Evolutionary Computation Homework 2

1. Because Evolutionary Strategies tend to search the genotype space by mutation, but mutation is unbiased by default. So, ES need to design the mutation strength and direction by the understanding of fitness. In comparison, Genetic Algorithms discover the genotype space by crossover more, so they can discover the whole space with unbiased mutation.
2. I think both one-point crossover and uniform crossover does not change the frequency of a single allele at a position. Because that crossover does not affect the total number of any allele, we need to know mutation and survivor selection to know how the frequency would be changed.

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| (1+1)-ES |  |  |  |
| Run #1 | 785 | 134827 | 10000000 |
| Run #2 | 961 | 220427 | 10000000 |
| Run #3 | 879 | 273836 | 10000000 |
| Run #4 | 892 | 337556 | 10000000 |
| Run #5 | 815 | 240235 | 10000000 |
| Run #6 | 823 | 152518 | 10000000 |
| Run #7 | 809 | 423719 | 10000000 |
| Run #8 | 865 | 45291 | 10000000 |
| Run #9 | 933 | 93133 | 10000000 |
| Run #10 | 810 | 509601 | 10000000 |
| (1,1)-ES |  |  |  |
| Run #1 | 10000000 | 10000000 | 10000000 |
| Run #2 | 10000000 | 10000000 | 10000000 |
| Run #3 | 10000000 | 10000000 | 10000000 |
| Run #4 | 10000000 | 10000000 | 10000000 |
| Run #5 | 10000000 | 10000000 | 10000000 |
| Run #6 | 10000000 | 10000000 | 10000000 |
| Run #7 | 10000000 | 10000000 | 10000000 |
| Run #8 | 10000000 | 10000000 | 10000000 |
| Run #9 | 10000000 | 10000000 | 10000000 |
| Run #10 | 10000000 | 10000000 | 10000000 |

1. For (1+1)-ES, the process can ensure that the gene after mutation and selection is no worse than the original one, so it can approach to the target value gradually, if the step size is not too large. But (1,1)-ES do not ensure the evolution process is approaching to the target value, more likely a random process.

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| (1+1)-ES |  |  |  |
| Run #1 | 700 | 5855 | 10000000 |
| Run #2 | 657 | 21183 | 10000000 |
| Run #3 | 698 | 14053 | 10000000 |
| Run #4 | 701 | 40419 | 10000000 |
| Run #5 | 675 | 102530 | 10000000 |
| Run #6 | 609 | 10359 | 10000000 |
| Run #7 | 796 | 34279 | 10000000 |
| Run #8 | 697 | 20845 | 10000000 |
| Run #9 | 625 | 46292 | 10000000 |
| Run #10 | 717 | 79250 | 10000000 |
| (1,1)-ES |  |  |  |
| Run #1 | 10000000 | 10000000 | 10000000 |
| Run #2 | 10000000 | 10000000 | 10000000 |
| Run #3 | 10000000 | 10000000 | 10000000 |
| Run #4 | 10000000 | 10000000 | 10000000 |
| Run #5 | 10000000 | 10000000 | 10000000 |
| Run #6 | 10000000 | 10000000 | 10000000 |
| Run #7 | 10000000 | 10000000 | 10000000 |
| Run #8 | 10000000 | 10000000 | 10000000 |
| Run #9 | 10000000 | 10000000 | 10000000 |
| Run #10 | 10000000 | 10000000 | 10000000 |

1. Using n step size can help the population perform a more creative mutation, it can take different step size for different gene location, and make it better to reach to the target value. The effect is more obvious on (1+1)-ES when .

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| (1+1)-ES |  |  |  |
| Run #1 | 825 | 4848 | 16237 |
| Run #2 | 788 | 4594 | 19147 |
| Run #3 | 866 | 5166 | 19127 |
| Run #4 | 785 | 3146 | 16942 |
| Run #5 | 815 | 4808 | 18078 |
| Run #6 | 858 | 3027 | 18329 |
| Run #7 | 874 | 4500 | 17692 |
| Run #8 | 775 | 3905 | 18373 |
| Run #9 | 855 | 5533 | 16338 |
| Run #10 | 818 | 5123 | 19036 |
| (1,1)-ES |  |  |  |
| Run #1 | 10000000 | 10000000 | 10000000 |
| Run #2 | 10000000 | 10000000 | 10000000 |
| Run #3 | 10000000 | 10000000 | 10000000 |
| Run #4 | 10000000 | 10000000 | 10000000 |
| Run #5 | 10000000 | 10000000 | 10000000 |
| Run #6 | 10000000 | 10000000 | 10000000 |
| Run #7 | 10000000 | 10000000 | 10000000 |
| Run #8 | 10000000 | 10000000 | 10000000 |
| Run #9 | 10000000 | 10000000 | 10000000 |
| Run #10 | 10000000 | 10000000 | 10000000 |

1. 1/5-rule for self-adaption effects the process of (1+1)-ES when . Because their step size is large by default, so they tend to overpass the target value when performing mutation, and self-adaption can larger their step size when approaching target value, lower when getting away from target, helps a lot for reaching to the target. But for (1+1)-ES, it has about 50% to perform a success mutation, so its step size would become larger and larger, but it tends to random exploring the space with large step size. Even worse, (1,1)-ES would get so far away to overflow the fitness value and break the program.