Project Report

Overview:

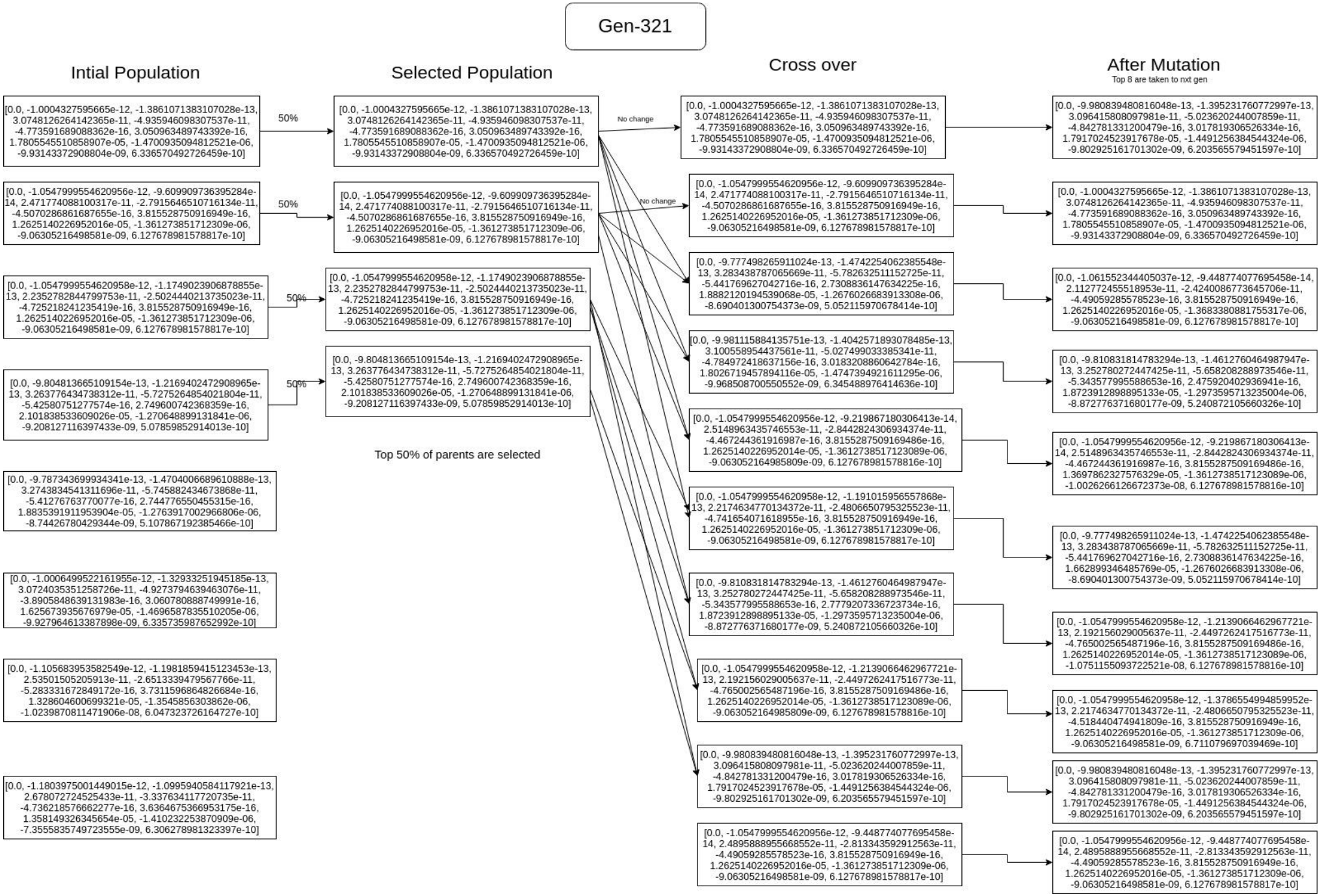
Our genetic algorithm tries to find the best fit vector for the required data by using the search heuristic ins[ired Charles Darwin's theory of evolution. The steps involved in the algorithm are similar to the basic genetic algorithm:

1. Initialize a population of any size(=n),and find fitness of each vector in the population
2. Selection, select some vectors from the population(not all) based on fitness of the vectors
3. Crossover, perform crossover function between selected vectors to regain initial population size
4. Mutation, mutate the vectors in the new population to ensure that they diverge from the previous population
5. Repeat above steps 2-4 until convergence occurs

Everytime convergence occurs a new population is taken and the above explained process is repeated. The initially given overfit vector was used to create the initial population by mutating it to create all the vectors required to form the population.

Diagramatic Representation of GA:

Move to the next page...


Gen-321
Intial Population
Selected Population
Cross over
After Mutation
Top 8 are taken to nxt gen
50%
50%
50%
50%
No change
No change
Top 50% of parents are selected
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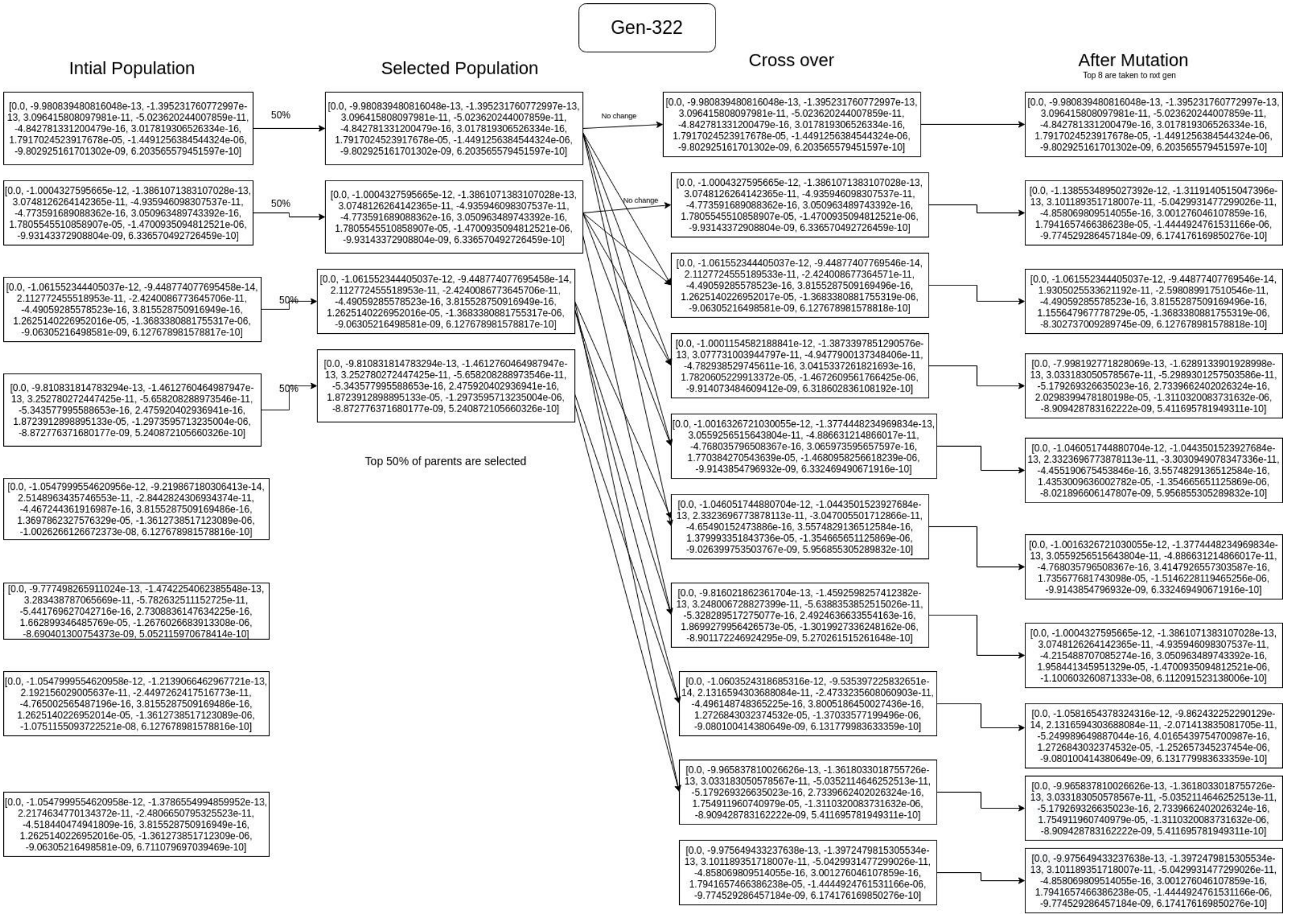
Gen-322
Intial Population
Selected Population
Cross over
After Mutation
Top 8 are taken to nxt gen
50%
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50%
50%
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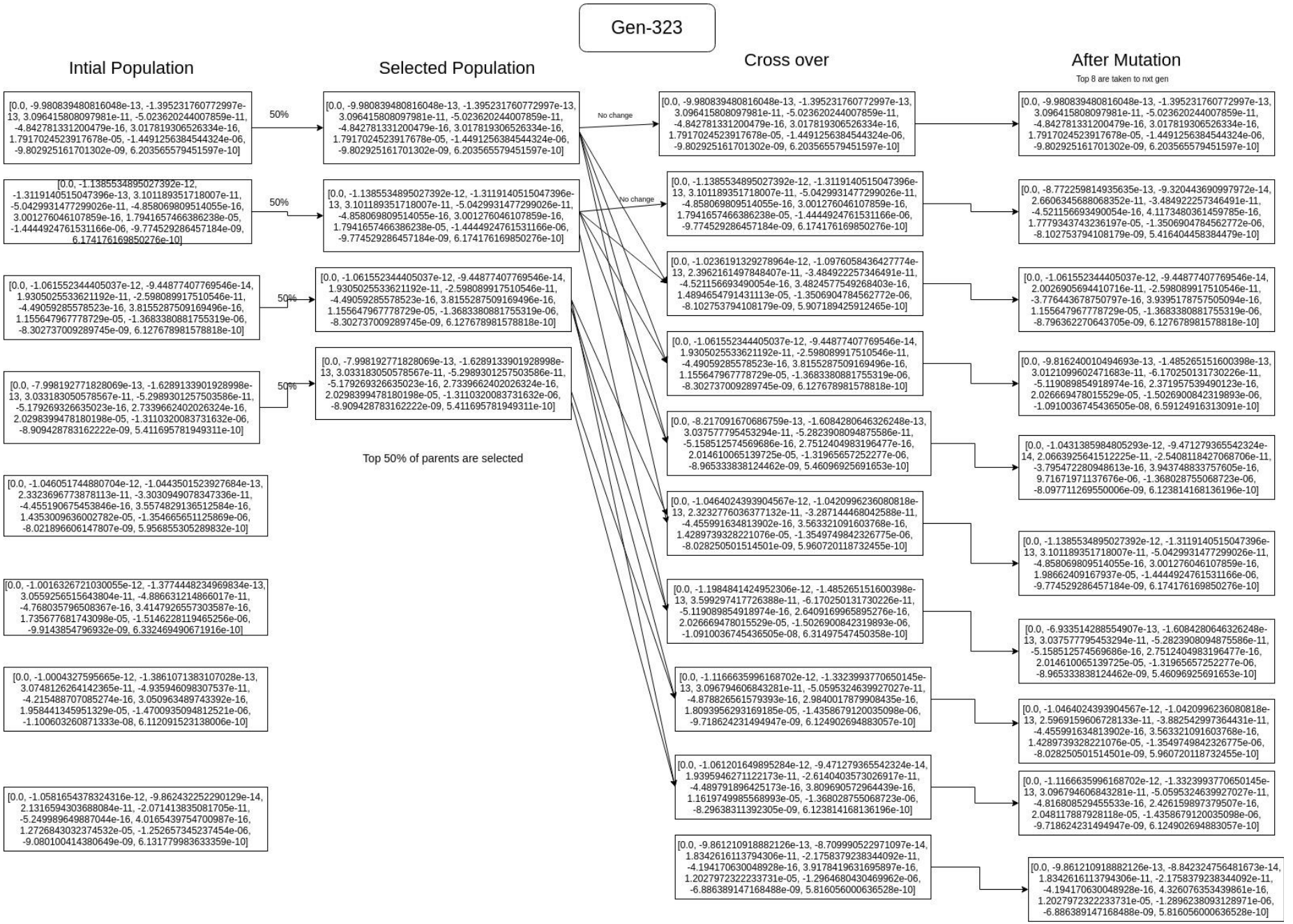
Gen-323
Intial Population
Selected Population
Cross over
After Mutation
Top 8 are taken to nxt gen
50%
50%
50%
50%
Top 50% of parents are selected
No change
No change
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Fitness Function:

We were given access to train and validation errors for the vectors produced through the algorithm. Our fitness function was made to output the arithmetic sum of those two values.

Crossover Function:

After selecting the top 5 out of the population, we take these vectors as the parents and discard the remaining 5. Based on the fitness values the top 2 parent vectors are forwarded to the next stage without any changes. Then we take these 5 parents and perform random single point crossovers between any two out of the 5 parents until we get 10 children. In single point crossovers we put the point of cutting at 6 that is first 6 values come from the first parent and the rest 5 values of the vector are copied from the corresponding places in the second vector. Now we have a total of 12 vectors with us, 2 parent vectors and 10 child vectors, we remove the bottom two vectors after mutation to bring back the population size to the initial value.

Brief on Mutation:

We tried to make mutations as random as possible while ensuring that the identity of the parents in the child is not lost completely.
For each value in the vector there is a 32% chance that it might get changed in the mutation phase. This was done to ensure that the vector retains traits from its parents and does not change completely.
Once a certain value is to be changed, the amount of change that takes place would lie in the range of -20% to +20%. Therefore, the value is multiplied by any float number in the range (-0.2,0.2) to get the new value.

Hyper Parameters:

Population size: 10
Initially we chose a population size of 16, though we later decided to reduce the population size to 10. We noticed that due to the limited number of requests, in a large population size we

weren't able to achieve much change in the population. Therefore we decided to reduce the population size to 10.

Pool Size: 5
We wanted to include the top half of the population once sorted based on fitness to take part in crossover. Since, any less than half would lead to very similar children given the random nature of our crossover function.

Number of parents passed down to new generation: 2
To ensure that the new generation will still appear to be different from the parent generation we pushed only the top half of the pool size forward.

Total number of children made during crossover: 10
Since we randomly pair parent vectors in the crossover function, we made 10 children instead of the required 8, so that all the vectors in the pool are covered during crossover. Creating more children than required also helps expand the available search space and helps the population diverge better.

Splitting point: 6
Since the length of the vector is 11, we chose splitting point as 6 to ensure that both the parents have an equal amount of influence on their child.

Mutation: 32% chance for value to change and change is in the range(-20,20) percent
We chose 32% instead of 50% because we noticed that vectors were diverging more than required and this led to a loss of vectors with good fitness. The percent change done to the values was initially set in the range(-10,10) percent, but since we dont change many values in the vector we noticed that the divergence was too little and hence doubled the range for better results

Heuristics Applied:

Initial Population
At first we generated the initial population by randomly generating values in the range(-10,10) to fill the vectors. Though this led to huge errors and there was no real change in the error values after multiple iterations

Then we used the given overfit vector to generate the initial population by mutating it to generate the whole population. This led to better error values and visible decrease in error after iterating.

Mutation
Initially, we mutated every value in the vectors generated after crossover, though this led to negligible decrease in error upon iterating. This might have been due to constantly deviating from the path that leads to the best fit vector in the search space.

Then we introduced a probability(of 32%) to ensure that every value in the vector is not mutated. This led to better reduction in error over iterating than in the previous case.

Number of children generated
Initially, we carried forward 3 parent vectors and made only the required number of children in the crossover stage(=7). The subsequent generations looked too similar to the previous generations in this case.

Therefore, we changed the number of parents carried forward to 2 and made 10 children insead of the required 8(in this case). This lead to greater exploration of the search space and thus the subsequent generations weren't as similar to the parent generation as observed in the previous case.

Output:

Train error + validation error=79238991237.18849

Vector = [0.00000000e+00 ,-9.98083948e-13, -1.39523176e-13 , 3.09641581e-11, -5.02362024e-11 ,-4.84278133e-16 , 3.01781931e-16 , 1.79170245e-05, -1.44912564e-06 ,-9.80292516e-09 , 6.20356558e-10]

Genetic algorithms are search algorithms, and every search algorithm has the task of finding the optimal vector/number in a given search space. Therefore things that the algorithm should be able to do are explore as much of the search space as possible and if a favourable branch is found, try and scope out that branch until needed. We made changes to the mutation and crossover phases(explained above), to ensure these two essential aspects.

We believe that our result will also work with unseen data because we prioritized exploring the search space over reducing the train and validation error, this way we avoided overfitting to the training data set and ensured that we obtained a generalized vector.