Abstract

The standard abstract Tile Assembly Model (aTAM) in 2D can be augmented to Active aTAM by allowing the presence of inactive binding sites and signal pathways on tiles: binding sites that are activated only by attachment to a corresponding signal-carrying tile [2, 4]. We note that the physical realization of DNA-based tiles with such a signaling mechanism has been confirmed experimentally [3]. The active 2D tile assembly model admits Turing universal computation at temperature 1 (not yet confirmed for the 2D aTAM though known to hold for temperature 2 [5]). We establish a direct comparison between the aTAM and the Active aTAM: we show how to construct a 2D temperature 1 active tile assembly system that simulates the dynamics of a given 2D temperature 2 standard (aTAM) tile assembly system. The simulating system preserves the relative geometry of the original tile assemblies but doubles their size (in each of the two dimensions).

The Intuitive Idea

The aTAM tile assembly on the left is “simulated” in the Active aTAM on the right. Heavy lines indicate sites of attachment between two tiles; blue and red lines indicate presence of active but not necessarily matching binding sites; thin black lines indicate the absence of any binding sites. The identity of the original tile is encoded in the upper left corner, outside its “body,” which consists of a center tile that directs signal transmission (signals not shown) and to which four tiles representing glue labels are attached. The glue label tiles are, in fact, shared between the tile and its “body,” which consists of a center tile that directs signal transmission (signals not shown) and to which four tiles representing glue labels are attached. The glue label tiles are, in fact, shared between the tile and its neighbor on a given side, thus creating an overlapping net representing the original tiling. If there is a mismatch in the simulated tiling between its neighbor on a given side, thus creating an overlapping net representing the original tiling. If there is a mismatch in the simulated tiling between its neighbor on a given side, thus creating an overlapping net representing the original tiling. If there is a mismatch in the simulated tiling between its neighbor on a given side, thus creating an overlapping net representing the original tiling.

Center Tiles

Each of the center tiles is paired uniquely with some label tile, as indicated by a single active label on one of their sides. The inactive +x, −y, −x tile sides can be activated via signals from an identity tile. The +y tile sides in b), c), and d) contain inactive labels for all possible decider tiles.

References


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