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Research Description

Currently, there are very few solar cell designs known to be viable for energy collection. The focus of this research is to use mathematical computation techniques to produce a variety of novel and viable solar cell designs. Genetic algorithms are implemented to combine existing solar cell designs to produce more effective designs for electron excitation and electron collection.

In the algorithm written in MATLAB, solar cells are represented by 4-dimensional matrices. The first three dimensions delineate the dimensions of the proposed solar cells, and each coordinate represents a voxel of size 1 nm3 in the device. The fourth dimension contains data about each solar cell design, including the material of each voxel and whether it is directly connected to the layer of conductive material present in the bottom layer of each cell. A generation of solar cells comprises a specified number of such 4D matrices.

Each design is evaluated for its ability to facilitate electron excitement from incident photons and its ability to conduct these electrons across the solar cell. A fitting function produces a value for each proposed design.

Fitting function values are computed for each solar cell design in a generation and are and used to determine which solar cells best exhibit the characteristics stated previously. With this information, two different techniques are utilized for the creation of new designs: mutation and crossover. Mutation entails slight changes of an existing solar cell design to produce a new one. When two designs are combined to form one design, it is a crossover. Computed fitting function values are used to ensure that only the best permutations of existing designs in a generation are used in the creation of new cells through crossover. In the creation of each new generation, a full generation of mutated designs and a full generation of designs through crossover are produced. Half of each type of generation is taken at random to form the final new generation to ensure generational diversity.

The goal of running this algorithm for many generations on an initial set of solar cell designs is that the final generation should contain new solar cell designs not yet implemented in current research.