Traveling Salesman Problem

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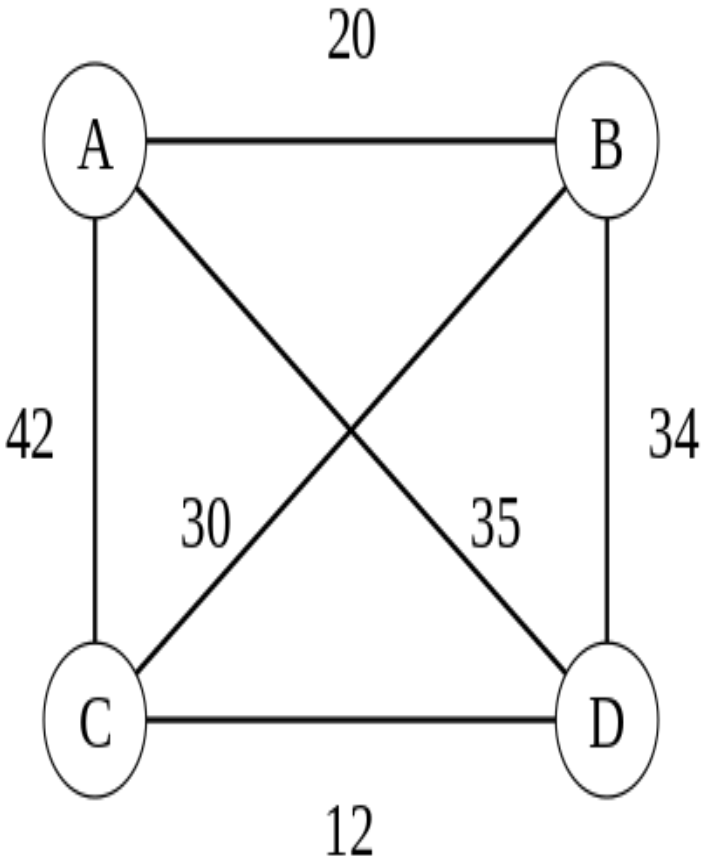
What is the Traveling Salesman Problem?

- Given a graph G
  - Every vertex, V, represents a city to which a salesman must visit on his/her business trip.
  - Every weighted edge, E, represents a road between each city and the respective distance between those two cities.
- We would like to minimize the distance the salesman needs to travel while requiring that he visits every city.



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Solution Methods

- Exact Solutions
  - Brute Force
  - Branch And Bound
- Approximate Solutions
  - Ant Colony System
  - Neural Networks
  - Simulated Annealing

We will examine some of the fastest solution techniques.

Trivial Approach: Brute Force

- Tries all permutations
- Always finds best solution
- O(n!) run time where n is the number of cities.
- Extremely inefficient on sets with only 20 cities.

Ant Colony

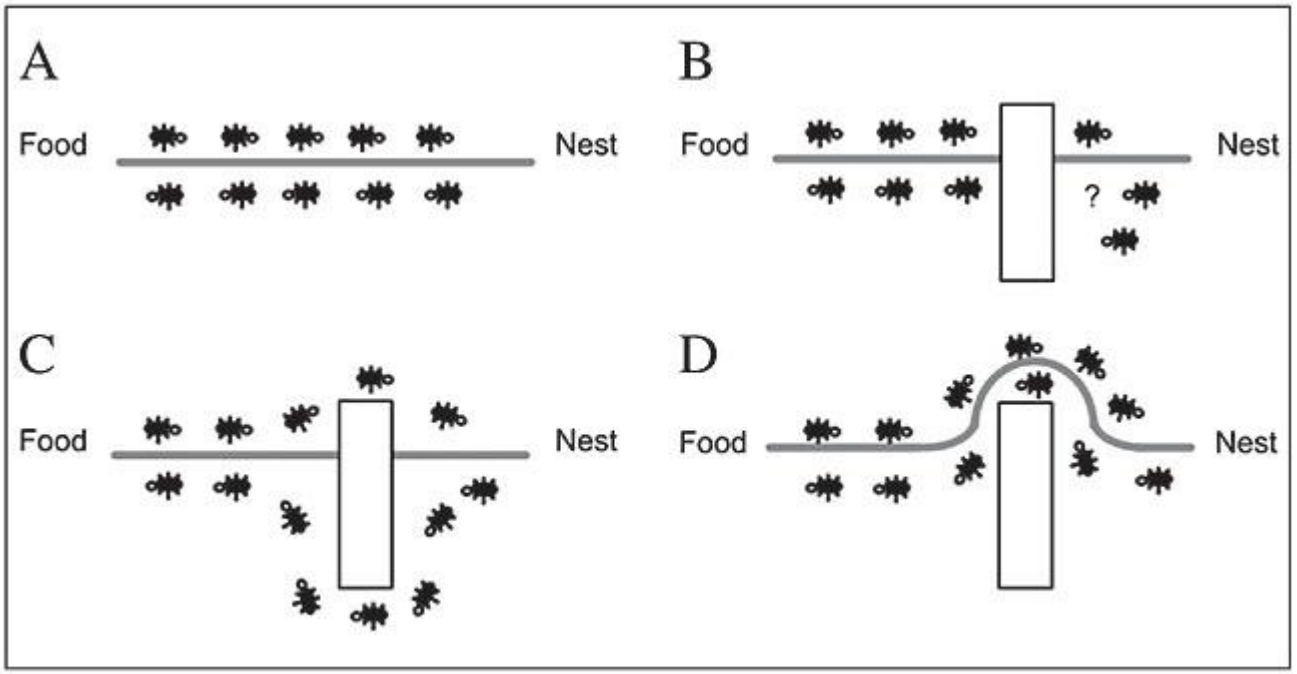


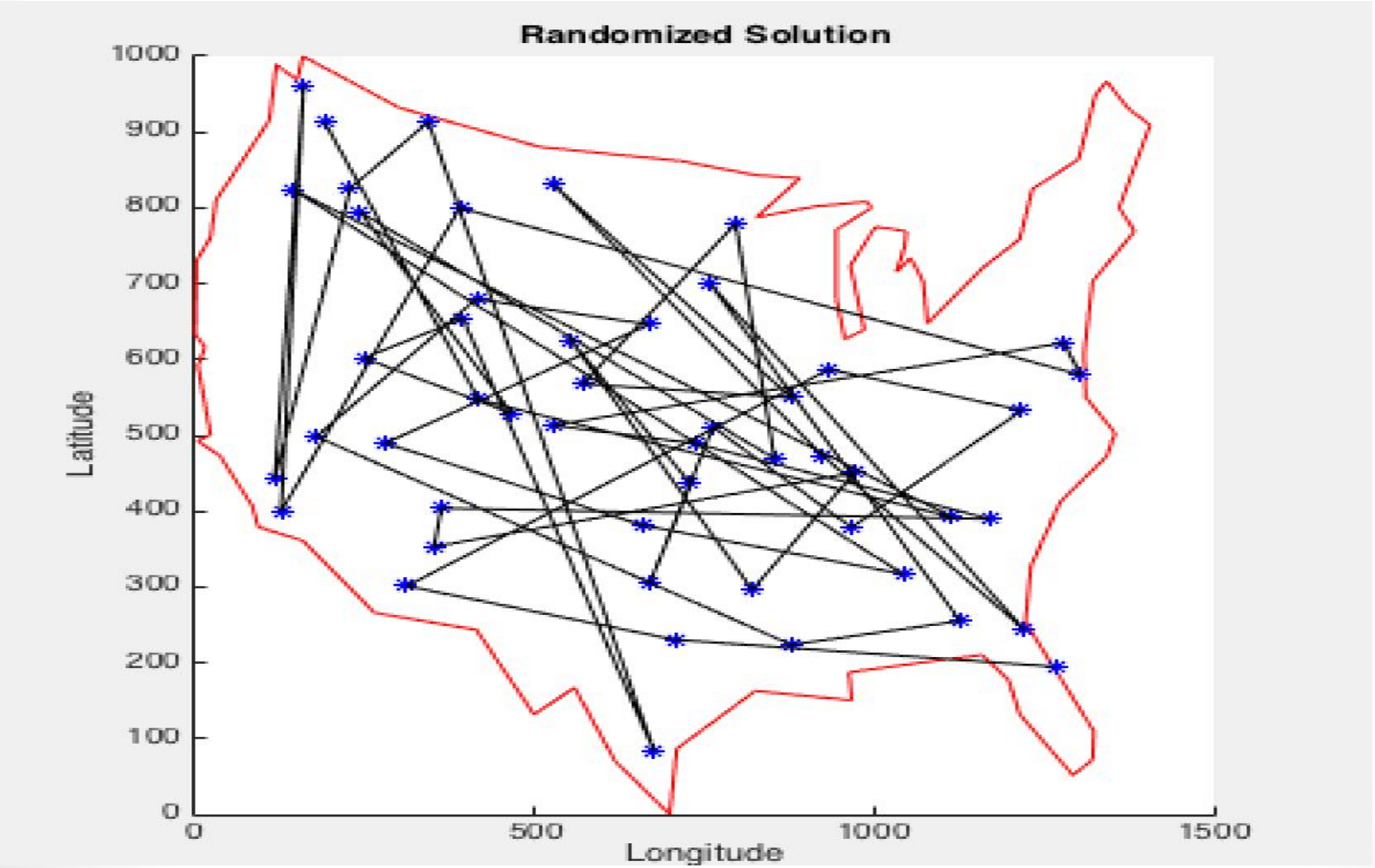
Figure 2. A. Ants in a pheromone trail between nest and food; **B.** an obstacle interrupts the trail; **C.** ants find two paths to go around the obstacle; **D.** a new pheromone trail is formed along the shorter path.

- Ants visit all cities
- Leave pheromone behind
- Favors shorter paths

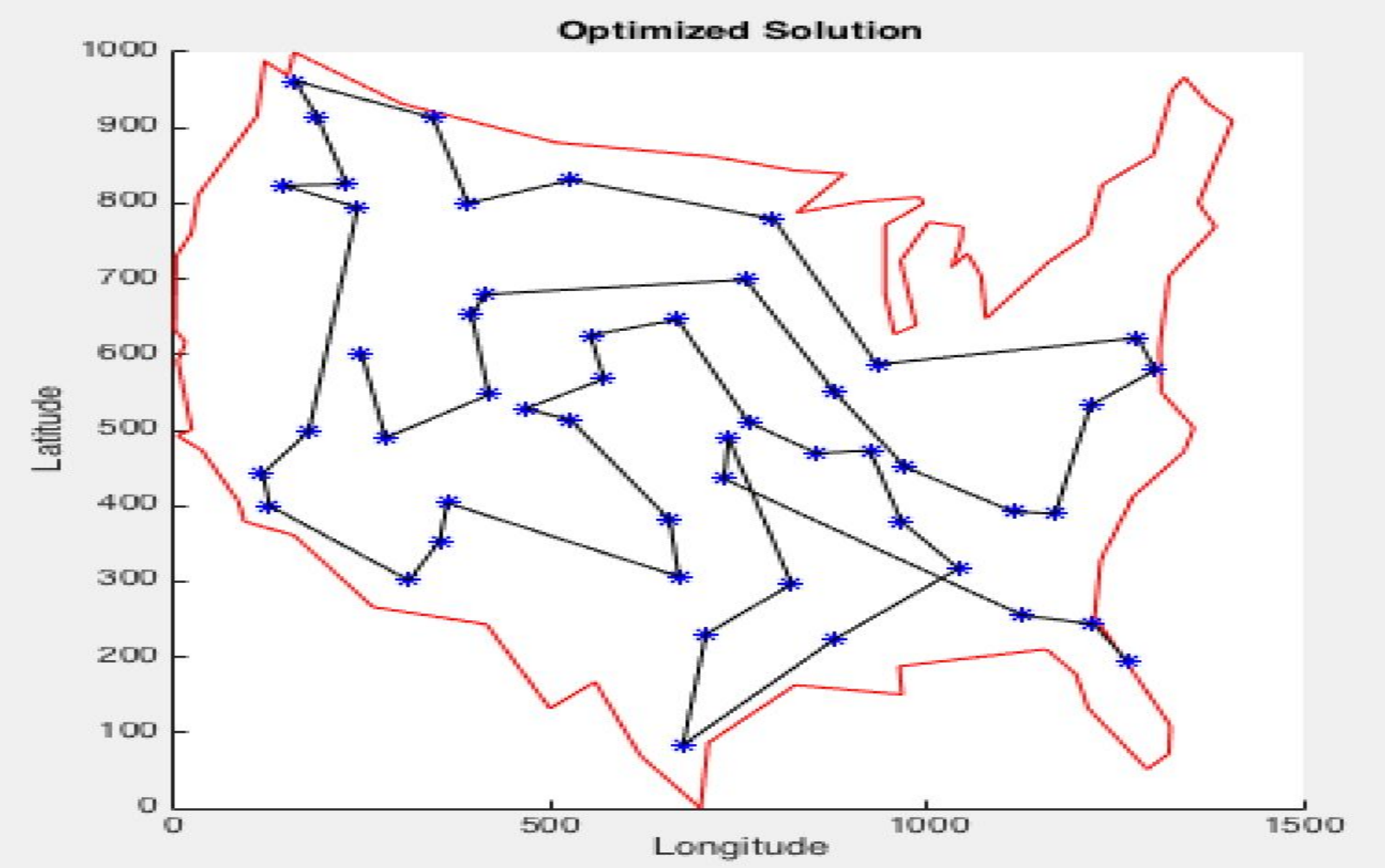
Simulated Annealing

- **Input**: A randomly ordered graph of vertices V and weighted edges E.
- **Output**: An approximately optimal graph.
- **Step 1**: Assume solution that is randomized (ensure input is properly distributed).
- **Step 2**: For two randomly chosen cities, switch their order in the path.
- **Step 3a**: If the solution is better than our previous solution, accept the new solution
- **Step 3b**: If the solution is worse than our previous solution, you can randomly choose the worse solution. The probability that we will choose the worse solution decreases as we iterate through the solution (simulating annealing in a physical system. As time goes on, we are *less* likely to choose a worse solution).
- **Step 4:** Loop back to 2.

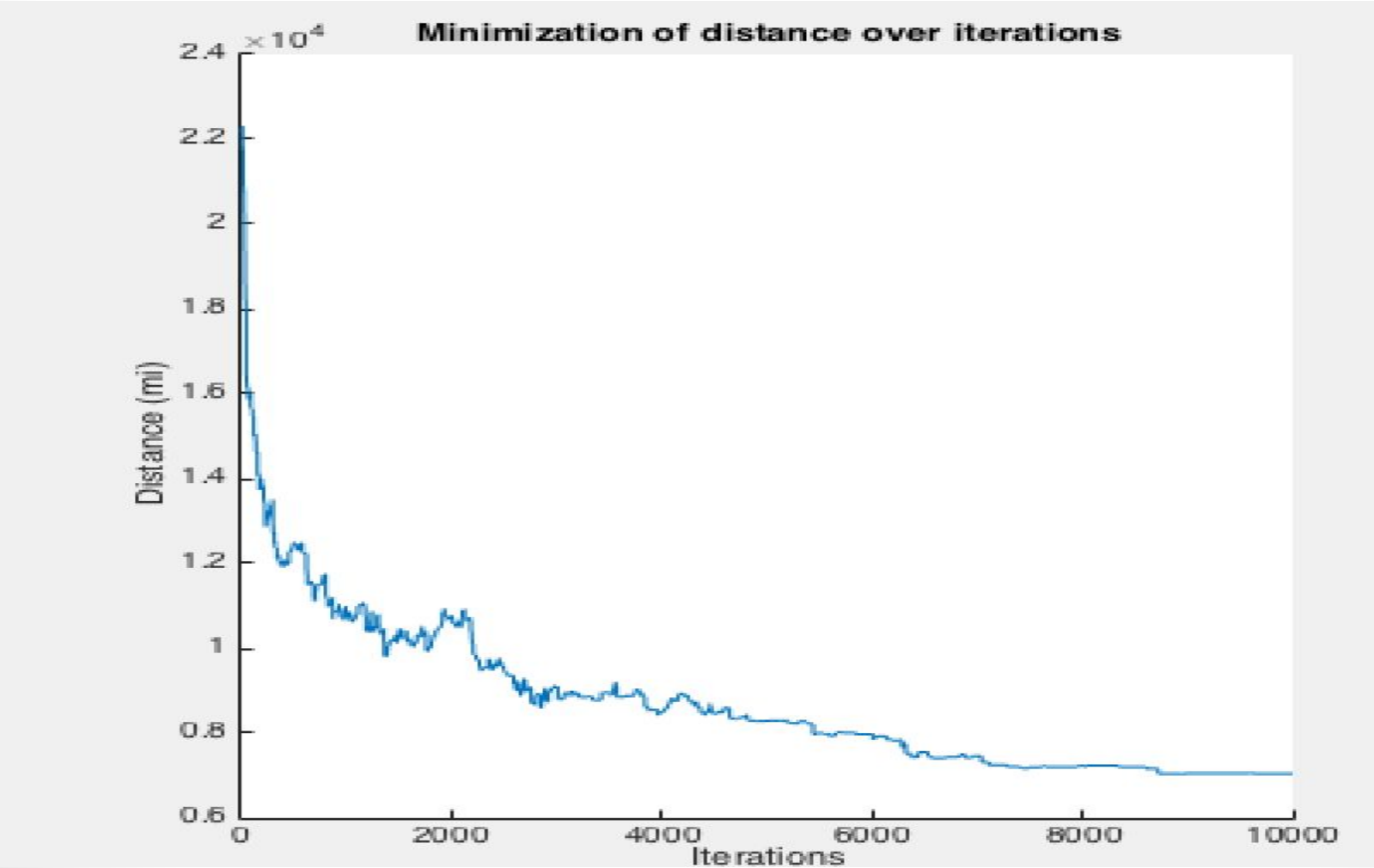
Simulated Annealing



Simulated Annealing



Simulated Annealing



QUESTIONS?