Preliminaries

During Lecture 9, we only use Travelling-Salesman-Problem (TSP) for our illustration. As your Mini Project involves another (NP?)-hard problem Low Autocorrelation Binary Sequence (LABS) Problem, let’s review Lecture 9 (and also a bit of Lecture 10) in the context of LABS Problem, a problem that you will not likely encounter in daily life but was quite important for Steven’s PhD journey.

Discussion Points

Q1: Understanding LABS Problem: Please brute force all possible $2^3 = 8$ bit strings $s$ of LABS Problem instance $n = 3$ and evaluate their objective function values/energy level $E(s)$ and merit factor $F(s)$. What can you conclude about these 8 bit strings? Note: Describe the bit strings in ‘Run Length Notation’ (RLN)! PS: Is this problem NP-hard?

Q2: Describe the search space $S$ (and how big it can be), solution set $S'$ (and whether the optimal solution is unique or can be more than one), possible neighborhood relation(s) $N$, memory states $M$ (if any), initialization function, step function (choose a neighborhood relation), and termination function of a simple Hill Climbing for LABS problem.

Q3: The naive evaluation of the objective function of this LABS Problem is $O(n^2)$ as you have performed in Question 1 above. If we are performing a local move and only changing one single bit (from 1 to -1 or from -1 to 1), we can utilize the delta evaluation technique discussed in Lecture 9. Show how to do such delta evaluation in $O(n)$ time. How important is this single technique for the overall SLS performance?

Q4: Based on what you have heard in Lecture 10 (Meta-heuristics) before this Tutorial T09, suggests some possible improvements to the simple Hill Climbing algorithm mentioned in Question 2 above, especially on the problem of escaping the local optima.

Postscript

The last tutorial T10 will be the last one for this semester where we will discuss various Meta-heuristics (that is, the more established SLS algorithms) and the SLS Design and Tuning Problem.