The Traveling Salesman Problem

Team 521

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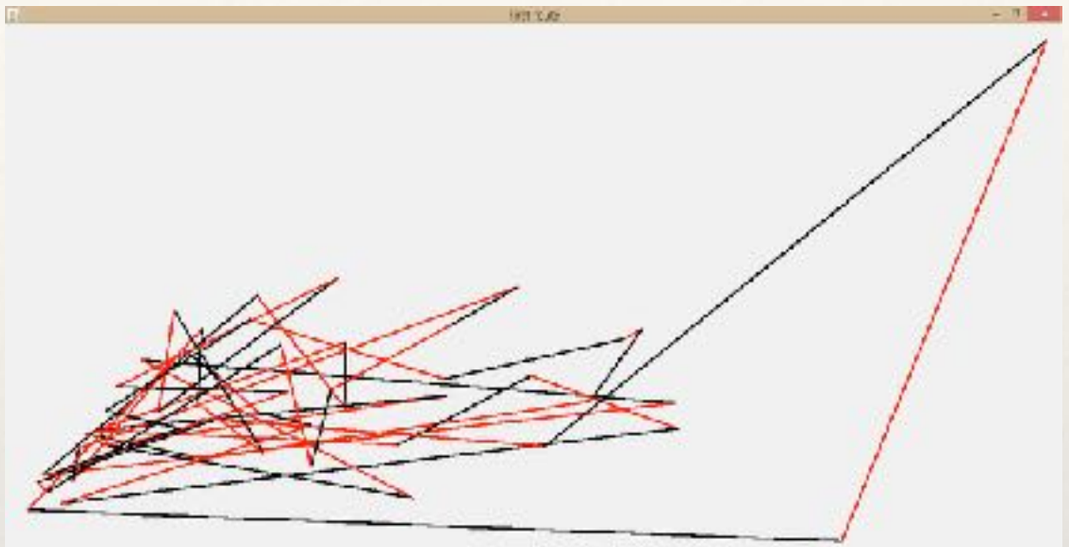
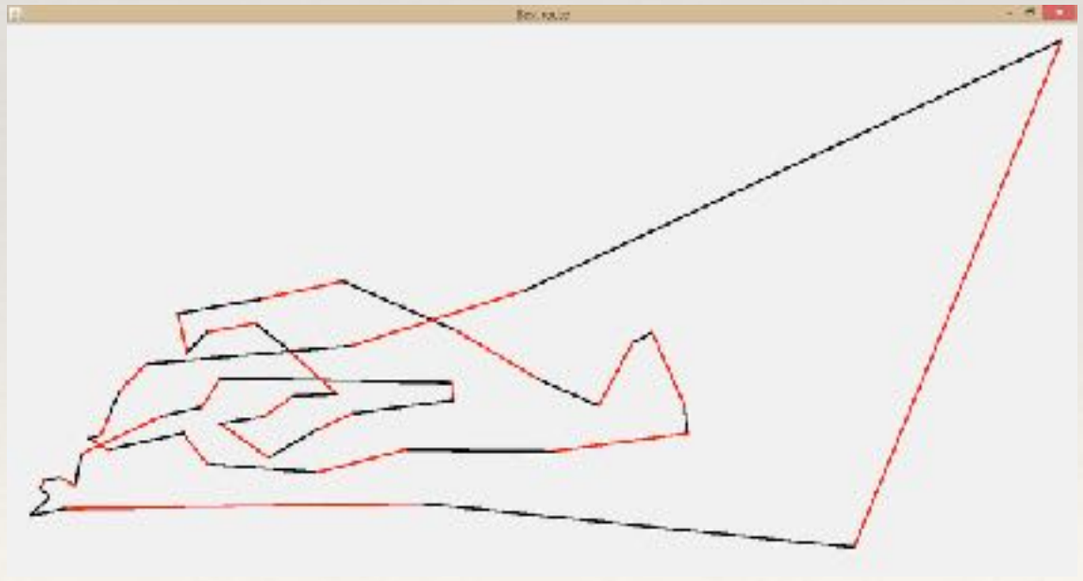
Problem Statement

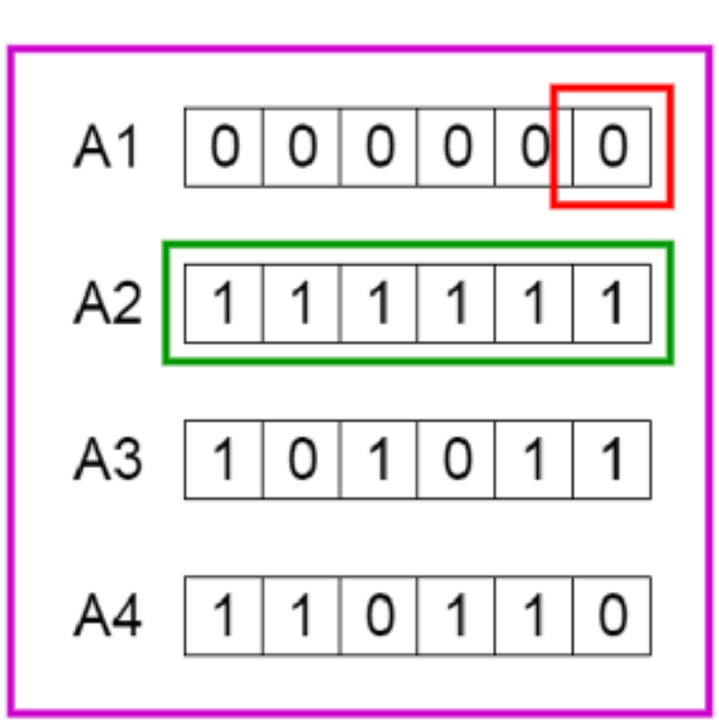
- The Traveling Salesman Problem (TSP) poses a situation that,
- Given a list of cities and having the distance between each pair of cities, calculate a shortest possible route visiting all the cities once and returning to the origin city.

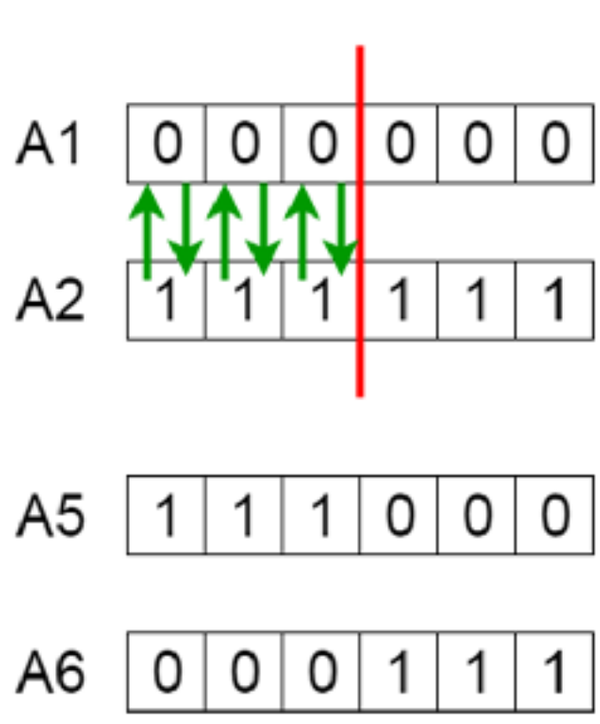




Approach

Genetic Algorithms





Implementation

- **Genetic Code**: Represented by chromosome of length as the number of nodes in the problem. Each gene of a chromosome takes a label of node such that no node can appear twice in the same chromosome.

Implementation

- **Gene Expression:** Path Representation. For e.g. let {1, 2, 3, 4, 5} be the labels of nodes in a 5 node instance, then a tour {1→ 3→4→ 2→ 5 →1} may be represented as (1, 3, 4, 2, 5).

Implementation

- **Fitness Function:** One way of defining a 'fitness function' is F(x) = 1/ f(x), where f(x) is the objective function. Since TSP is a minimization problem, we consider this fitness function where f(x) calculates the total distance of the route of visiting all cities.

Implementation

- **Crossover:** The Crossover operator speeds up the evolution by inheriting different parts of genotype from different parents. For Eg: From the two routes like (1, 3, 4, 2, 5) & (5, 2, 1, 4, 3) we will generate a crossbreed of (3, 4, 2, 5, 1)

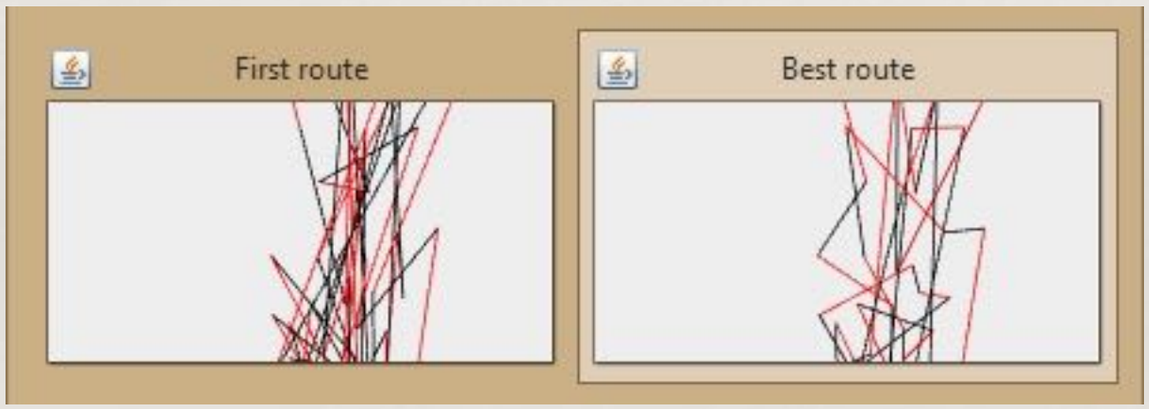
Implementation

- **Mutation:** The mutation operator randomly selects a position in the chromosome and changes the corresponding allele, thereby modifying information. For this investigation, we have considered the reciprocal exchange mutation that selects two nodes randomly and swaps them. For Eg: (5, 3, 4, 2, 1) mutates to (5, 3, 2, 4, 1).

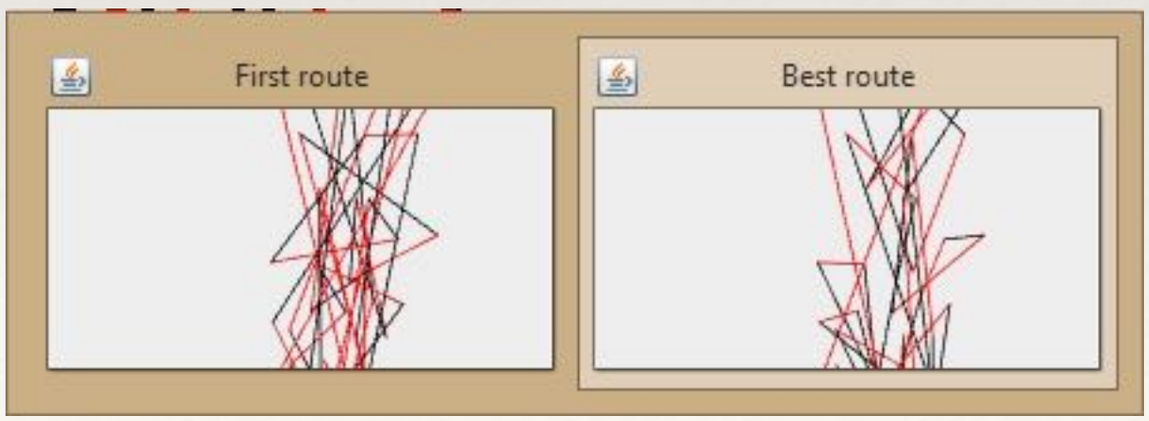
Analysis

- Mutation Rate 0.15

- Mutation Rate 0.035



- Mutation Rate 0.30



- Mutation Rate 0.60

	5	10	25	50
Trail 1				
Generations	4	10	15	15
Best Distance	10431.98942	12820.05776	28878.86085	57484.86599
Time to run	2s	3s	3s	6s
Trail 2				
Generations	250	250	250	250
Best Distance	10431.98942	12820.05776	22995.36332	42131.45047
Time to run	7s	7s	15s	43s
Trail 3				
Generations	800	800	800	800
Best Distance	10431.98942	12820.05776	22995.36332	41138.90912
Time to run	14s	44s	45s	1 min 41s
Trail 4				
Generations	1500	2500	2500	1500
Best Distance	10431.98942	12820.05776	22600.08828	34444.62617
Time to run	18s	1 min 1s	2min 19s	2 min 38 s
Trail 5				
Generations	10000	10000	10000	10000
Best Distance	10431.98942	terminated	terminated	37302.43561
Time to run	terminated			24 min 48s

- Calculated for **Population size 150.**
- Considered **5, 10, 15, 50 vertices**.
- With increasing number of **generations**, execution **time** increases but, we get better and better result of **distance** for the route.

The Best we found…. (So many trails!!!)

Fitness: 2.738760154760697 - Distance: 29210.29790101869 - Mutation Rate - 0.125 - Generations - 2000