



Inspire...Educate...Transform...

AI and Decision Sciences

Genetic Algorithms

Data Scientists

Genetic Algorithm Logical flow

```
{  
    initialize population;  
    evaluate population;  
    while TerminationCriteriaNotSatisfied  
    {  
        select parents for reproduction;  
        perform recombination and mutation;  
        evaluate population;  
    }  
}
```

Genetic Algorithms

- Define Initial population size, elite percentage, mutation probability, crossover probability, fitness function and a fitness criteria if required.
- Generate a random population of n possible solutions (Chromosomes)
- Calculate the fitness for all the chromosomes.
- Evaluate the new population based on the fitness criteria and repeat the process until fitness criteria is met.

Contd..

- While stopping condition is not met, perform cross over or mutation based on the random number generated and generate new population.
- For crossover : Select 2 parents from the elite and perform cross over the parents to form 2 new offspring.
 - We have used PMX crossover here.
- For Mutation: Take 1 parent and mutate it to generate 1 child.

Note: Select top few based on the fitness criteria and add them to the next generation.



Contd...

- If the stopping criterion is satisfied **Stop** and return the best solution.

Activity

- Statement: You are planning to visit a few places in India, In the interest of time you have narrowed them down to 10 places, you start from Bangalore visit 10 places and come back to Bangalore.
- We have generated a matrix with 10 places and the distances.
- The goal is to cover all the places by travelling as little as possible, you decide to find the smallest distance possible using ‘Genetic Algorithm’.



- Data: (Distance matrix)

	Bangalore	Jaipur	Varanasi	Udaipur	Delhi	Chennai	Mysore	Agra	Kolkata	Mumbai	Hyderabad
Bangalore	0	2026	1825	1724	2166	346	149	1923	1862	980	569
Jaipur	2026	0	849	393	287	2108	2121	240	1520	1146	1483
Varanasi	1825	849	0	1154	834	1862	1976	614	683	1524	1237
Udaipur	1724	393	1154	0	661	2077	1809	634	1825	753	1349
Delhi	2166	287	834	661	0	2203	2317	233	1498	1415	1578
Chennai	346	2108	1862	2077	2203	0	482	1957	1669	1345	627
Mysore	149	2121	1976	1809	2317	482	0	2072	2012	1064	718
Agra	1923	240	614	634	233	1957	2072	0	1280	1323	1334
Kolkata	1862	1520	683	1825	1498	1669	2012	1280	0	2053	1493
Mumbai	980	1146	1524	753	1415	1345	1064	1323	2053	0	711
Hyderabad	569	1483	1237	1349	1578	627	718	1334	1493	711	0



Terminology – Quick Recap

- 1) Gene: The reproducible building block of chromosome
- 2) Chromosome: A possible solution
- 3) Population: A set of chromosomes
- 4) Generation: A population derived from the fittest chromosomes of the previous population
- 5) Reproduction and Mutation: Create a new solution from the old fitter solutions

Functions Used

- 1) createRandomRoute – To generate random routes
- 2) fitnessFunction – To compute the route cost
- 3) mutateRoute – Generate Mutated Path
- 4) initialPopCost – To create initial population. It will generate new routes and calculate the cost for each route.
- 5) crossOverFunction – Perform cross over to generate new offspring
- 6) genetic_algorithm – Generate better offspring with each iteration
- 7) perform_genetic_algorithm – Iterate over few solutions and find the best solution (shortest distance for travel)



Stopping Criteria

- For this example the stopping criteria is not defined, you may set the stopping criteria to a number like 7000 km or so, but we do not know the least distance possible so we did not set any stopping criteria.

Solution from GA covering 8064 kilometers with an initial population size of 25



Solution from GA covering 7276 kilometers with an initial population size of 50



Solution from GA covering 6815 kilometers with an initial population size of 100



Solution from GA covering 6815 kilometers with an initial population size of 150



Solution from GA covering 6917 kilometers with an initial population size of 200



Solution from GA covering 6982 kilometers with an initial population size of 250



Solution from GA covering 6967 kilometers with an initial population size of 300



Final Solution

Solution from GA covering 6815 kilometers with an initial population size of 100



Total distance travelled to cover the final solution

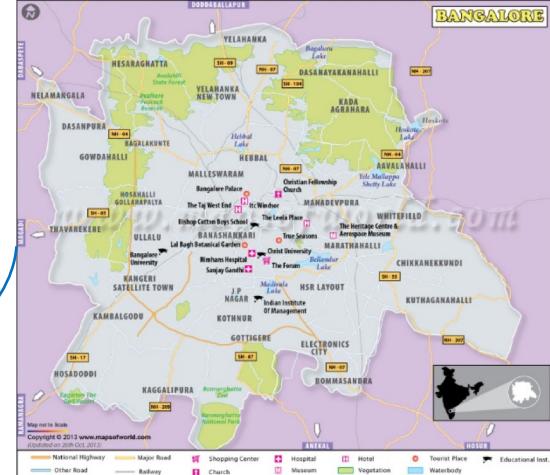
Bangalore => Chennai => Hyderabad => Kolkata => Varanasi => Delhi => Agra => Jaipur => Udaipur => Mumbai => Mysore => Bangalore is 6815 Km.



Conclusion

- We now have an overview of the working of genetic algorithms.
- Understood how we can implement mutation and crossover.
- We have seen how to code genetic algorithm in python from scratch.
- Tried solving the travelling salesman problem using genetic algorithms.





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