Evolutionary Computation Final Exam

Problem 1.

$$S_1 =* 0 **** 11 **** \ and \ S_2 =***** 10 * 0 ***$$

1.a. The $order\ o(S_1)$ is the number of the match points in S_1, so $o(S_1) = 3$, similarly $o(S_2) = 3$. The $defining\ length\ \delta(S_1)$ is the length between the first and last match point in S_1, so $\delta(S_1) = 8 - 2 = 6$, and $\delta(S_2) = 9 - 6 = 3$ similarly.

1.b. When one-point crossover chooses a point in the match region, then it may break the schemata. So, the probability to choose a point for one-point crossover in $S_1 = \frac{\delta(S_1)}{l-1} = \frac{6}{11}$, and the probability to perform crossover and choose the breaking point is $P_{b,c} = p_c * \frac{6}{11}$.

1.c. When mutation is performed on any match point of S_1, the schemata would be broken, so the probability of mutation breaking the schemata is $P_{b,m} = o(S_1) * p_m = p_m * 3$.

1.d. If both crossover and mutation didn't break the schemata, then S_1 survives the operations. The probability to survive is

$$P_s = 1 - P(b,c\ or\ b,m) = 1 - (P_{b,c} + P_{b,m}) + P_{b,c} * P_{m,c}$$

$$= 1 - \left(p_c * \frac{6}{11} + p_m * 3\right) + \left(p_c * \frac{6}{11}\right) * (p_m * 3)$$

1.e. For S_2, the chance to break with crossover is $P_{b,c} = p_c * \frac{\delta(S_2)}{l-1} = p_c * \frac{3}{11}$, and the chance to break with mutation is $P_{b,m} = o(S_2) * p_m = p_m * 3$. According to the calculation above, we can get the probability of S_2 to survive the operations is

$$P_s = 1 - (P_{b,c} + P_{b,m}) + P_{b,c} * P_{m,c}$$

$$= 1 - \left(p_c * \frac{3}{11} + p_m * 3\right) + \left(p_c * \frac{3}{11}\right) * (p_m * 3)$$

1.f. Suppose both $S_1\ and\ S_2$ has higher fitness than other individuals. In the case of S_1, because that it has more than 50% when performing a crossover, which is a high chance. So, I would not call S_1 a building block. As for S_2, I would more likely to call it a building block, because it has much bigger chance to survive the crossover and mutation operators, and thus spread its schema among the population. So, I think it is appropriate to call S_2 a building block, rather than S_1.

Problem 2.

Fitness sharing shares the fitness among its neighbors and select based on the shared fitness. The expected distributions for fitness sharing are the population crowding around different local optima, and the population distribution has positive relation to the optima values. So, population around optima of 40 has the most populations, and the lesser the optima value, the lesser the population around the optima.

Deterministic crowding pairs parent and children, and select based on the similarity and fitness of the pairs. Deterministic crowding can maintain the original distribution and cumulate the population to local optima at the same time. For different local optima in deterministic crowding, they have about the same population count around them. So, for the 4 local optima, whatever the fitness value is, they all have about the same size of population distributed around them.

Problem 3.

Because population tends to get close to the closest local optima around them, so the initialization is important, and once it is trapped in local optima, it is hard to break free and search for the global optima. Thus, increasing mutation strength is needed for increasing the chance to escape from local optima and search for global optima.

But when approaching global optima, large mutation strength would let the population hard to converge to the optima. So, for this case, lower mutation strength can make the process faster and more stabilize. Thus, we should also decrease the mutation strength during the evolutionary process.