

Complex dynamical transitions in granular flow: Augmented intelligence models for real-time decision making from the factory floor to open fields

Antoinette Tordesillas
Department of Mathematics and Statistics
University of Melbourne

Oh, the curses of in-betweens! Regimes in between granular solid and granular flow pose multifactorial challenges: multiphysics, multiscale, multiphase, multidimensional etc. It is very difficult if not impossible to model these regimes using traditional continuum and/or discrete approaches. Traditional models deliver output predictions of future system behaviour from 'static' inputs: measurements of the system from selected fixed states in space and historical time. Whether these prescribed inputs capture enough information for the model to predict "emergent phenomena" that invariably arise in complex granular systems is essentially anyone's guess. This problem is even more acute in open field conditions which are subject to climate change. Here we share experiences from recent efforts with industry partners to tackle this problem in a way that exploits the unprecedented advances in remote monitoring and sensing technologies from Industrial Internet of Things (IIoT) coupled with big data analytics and AI. These efforts shift the focus to a continuous monitoring of the system -- whether this is under the controlled conditions of a factory floor to the uncontrolled conditions of an open field -- to deliver data at high precision and high space-time resolution for input to a data-driven augmented intelligence model. The model is then configured to continuously and efficiently learn from the streaming, big spatiotemporal data the essential governing relations and their associated parameters, with quantified uncertainty, for real-time decision support.