Abstract

We show how to design a universal *shape replicator* in a self-assembly system with both attractive and repulsive forces. More precisely, we show that there is a universal set of constant-size objects that, when added to *any unknown* hole-free polyomino shape, produces an unbounded number of copies of that shape (plus constant-size garbage objects). The constant-size objects can be easily constructed from a constant number of individual tile types using a constant number of preprocessing self-assembly steps. Our construction uses the well-studied 2-Handed Assembly Model (2HAM) of tile self-assembly, in the simple model where glues interact only with identical glues, allowing glue strengths that are either positive (attractive) or negative (repulsive), and constant temperature (required glue strength for parts to hold together). We also require that the given shape has specified glue types on its surface, and that the feature size (smallest distance between nonincident edges) is bounded below by a constant. Shape replication necessarily requires a self-assembly model where parts can both attach and detach, and this construction is the first to do so using the natural model of negative/repulsive glues (also studied before for other problems such as fuel-efficient computation); previous replication constructions require more powerful global operations such as an "enzyme" that destroys a subset of the tile types.