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Simulating industrial scenarios: with the open-source software MercuryDPM

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Abstract

Creating predictive computer simulations, i.e. virtual prototypes, of complex granular industrial processes has many challenges. In this paper we review recent advances in creating such virtual prototypes. We introduce the open-source code MercuryDPM [1], which is often applied to complex industrial applications via the spin-off company MercuryLab. We briefly discuss how to import complex industrial geometries and how to deal with large numbers of particles and wide size-distributions. Then we focus on how to create a computer representation of an actual granular material, the so-called model calibration. For calibration, we start by reviewing what parameters need to be measured and what experimental characterisation machines are available. We present an industrially practical calibration method, where certain parameters are directly measured and others are indirectly calibrated, using a variety of machine-learning techniques, implemented in the open-source codes GrainLearning [2], TensorFlow [3] and scikit-learn [4]. With GrainLearning, one can find local optima in only two to three iterations, even for complex contact models with many microscopic parameters. On the other hand, TensorFlow and scikit-learn use two popular supervised learning algorithms, Neural Network (NN) and Random Forest (RF) regression, respectivly. After a training period consisting of hundreds of particle simulations, NN and RF are capable of providing a mapping between the micro-parameters and the bulk behaviour, which can be used to find the optimal micro-parameters that correspond to the experimentally observed behaviour.

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