Modeling of the Road Coloring Problem using Cell-Cell Communication and a Microfluidic Device

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Synthetic Biology:

Synthetic biology uses DNA, cells and other molecular materials as basic components (parts) to build functional modules. From these modules novel biological systems are constructed [3, 5,9]. Such biological systems have either introduced new functionality by using natural parts in an unnatural configuration or environment, or using modified parts to mimic natural functions [3,5,9]. Some examples include synthetic biofilm, logic gates and switches, sensors and artificial cell-cell communication devices [4,7,9,10,13].

To illustrate the computational capability of molecular materials to implement mathematical games or problems, Adleman used DNA to implement a solution to the directed Hamiltonian path problem, more commonly known as the Traveling Salesman Problem [1]. Additionally, Stojanovic and Stefanovic built a DNA automaton that can play tic-tac-toe with a human [11, second version in 8].

The Road Coloring Problem:

The Road Coloring Problem (RCP) originated in the fields of Graph Theory, Symbolic Dynamics, and Synchronization. The problem, based on the Cerny Conjecture, was stated by Adler et al. [2] to be as follows: is it possible to create a graph where following a set of synchronized instructions, regardless of the starting point one would always arrive at the same destination node? Synchronizing instructions in this context refer to a set of instructions that would make the system converge to a single destination point regardless of the origin while following a pattern of an identical set of instructions. The RCP problem states that such a pattern can be found in any directed graph where all nodes have the same out degree. In 2007, Trahtman proved the conjecture for the general case [12]. In 2002, Jonoska and Karl proposed DNA as a synthetic biology approach to execute the Road Coloring Problem *in-vitro* providing protocols and procedures for implementation [6]. This project seeks to model a Road Coloring Problem graph using cell-cell communication and a microfluidic device.