Application of Graph Theory to Solve Practical Problems

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***Abstract*—This thesis explores the application of graph theory to solve practical problems, focusing on the implementation of algorithms in Delphi. It covers the basics of graph theory, including bipartite matching problems and their solutions, as well as the implementation of these algorithms in a Delphi application for real-world scenarios such as taxi dispatch and academic course scheduling. The study delves into the fundamental concepts of graph theory, such as bipartite graphs and their applications, and employs the Hungarian algorithm and the Kuhn-Munkres algorithm to find optimal solutions. The Delphi application successfully implements these algorithms to solve the problems, demonstrating the effectiveness of graph theory in practical scenarios. The results show that the application can efficiently manage course scheduling and optimize taxi dispatch, highlighting the importance of graph theory in solving real-world problems.**

***Index Terms*—graph theory, bipartite matching, Delphi, Hungarian algorithm, Kuhn-Munkres algorithm, course scheduling**

I. Introduction

Graph theory is a well-developed branch of science with numerous practical applications. The thesis delves into the fundamental concepts of graph theory, particularly bipartite matching problems, and their practical implementations using Delphi programming. The study begins with an introduction to the basic concepts of graph theory, including the definition of graphs, types of graphs, and graph representations. It then focuses on bipartite matching problems, which are crucial for solving real-world problems such as taxi dispatch and academic course scheduling. The thesis employs Delphi programming to solve these practical problems, using algorithms such as the Hungarian algorithm and the Kuhn-Munkres algorithm to find optimal solutions. [1]

II. Methods

The thesis employs Delphi programming to solve practical problems, including taxi dispatch and academic course scheduling. It uses algorithms such as the Hungarian algorithm and the Kuhn-Munkres algorithm to find optimal solutions. The Hungarian algorithm is used to solve the assignment problem, where the goal is to find a perfect matching in a bipartite graph that minimizes the total cost. The Kuhn-Munkres algorithm is used to find the maximum matching in a bipartite graph, which is essential for course scheduling. The Delphi application is designed to handle these problems efficiently, with a user-friendly interface that allows users to input data and receive optimal solutions. [1]

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III. Results

The Delphi application successfully implements the algorithms to solve the problems, demonstrating the effectiveness of graph theory in practical scenarios. The results show that the application can efficiently manage course scheduling and optimize taxi dispatch. For course scheduling, the application uses the Kuhn-Munkres algorithm to find the maximum matching in a bipartite graph, ensuring that all students are assigned to courses with the minimum total cost. For taxi dispatch, the Hungarian algorithm is used to find the optimal assignment of taxis to passengers, minimizing the total travel distance. The application is tested with various scenarios, and the results are consistent with the expected outcomes, indicating that the algorithms are effective and efficient. [1]

IV. Discussion

The discussion highlights the importance of graph theory in solving real-world problems. The thesis compares the performance of different algorithms and concludes that the Delphi implementation is effective and efficient. The Hungarian algorithm and the Kuhn-Munkres algorithm are both well-known and widely used in solving assignment and matching problems. The thesis demonstrates that these algorithms can be effectively implemented in Delphi to solve practical problems. The results show that the Delphi application can handle large datasets and provide optimal solutions in a timely manner. The limitations of the study include the lack of extensive performance testing and the absence of a detailed comparison with other programming languages or tools. However, the thesis provides a solid foundation for further research and practical applications of graph theory in real-world scenarios. [1]

V. Conclusion

The thesis concludes that graph theory provides a robust framework for solving practical problems, and the Delphi implementation enhances its applicability in real-world scenarios. The study demonstrates the effectiveness of graph theory in solving real-world problems such as taxi dispatch and academic course scheduling. The Delphi application successfully

implements the algorithms to find optimal solutions, highlighting the importance of graph theory in practical applications. The thesis provides a valuable contribution to the field of graph theory and its applications, and it opens up new avenues for further research and development in this area. [1]

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