CS348 FS2013 Assignment 1c with Bonus

**Plot1-Plain Vanilla EA**

**Plot2-Constraint Satisfaction EA with penalty fitness function**

**Plot3-Constraint Satisfaction EA with additional constraint**

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| --- | --- | --- |
| F-Test Two-Sample for Variances |  |  |
|  |  |  |
| *Provided Puzzle* | *Original Problem Statement Fitness Function* | *Penalty Fitness Function* |
| Mean | 50.73333333 | 50.53333333 |
| Variance | 92.20229885 | 63.01609195 |
| Observations | 30 | 30 |
| df | 29 | 29 |
| F | 1.463154823 |  |
| P(F<=f) one-tail | 0.155536299 |  |
| F Critical one-tail | 1.860811434 |  |

Table1

In table 1, p is greater than alpha, so the null hypothesis is failed to be rejected,.Hence it is difficult to prove the statistical difference between the means. For the provided puzzle file, penalty fitness function is not outperforming the original problem statement fitness function. It is also observed from plot 1 and plot2, that constraint satisfaction EA with penalty fitness function has almost similar fitness as compared to plain Vanilla EA.

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| --- | --- | --- |
| t-Test: Two-Sample Assuming Unequal Variances |  |  |
|  |  |  |
| *Provided Puzzle* | *Penalty Fitness Function* | *Repair Fitness Function* |
| Mean | 50.53333333 | 53.9 |
| Variance | 63.01609195 | 58.09310345 |
| Observations | 30 | 30 |
| Hypothesized Mean Difference | 0 |  |
| df | 58 |  |
| t Stat | -1.675607081 |  |
| P(T<=t) one-tail | 0.04959937 |  |
| t Critical one-tail | 1.671552763 |  |
| P(T<=t) two-tail | 0.09919874 |  |
| t Critical two-tail | 2.001717468 |  |

Table2

In Table 2,p is less than alpha, so the null hypothesis is rejected. Statistically the means of repair fitness function and penalty fitness function of the provided puzzle are not the same. And repair function performs better than the penalty function for the provided puzzle. It is also be observed from plot 2 and plot 3

|  |  |  |
| --- | --- | --- |
| t-Test: Two-Sample Assuming Unequal Variances |  |  |
|  |  |  |
| *Provided Puzzle* | *Original Problem Statement Fitness Function* | *Repair Function* |
| Mean | 50.73333333 | 53.9 |
| Variance | 92.20229885 | 58.09310345 |
| Observations | 30 | 30 |
| Hypothesized Mean Difference | 0 |  |
| df | 55 |  |
| t Stat | -1.414783969 |  |
| P(T<=t) one-tail | 0.081384347 |  |
| t Critical one-tail | 1.673033966 |  |
| P(T<=t) two-tail | 0.162768693 |  |
| t Critical two-tail | 2.004044769 |  |

Table3

In table 3,p is greater than alpha, so the null hypothesis is failed to be rejected. Hence, it is difficult to prove the statistical difference between the means. For provided puzzle file, repair fitness function is not outperforming the original problem statement fitness function. It is also observed from plot 1 and plot 2 that their fitness values for best fitness and average fitness are almost similar

**Plot4- Plain Vanilla EA for random generated file**

**Plot5- Constraint Satisfaction EA employing penalty fitness function for the random generated file**

**Plot 6-Constraint Satisfaction EA employing the repair fitness function for the random generated puzzle file**

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| --- | --- | --- |
| t-Test: Two-Sample Assuming Unequal Variances |  |  |
|  |  |  |
| *Random Generated File* | *Original Problem Statement Fitness Function* | *Repair Fitness Function* |
| Mean | 20.96666667 | 29.93333333 |
| Variance | 20.72298851 | 5.926436782 |
| Observations | 30 | 30 |
| Hypothesized Mean Difference | 0 |  |
| df | 44 |  |
| t Stat | -9.513662242 |  |
| P(T<=t) one-tail | 1.51929E-12 |  |
| t Critical one-tail | 1.680229977 |  |
| P(T<=t) two-tail | 3.04E-12 |  |
| t Critical two-tail | 2.015367547 |  |

Table4

In table 4,p is much less than alpha. So the null hypothesis is rejected . Hence, their means are not the same. Repair Fitness function outperforms the original problem statement fitness function for random generated file. This is also observed from plot 4 and plot 6, that repair fitness function has higher average and best fitness when compared to original problem statement fitness function.

|  |  |  |
| --- | --- | --- |
| t-Test: Two-Sample Assuming Unequal Variances |  |  |
|  |  |  |
| *RandomGenerated File* | *RepairFitness Function* | *Penalty Fitness Function* |
| Mean | 29.93333333 | 21.83333333 |
| Variance | 5.926436782 | 22.41954023 |
| Observations | 30 | 30 |
| Hypothesized Mean Difference | 0 |  |
| df | 43 |  |
| t Stat | 8.332972161 |  |
| P(T<=t) one-tail | 8.04305E-11 |  |
| t Critical one-tail | 1.681070704 |  |
| P(T<=t) two-tail | 1.60861E-10 |  |
| t Critical two-tail | 2.016692173 |  |

Table5

In table 5, p is much less than alpha. So the null hypothesis is rejected and their means are not the same. Repair Fitness function outperforms the penalty fitness function for random generated file. This is also observed from plot 5and plot 6, that repair fitness function has higher average and best fitness when compared to penalty fitness function

|  |  |  |
| --- | --- | --- |
| F-Test Two-Sample for Variances |  |  |
|  |  |  |
| *Random Generated file* | *Original Problem Fitness Function* | *Penalty Fitness Function* |
| Mean | 20.96666667 | 21.83333333 |
| Variance | 20.72298851 | 22.41954023 |
| Observations | 30 | 30 |
| df | 29 | 29 |
| F | 0.924327096 |  |
| P(F<=f) one-tail | 0.416821278 |  |
| F Critical one-tail | 0.537399965 |  |

Table6

In table 6, p is greater than alpha. We fail to reject the null hypothesis, so it is difficult to prove the statistical difference between the means. For the random generated file, penalty fitness function is not outperforming the original problem statement fitness function. It is also observed from plot 4 and plot 5 that their fitness values for best fitness and average fitness are almost similar.

**Plot7**

**Plot8**

**Plot9**

**Plot10**

**Plot11**

**Plot12**

Validity forced uniform random did not outperform uniform random initialization for both random generated puzzle file and provided puzzle file employing plain vanilla EA(with original fitness function) and penalty function, and repair function. It can be observed when comparing plot1-6 with plot7-12

Plot1-6 are the plots for random generated puzzle file and provided puzzle employed uniform random initialization. Plot 7-12 are the plots for random generated puzzle file and provided puzzle employing validity forced uniform random initialization. The fitness of the plot 7-12 employing validity forced uniform random initialization are similar to the fitness of the plot1-6 emplyoing uniform random initialization.

**Plot13**

**Plot14**

Plot13 and Plot14 are generated for the provided puzzle file and random generated puzzle file, both employing penalty coefficient as 10. Their fitness is lower when compared to the fitness of the plots 2 and 5 , i.e, the provided puzzle file and random generated puzzle file which employs a penalty coefficient 1.

Hence, it is observed that, as the penalty coefficient increases, the fitness of the solution decreases. So the penality coefficient is indirectly proportional to the solution quality of the constraint satisfaction EA employing a fitness function.