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EXPERIMENTAL IMPLEMENTATION OF BOOLEAN MATRIX MULTIPLICATION WITH DNA COMPUTING USING PARALLEL OVERLAP ASSEMBLY

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Abstract. *While there are many proposals to implement DNA computations, very few are realized in laboratory works. In this paper we present experimental implementation of Boolean matrix multiplication operation with DNA. We use Parallel Overlap Assembly method to generate the initial pool and encode the problem without the use of restriction enzymes. The read out from computation with DNA yield the same results as the actual Boolean matrix multiplication and the proposed approach present a more simplified design of DNA sequences with easier read-out.*

Keywords: Boolean matrix multiplication, DNA computing, Parallel overlap assembly (POA)

1. **Introduction.** With the ever increasing need for speed and prediction of Moore's Law, many researchers begin to look for other alternatives to traditional silicon computers. Among these alternatives, the idea to use nature or bio-inspired computing became one of the highlighted proposals for a new computation medium. The self-assembly, huge information storage capacity, low dissipation energy and massive parallelism properties of DNA holds the promise which attracted many researchers in various fields extending from biology, chemical, mathematics to information technology [1,2].

While there are many papers that have been published to propose the implementation of DNA computing in various applications, these proposals are seldom realized in laboratory experiments. Factors contributing to the difficulties of physically implementing DNA computations in laboratories such as the concentration of different species, and the environment, especially temperature, are critical [3]. DNA computing relies on developing algorithms that solve problems using the encoded information in the sequence of nucleotides that make up DNA double helix and then breaking and making new bonds between them to reach the answer [2].

Adleman made a major breakthrough when he solved a seven-node Traveling Salesman Problem (TSP) using actual DNA molecules [4]. His works later spurred many other proposals to use DNA computation for solving combinatorial optimization, Boolean circuits, nanotechnology and NP problems such as maximal clique problem and shortest path problem. However, most proposals to compute problems with DNA computing are based on Adleman-Lipton architecture which uses hybridization-ligation method to generate an initial pool of possible solutions and restriction enzymes to cut the DNA molecules encoding the problems. Restriction enzymes and its complexities offer liabilities to DNA computing as it is limited in number which constrains larger computations. Moreover, experiments with restriction enzymes cannot guarantee fidelity in their results [3]. The designs of the