# CS5401 FS2018 Assignment 1d

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## Contents



## Introduction

Assignment 1d involved implementing a Multi-Objective Evolutionary Algorithm (MOEA) to more effectively solve Light Up puzzles by balancing the fulfillment of three objectives:

1. maximize the number of cells lit up (represented in this implementation as a ratio of lit cells to the total number of white cells)
2. minimize the number of bulbs shining on each other
3. minimize the number of black cell adjacency constraint violations

For BONUS #1, a fourth objective was added, namely minimizing the number of bulbs placed on the board.

This report outlines this solution's particular implementation of a MOEA, the impact of initialization strategies on the MOEA's performance, a comparison between parent selection, survival strategy, and survival selection strategies on MOEA performance, as well as the impact of increasing the number of objectives on non-domination and MOEA performance (BONUS #1).

## MOEA Overview

The MOEA implemented in this assignment is based on the NSGA-II algorithm. It begins, similar to a standard evolutionary algorithm, by creating an initial population using either uniform random or validity enforced plus uniform random initialization, the settings for which

Table 1: Statistical Analysis performed on the TODO caption, EA configurations

| | random_gen | random_gen_uniform_random_init |
|---|---|---|
| mean | 1.1032528479567796 | 1.0764116503308312 |
| variance | 0.5771562510229628 | 0.5665987346326673 |
| standard deviation | 0.7597080037902475 | 0.7527275301413303 |
| observations | 90 | 90 |
| df | 89 | 89 |
| F | 1.018633145019535 | |
| F critical | 0.7042808002041888 | |
| Unequal variances assumed | | |
| | | |
| observations | 90 | |
| df | 91 | |
| t Stat | 0.23677202742177048 | |
| P two-tail | 0.8131059379632284 | |
| t Critical two-tail | 1.9864 | |
| Nether random_gen_uniform_random_init nor random_gen is statistically better | | |

are specified in the algorithm configuration file. That population is evaluated and the subfitnesses are determined and assigned to each individual in the population.

The population is then evaluated on the basis of non-domination. A list of Pareto fronts is created from the initial population where all genotypes in a given front are not dominated by any other genotypes in that front while genotypes in higher level fronts are dominated by genotypes in lower level fronts. The 'best' genotypes, those in the best level of non-domination, are assigned to level number one. Subsequent levels increase in increments of one for other levels of non-domination.

The fitness of each genotype is then set to its level in the list of Pareto fronts, with individuals exhibiting a smaller fitness (level number) are more fit. A binary tournament selection is performed to choose breeding parents. Then offspring are created using an n-point crossover recombination (with n determined in the configuration file). Following that, mutation is performed, completing the child population.

For the standard NSGA-II configuration (exhibited in the deliverables configuration folder), the plus survival strategy is exhibited, combining the children and parent populations into one large population from which to choose the new population. Individuals are then selected for survival using a binary tournament selection and the process is repeated using the new population until the end of the experiment.

## Impact of Initialization on MOEA Performance

## Comparison of Parent Selection, Survival Strategy, and Survival Selection Strategies

## BONUS #1: Impact of Increasing Number of Objectives on Number of Non-Domination and MOEA Performance

TODO: need to create config files and run test for this

Table 2: Statistical Analysis performed on the TODO caption, EA configurations

| | website_puzzle | website_puzzle_uniform_random_init |
|---|---|---|
| mean | 0.8031737242867952 | 0.7959489651519913 |
| variance | 0.734732706694364 | 0.7417386264875153 |
| standard deviation | 0.8571655071772102 | 0.8612424899454946 |
| observations | 90 | 90 |
| df | 89 | 89 |
| F | 0.9905547324313853 | |
| F critical | 0.7042808002041888 | |
| Unequal variances assumed | | |
| | | |
| observations | 90 | |
| df | 91 | |
| t Stat | 0.05609263818405474 | |
| P two-tail | 0.9553309228197409 | |
| t Critical two-tail | 1.9864 | |
| Nether website_puzzle_uniform_random_init nor website_puzzle is statistically better | | |