Problem Set: Local Search

Course: CSE422 Artificial Intelligence

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Problem Setups

1. For six cities, the matrix is given by:

```
[[ 0 39 65 53 56 41]
 [39  0 35 36 32 36]
 [65 35  0 80 28 56]
 [53 36 80  0 40 63]
 [56 32 28 40  0 46]
 [41 36 56 63 46  0]]
```

   I would like to visit all cities, traveling the minimum distance.

2. I have ten courses to select from. The work-load/per week and the expected marks for each course is given below. I would like to find the set of courses so my expected marks are maximum and the work-load per week does not exceed 50 hours.

Course	Work-load per week	Expected Marks
1	7	72
2	16	68
3	12	90
4	7	54
5	16	73
6	3	44
7	16	64

8	4	38
9	4	18
10	19	94

3. Graph Description:
    - Vertices: 7 vertices named A, B, C, D, E, F, G.
    - Edges: Connections between the vertices are as follows:
        - A is connected to B, C, and D.
        - B is connected to A, C, E, and F.
        - C is connected to A, B, and G.
        - D is connected to A, E, and G.
        - E is connected to B, D, F.
        - F is connected to B, E, G.
        - G is connected to C, D, F.

    Goal: The goal is to color the graph using the minimum number of colors such that no two adjacent vertices share the same color.

4. Graph Description:
    - Vertices: 8 vertices named V1, V2, V3, V4, V5, V6, V7, V8.
    - Edges:
        - V1 connected to V2, V3, V4
        - V2 connected to V3, V5
        - V3 connected to V4, V6
        - V4 connected to V7
        - V5 connected to V6, V8
        - V6 connected to V7, V8
        - V7 connected to V8

    Objective: Divide the vertices into two groups such that the number of edges between the two groups is maximized.

5. Problem Description:
    - Assets: There are 5 different assets available for investment, each with its own expected return.
    - Budget: The total amount available for investment is $50,000.

    Asset Details:
    - Asset 1: Expected return = 6%
    - Asset 2: Expected return = 4%
    - Asset 3: Expected return = 8%
    - Asset 4: Expected return = 3%

- Asset 5: Expected return = 7%

Constraints:

- Investment Limits: No single asset should contain more than 40% of the total investment.
- Diversification: At least 3 different assets must be included in the portfolio.

Objective: Maximize the expected return of the portfolio while adhering to the investment limits and diversification requirements.

6. Problem Description:
   - Jobs: There are 10 jobs to be scheduled, each with different processing times.
   - Machines: There are 3 machines available to process these jobs.
   - Processing Times: Each job has a specific processing time, which is the same on any machine.

   Job Details:

   - Job 1: Processing time = 4 units
   - Job 2: Processing time = 1 unit
   - Job 3: Processing time = 8 units
   - Job 4: Processing time = 5 units
   - Job 5: Processing time = 3 units
   - Job 6: Processing time = 6 units
   - Job 7: Processing time = 2 units
   - Job 8: Processing time = 7 units
   - Job 9: Processing time = 9 units
   - Job 10: Processing time = 3 units

   Objective: Minimize the total time (makespan) to complete all jobs, where makespan is the time at which the last job finishes.

Questions:

For each of the above problem setups:

a. Encode the problems. (This means structuring the problem representation, defining the neighborhood. Examples given in lecture notes)
b. Demonstrate the Hill Climbing algorithm up to two iterations. Using the idea of the evaluation function for this problem, explain the problems with the Hill-Climbing algorithm.
c. Using the problem scenario, explain First-choice hill-climbing, Stochastic hill climbing and Random-restart hill climbing algorithm.
d. Let $T = 100$, $\alpha = .5$ and the change of temperature at each iteration be described by $T(k) = T_0 \alpha^k$. Demonstrate simulated annealing up to 3 iterations, find the optimal solution. In case you need it, let the random numbers generated are (0.2, 0.5, 1) Explain

the significance of the change of temperature in simulated annealing using this problem as an example. What will happen if the temperature is increasing at each iteration of simulated annealing.

e. Demonstrate the Genetic algorithm up to 1 iteration.
f. What will happen if all the chromosomes in the initial population are the same? Explain why mutation is helpful in finding a better solution. Use the problem scenario as an example.