides the tools to model real-life activities such as search-and-rescue operations, coal mining, or motion planning in robotics. Thus, the field has several applications in the domains of Artificial Intelligence, and Operations Research. Equally important, it is driven by foundational issues rooted in Complexity Theory, Graph Theory, Analysis of Algorithms, and Discrete Mathematics.

This Special Issue received 14 submissions in total. All submissions were reviewed according to the highest standards of *Theoretical Computer Science*, and 8 submissions were accepted for publication. The Editorial Team ensured that the submissions were reviewed in a timely manner, and all final decisions were made within 17 months from the submission deadline. The selected papers cover a wide range of topics such as: Parameterized complexity of search games, Visibility parameters in searching, Cleaning and Spreading Games, Competitive analysis of online searching, Graph domination, Equilibria in search games, and Random walks. A more detailed description of the accepted papers, in order of final acceptance date, is as follows.

- The paper "How Many Zombies are Needed to Catch the Survivor on Toroidal grids?" by Pralat studies a probabilistic search game known as *Zombies and Survivors*, in which a number of "zombies" aim to locate a lone "survivor". The zombie number is of a graph is the minimum number of zombies needed so that the zombies win with probability at least 1/2. This game has been studied for several graph families, and this paper focuses on toroidal graphs. Improvements in the upper and lower bounds are presented, but as noted by the author, we are far from resolving this intriguing setting.

- In their paper titled "Bounds on the Burning Numbers of Spiders and Path-forests", Bonato and Lidbetter study the *burning number* of a graph, which can measure the speed of contagion in social networks. It is conjectured that the burning number of a graph of order n is at most $\lceil \sqrt{n} \rceil$, but this question remains open for several graph families. The paper proves the conjecture for the class of spider graphs, and provides also a 3/2 approximation on the burning number of path forests.

- The paper "Search for an Immobile Hider in a Known Subset of a Network" by Alpern considers the setting in which a unit-speed searcher, constrained to start in a given set S, aims to locate a point x known to lie in a given subset of a metric network Q. This defines a game in which the payoff to the hider is the time for the searcher to locate x. The paper resolves this problem for tree networks, which generalizes known results by Gal and Dagan and Gal.

- Lamprou, Martin, and Schewe in their paper "Perpetually Dominating Large Grids" study the *Eternal Domination* game, in which a team of "guards" must defend against attacks in a domain modeled by a graph. The difficulty lies in establishing a robust guards' placement in order to retain domination after each attack, by perpetually occupying vertices of a dominating set. The paper studies grid graphs and shows that a square rotation principle eternally dominates $m \times n$ grids by using approximately $\frac{mn}{5}$ guards, which is asymptotically optimal.

- Dereniowski, Gavenčiak and Kratochvíl in their paper "Cops, a Fast Robber and Defensive Domination on Interval Graphs" explore and extend two independent areas concerning the class of interval graphs, namely a version of the Cops and Robber game in which the robber is infinite-fast, and the concept of *defensive domination*. The paper shows how to solve, in polynomial time, the latter problem for interval graphs, which in turn can be used to show that the former is decidable in polynomial time, thus answering an open question due to Fomin *et al.*

- The paper "Hyperopic Cops and Robbers" by Bonato, Clarke, Cox, Finbow, Mc Inerney, and Messinger introduces a variant of the Cops and Robbers game on graphs in which the robber is invisible unless outside the neighbor set of a cop (hence the cops are "hyperopic", or farsighted). The hyperopic cop number is the corresponding analogue of the cop number, and the paper investigates bounds and other properties of this parameter, for several graph classes.

- In their paper titled "Firefighting on Trees", Coupechoux, Demange, Ellison, and Jouve consider the *firefighting problem*, in which a fire spreads through a tree graph while a player chooses which vertices to protect in order to contain it. The paper first studies the online variant of this problem, in which the number of firefighters available at each turn is revealed over time. Next, the authors show conditions for separating two firefighting sequences, in the sense of presenting a tree for which one sequence can contain the fire, whereas the other cannot. Finally, the paper gives sufficient conditions for the fire to be contained, expressed as the asymptotic comparison of the number of firefighters and the size of the tree levels.

- The paper "Finding Small-Width Connected Path Decompositions in Polynomial Time" by Dereniowski, Osula and Rzążewski studies connected graph decompositions in a simple graph. The connected pathwidth of the graph is then the minimum width over all connected path decompositions. The paper answers, in the affirmative, an open question proposed by Fedor Fomin at the GRASTA 2017 workshop, namely whether we can verify, in polynomial time, if the connected pathwidth of a given graph is at most k, for fixed constant k.

We are hopeful that the papers selected for this Special Issue will motivate further advances in the exciting field of Graph Searching.

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