Abstract Details

Title: Identifying Novel Graph Properties and Solving Graph Isomorphism for Hard Instances of Symmetrical Graphs

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Abstract: Applications of graph theory are ubiquitous however, many unsolved problems cap its utility. One of these is to say whether two graphs are isomorphic or not by using graph invariants within polynomial time. It is extremely difficult as the quest for a complete graph invariant which can distinguish graphs uniquely and is still easy to calculate is not complete. Here, in this paper, we discuss some of the important existing graph invariants and show how they fail in the case of regular graphs. Also, we have discovered some new graph invariants (First Order Cyclical Shapes, First Order Participation Number, Second Order Cyclical Shapes, Second Order Participation Number and Neighbourhood Cluster Analysis) that can be used as complete graph invariants for highly symmetrical graphs. The complexity to calculate our proposed invariants increases merely in polynomial manner with respect to the input size of graph. These invariants can act as stepping stones to test for graph isomorphism. A method to shift the runtime complexity of graph isomorphism from non-polynomial space to polynomial space would have wide ranging effects. Such methods will eventually develop significant advancements in the field of cryptography, automata theory, compilers, image processing etc. and in future can also be modified to develop a solution for complete Graph Isomorphism problem in polynomial time.

Keywords: Graph theory, graph isomorphism, Generalised Johnson graphs, graph invariant, strongly regular graphs.