Electrical & Computer ENGINEERING

18-799: Evolutionary Algorithms in Engineering Optimization
Fall Semester, 2014

Homework #2

Assigned: 9/8/2014
Due: 9/17/2014 at 14:00 US Pacific Time, 17:00 US Eastern Time

1. (5pts) Eiben & Smith Textbook 4-4

2. (5pts) Eiben & Smith Textbook 8-1

3. (5pts) Eiben & Smith Textbook 8-3

4. (15pts) Eiben & Smith Textbook 11-1

Programming Assignment

5. (30pts) Eiben & Smith Textbook 4-5. On the following page there is some additional information about recombination.

You may use any programming language (Java, Python, C++, Matlab, etc.)

- You must write the code yourself (no GA libraries allowed) and submit the code with the assignment
- We will run you code so you must: 1) include compilation and run instructions; 2) seed your random number generator with the value 1234 so that we will get the same results
- You may re-use any code you wrote for the first programming assignment

Extra resources for HW #2 Papers referenced in the E&S textbook can be found below in case you need them. They have useful information to optimize your code and/or choosing initial parameter values.
- An Overview of Evolutionary Algorithms for Parameter Optimization (https://db.tt/ZrPX2S2d)
- Evolutionary Programming and Evolution Strategies: Similarities and Differences (https://db.tt/MiRgq5Vu)

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2.1.3 Recombination Different recombination mechanisms are used in ESs either in their usual form, producing one new individual from two randomly selected parent individuals, or in their *global* form, allowing components to be taken for one new individual from potentially all individuals available in the parent population. Furthermore, recombination is performed on strategy parameters as well as on the object variables, and the recombination operator may be different for object variables, standard deviations, and rotation angles. Recombination rules for an operator $r' : I^{\mu} \rightarrow I$ creating an individual $r'(P(t)) = \vec{a}' = (\vec{x}', \vec{\sigma}', \vec{\alpha}') \in I$ are given here representatively only for the object variables $(\forall i \in \{1, \ldots, n\})$:

$$x_i' = \begin{cases} x_{S,i} & \text{without recombination} \\ x_{S,i} \text{ or } x_{T,i} & \text{discrete recombination} \\ x_{S,i} + \chi \cdot (x_{T,i} - x_{S,i}) & \text{intermediate recombination} \\ x_{S_i,i} \text{ or } x_{T_i,i} & \text{global, discrete} \\ x_{S_i,i} + \chi_i \cdot (x_{T_i,i} - x_{S_i,i}) & \text{global, intermediate} \end{cases} \tag{4}$$

Indices S and T denote two parent individuals selected at random from $P(t)$, and $\chi \in [0, 1]$ is a uniform random variable. For the global variants, for each component of $\vec{x}$ the parents S_i, T_i as well as χ_i are determined anew. Empirically, discrete recombination on object variables and intermediate recombination on strategy parameters have been observed to give best results. Recombination of strategy parameters has been shown to be mandatory for this mechanism to work. Historically, intermediate recombination and its global form have always been used with a fixed value of $\chi = 1/2$; only recently Schwefel proposed the generalization indicated in (4).

From: Back, Schwefel, An Overview of Evolutionary Algorithms for Parameter Optimization, *Evolutionary Computation* (1): 1-23, 1993.