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Rainbow connectivity: hardness and tractability.

Chakraborthy, Supraik (ed.) et al., IARCS annual conference on foundations of software technology and theoretical computer science (FSTTCS 2011), Mumbai, India, December 12–14, 2011. Wadern: Schloss Dagstuhl – Leibniz Zentrum für Informatik (ISBN 978-3-939897-34-7). LIPICS – Leibniz International Proceedings in Informatics 13, 241-251, electronic only (2011).

Summary: A path in an edge colored graph is said to be a rainbow path if no two edges on the path have the same color. An edge colored graph is (strongly) rainbow connected if there exists a (geodesic) rainbow path between every pair of vertices. The (strong) rainbow connectivity of a graph G, denoted by (src(G), respectively) $rc(G)$ is the smallest number of colors required to edge color the graph such that G is (strongly) rainbow connected. In this paper we study the rainbow connectivity problem and the strong rainbow connectivity problem from a computational point of view. Our main results can be summarised as below: 1) For every fixed $k \geq 3$, it is NP-complete to decide whether $\mathrm{src}(G) \leq k$ even when the graph G is bipartite. 2) For every fixed odd $k \geq 3$, it is NP-complete to decide whether $\mathrm{rc}(G) \leq k$. This resolves one of the open problems posed by Chakraborty et al. (J. Comb. Opt., 2011) where they prove the hardness for the even case. 3) The following problem is fixed parameter tractable: Given a graph G, determine the maximum number of pairs of vertices that can be rainbow connected using two colors. 4) For a directed graph G, it is NP-complete to decide whether $\mathrm{rc}(G) \leq 2$.

Keywords: computational complexity; rainbow connectivity; graph theory; fixed parameter tractable algorithms
doi:10.4230/LIPIcs.FSTTCS.2011.241