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Avalanche complex and topology of the sandpile dynamics on digraphs

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Sandpile model, or chip firing, is a discrete dynamical system on (di)graphs with connections to combinatorics, algebra, and statistical physics, and which poses open questions related to certain fractal type patterns emerging from the dynamics. Configurations of this system are natural number valued vertex functions, also called chip configurations. Vertex whose value exceeds its (out-)degree is unstable and fires by sending one chip to each of its (out-)neighbours, thus taking the system to a new configuration. A variant of the vertex firing is the avalanche, in which all unstable vertices in a chip configuration fire simultaneously. To study sandpile dynamics topologically, we introduce a simplicial complex, called the avalanche complex, generated by the avalanching sets of vertices. Our results concern the topology of the avalanche complex for certain classes of graphs, particularly cycles, and decomposition of the configuration space into domains by Betti numbers, a kind of hyperplane arrangement. This is a joint ongoing work with Jason Smith.

Primary author: Dr RIIHIMÄKI, Henri (Nordita / Stockholm University)

Presenter: Dr RIIHIMÄKI, Henri (Nordita / Stockholm University)