

Team 61:-ML chorro DASS krenge [Ayush(2019111026) , Kartik(2019101060)]

Summary of Genetic Algorithm:

- *Initial Population Size:* A wide variety of models were trained with the following population sizes.
 - Very first model had 30 as its population size.
 - Then we shifted on to 10 as its size for about 20 generations.
 - Although most of the models after the above two had 15 as its population size. This is the model that gave us our best vectors.
- So, since we have our initial population ready then proceeding like the base genetic algo, we now will let the population to crossover among itself. More details are discussed in the crossover function.
- After Crossover some of the new offsprings will undergo mutations like the traditional algorithm. There is a slight deviation from the traditional algo here that is in the original one the mutation probability is kept quite low, around 0.01 but in the algo that we applied we kept it varying from as max as 1 to as low as 0.2 . In most of the cases it was kept around 0.25 . More details of the mutations are discussed in the mutation function.
- Then comes the selection of the best pool from the (parent+child) generation. Parents were considered here because we will like to keep the better genes in the pool incase the parents are performing better than the child population. This selection procedure is defined in the fitness function.
- All of the above points then function in a loop, until we observe a constancy in the data or all of the population comprises of similar genes and we can no longer improve them as we have reached a local minima, can be the global minima too.

Diagramtic view of three generations:

Iteration 1:

Initial Population 1:

```
[[-3.08825368e-06  4.53500183e-08  1.11347798e-06 -3.81401202e-06
 -2.19437597e-06 -1.44643741e-15 -6.48759056e-07  1.79199133e-05
 -1.64404376e-06 -1.03657432e-08  7.33321351e-10]
 [-3.13225232e-06  8.96106255e-07 -1.50445939e-07 -4.81299059e-06
 -2.28444563e-06 -1.44550198e-15 -7.13473911e-07  1.78214071e-05
 -1.64774569e-06 -1.02320669e-08  7.33097369e-10]
 [-1.46970692e-06  6.16876512e-08 -4.74187411e-07 -5.90664819e-06
 -2.13496034e-06 -1.44362994e-15 -1.20024339e-08  1.76331432e-05
 -1.66011791e-06 -1.00035699e-08  7.36193609e-10]
 [-1.37559718e-06  1.28346193e-07 -5.95133538e-07 -5.96751324e-06
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 -1.65974333e-06 -9.96043968e-09  7.34275668e-10]
 [-2.53534691e-06  2.19629250e-06  2.44197255e-07 -3.94037433e-06
 -1.14089613e-08 -1.45235078e-15  8.56405221e-08  1.78914438e-05
 -1.64822418e-06 -1.03174026e-08  7.36212647e-10]
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 -1.65958007e-06 -9.97739185e-09  7.34180524e-10]
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 -1.66058874e-06 -1.02173711e-08  7.40505381e-10]
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 [ 6.21257140e-07 -1.25711268e-06 -4.07479463e-06 -3.39210588e-06
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Parents:

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    -2.13176535e-06 -1.47480045e-15  2.64972618e-08  1.77030782e-05
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    -2.00667599e-06 -1.46917398e-15 -8.52460448e-07  1.77007797e-05
    -1.64845703e-06 -1.03624444e-08  7.39259264e-10]]

[ [-1.31835081e-06  2.39304536e-07 -1.72372100e-06 -6.20745836e-06
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[ [-1.37559718e-06  1.28346193e-07 -5.95133538e-07 -5.96751324e-06
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[ [ 6.21257140e-07 -1.25711268e-06 -4.07479463e-06 -3.39210588e-06
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[[ -5.02332608e-06 -3.20666643e-07 -1.82414268e-06  2.05583833e-06  
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Children:

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[ [-2.53720940e-06 -2.10590547e-07 6.13904721e-07 -3.55890279e-06
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-1.65982191e-06 -9.90024206e-09 7.35235444e-10]
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[-2.36441202e-06 6.06470084e-08 8.66203249e-07 -4.02754944e-06
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Mutated Children

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-1.65982191e-06 -9.90024206e-09 7.35235444e-10]
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[-2.36441202e-06 6.06470084e-08 8.66203249e-07 -4.02754944e-06
-2.14398581e-06 -1.44521223e-15 -5.26578617e-07 1.77273565e-05
-1.64833850e-06 -1.03356679e-08 7.35702952e-10]
[-2.64260821e-06 2.16242322e-07 -2.20972827e-06 -4.34300392e-06
-1.59665350e-06 -1.40639456e-15 -5.38498126e-07 1.83073025e-05
-1.66925266e-06 -1.03264189e-08 7.53520222e-10]
[-4.81892444e-06 1.44293083e-07 -3.58006006e-06 -6.83852864e-07
-2.12527396e-06 -1.42617635e-15 -3.36057281e-08 1.61382254e-05
-1.69851106e-06 -9.69513298e-09 7.24020244e-10]
[-2.29872866e-06 5.38526775e-08 -2.03519582e-08 -1.65643047e-06
1.78835725e-05 -3.82407031e-07 -1.44564467e-15 -2.18819541e-06
-4.65244990e-06 -1.00099500e-08 7.35352787e-10]
[-1.32109520e-06 1.41629094e-07 -1.65625798e-06 -6.07266491e-06
-1.86711633e-06 -1.44150000e-15 -7.92637447e-07 1.77715688e-05
-1.65707421e-06 -9.89253078e-09 7.31636870e-10]
[-2.08794969e-06 4.19864710e-07 -1.01445220e-06 -3.66186262e-06
-1.15635625e-06 -1.46603786e-15 -1.51715971e-07 1.77996422e-05
-1.65364587e-06 -1.03267642e-08 7.38742018e-10]]
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Next Population

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  -1.64404376e-06 -1.03657432e-08  7.33321351e-10]
 [ -1.69280490e-06  7.15849941e-07 -4.31115917e-07 -5.38785680e-06
  -1.99969219e-06 -1.44464373e-15 -3.94715046e-07  1.77835040e-05
  -1.64871354e-06 -1.01965612e-08  7.33104563e-10]
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  -2.28444563e-06 -1.44550198e-15 -7.13473911e-07  1.78214071e-05
  -1.64774569e-06 -1.02320669e-08  7.33097369e-10]
 [ -1.46970692e-06  6.16876512e-08 -4.74187411e-07 -5.90664819e-06
  -2.13496034e-06 -1.44362994e-15 -1.20024339e-08  1.76331432e-05
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  -1.99726580e-06 -1.44342783e-15 -1.63406556e-07  1.77188285e-05
  -1.65974333e-06 -9.96043968e-09  7.34275668e-10]
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  -2.14398581e-06 -1.44521223e-15 -5.26578617e-07  1.77273565e-05
  -1.64833850e-06 -1.03356679e-08  7.35702952e-10]
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  -1.14089613e-08 -1.45235078e-15  8.56405221e-08  1.78914438e-05
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 [ -1.35229352e-06  1.39189124e-07 -7.18735833e-07 -6.01018742e-06
  -1.97952796e-06 -1.44331092e-15 -7.26526141e-07  1.77601854e-05
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  -1.65707421e-06 -9.89253078e-09  7.31636870e-10]
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  -1.65364587e-06 -1.03267642e-08  7.38742018e-10]
 [ -9.92705136e-07  2.67878688e-07 -3.82024075e-06 -3.29732685e-06
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  -1.67045576e-06 -9.80860803e-09  7.34404942e-10]
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  -2.11134194e-06 -1.44372576e-15 -1.93054334e-07  1.78532346e-05
  -1.65958007e-06 -9.97739185e-09  7.34180524e-10]
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  -1.86417140e-06 -1.44086737e-15 -8.81511824e-07  1.77841063e-05
  -1.65688400e-06 -9.87007689e-09  7.31341992e-10]
 [ -3.69150022e-06 -3.55624460e-07  1.02069416e-06 -3.62453131e-06
  -2.00667599e-06 -1.46917398e-15 -8.52460448e-07  1.77007797e-05
  -1.64845703e-06 -1.03624444e-08  7.39259264e-10]
 [ -5.02332608e-06 -3.20666643e-07 -1.82414268e-06  2.05583833e-06
  -2.13176535e-06 -1.47480045e-15  2.64972618e-08  1.77030782e-05
  -1.66058874e-06 -1.02173711e-08  7.40505381e-10]]
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Iteration 2:

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 -1.64404376e-06 -1.03657432e-08  7.33321351e-10]
 [-1.69280490e-06  7.15849941e-07 -4.31115917e-07 -5.38785680e-06
 -1.99969219e-06 -1.44464373e-15 -3.94715046e-07  1.77835040e-05
 -1.64871354e-06 -1.01965612e-08  7.33104563e-10]
 [-3.13225232e-06  8.96106255e-07 -1.50445939e-07 -4.81299059e-06
 -2.28444563e-06 -1.44550198e-15 -7.13473911e-07  1.78214071e-05
 -1.64774569e-06 -1.02320669e-08  7.33097369e-10]
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 -2.13496034e-06 -1.44362994e-15 -1.20024339e-08  1.76331432e-05
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 [-1.37559718e-06  1.28346193e-07 -5.95133538e-07 -5.96751324e-06
 -1.99726580e-06 -1.44342783e-15 -1.63406556e-07  1.77188285e-05
 -1.65974333e-06 -9.96043968e-09  7.34275668e-10]
 [-2.36441202e-06  6.06470084e-08  8.66203249e-07 -4.02754944e-06
 -2.14398581e-06 -1.44521223e-15 -5.26578617e-07  1.77273565e-05
 -1.64833850e-06 -1.03356679e-08  7.35702952e-10]
 [-2.53534691e-06  2.19629250e-06  2.44197255e-07 -3.94037433e-06
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 [-1.35229352e-06  1.39189124e-07 -7.18735833e-07 -6.01018742e-06
 -1.97952796e-06 -1.44331092e-15 -7.26526141e-07  1.77601854e-05
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 [-1.32109520e-06  1.41629094e-07 -1.65625798e-06 -6.07266491e-06
 -1.86711633e-06 -1.44150000e-15 -7.92637447e-07  1.77715688e-05
 -1.65707421e-06 -9.89253078e-09  7.31636870e-10]
 [-2.08794969e-06  4.19864710e-07 -1.01445220e-06 -3.66186262e-06
 -1.15635625e-06 -1.46603786e-15 -1.51715971e-07  1.77996422e-05
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 [-9.92705136e-07  2.67878688e-07 -3.82024075e-06 -3.29732685e-06
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 [-1.31835081e-06  2.39304536e-07 -1.72372100e-06 -6.20745836e-06
 -1.86417140e-06 -1.44086737e-15 -8.81511824e-07  1.77841063e-05
 -1.65688400e-06 -9.87007689e-09  7.31341992e-10]
 [-3.69150022e-06 -3.55624460e-07  1.02069416e-06 -3.62453131e-06
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 [-5.02332608e-06 -3.20666643e-07 -1.82414268e-06  2.05583833e-06
 -2.13176535e-06 -1.47480045e-15  2.64972618e-08  1.77030782e-05
 -1.66058874e-06 -1.02173711e-08  7.40505381e-10]]
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Parents:

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-1.64833850e-06 -1.03356679e-08  7.35702952e-10]]
[[-1.69280490e-06  7.15849941e-07 -4.31115917e-07 -5.38785680e-06
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[[[-9.92705136e-07  2.67878688e-07 -3.82024075e-06 -3.29732685e-06
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[[[-3.69150022e-06 -3.55624460e-07  1.02069416e-06 -3.62453131e-06
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[[[-1.46970692e-06  6.16876512e-08 -4.74187411e-07 -5.90664819e-06
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[[[-1.35229352e-06  1.39189124e-07 -7.18735833e-07 -6.01018742e-06
-1.97952796e-06 -1.44331092e-15 -7.26526141e-07  1.77601854e-05
-1.65804467e-06 -9.89944667e-09  7.32115708e-10]]
[[-1.37559718e-06  1.28346193e-07 -5.95133538e-07 -5.96751324e-06
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[[[-2.36441202e-06  6.06470084e-08  8.66203249e-07 -4.02754944e-06
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[[[-1.69280490e-06  7.15849941e-07 -4.31115917e-07 -5.38785680e-06
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[[[-3.08825368e-06  4.53500183e-08  1.11347798e-06 -3.81401202e-06
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  -1.64822418e-06 -1.03174026e-08  7.36212647e-10]
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[[ -2.08794969e-06  4.19864710e-07 -1.01445220e-06 -3.66186262e-06
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  -1.65364587e-06 -1.03267642e-08  7.38742018e-10]
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  -2.13496034e-06 -1.44362994e-15 -1.20024339e-08  1.76331432e-05
  -1.66011791e-06 -1.00035699e-08  7.36193609e-10]]

[[ -1.69280490e-06  7.15849941e-07 -4.31115917e-07 -5.38785680e-06
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  -1.65974333e-06 -9.96043968e-09  7.34275668e-10]]]
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Children:

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[[-1.93877181e-06 4.12340084e-07 3.13448209e-07 -5.28370472e-06
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-1.64861167e-06 -1.02201746e-08 7.34872065e-10]
[-1.07636821e-06 2.43389671e-07 -3.26175128e-06 -6.03665945e-06
-1.85142956e-06 -1.43918720e-15 -8.33342167e-07 1.77858077e-05
-1.65749202e-06 -9.84572865e-09 7.32626523e-10]
[-3.96256787e-06 -3.24945153e-07 -6.76442321e-07 1.11085530e-06
-2.15886869e-06 -1.46199168e-15 -3.88074406e-07 1.74563538e-05
-1.02444796e-08 7.25778180e-10]
Firefox Web Browser [-1.65520947e-06 -4.33847068e-07 -5.42736867e-06
-2.07056992e-06 -1.44447226e-15 -3.18270400e-07 1.77150820e-05
-4.47320368e-07 -1.00501231e-08 7.35697072e-10]
[-1.37054492e-06 1.32778969e-07 -7.13021432e-07 -5.98666413e-06
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[-2.87872230e-06 5.64016834e-08 9.24334857e-07 -4.00949390e-06
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-1.56378443e-06 -1.07032038e-08 7.09294674e-10]
[-1.63376478e-06 1.82142436e-07 -7.32886480e-10 -5.84019608e-06
-1.99820264e-06 -1.44336520e-15 -6.38634451e-07 1.77726247e-05
-1.65059441e-06 -1.01263662e-08 5.54097577e-07]
[-1.78044968e-06 5.57829569e-07 1.01323597e-06 -3.94070122e-06
-2.05000319e-06 -1.44483067e-15 -4.37321521e-07 1.78455639e-05
-7.33256435e-10 -1.02374209e-08 1.64661409e-06]
[-2.15543548e-06 8.80969632e-08 -3.10769857e-07 -5.95522780e-06
-2.11950454e-06 -1.40253011e-15 -7.47090061e-07 1.95848764e-05
-1.84677601e-06 -1.16277602e-08 7.37101600e-10]
[-1.42325785e-06 7.36110249e-08 7.95746741e-07 -4.77818016e-06
-2.06494856e-06 -1.44342171e-15 -5.25767036e-07 1.77786589e-05
-1.65848031e-06 -9.93196993e-09 7.33797394e-10]
[-1.41473182e-06 7.33329339e-08 -1.06286473e-06 -5.83618836e-06
-1.89159574e-06 -1.43845076e-15 -5.80122125e-07 1.80615575e-05
-1.63898857e-06 -1.00562198e-08 7.25401229e-10]
[ 2.12429864e-06 1.36645113e-07 -9.70555147e-07 -5.68606285e-06
 2.20582796e-06 -1.44213559e-15 -6.98533856e-07 1.77278752e-05
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[-3.27839780e-06 1.52717019e-06 5.05372708e-07 -3.87121480e-06
-1.69738590e-06 -1.45625987e-15 1.01404850e-08 1.77692129e-05
-1.64835811e-06 -1.03332359e-08 7.38270799e-10]
[-1.63238166e-06 2.91102507e-07 -9.11146510e-07 -5.01100002e-06
-1.43870313e-06 -1.44707807e-15 -1.36018743e-07 1.76821503e-05
-1.65621714e-06 -1.03209026e-08 7.37668434e-10]
[-1.55981333e-06 1.46398014e-07 -5.58216495e-07 -5.64195059e-06
-1.99858490e-06 -1.28736154e-15 -2.93902384e-07 1.82036577e-05
-1.51495796e-06 -9.55734015e-09 7.06015911e-10]]
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Mutated Children

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-2.02012554e-06 -1.44483026e-15 -4.96821502e-07 1.77636148e-05
-1.64861167e-06 -1.02201746e-08 7.34872065e-10]
[-1.07636821e-06 2.43389671e-07 -3.26175128e-06 -6.03665945e-06
-1.85142956e-06 -1.43918720e-15 -8.33342167e-07 1.77858077e-05
-1.65749202e-06 -9.84572865e-09 7.32626523e-10]
[-3.96256787e-06 -3.24945153e-07 -6.76442321e-07 1.11085530e-06
-2.15886869e-06 -1.46199168e-15 -3.88074406e-07 1.74563538e-05
-1.63442829e-06 -1.02444796e-08 7.25778180e-10]
[-1.65192272e-06 -1.65520947e-06 -4.33847068e-07 -5.42736867e-06
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[-1.37054492e-06 1.32778969e-07 -7.13021432e-07 -5.98666413e-06
-1.99061938e-06 -1.34466742e-15 -6.98833232e-07 1.92522331e-05
-1.58033731e-06 -9.26147664e-09 8.07296152e-10]
[-2.87872230e-06 5.64016834e-08 9.24334857e-07 -4.00949390e-06
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[-1.63376478e-06 1.82142436e-07 -7.32886480e-10 -5.84019608e-06
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-1.65059441e-06 -1.01263662e-08 5.54097577e-07]
[-1.78044968e-06 5.57829569e-07 1.01323597e-06 -3.94070122e-06
-2.05000319e-06 -1.44483067e-15 -4.37321521e-07 1.78455639e-05
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[-2.15543548e-06 8.80969632e-08 -3.10769857e-07 -5.95522780e-06
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[-1.42325785e-06 7.36110249e-08 7.95746741e-07 -4.77818016e-06
-2.06494856e-06 -1.44342171e-15 -5.25767036e-07 1.77786589e-05
-1.65848031e-06 -9.93196993e-09 7.33797394e-10]
[-1.41473182e-06 7.33329339e-08 -1.06286473e-06 -5.83618836e-06
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-1.63898857e-06 -1.00562198e-08 7.25401229e-10]
[ 2.12429864e-06 1.36645113e-07 -9.70555147e-07 -5.68606285e-06
 2.20582796e-06 -1.44213559e-15 -6.98533856e-07 1.77278752e-05
-1.65352490e-06 -9.96866021e-09 7.31886161e-10]
[-3.27839780e-06 1.52717019e-06 5.05372708e-07 -3.87121480e-06
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-1.64835811e-06 -1.03332359e-08 7.38270799e-10]
[-1.63238166e-06 2.91102507e-07 -9.11146510e-07 -5.01100002e-06
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-1.65621714e-06 -1.03209026e-08 7.37668434e-10]
[-1.55981333e-06 1.46398014e-07 -5.58216495e-07 -5.64195059e-06
-1.99858490e-06 -1.28736154e-15 -2.93902384e-07 1.82036577e-05
-1.51495796e-06 -9.55734015e-09 7.06015911e-10]]
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Next Population

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  -2.02012554e-06 -1.44483026e-15 -4.96821502e-07  1.77636148e-05
  -1.64861167e-06 -1.02201746e-08  7.34872065e-10]
 [ -3.08825368e-06  4.53500183e-08  1.11347798e-06 -3.81401202e-06
  -2.19437597e-06 -1.44643741e-15 -6.48759056e-07  1.79199133e-05
  -1.64404376e-06 -1.03657432e-08  7.33321351e-10]
 [ -1.69280490e-06  7.15849941e-07 -4.31115917e-07 -5.38785680e-06
  -1.99969219e-06 -1.44464373e-15 -3.94715046e-07  1.77835040e-05
  -1.64871354e-06 -1.01965612e-08  7.33104563e-10]
 [ -3.13225232e-06  8.96106255e-07 -1.50445939e-07 -4.81299059e-06
  -2.28444563e-06 -1.44550198e-15 -7.13473911e-07  1.78214071e-05
  -1.64774569e-06 -1.02320669e-08  7.33097369e-10]
 [ -1.46970692e-06  6.16876512e-08 -4.74187411e-07 -5.90664819e-06
  -2.13496034e-06 -1.44362994e-15 -1.20024339e-08  1.76331432e-05
  -1.66011791e-06 -1.00035699e-08  7.36193609e-10]
 [  2.12429864e-06  1.36645113e-07 -9.70555147e-07 -5.68606285e-06
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  -1.65352490e-06 -9.96866021e-09  7.31886161e-10]
 [ -1.37559718e-06  1.28346193e-07 -5.95133538e-07 -5.96751324e-06
  -1.99726580e-06 -1.44342783e-15 -1.63406556e-07  1.77188285e-05
  -1.65974333e-06 -9.96043968e-09  7.34275668e-10]
 [ -2.36441202e-06  6.06470084e-08  8.66203249e-07 -4.02754944e-06
  -2.14398581e-06 -1.44521223e-15 -5.26578617e-07  1.77273565e-05
  -1.64833850e-06 -1.03356679e-08  7.35702952e-10]
 [ -2.53534691e-06  2.19629250e-06  2.44197255e-07 -3.94037433e-06
  -1.14089613e-08 -1.45235078e-15  8.56405221e-08  1.78914438e-05
  -1.64822418e-06 -1.03174026e-08  7.36212647e-10]
 [ -1.35229352e-06  1.39189124e-07 -7.18735833e-07 -6.01018742e-06
  -1.97952796e-06 -1.44331092e-15 -7.26526141e-07  1.77601854e-05
  -1.65804467e-06 -9.89944667e-09  7.32115708e-10]
 [ -1.32109520e-06  1.41629094e-07 -1.65625798e-06 -6.07266491e-06
  -1.86711633e-06 -1.44150000e-15 -7.92637447e-07  1.77715688e-05
  -1.65707421e-06 -9.89253078e-09  7.31636870e-10]
 [ -2.08794969e-06  4.19864710e-07 -1.01445220e-06 -3.66186262e-06
  -1.15635625e-06 -1.46603786e-15 -1.51715971e-07  1.77996422e-05
  -1.65364587e-06 -1.03267642e-08  7.38742018e-10]
 [ -9.92705136e-07  2.67878688e-07 -3.82024075e-06 -3.29732685e-06
  -1.83202891e-06 -1.43690547e-15 -5.55577332e-07  1.78088900e-05
  -1.67045576e-06 -9.80860803e-09  7.34404942e-10]
 [ -1.45436217e-06  7.27136795e-08  9.71675678e-07 -3.89273843e-06
  -2.11134194e-06 -1.44372576e-15 -1.93054334e-07  1.78532346e-05
  -1.65958007e-06 -9.97739185e-09  7.34180524e-10]
 [ -1.31835081e-06  2.39304536e-07 -1.72372100e-06 -6.20745836e-06
  -1.86417140e-06 -1.44086737e-15 -8.81511824e-07  1.77841063e-05
  -1.65688400e-06 -9.87007689e-09  7.31341992e-10]]
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Iteration 3:

Initial Population 1:

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 -2.02012554e-06 -1.44483026e-15 -4.96821502e-07  1.77636148e-05
 -1.64861167e-06 -1.02201746e-08  7.34872065e-10]
 [-3.08825368e-06  4.53500183e-08  1.11347798e-06 -3.81401202e-06
 -2.19437597e-06 -1.44643741e-15 -6.48759056e-07  1.79199133e-05
 -1.64404376e-06 -1.03657432e-08  7.33321351e-10]
 [-1.69280490e-06  7.15849941e-07 -4.31115917e-07 -5.38785680e-06
 -1.99969219e-06 -1.44464373e-15 -3.94715046e-07  1.77835040e-05
 -1.64871354e-06 -1.01965612e-08  7.33104563e-10]
 [-3.13225232e-06  8.96106255e-07 -1.50445939e-07 -4.81299059e-06
 -2.28444563e-06 -1.44550198e-15 -7.13473911e-07  1.78214071e-05
 -1.64774569e-06 -1.02320669e-08  7.33097369e-10]
 [-1.46970692e-06  6.16876512e-08 -4.74187411e-07 -5.90664819e-06
 -2.13496034e-06 -1.44362994e-15 -1.20024339e-08  1.76331432e-05
 -1.66011791e-06 -1.00035699e-08  7.36193609e-10]
 [ 2.12429864e-06  1.36645113e-07 -9.70555147e-07 -5.68606285e-06
  2.20582796e-06 -1.44213559e-15 -6.98533856e-07  1.77278752e-05
 -1.65352490e-06 -9.96866021e-09  7.31886161e-10]
 [-1.37559718e-06  1.28346193e-07 -5.95133538e-07 -5.96751324e-06
 -1.99726580e-06 -1.44342783e-15 -1.63406556e-07  1.77188285e-05
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 -2.14398581e-06 -1.44521223e-15 -5.26578617e-07  1.77273565e-05
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 [-2.53534691e-06  2.19629250e-06  2.44197255e-07 -3.94037433e-06
 -1.14089613e-08 -1.45235078e-15  8.56405221e-08  1.78914438e-05
 -1.64822418e-06 -1.03174026e-08  7.36212647e-10]
 [-1.35229352e-06  1.39189124e-07 -7.18735833e-07 -6.01018742e-06
 -1.97952796e-06 -1.44331092e-15 -7.26526141e-07  1.77601854e-05
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 [-1.32109520e-06  1.41629094e-07 -1.65625798e-06 -6.07266491e-06
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 [-2.08794969e-06  4.19864710e-07 -1.01445220e-06 -3.66186262e-06
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 -1.65364587e-06 -1.03267642e-08  7.38742018e-10]
 [-9.92705136e-07  2.67878688e-07 -3.82024075e-06 -3.29732685e-06
 -1.83202891e-06 -1.43690547e-15 -5.55577332e-07  1.78088900e-05
 -1.67045576e-06 -9.80860803e-09  7.34404942e-10]
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Parents:

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[[[-3.08825368e-06  4.53500183e-08  1.11347798e-06 -3.81401202e-06
   -2.19437597e-06 -1.44643741e-15 -6.48759056e-07  1.79199133e-05
   -1.64404376e-06 -1.03657432e-08  7.33321351e-10]
 [-1.32109520e-06  1.41629094e-07 -1.65625798e-06 -6.07266491e-06
  -1.86711633e-06 -1.44150000e-15 -7.92637447e-07  1.77715688e-05
  -1.65707421e-06 -9.89253078e-09  7.31636870e-10]]

[[-9.92705136e-07  2.67878688e-07 -3.82024075e-06 -3.29732685e-06
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  -1.67045576e-06 -9.80860803e-09  7.34404942e-10]
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  -1.86417140e-06 -1.44086737e-15 -8.81511824e-07  1.77841063e-05
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[[-3.08825368e-06  4.53500183e-08  1.11347798e-06 -3.81401202e-06
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  -1.64404376e-06 -1.03657432e-08  7.33321351e-10]
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[[-9.92705136e-07  2.67878688e-07 -3.82024075e-06 -3.29732685e-06
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  -2.02012554e-06 -1.44483026e-15 -4.96821502e-07  1.77636148e-05
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[[ 2.12429864e-06  1.36645113e-07 -9.70555147e-07 -5.68606285e-06
   2.20582796e-06 -1.44213559e-15 -6.98533856e-07  1.77278752e-05
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  -2.19437597e-06 -1.44643741e-15 -6.48759056e-07  1.79199133e-05
  -1.64404376e-06 -1.03657432e-08  7.33321351e-10]]

[[-1.37559718e-06  1.28346193e-07 -5.95133538e-07 -5.96751324e-06
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  -2.28444563e-06 -1.44550198e-15 -7.13473911e-07  1.78214071e-05
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[ [-1.35229352e-06  1.39189124e-07 -7.18735833e-07 -6.01018742e-06
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[ [-1.35229352e-06  1.39189124e-07 -7.18735833e-07 -6.01018742e-06
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-1.64871354e-06 -1.01965612e-08  7.33104563e-10]]

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[ [-3.08825368e-06  4.53500183e-08  1.11347798e-06 -3.81401202e-06
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-1.64404376e-06 -1.03657432e-08  7.33321351e-10]
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-1.14089613e-08 -1.45235078e-15  8.56405221e-08  1.78914438e-05
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```

Microsoft Teams - Preview

Children:

```
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[-2.24380616e-06  1.83730446e-07 -6.95421006e-07 -5.21133013e-06
-6.02791860e-07 -1.45052132e-15 -1.65951351e-07  7.35996558e-10
-1.65458416e-06 -1.01679763e-08  1.78875883e-05]
[-7.98942595e-07  1.40765836e-07 -1.00183616e-06 -4.89839543e-06
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```


Mutated Children

```
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-1.87551074e-06 -1.57730567e-15 -7.85621660e-07  1.83172693e-05
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-2.17841109e-06 -1.44588425e-15 -5.32761290e-07 -5.89947433e-08
-1.64661031e-06 -1.03508424e-08  7.34220390e-10]
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-1.19348834e-06 -1.43768754e-15 -6.20790062e-07  1.77412350e-05
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[-1.90138808e-06  2.70646227e-07  3.32172050e-08 -3.69846574e-06
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 7.34552196e-10 -1.01271711e-08  1.65763913e-06]
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-1.79692213e-06 -1.45216960e-15 -2.27792279e-07  1.79131379e-05
-1.64633104e-06 -1.03468736e-08  7.33943556e-10]]
```

Next Population

Next Population

```
[[-1.93877181e-06  4.12340084e-07  3.13448209e-07 -5.28370472e-06
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-1.64861167e-06 -1.02201746e-08  7.34872065e-10]
[-3.08825368e-06  4.53500183e-08  1.11347798e-06 -3.81401202e-06
-2.19437597e-06 -1.44643741e-15 -6.48759056e-07  1.79199133e-05
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 4.88096680e-07 -1.45387001e-15 -6.52975997e-07  1.77408641e-05
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-1.79692213e-06 -1.45216960e-15 -2.27792279e-07  1.79131379e-05
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-1.64822418e-06 -1.03174026e-08  7.36212647e-10]
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-1.65804467e-06 -9.89944667e-09  7.32115708e-10]
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-1.65707421e-06 -9.89253078e-09  7.31636870e-10]]
```

The Above attached are the screenshots of our Starting Population of each iteration, What parents were selected, we have 15 pairs of parents that will result in 15 children whose screenshot is also attached. Then comes the screenshot of the mutated children. And at last the ones that were selected to be forwarded to the next generation. It can be easily observed that the last screenshot of each iteration and the first screenshot of next iteration contains the same vectors. The diagram was omitted because since we have 15*11 elements to write and there was no way to display them in a single page.

Fitness Function:

Since we were given an overfit vector initially so we proceeded on by considering validation error, but eventually on thinking more on it we thought we cant just leave train error as it as because it may sky rocket on the way to decrease validation error, in case we were just considering it. So the best solution that we came across to handle it was to consider some linear combination of train error and validation error.

$$\text{Fitness}(v) = a * \text{trainError}(v) + b * \text{validationError}(v)$$

Where a,b are the respective weights. Now on the some of the initial iterations(around 20) we considered a=3, b=8; because we already had an overfit vector so can neglect train error to some extent so validation error was given more weight. On proceeding to higher generations we increased a to 6 and b remained the same. Because of the fact train Error was now a bit much higher when compared to validation error. On the final some of the generation we kept the weights equal to give both of them an equal say.

Different weights we tried:

a=3, b=8

a=3,b=12

a=3,b=9

a=3,b=4

a=7,b=8

a=1,b=-1

The reason for the last one was that on observing the vectors and the scoreboard rank we found that the more the train error and validation error are close the better the vector performs on an unseen data. So the last one was used but unfortunately that model failed miserably. So we dropped it. That one was continued for at max 5 generations.

After calculating the fitness for each vector they were then sorted on the basis of fitness given by the fitness function, and eventually top 15 vectors were selected. Top 15 from the combination of all parents and all children.

Crossover Function:

We tried a wide variety of functions in this too, precisely 3 types

Type 1: Constant α in range (0,1)

for each gene of a vector,(that is a loop of 11)

$$\text{newGene} = \text{gene1} * \alpha + (1-\alpha) * \text{gene2}$$

where gene1 is the corresponding gene of the parent 1 and gene2 is the corresponding gene of parent 2.

Type 2: Randomised selection

for each gene of the vector, we will select a random number either 1 or 2
`a = random.randint(1,2)`

if a is 1 then we will pick the corresponding gene from the first parent
else, that is a=2 then we will pick the same from the second parent

Type 3: consecutive chunks

for each child to be made, we will select a random number between 3 and 8
And corresponding to this number, we will pick this many consecutive genes starting from index 0 from the parent 1 and the remaining genes from the parent 2 (in a consecutive fashion) such that the last gene selected is the last gene of the parent 2.

Mutation Function:

Again a wide variety of mutations were tried so as to improve our population.

Type 1: Swap

Type a: We selected two random indices and swapped their values. (probability = 0.8)

Type b: We made the first 5 genes out of 11 to swap with the last 5 genes. (probability = 0.2)

Type 2: Inversion

Two random indices were selected in the range(0,11) such that both of them were different.

Then the genotype between these indices were flipped. Ex.

$(a,b,c,d,e,f) \Rightarrow (a,e,d,c,b,f)$

in this vector of size 6, we selected 1 and 5 as our indices (0 based indexing) and the inverted the genotype.

Type 3: Multiplication

Type a: Selecting an index and then multiplying that value with a random float chosen from a certain range. One of the ranges that were selected for this was (0.8,1.2).

Type b: Multiplying each of the gene in the vector with a number selected in the similar fashion as above.

Type c: In one of the variations, we thought that since the initial overfit vector just had positive values which means we are lacking to discover the negative side, so we introduced a +1 or -1 in the above two types to make a new type of mutation.

Type 4: Addition

Type a: To a single (like case a of type 3) or multiple (case b of type 3) gene as will add a certain part of our overfit vector because since in the subsequent models that we trained after the first one was not made to have the overfit vector as a vector in the initial population so we wanted to incorporate it.

Type b: just another variant of the above type, instead of picking the overfit vector we just picked any random vector from the parent population and added a part of that. So as to improve the cohesion of two different set of genes from the parent population.

Hyperparameters:

All the hyperparameters required are mentioned in the above parts, although we have the reasons to state yet.

Pool Size: We tried a pool size of 10, which lead to very early convergence due to lack of diversity and knowledge. And the pool size of 30 was rejected because of the limitation on the number of requests and moreover since we had to just select 10 vectors so ideally there is no point to keep 30 as the population size since most of them will be rejected in the end. So we ended up on 15 which proved to be optimal for us.

Splitting Point: Splitting point was just used in one of the types of crossover and the range was 3-8. This was chosen so as to keep some say from each of the parents. Like even if we select 3/8, even then we will have 0.27% contribution from one of the parents and it can go higher than it because of the intrinsic randomness.

There was this another type of crossover the alpha one, it does not have any splitting point but it does some sort of thing like it. We chose it again to have some say of both the parents instead of just picking the gene from a single parent.

Statistical Avg(iterations) = 55.67(approx)[over all the models, even the ones that failed for us or the ones that we left in between because of no improvement]

Statistical Avg(Validation Error) = $1.06 * 10^{11}$ [similar reasons as above]

Statistical Avg(Train Error) = $1.36 * 10^{11}$ [this is pretty high because we initially had some of the populations having 10^{12} as their error]

Heuristics:

genetic algo=> population -> crossover -> children -> mutations ->selection

All of the parts of the genetic algo are already discussed above and we already mentioned all of the approaches that we used.

Validation and Train Errors:

min(Validation Error) => $7.7 * 10^{10}$

min(train Error) => $5.1 * 10^{10}$

Actually it should perform better according to us and what we studied but this does not correspond to the best vector we have for our submission.

We initially had a viewpoint that since we were given an overfit vector so there is not point in decreasing the trainerror as it is already exceptionally low (this is what is meant by the overfitting). This viewpoint arised from the fact that in the initial stages of our training our validation error decreased while at the same time train error increased. This is when we considered a linear combination of both with a =3 and b=8.

Till now what we observed was that decreasing the train and validation errors does help us but what is more preferable is the closeness of the two. The more they are close the better they perform on an unseen data. Well of course this does not mean that you can keep their errors of the order 10^{19} or something bizarre. This is just an observation and this was not always followed, if taken on statistical terms then we will say that this happened every 3 out of 5 times we made a submission.

The vector with the min validation and min train error should perform better because we just have these two to train or proceed our model but this wasnt what that was happening. We literally have two different vectors one with both validation and train error of the order 10^{11} and the other with an order of 10^{13} but the second vector is performing better (The vectors are like close to 0).So we are literally confused on how we should proceed. Even we did train one of the model of ours to a generation level of above 120 and we assure we did have different vectors in each generation but still the model wasn't performing good.

Theoretically a vector with low validation error and train error should perform better.

We think for this project, in view that we were given an overfit vector, our model should perform good even if the train error increased from the original overfit vector but this wasn't what was happening.

Some random tricks tried:

We tried a hell lot of tricks to get some good vectors to start with but the train and validation errors of each such vector were very high altho they performed much better on the test set. On training these vectors basically decreasing train and validation errors the vectors again dropped on their performance on the test set.