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Evaluation of Ioannis Caragiannis

This is an assessment of Dr Ioannis Caragiannis' research who is considered for a promotion to the rank of Associate Professor at the University of Patras.

In a nutshell, Dr Caragiannis is one of the very best young researchers in Europe in theoretical computer science. Had he been in another top European university with a less rigid academic system than the Greek one, he would have been promoted to associate professor years ago.

Dr Caragiannis' research interests are broad; his more important work is in the areas of algorithmic game theory and approximation and online algorithms. He has a very rich publication record. His work is published in the top conferences and journals of the field and it is widely recognized and cited. I will describe below some of his best publications.

In his paper on taxes [ESA 2006], he considers the question of improving the Price of Anarchy of a discrete (atomic) congestion game by levying taxes. The paper successfully addresses the question that has been considered before for the easier class of non-atomic games. This work extends my work (joint work with George Christodoulou) on the Price of Anarchy of these games. Incidentally, another paper by Dr Caragiannis on selfish and greedy load balancing [ICALP 2006], also improves and tightens some results of my aforementioned work.

The Price of Anarchy is simply the approximation ratio achieved by selfish solutions but it can be useful as a design tool when we are allowed to apply certain changes to the game. Following this approach and by generalizing the idea of taxes, Christodoulou and myself proposed coordination mechanisms as a framework to deal with selfishness. Despite the appeal of this notion to computer scientists, very little is known about coordination mechanisms; the technical problems that arise seem to be very hard. Some of the few positive results on coordination mechanisms were obtained by Dr Caragiannis in a single-authored paper in SODA 2009 were he improved the Price of Anarchy of coordination mechanisms for unrelated machines.

In his EC 2011 work, he deals with the problem of quantifying the efficiency

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of the Generalized Second Price (GSP) auction. This very important auction is used by the search engines to select the ads of each search result. It resembles the Vickrey (or second-price auction), but unlike the Vickrey auction it is not truthful. This raises the challenging problem of understanding the consequences of its untruthfulness. Dr Caragiannis' work targets this problem from the Price of Anarchy point of view: how inefficient are the equilibria of the resulting game. In his work, he considers Nash and more general equilibria in the incomplete as well as in the full information regimes, and he gives strong bounds on the Price of Anarchy. This work exhibits his technical strength and his good taste in selecting research problems. The results on this work strengthen weaker results that were previously obtained by Leme and Tardos in FOCS 2010.

In his EC 2012 work, he addresses the problem of designing mechanisms with verification. The central problem in designing algorithms for selfish agents is to find a way to deal with truthfulness, because the agents may provide incorrect values that suit their own objective. One way to deal with this problem is to incentivize the agents by payments. This approach however has not proved very successful in most situations, and its actual limits remain a major open problem in Economics; this is the characterization problem of truthful mechanisms. Another way to deal with the problem is to enhance the mechanism with some verification procedure that will penalize the agents for lying. Amazingly, some fundamental questions about probabilistic verification in mechanisms have not been addressed before. This work provides a concrete model to formalize probabilistic verification, for which it gives a complete characterization of the truthful mechanisms, similar in spirit with the characterization by Rochet of truthful classical mechanisms. As it is the case with the Rochet characterization, this characterization is complete, yet it may not be suitable for understanding the power of these mechanisms. In any case, this work is a concrete step in understanding the power of verification in mechanisms.

His FOCS 2011 paper is different in spirit from the above mentioned work. It addresses computational issues of congestion games. Finding polynomial-time algorithms to compute a Nash equilibrium is a difficult problem (i.e., it is PPAD-complete for general 2-player games). Solving the problem for games that are given implicitly is even more difficult. For special classes of games, such as congestion games, this could be possible. However this particular problem is known to be PLS-complete, a fact that dashes our

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hopes for a positive result. Yet, in this paper, a polynomial-time algorithm is given for the relaxation of the problem in which we seek approximate Nash equilibria. One of the few rare positive results in computational game theory.

Finally, let me mention the work of Dr Caragiannis that addresses the classical online problem of load balancing on unrelated machines [SODA 2008]. This problem has nothing to do with games, yet in an ingenious solution, Dr Caragiannis connects this problem with recent approaches for bounding the Price of Anarchy to improve the upper bounds on this long-standing open problem.

Dr Caragiannis' taste of research problems is very good. Also, time and again he has proved that he is very capable in following, tightening, and cleaning up results, demonstrating his strong technical abilities. He has already done some path-breaking work; for example, by applying tools from the Price of Anarchy to the classical problem of scheduling. And I am sure, that as he becomes more mature and confident, he will become more active in shaping the research agenda of the community.

To summarize, Dr Caragiannis is a talented researcher who has made significant contributions. He is one of the best young researchers in Europe in algorithmic game theory. He is both independent, as his single-authored papers demonstrate, and very cooperative in small or large groups, as his publication and funding record indicate. I very strongly recommend his promotion to the rank of associate professor at the University of Patras.

Yours sincerely,

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