Falling Sand

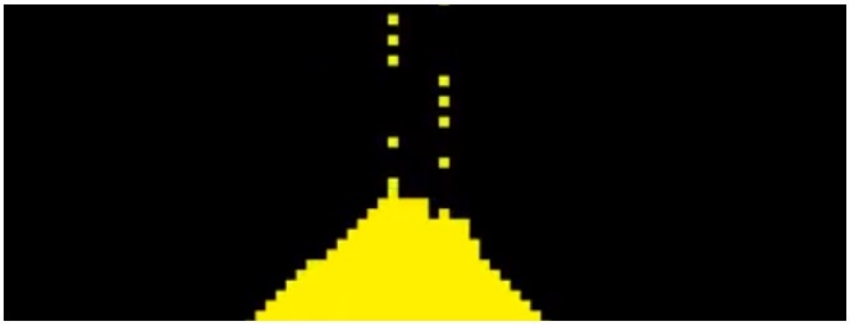

Figure 1: Falling sand automaton [1]

Motivation

A great portion of concrete (around 70 vol-%) consists of sand. In order to produce concrete more sustainably, material scientists try to find a way to use desert sand for producing concrete. This is only possible to a certain amount, because desert sand is almost perfectly round, due to erosion. This leads to a flowability (see figure 2) of the desert sand that is too high for the use in concrete.
One approach is to mix the round sand particles with more granular particles, such that a certain cohesion is reached.

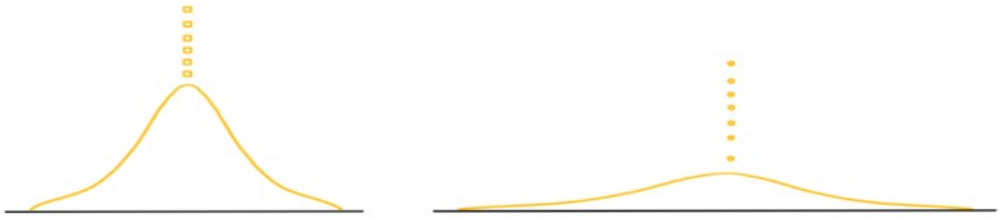

Figure 2: flowability of particles, left: low flowability, right: high flowability

Model

Falling particles is a good example for creating an cellular automaton. The model should be able to simulate two things:

- the pouring of a mixture of sand particles of two different granularities on a flat surface inside a box
- the behaviour of falling sand on a non-flat surface inside a box

For the first point, the model should have a parameter that is responsible for the ratio between the two granularities. After a simulation, the model should return nice visualizations and Δh, which is the height difference between the lowest and the highest sand particle on the surface, see Figure 3 [1].

[1] Note: Usually, the flowability of particles is obtained using the angle of response, see `https://www.granutools.com/en/news/55_angle-of-repose` for more information.

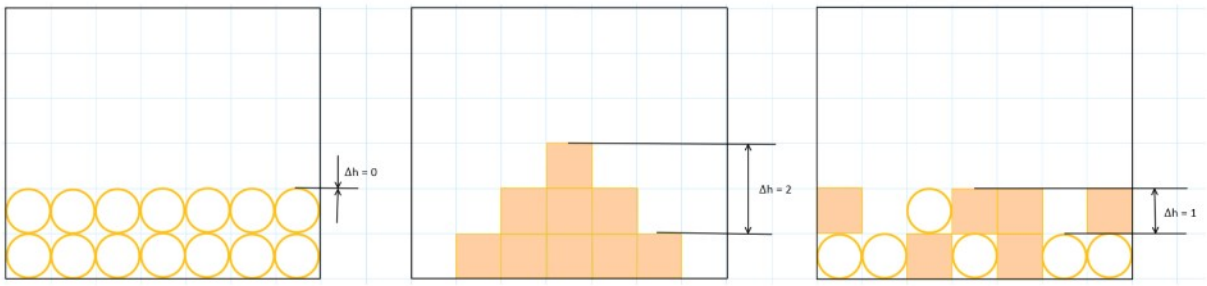

Figure 3: examples for Δh on different heaps in a box

To Do's

Task 1

Sketch a plan for the model and set the assumptions, i.e.: List the parameters of the model. Work out update rules for the two different types of sand particles. These rules should represent the behaviour of edgy and round sand particles.

Task 2

Implement the model in a language of your choice (Python, Matlab, etc). The model should have a parameter for the ratio and the type of surface, produce vizualisations and return Δh.

Task 3

Run the model with different ratios and at least one non-flat surface.

Task 4

Create a nice visualizations and write the protocol. Document the division of labour.

References

[1] Hahm, Christian. (2023). A Framework of Artificial Matter.