30th May 2010

Dear Dr. Pascual,

I am writing to apply for the position as postdoctoral researcher for the research project Combinatorial Optimization with competing agents (COCA) which you advertised via DMANET. I have recently been awarded a PhD from the Computer Science Department at the University of Ioannina, Greece, under the supervision of Professor Stavros D. Nikolopoulos. My research interests include algorithms, graphs, combinatorial optimization and complexity theory, with special interest in algorithmic graph theory. Also, I am particularly interested in broadening my research agenda to include algorithmic game theory problems. I believe that my research background makes me a strong candidate for the advertised position.

As my curriculum vitae shows, I completed my PhD on December 2009. My previous studies include an MSc in Analysis, Design & Management of Information Systems from LSE, UK, and an undergraduate degree in Mathematics from the Aristotle University of Thessaloniki, Greece. During my PhD studies, I was part of a group working on the research project Design and Implementation of Efficient Algorithms for Recognition and Optimization Problems on Perfect Graphs co-financed by the E.U.- European Social Fund and the Greek Ministry of Development.

My current research focus is on algorithmic graph theory, with particular interest in the complexity of optimization problems on classes of perfect graphs. Specifically, my work includes defining and characterizing two new classes of perfect graphs, namely colinear and linear graphs, and providing polynomial-time algorithms or NP-completeness results for various types of the coloring problem on graphs. My most recent work focuses on designing polynomial-time algorithms for the longest path problem on known and important classes of perfect graphs. While my research agenda for the future includes extending some of my previous results to answer some questions left open, I am also particularly interested in broadening my research interests into algorithmic game theory problems. Below I briefly describe some of my research contributions; the published papers describing these results can be found in my list of publications.

Colinear Coloring and Colinear Graphs. Motivated by the definition of linear coloring on simplicial complexes, recently introduced in the context of algebraic topology, and the framework through which it was studied, we introduced the colinear coloring on graphs. The colinear coloring of a graph G is a vertex coloring such that two vertices can be assigned the same color, if their corresponding clique sets are associated by the set inclusion relation (a clique set of a vertex u is the set of all maximal cliques containing u); the colinear chromatic number $\lambda(G)$ of G is the least integer k for which G admits a colinear coloring with k colors. We proved that for any graph G, $\lambda(\overline{G}) \geq \chi(G)$, providing thus an upper bound for the chromatic number $\chi(G)$ of G, and showed that any graph G can be colinearly colored in polynomial time by proposing a simple algorithm. Based on the colinear coloring, we defined the χ-colinear and α-colinear properties and characterized known graph classes in terms of these properties.

Based on these results and the definition of perfect graphs (a graph G is perfect if and only if $\chi(G_A) = \omega(G_A)$, $\forall A \subseteq V(G)$, where $\omega(G)$ is the clique number of G), we studied those graphs which are characterized completely by the χ-colinear or the α-colinear property, and concluded that these graphs form two new classes of perfect graphs, which we call colinear and linear graphs. A graph G is called colinear if and only if $\chi(G_A) = \lambda(\overline{G}_A)$, $\forall A \subseteq V(G)$. A graph G is called linear if and only if $\alpha(G_A) = \lambda(G_A)$, $\forall A \subseteq V(G)$; note that $\alpha(G)$ is the stability number of G. We provided characterizations for colinear and linear graphs and proved structural properties in terms of forbidden induced subgraphs. An interesting question for future work would be to study structural and recognition properties of colinear and linear graphs and see whether they can be characterized by a finite set of forbidden induced subgraphs. Moreover, an obvious though interesting open question would be whether combinatorial and/or optimization problems can be efficiently solved on the classes of colinear and linear graphs.

The Harmonious Coloring Problem. A harmonious coloring of a simple graph G is a proper vertex coloring such that each pair of colors appears together on at most one edge. The harmonious chromatic number is the least integer k for which G admits a harmonious coloring with k colors. Extending previous work on the NP-completeness of the harmonious coloring problem when restricted to the class of disconnected graphs which are simultaneously cographs and interval graphs, we proved that the problem is also NP-complete for connected interval and permutation graphs. We also showed that the harmonious coloring problem is NP-complete on split graphs.

In the sequence we extended our results for the harmonious coloring problem on subclasses of chordal and co-chordal graphs, by proving that the problem remains NP-complete for split undirected path graphs; we also proved that the problem is NP-complete for colinear graphs by showing graph class inclusion relations. Moreover, we provided a polynomial solution for the harmonious coloring problem for the class of split strongly chordal graphs, the interest of which lies on the fact that the problem is NP-complete on both split and strongly chordal graphs. In addition, polynomial solutions for the problem are only known for the classes of threshold graphs and connected quasi-threshold graphs; note that, the harmonious coloring problem is NP-complete on disconnected quasi-threshold graphs. Since linear graphs form a superclass of both quasi-threshold graphs and split strongly chordal graphs, the harmonious coloring problem is NP-complete on disconnected linear graphs, while it still remains open on connected linear graphs.

The Longest Path Problem. The longest path problem is the problem of finding a path of maximum length in a graph. A well studied problem in graph theory with numerous applications is the Hamiltonian path problem, i.e., the problem of determining whether a graph is Hamiltonian; a graph is said to be Hamiltonian if it contains a Hamiltonian path, that is, a simple path in which every vertex of the graph appears exactly once. Even if a graph is not Hamiltonian, it makes sense in several applications to search for a longest path, or equivalently, to find a maximum induced subgraph of the graph which is Hamiltonian. However, finding a longest path seems to be more difficult than deciding whether or not a graph admits a Hamiltonian path. The longest path problem is NP-hard on every class of graphs on which the Hamiltonian path problem is NP-complete. In contrast to the Hamiltonian path problem, there are few known polynomial time solutions for the longest path problem, and these restrict to trees and some small graph classes. We have shown that the longest path problem on interval graphs has a polynomial solution, thus, answering the question left open by Uehara and Uno in (Proc. of the 15th Annual International Symp. on Algorithms and Computation (ISAAC), LNCS, vol. 3341, pp. 871883, 2004).

Moreover, we have studied the longest path problem on the class of cocomparability graphs, a well-known class of perfect graphs which includes both interval and permutation graphs. Although the Hamiltonian path problem on cocomparability graphs was proved to be polynomial almost two decades ago (P. Damaschke *et al.*, Order, vol. 8, pp. 383-391, 1992), the complexity status of the longest path problem on cocomparability graphs has remained open until recently; actually, the complexity status of the longest path problem has been open even on the more special class of permutation graphs. In our most recent work, we present a polynomial-time algorithm for solving the longest path problem on the class of cocomparability graphs. This result extends our polynomial solution of the longest path problem on interval graphs, and resolves the open question for the complexity of the problem on cocomparability graphs, and thus on permutation graphs.

I am enthusiastic about broadening my research agenda to include algorithmic game theory, and with my experience in algorithmic graph theory, combinatorial optimization, and complexity theory, I hope to make valuable contributions to this field.

Thank you for your consideration and I look forward to hearing from you.

Sincerely,

Kyriaki Ioannidou