

## COMPLEXITY OF TWO DIMENSIONAL SANDPILES

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### Abstract

We prove that in a two-dimensional Sandpile automaton, embedded in a regular infinite planar cellular space, it is impossible to cross information, if the bit of information is the presence (or absence) of an avalanche. This proves that it is impossible to embed arbitrary logical circuits in a Sandpile through quiescent configurations.

Our result applies also for the non-planar neighborhood of Moore. Nevertheless, we also show that it is possible to compute logical circuits with a two-dimensional Sandpile, if a neighborhood of radius two is used in  $\mathbb{Z}^2$ ; crossing information becomes possible in that case, and we conclude that for this neighborhood the Sandpile is P-complete and Turing universal.

**Key words:** Sandpile, Discrete Dynamical System, Cellular Automata, Calculability, Complexity