Swarm Intelligence for Solving a Traveling Salesman Problem

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I did a cooperative study program at

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Motivation

Board Game Halma (Chinese Checkers)  Drones for Disaster Management
Traveling Salesman Problem
Traveling Salesman Problem

- Ant Colony Optimization (ACO)
- Particle Swarm Optimization (PSO)
- Bee Colony Optimization (BCO)
Ant Colony Optimization (ACO)
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- Initialization
- Path planning based on Pheromone values on edges
- Random-proportinal rule
- Local update
- Global update
- Evaporation

Exploration
Particle Swarm Optimization (PSO)
Particle Swarm Optimization (PSO)
Particle Swarm Optimization (PSO)
Particle Swarm Optimization (PSO)

Initialization

Include personal best path?

Create swap sequence to personal best path

Combine velocity with swap sequence

Include global best path?

Create swap sequence to global best path

Combine velocity with swap sequence

Change path according to velocity

Update personal best path

Update global best path

Include personal best path?

Include global best path?
Bee Colony Optimization (BCO)
Bee Colony Optimization (BCO)
Bee Colony Optimization (BCO)
Bee Colony Optimization (BCO)

- Initialization
- Complete Path build?
  - False: Build part of path randomly
  - True: Exploration, Abandon part of path
- Backward Pass
- Exploitation
  - Advertise part of path
  - Exploration
- Update global best path
Experimental Results

- Cities for TSP: 10
- Iterations: 200
- Tests per algorithm: 1000
Experimental Results

ACO with 100% exploitation

Cities for TSP: 10
Iterations: 200
Tests per algorithm: 1000

ACO (100 elements)
PSO (50 elements)
BCO (100 elements)
Optimal solution

Length of Path vs. Number of Iterations
## Experimental Results

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>Advantages</th>
<th>Disadvantages</th>
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</table>
| ACO       | + Converges for small number of iterations  

  + Parameter to control balance between exploration and exploitation | - Parameter tuning |
| PSO       | + Good balance between exploration and exploitation | - Needs more iterations |
| BCO       | + Few parameters | - Exploitation predominates over exploration |
Conclusion

➔ ACO performs best for TSP
➔ Balance between exploration and exploitation is important
Future Work

Board Game Halma (Chinese Checkers)

Drones for Disaster Management