

# Rerouting Planar Curves and Disjoint Paths

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**Abstract:** In this paper, we consider a transformation of  $k$  disjoint paths in a graph. For a graph and a pair of  $k$  disjoint paths  $\mathcal{P}$  and  $\mathcal{Q}$  connecting the same set of terminal pairs, we aim to determine whether  $\mathcal{P}$  can be transformed to  $\mathcal{Q}$  by repeatedly replacing one path with another path so that the intermediates are also  $k$  disjoint paths. The problem is called `\textsc{Disjoint Paths Reconfiguration}`. We first show that `\textsc{Disjoint Paths Reconfiguration}` is  $PSPACE$ -complete even when  $k = 2$ . On the other hand, we prove that, when the graph is embedded on a plane and all paths in  $\mathcal{P}$  and  $\mathcal{Q}$  connect the boundaries of two faces, `\textsc{Disjoint Paths Reconfiguration}` can be solved in polynomial time. The algorithm is based on a topological characterization for rerouting curves on a plane using the algebraic intersection number. We also consider a transformation of disjoint  $s$ - $t$  paths as a variant. We show that the disjoint  $s$ - $t$  paths reconfiguration problem in planar graphs can be determined in polynomial time, while the problem is  $PSPACE$ -complete in general.

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