Hybrid: 2022 SIAM Conference on Mathematics of Data Science

Part of
Physics Informed Neural Network: Dynamics of Granular Matter Flow

Abstract. We propose physics informed neural network that are trained to solve supervised learning tasks while respecting physical properties of the dynamics of growing sandpiles generated by a vertical source on a flat rectangular table, modeled by a 2×2 system of non-linear partial differential equations, for which classical/approximate Riemann solvers are not possible. The model is given by:

$$u_t + N_u[u,v](t,x) = 0 \quad \text{in} \quad \Omega \times (0,T], v_t + N_v[u,v](t,x) = 0 \quad \text{in} \quad \Omega \times (0,T], \tag{1}$$

$$u(x,0) = u_0(x) = 0, \quad v(x,0) = v_0(x) = 0 \quad \text{in} \quad \Omega. \tag{2}$$

and with the boundary condition

$$u_b(.\,,t) = 0 \quad \text{in} \quad \partial\Omega \times [0,T] \tag{3}$$

, where $N_u[u,v](t,x) = -(1-|\nabla u|)v, N_v[u,v](t,x) = -\nabla.\,(v\nabla u) + (1-|\nabla u|)v - f$,\$u(**x**, t)\$ is the local height of the pile containing the grains at rest and is called as the *standing* layer, and \$v(**x**, t)\$ is the rolling layer representing the sand above the *standing* layer, which is formed only by the grains that roll on the surface of the pile until they are captured by the standing layer. Simulations are presented to illustrate that the proposed surrogate model detects the solutions efficiently and comparisons are made with the existing studies.

Authors

- *Aekta Aggarwal*
  Indian Institute of Management, Indore
  aektaaggarwal@iimidr.ac.in
- Luv Verma
  Indian Institute of Technology, Madras
  luvverma2011@gmail.com