

3 Self-organized criticality: the Oslo model

This section provides the tasks and questions related to implementing and analyzing the Oslo model of self-organized criticality. **The tasks should be finished till 21.11.2024.**

The Oslo rice-pile model is a theoretical model of self-organized criticality (SOC) used to study the behavior of granular materials and avalanche-like phenomena in a simple, discrete system. It was introduced as a variation of the sandpile model, and it's named after the city of Oslo, Norway, where it was developed.

1. Implement the Oslo model using the following algorithm focusing on slopes z_i :

- (a) Initialize the system in arbitrary stable configuration $z_i \leq z_i^T$, where z_i^T is i -th slope threshold $\in [1, 2]$;
- (b) Drive the system by adding a grain at left-most site;
- (c) If $z_i > z_i^T$, relax the site i ,

for $i = 1 : z_1 \rightarrow z_1 - 2, z_2 \rightarrow z_2 + 1$;
 for $i = 2 \dots L - 1 : z_i = z_i - 2, z_{i\pm 1} \rightarrow z_{i\pm 1} + 1$;
 for $i = L : z_L \rightarrow z_L - 1, z_{L-1} \rightarrow z_{L-1} + 1$.

During relaxation do not forget about choosing randomly new threshold $z_i^T \in [1, 2]$ for the relaxed site. Continue relaxation until $z_i \leq z_i^T$ for all i ;

- (d) Return to point (b).
2. Plot scaled avalanche size s/s_{max} in function of time t (measured in terms of grain additions). Does it makes sense to analyze data for small t ? Which condition should be satisfied in avalanche size statistical analysis?
 3. Plot in log-log scale avalanche size probability $P(s, L)$ with respect to avalanche size s for several lengths of the system (L should be at least 64). Do you observe power law behavior? Why this power law breaks for large s ?