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AI Assignment 2

Question 1: Graph Coloring

Steps Involved:

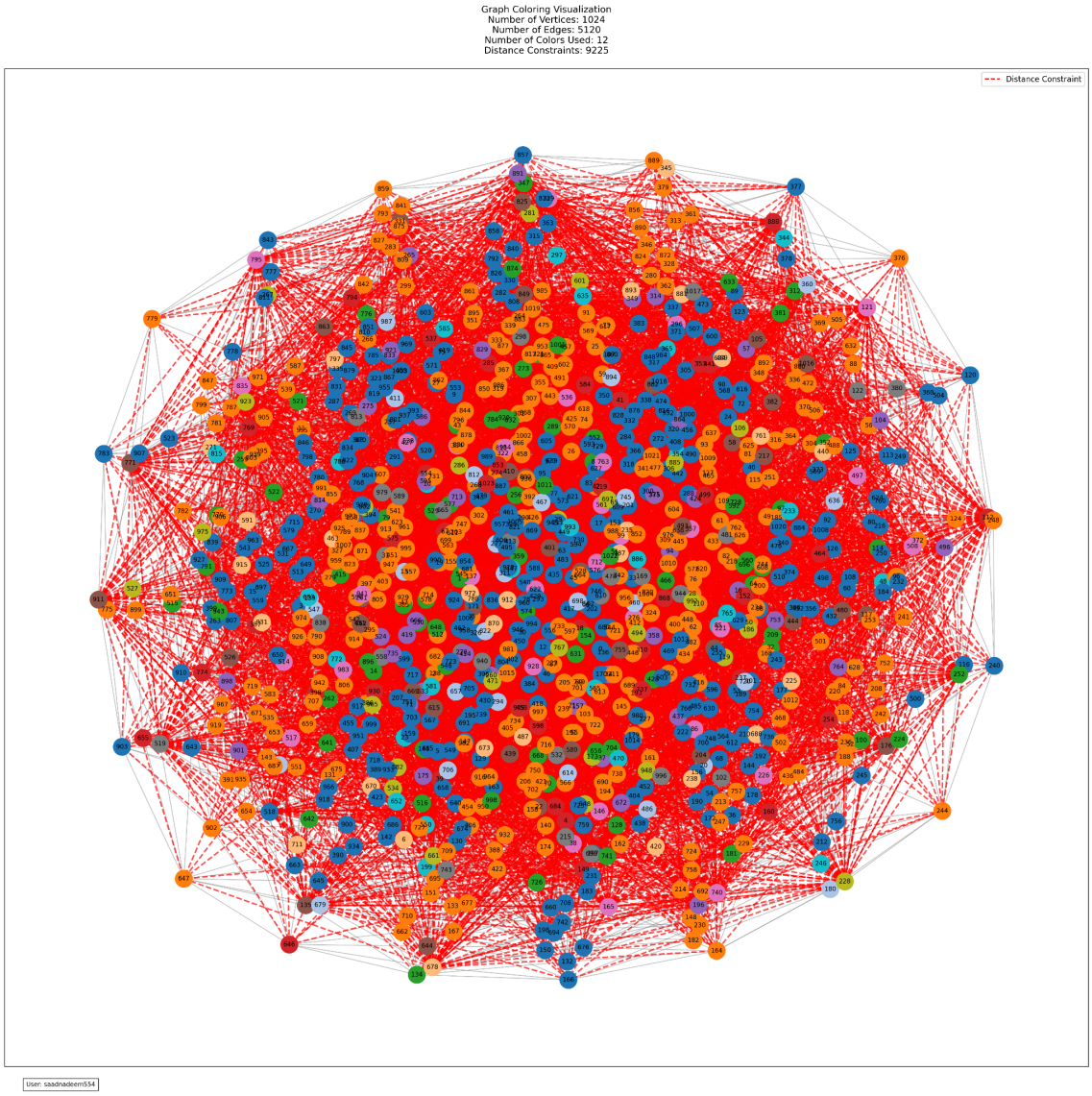
1. **Read Dataset**: The program reads a hypercube dataset containing 1023 nodes and 5120 edges.
2. **Graph Representation**: The graph is represented using an adjacency list.
3. **Preassigned Colors**: Some vertices are preassigned specific colors.
4. **Distance Constraints**: A subset of vertices is assigned two-hop constraints to ensure no two such vertices share the same color. I randomly choose 20% of the vertices for this.
5. **Local Beam Search Algorithm**:
    - Generates an initial set of k random valid colorings.
    - Evaluates each state based on the number of colors used and balance score.
    - Generates new states by modifying colors of vertices.
    - Selects the top k best states over multiple iterations.
    - Stops when no improvement is observed over multiple iterations.
6. **Result Evaluation**:
    - Checks if the final coloring satisfies all constraints.
    - Computes the number of colors used and the color balance score.
    - Generates a visualization of the colored graph.

Results:

For the dataset given

- **Number of colors used**: 12
- **Color balance score**: 0.6982421875

Graph:



Question 2: Shelf Space Optimization

Steps Involved:

1. **Define Product and Shelf Constraints**:
    - Products have attributes such as weight, category, perishability, theft risk, and required storage conditions.
    - Shelves have capacities, placement preferences, and storage type constraints.
2. **Genetic Algorithm for Optimization**:
    - Generates an initial population of shelf allocation solutions.
    - Evaluates fitness based on factors such as shelf capacity usage, high-demand placement, theft prevention, and category grouping.
    - Performs crossover and mutation to refine solutions.

    - Implements an adaptive mutation rate and population diversity management to prevent stagnation.
3. **Solution Selection**:
    - The algorithm iterates for a defined number of generations to find the best solution.
    - The best allocation is stored and saved to an Excel file for analysis.

Results:

- **Best Solution Fitness**: 3950.0

- **Optimal Shelf Allocation**:

    - **Lower Shelf (Capacity: 25kg, Current: 12kg)**: Rice Bag (12kg)
    - **Secure Shelf (Capacity: 15kg, Current: 1kg)**: Luxury Perfume (1kg)
    - **Eye-Level Shelf (Capacity: 15kg, Current: 3kg)**: Cereal (3kg)
    - **General Aisle Shelf (Capacity: 20kg, Current: 5kg)**: Pasta (2kg), Pasta Sauce (3kg)
    - **General Aisle Shelf 2 (Capacity: 20kg, Current: 4kg)**: Chips (2kg), Chocolate (2kg)
    - **Refrigerator Zone (Capacity: 20kg, Current: 14kg)**: Milk (5kg), Frozen Nuggets (5kg), Cheese (4kg)
    - **Hazardous Item Zone (Capacity: 10kg, Current: 10kg)**: Detergent (4kg), Glass Cleaner (5kg), Drain Cleaner (1kg)
- results are saved in 'shelf_allocation.xlsx'.