GA-based Optimisation for Path Planning

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By Monday, August 1, we should have a function/program that computes the optimum trajectory path for certain coordinates.

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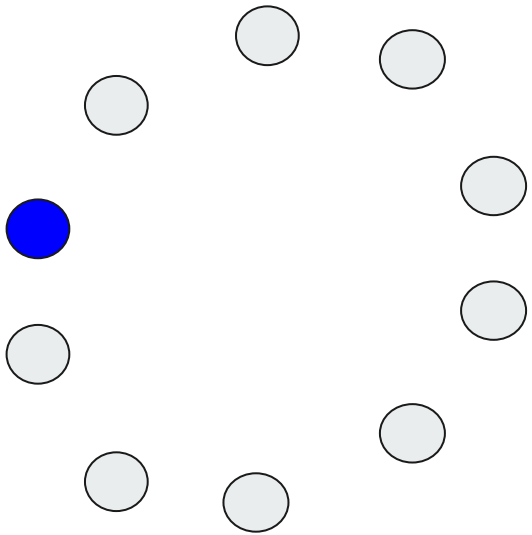

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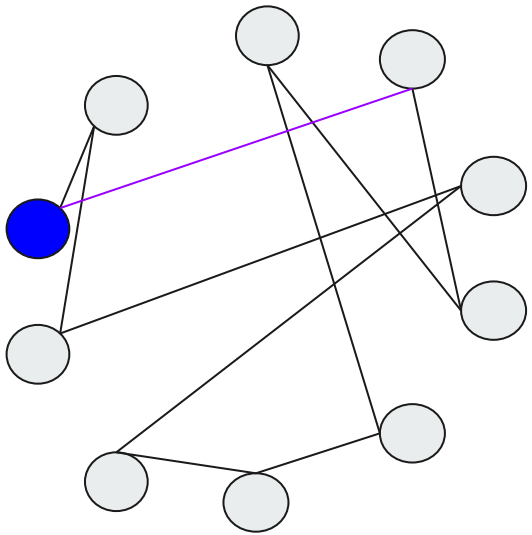

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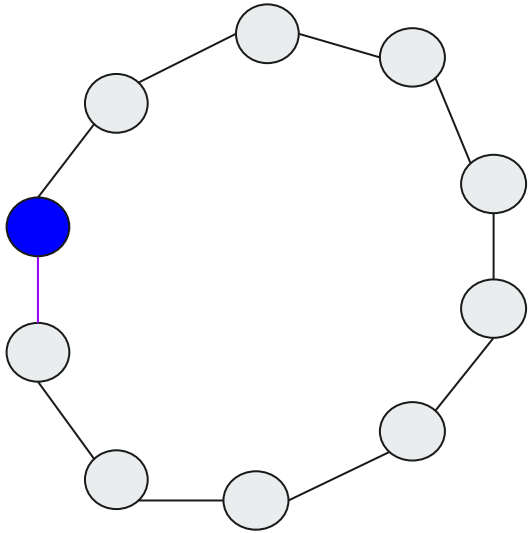


GA Summary

Genetic algorithms are a type of optimization algorithm (they're used to find the maximum or minimum of a function), inspired by Charles Darwin's theory of natural evolution.

They have 5 basic components:

>population initialization

>fitness function

>selection

>crossover

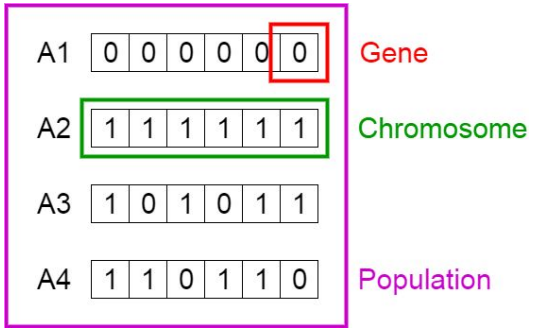
>mutation

Every generation you go through the four highlighted steps

GA Summary: Pop. Initialization

Population Initialization:

- generate a set of permutations (AKA solutions or chromosomes) from your sites, which represent a path
- two variations:
    - random
    - heuristic (you choose the permutations specifically based on a hunch)



our chromosomes obviously won't contain just 0's and 1's, but this is a good visual

GA summary: Fitness Function

Fitness Function:

- determines how fit an individual is (the ability of an individual to compete with other individuals)
- probability that an individual will be selected for reproduction is based on its fitness score
    - fitness score of a solution = total travelled distance of the solution
        - the smaller the total distance, the fitter the solution

GA summary: Selection

Selection:

- select the fittest individuals and let them pass their genes to the next generation; survival of the fittest
- two pairs of individuals (parents) are selected based on their fitness scores
    - individuals with high fitness have more chance to be selected for reproduction
- three variations of many: Roulette Wheel method, the Rank method, and the Tournament Size

GA summary: Crossover

Crossover:

- 2 parents from the selection function “mate” during crossover, to make a “child” (a new permutation)
    - many variations: Order 1, Cycle, Partially mapped, Order Multiple and Insertion

GA summary: Mutation

Mutation:

- in certain new offspring formed, some of their genes can be subjected to a mutation with a low random probability
    - essence: some genes exchange places
- occurs to maintain diversity within the population and prevent premature convergence (gives a suboptimal solution)
- variations: swap, scramble, insert, reverse

Genetic Algorithm driven Path Planning

This is the outline I'm thinking of, on how we can work together to cover individual GA steps:

> introduction: what is GA?

> initialization

> fitness function

> selection

> crossover

> mutation

I recommend using a tutorial before we start covering the GA step of choice. There is a repo at the end if you would like to try to implement it.

TIMELINE

Wednesday, July 13:

- understanding a step in GA + decide a test data: a test input, and an expected output
- each of us should try to master a GA chunk of choice by this meeting
- we should think of the test data which should cover what i said in the beginning slides
    - please make sure your work is in mural for easy access!
    - goal is to help each other by asking questions and meeting regularly

Wednesday, July 20:

- have the implementation ready and make sure it runs correctly on your test data

Wednesday, July 27: put everything together

- make sure everything works together end to end (every function does its own job) , we do this by running it on the test data (square + decagon + NASA)

Sunday, July 31:

- create animation
- create report

Before presenting our project:

- demo, and report done

TIMELINE

Wednesday, July 13:

- each of us should try to understand a GA chunk of choice by this meeting + decide a test data: a test input, and an expected output
    - we should make sure our work (research on GA chunk) is in mural for easy access!
- think of the test data which should cover what I said in the beginning slides
- goal is to help each other by asking questions and meeting regularly

TIMELINE

Wednesday, July 20:

- have the implementation ready and make sure it runs correctly on your test data

TIMELINE

Wednesday, July 27: put everything together

- make sure everything works together end to end (every function does its own job) , we do this by running it on the final test data (decagon, for example)

TIMELINE

Sunday, July 31:

- create animation
- finalize report (motivation, problem statement, algorithm, results)

Before presenting our project:

- demo, and report done

Github Repo

I created this repo (https://github.com/iulia-iordanescu/NASA_VIP_interns).

If you guys are open to using it, we should each use a branch named “vip_user/yourname”

Please feel free to send me your github username so that I can invite you to work on the repository. You can also clone/fork it on your own.

collaborating