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CS5401 FS2018 Assignment 1c

Constraint-Satisfaction EA

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October 7, 2018

1 Methodology

All T-test preformed using a two-tailed distribution, a two-sample unequal variance (heteroscedastic) test is performed, the alpha parameter is 0.05 and each sample size is fifty fitnesses. The null hypothesis for all test is that the population mean fitnesses for the first sample is equal to the second sample. All comparisons between runs of the EA are kept as similar as possible only changing the parameter of interest. All data is in terms of average population fitness per number of evaluations.

2 Analyzing Improvement in a Constraint-Satisfaction EA Employing a Penalty Function

2.1 Assigned Board

A constraint-satisfaction EA employing a penalty function offers better results than a basic EA, considering the T-test p-value of 0; when compared to a repair function the T-test p-value of 0.0005 shows that the repair function preforms better.
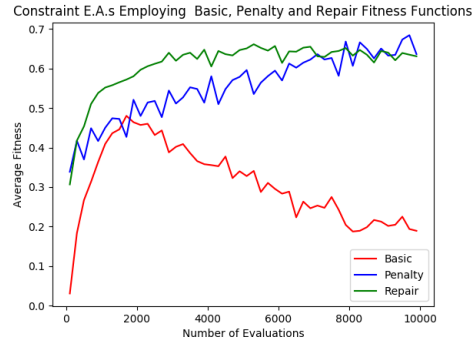
	Basic	Penalty	Repair
Average	0.3070432432	0.5558156757	0.6092613514
Standard Deviation	0.09853981983	0.08217763332	0.06606127677
variance	0.009710096093	0.006753163418	0.004364092289
T-test	0		0.0005390132579

2.2   Random Boards

A constraint-satisfaction EA employing a penalty function offers equivalent results to a basic EA, considering the T-test p-value of 0.19; when compared to a repair function the T-test p-value of 0 shows that the repair function preforms better.


Constraint E.A.s Employing Basic, Penalty and Repair Fitness Functions

	Basic	Penalty	Repair
Average	0.45654198	0.4347807821	0.7401661915
Standard Deviation	0.08695585547	0.08118205986	0.06595359204
variance	0.007561320801	0.006590526844	0.004349876303
T-test	0.1988983448		0

3

3 Comparing EAs Employing Forced Validity and Uniform Random Initialization

## 3.1 Assigned Board

3.1.1 Basic Fitness

Both configurations preformed equivalently bad. Uniform random initialization preformed very poorly for basic fitness, if the few fit individuals in a population do not get picked to be parents, the average fitness falls to zero quickly.
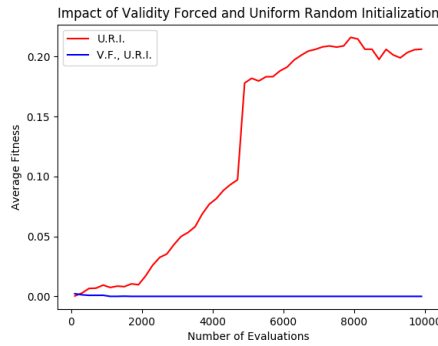
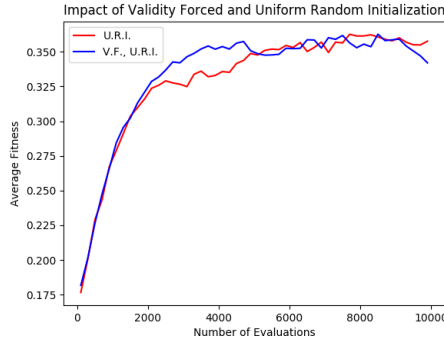|	F.V. and U.R.	U.R.
Average	0.1215887387	0.0001240540541
Standard Deviation	0.08535172176	0.000402820311
variance	0.007284916408	0.000000162264203
T-test	0	

3.1.2 Penalty Fitness

Uniform random initialization preformed less poorly for Penalty fitness, the added genetic diversity help slow fitness degradation. But, again, both configurations preformed equivalently poor.

Impact of Validity Forced and Uniform Random Initialization
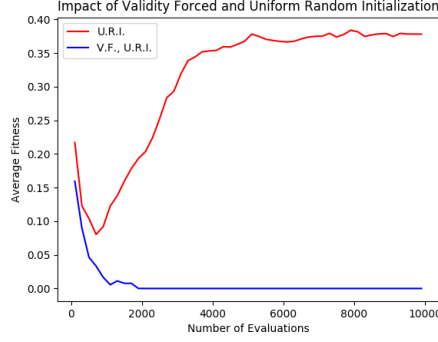
	F.V. and U.R.	U.R.
Average	0.3111825676	0.007559121622
Standard Deviation	0.09619133965	0.02651297888
variance	0.009252773823	0.0007029380489
T-test	0	

3.1.3 Repair Fitness

Both configurations with repair preformed equivalently well. These configurations did not share the same loss of fitness as the other configurations due to the volume of fit individuals.
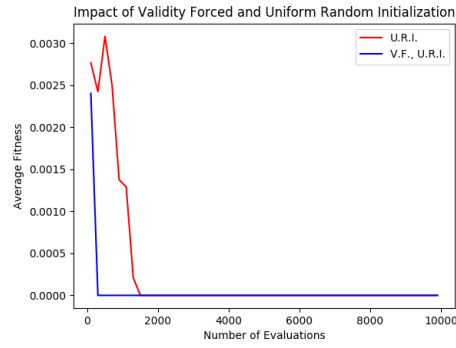

Impact of Validity Forced and Uniform Random Initialization

	F.V. and U.R.	U.R.
Average	0.3302622748	0.3339137838
Standard Deviation	0.04177146796	0.04148344913
variance	0.001744855536	0.001720876551
T-test	0.6619232128	

3.2   Random Boards
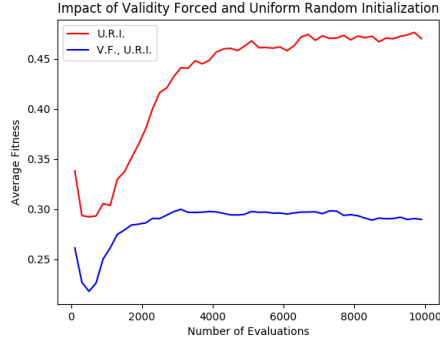
Again, both configurations preformed equivalently bad.

3.2.1   Basic Fitness

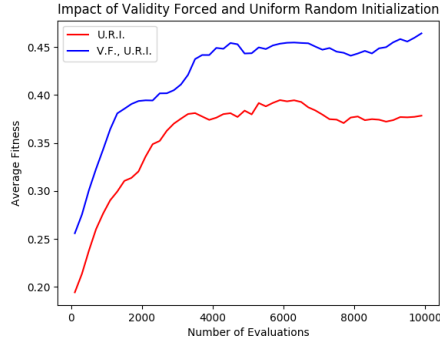|	F.V. and U.R.	U.R.
Average	0.0002730228525	0.00004809653916
Standard Deviation	0.0007716248776	0.0003400938899
variance	0.0000005954049518	0.000000115663854
T-test	0.06359168534	

3.2.2 Penalty Fitness

Given the p-value of the T-test, both configurations performed equivalently.

	F.V. and U.R.	U.R.
Average	0.4299146547	0.2870118415
Standard Deviation	0.05929583822	0.01890259673
variance	0.00351599643	0.000357308163
T-test	0	

3.2.3 Repair Fitness

Both configurations were equivalent. Repair fitness functions similarly to non-random initialization.

	F.V. and U.R.	U.R.
Average	0.3561276062	0.4215879912
Standard Deviation	0.04777985977	0.0488061994
variance	0.002282915	0.0023820451
T-test	0.0000000009247323641	

4 Penalty Function Coefficient Effects on Solution Quality

4.1 Assigned Board

A constraint-satisfaction EA employing different penalty coefficients preform at different levels. Considering the T-test comparing values 0.5 and 1.0, it is clear from the p-value of 0.005 that the latter preforms better. Although, when comparing values 1.0 and 1.5 the performance is similar. Overall, The value of the penalty coefficient is positively correlated to solution quality to a point, where the coefficient stops mattering and the EA is basically operating with only valid individuals.
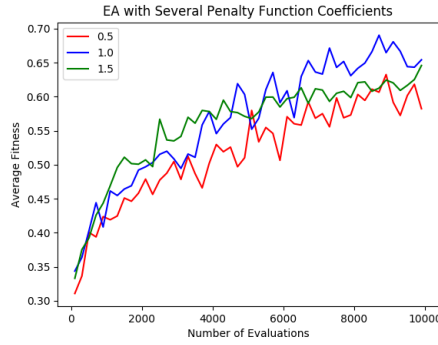
	P.C. = 0.5	P.C. = 1.0	P.C. = 1.5
Average	0.5189377027	0.5656762162	0.5592304054
Standard Deviation	0.07416746452	0.08893047016	0.06975757603
variance	0.005500812794	0.007908628523	0.004866119414
T-test	0.005300537023		0.687684336

4.2 Random Boards

Considering the T-test comparing values 0.5 and 1.0, the p-value is greater than alpha, so, both samples preform equivalently. The same situation occurs with values 1.0 and 1.5. Overall, all values preformed similarly on the random boards, considering the assigned board's results this may indicate that random boards could use a slightly higher coefficient to see any performance differences.
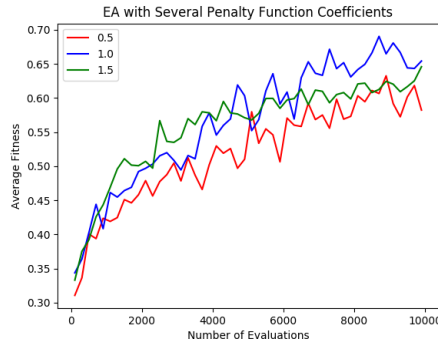
	P.C. = 0.5	P.C. = 1.0	P.C. = 1.5
Average	0.7081163989	0.7104515572	0.7232313518
Standard Deviation	0.06341326214	0.05701996763	0.05999335936
variance	0.004021241816	0.003251276708	0.003599203167
T-test	0.8468756373		0.2775989777