Optimizing Urban Accessibility: Constructing a 15-Minute City Using Steiner Tree Approximation

Prishaa Shrimali

Abstract

The concept of the 15-minute city (15-MC) aims to create urban environments where essential services are accessible within a 15-minute walk or bike ride from any point. This study explores an innovative approach to constructing a 15-minute city by leveraging the Steiner tree problem and its polynomial-time approximation. By focusing on connecting key amenities such as pharmacies, post offices, and supermarkets, our method efficiently minimizes the total travel time within a pedestrian network. The proposed approach significantly reduces computational complexity by prioritizing service locations over residential areas, resulting in detailed urban layouts that can be used as digital models for city planning. These models provide practical tools for optimizing mobility, service placement, and sustainable urban design. The method's effectiveness is demonstrated through its ability to generate detailed maps that highlight service accessibility, offering valuable insights for urban planners in creating more connected and accessible cities.

1 Introduction

Graph theory is a branch of mathematics that studies the properties and applications of graphs, which are abstract representations of a set of objects and the connections between them. In a graph, the objects are called vertices (or nodes), and the connections between them are called edges. Graphs can be used to model a wide variety of systems in which relationships between pairs of objects are significant. A graph can be directed, where the edges have a direction (indicating, for example, one-way streets in a city), or undirected, where the connections have no direction (as in two-way streets). See [1][2][3]for a thorough introduction.

When additional information, such as distance, cost, or time, is associated with each edge, the graph is referred to as a weighted graph. In a weighted graph, every edge is assigned a numerical value or weight that typically represents the cost of traversing the edge. This weight could represent physical distance, time required to travel, or any other metric relevant to the application. Weighted