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Assignment 9

Topic 'Mutation Operators'

In this assignment we always consider a bit string x of length n as an array where the first position is $x[0]$ and, consequently, $x[n-1]$ is the last position.

We consider three different mutation operators, standard bit mutation with mutation probability $p_m = 1/n$, asymmetric mutation, and a mutation operator that we call hypermutation and that is defined as follows.

1. Select $p \in \{0, 1, \ldots, n-1\}$ uniformly at random.
2. Select $l \in \{0, 1, \ldots, n\}$ uniformly at random.
3. For $i := 0$ to $n - 1$ do
4. If $i \leq l - 1$
   Then $y[(p + i) \bmod n] := 1 - x[(p + i) \bmod n]$
   Else $y[(p + i) \bmod n] := x[(p + i) \bmod n]$

Let $m_1(x)$ denote the random bit string resulting from applying standard bit mutation with mutation probability $p_m = 1/n$ to $x \in \{0,1\}^n$. Let $m_2(x)$ denote the random bit string resulting from applying asymmetric mutation to $x \in \{0,1\}^n$. Let $m_3(x)$ denote the random bit string resulting from applying hypermutation to $x \in \{0,1\}^n$.

Problem 1 Consider the following four bit strings (all of length n). $z_1 := 0^n$, $z_2 := 10^{n-1}$, $z_3 := 1010^{n-3}$, $z_4 := 1^n$. For all $i \in \{1, 2, 3\}$, compute $\text{Prob}\,(m_i(z_1) = z_2)$, $\text{Prob}\,(m_i(z_2) = z_1))$, $\text{Prob}\,(m_i(z_1) = z_3)$ and $\text{Prob}\,(m_i(z_1) = z_4)$.

Problem 2 Consider the (1+1) EA in a variant where you replace standard bit mutation by hypermutation. Prove an upper bound on the expected optimisation time on OneMax.

Problem 3 **Implementation Task**
Remember your implementation for Assignment 8. Add the asymmetric (1+1) EA to your implementation. Perform the same experiments for this RSH as you did for random local search and the (1+1) EA. Compare the results. Can you explain the results?

Assignments are handed out on each Friday during the lecture. Written solutions are due the next Wednesday. Feedback is given and solutions are discussed the Wednesday after that.