



**Tecnológico
de Monterrey**

TECNOLÓGICO DE MONTERREY

Analysis and Design of Advanced Algorithms

Integrated Activity 2

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Introduction

The year 2020 was a landmark period for digital connectivity, especially in small towns, where the COVID-19 pandemic dramatically increased reliance on internet services. Addressing this surge, a specific program was developed, utilizing a set of algorithms each chosen for their unique strengths in optimizing network functionality. This essay delves into the reasons behind selecting each algorithm, demonstrating how they collectively contribute to an efficient, robust internet infrastructure.

The Need for Enhanced Internet Services

As the pandemic pushed many activities online, small towns faced the challenge of rapidly upgrading their internet infrastructure. This required not only expanding the network's reach but also ensuring its speed and reliability. The program in focus was designed to meet these needs by optimizing the network layout, data flow, and future scalability.

Strategic Algorithm Selection

The program employs four key algorithms, each selected for its specific ability to address a distinct aspect of network optimization:

Kruskal's Algorithm for Network Layout:

Choice Reasoning: Kruskal's algorithm was chosen over others like Prim's for its efficiency in handling sparse networks, common in small towns. It emphasizes minimal cable usage, which is essential for cost-effectiveness.

Function: It identifies the shortest, most direct connections between network points, avoiding unnecessary loops to minimize infrastructure costs.

Solving the Traveling Salesman Problem (TSP):

Choice Reasoning: The dynamic programming approach to TSP was selected for its precision in small-scale networks. It's preferred over heuristic methods because it guarantees the shortest possible route, crucial for efficiency in service delivery or maintenance tasks.

Function: Calculates the most efficient route to cover all network points, crucial for tasks like maintenance or data packet routing.

Edmonds-Karp Algorithm for Data Flow:

Choice Reasoning: Chosen for its ability to handle variable data flows, Edmonds-Karp is effective in determining the network's maximum data handling capacity. It's preferred over other flow algorithms like Ford-Fulkerson because it performs better in networks with many possible data paths.

Function: Determines the maximum volume of data that can move through the network, ensuring robust performance during high usage.

Delaunay Triangulation and Voronoi Diagrams for Expansion:

Choice Reasoning: These geometric algorithms are selected for their ability to model spatial relationships, crucial in planning network expansion in physically diverse small-town landscapes.

Function: They help identify optimal new connection points, considering geographical and existing infrastructure constraints.

Reflecting on the Approach

Each algorithm was carefully chosen not only for its standalone efficiency but also for how it complements the others, creating a holistic network optimization strategy. While these methods are well-suited for small-town scenarios, larger networks might require different approaches, such as more scalable versions of TSP or more dynamic data flow algorithms.

Conclusion

In conclusion, the program presents a well-rounded approach to upgrading internet infrastructure in small towns, with each algorithm playing a crucial role in addressing specific challenges. While highly effective in theoretical application, real-world deployments may require adjustments for physical and regulatory constraints. This program serves as a model of how strategic algorithm selection can significantly enhance digital connectivity in times of crisis, like during the COVID-19 pandemic.

