Covering Arrays on Direct Product Graphs

Raina Mary Thomas

p20220019@goa.bits-pilani.ac.in

Department of Mathematics, Birla Institute of Technology and Science Pilani, K K Birla Goa Campus, India

(Joint work with Yasmeen Akhtar.)

Covering arrays (CAs) are widely recognized combinatorial designs that facilitate efficient test suite generation in software testing. For a positive integer n and a set S of size g, a *covering array on a graph* $G = (V, E)$ of size n and alphabet size g, denoted $CA(n, G, g)$, is an $n \times |V|$ array with entries from S, where columns correspond to the vertices in V, such that for every edge $e \in E$, the sub-array indexed by the vertices of e contains all the ordered pairs from S^2 at least once, as a row. The smallest n for which such an array exists is the *covering array number of* G, denoted $CAN(G, g)$. This parameter represents the minimal test suite size in practical applications. The direct product of graphs $G_1, G_2, \ldots, G_k$, denoted by $G_1 \times G_2 \times \ldots \times G_k$, is the graph with vertex set $V(G_1) \times V(G_2) \times \ldots \times V(G_k)$, and for which vertices $(u_1, u_2, \ldots, u_k)$ and $(v_1, v_2, \ldots, v_k)$ are adjacent whenever $u_i v_i \in E(G_i)$, for each index i. We give a polynomial time approximation algorithm with approximation ratio $\frac{1}{k} \log |V|$ to construct a CA on a large graph $G = (V, E)$ obtained from the direct product of k smaller graphs. We also deduce some bounds on the covering array number of direct product graphs, as well as strong product hypergraphs and weak modular product graphs.

Keywords: Graph products; Covering Array; Approximation algorithm; Direct product;