# ASSIGNMENT-5: Genetic Algorithm v/s Simulated Annealing

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Solve the 8puzzle problem using a genetic algorithm. Start state (Can take any random order of numbers with B denoting a blank)

**Start State:** P1: [5,9,8,4,2,1,7,3,6]   **Goal State:** [1,2,3,4,5,6,7,8, B]

## Simulated Annealing:

**Start state**

| | | |
|---|---|---|
| 5 | B | 8 |
| 4 | 2 | 1 |
| 7 | 3 | 6 |

| | | |
|---|---|---|
| 1 | 2 | 3 |
| 4 | 5 | 6 |
| 7 | 8 | B |

A. **Input:** Input should be taken from an input file and processed as a matrix. Other inputs are Temperature variable T, heuristic function, neighborhood generating function, probability function to decide state change, and a cooling function.

B. Objective functions to be checked:

   a. $h1(n)$ = Number of displaced titles.

   b. $h2(n)$ = Total Manhattan distance.

## Genetic Algorithm

A genetic algorithm is a search heuristic that is inspired by Charles Darwin's theory of natural evolution. This algorithm reflects the process of natural selection where the fittest individuals are selected for reproduction in order to produce offspring of the next generation.

   Five phases are considered in a genetic algorithm.

1. Initial population
2. Fitness function
3. Selection
4. Crossover
5. Mutation

## Algorithm

1) Randomly initialize populations p

2) Determine fitness of population

3) Until convergence repeat:

    a) Select parents from population

    b) Crossover and generate new population

    c) Perform mutation on new population

    d) Calculate fitness for new population


**Q.1)** Compare and contrast (with justification) the results obtained from the twodifferent Fitness functions. Justify the fitness function choice. Why was it chosen and how is it handling the problem in hand*?*

Heuristics used in informed Search was used as fitness function.
There are many ways to find fitness of a parent and fitness is how fit a parent is compared to target

- No. of Matching tiles

This fitness function gives max fitness to the target and every parent near to the target will be having more fitness so chances of being selected in Roulette wheel is more


- Distance of every element from its original place

This fitness calculates distance of each gene for its target gene and returns a value better chromosome will be have low fitness
So, 1/sum was used to since it was inversely proportional to distance target will have 0 so initial value of sum was taken 1

heuristic Misplaced tiles was used for
Fitness functions used in Genetic algorithm are

    a. No. of Matching tiles
    b. Distance of every element from its original place

**Q.2)** Compare your results obtained in the Simulated Annealing implementations(from previous assignment) with the Genetic Algorithm implementations.

    **a.** Take multiple examples (at least 3) of the same start state and goal state combinations and compare both algorithms.

**Example 1**
**Start State: 5 0 8 4 2 1 7 3 6**

| | SA Misplaced | SA Manhattan | GA Mismatch Tiles | GA other |
|---|---|---|---|---|
| Time Taken | 12.087269 | 31.856226 | 0.0 | 0.001006 |
| Total number of states explored | 88851 | 23401 | 743 | 4860 |
| Success or failure | Success | Success | Success | Success |

For genetic algorithm it took less time so it is fast.

**Example 2**
**Start State: 3 2 1 4 5 6 8 7 0**

| | SA Misplaced | SA Manhattan | GA Mismatch Tiles | GA other |
|---|---|---|---|---|
| Time Taken | 11.4867 | 5.92365 | 0.0 | 0.0 |
| Total number of states explored | 108137 | 9450 | 666 | 868 |
| Success or failure | Success | Success | Success | Success |

**Example 3**
**Start State: 8 7 6 5 4 3 2 1 0**

| | SA Misplaced | SA Manhattan | GA Mismatch Tiles | GA other |
|---|---|---|---|---|
| Time Taken | 0.62818 | 21.9173 | 0.0 | 0.0 |
| Total number of states explored | 16216 | 51802 | 231 | 2532 |
| Success or failure | Success | Success | Success | Success |

For this example, simulated annealing misplaced did better than Manhattan.

**b.** Analyze the results obtained with proper justifications.

**c.** Describe your results on both algorithms and state the reasons for the difference of approach in both algorithms.

1. 8 puzzle problem is a path finding problem since we always knew what the goal will be

   1 2 3

   4 5 6

   7 8 0

 so, for path finding problem informed and uninformed searches works better

2. If we follow local search algorithm for this type of problem, we may end up faster than A* but it will never be optimal because of numerous mis steps took.

3. Temperature from 6 degree to 0 degrees but decrement taken 0.00005 degrees per iteration since the function $y=e^{(1/x)}$ changes values only form 8 and 0 almost all other temperature values have almost 0.9 prob making it almost random walk.

**d.** Describe your views on what algorithm should have performed better for this particular problem and does your intuition match the results.

1. Genetic Algorithm does better than Simulated Annealing but its only "time" that GA was better since it was path finding problem mixing two possible solutions to generate a better one is not a better option for path finding problems.

2. Simulated is better one if we want to find path since its progressing towards solution by moving blank tile so it will give a path in the end ever its very long path.