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Minimum Manhattan Network is NP-Complete

Given a set $T$ of $n$ points in $R^2$, a network $G$ is said to be a Manhattan network on $T$, if for all $p$, $q \in T$ there exists a Manhattan path, consisting of horizontal and vertical line segments, between $p$ and $q$ and all its line segments are in $G$. For a given network $G$, let the length of $G$, denoted by $L(G)$, be the total length of all the segments in $G$. For a given point set $T$, the Minimum Manhattan Network Problem is to find a Manhattan network $G$ on $T$ with minimum $L(G)$. Over the past ten years, whether this problem is NP-complete has been open, and there has been a vast amount of research devoted to the designing of approximation algorithms for this problem.

In this paper, we shall prove that this problem is strongly NP-complete, which implies that there does not exist FPTAS algorithms for this problem unless P=NP. The reduction is from the well-known 3-SAT problem, relying on six different gadgets in the reduction. The validity of the reduction has been confirmed with a computer program.