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Partial decidability protocol for the Wang tiling problem from statistical mechanics and chaotic mapping

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Content

We introduce a partial decidability protocol for the Wang tiling problem (which is the prototype of undecidable problems in combinatorics and statistical physics) by constructing a suitable mapping from tilings of finite squares of different sizes. Such mapping depends on the initial family of Wang tiles (the alphabet) with which one would like to tile the plane. This allows to define effective entropy and temperature associated to the alphabet (together with the corresponding partition function). We identify a subclass of good alphabets by observing that when the entropy and temperature of a given alphabet are well-behaved in the thermodynamical sense then such alphabet can tile the infinite two-dimensional plane. Our proposal is tested successfully with the known available good alphabets (which produce periodic tilings, aperiodic but self-similar tilings as well as tilings which are neither periodic nor self-similar). Our analysis shows that the Kendall Tau coefficient is able to distinguish alphabets with a good thermodynamical behavior from alphabets with bad thermodynamical behavior. The transition from good to undecidable behavior is related to a transition from non-chaotic to chaotic regime in discrete dynamical systems of logistic type.

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