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Predicting a clog: characterizing 2D granular hopper flows using machine learning methods[1] JESSE HANLAN, DOUGLAS DURIAN, University of Pennsylvania — In contrast to other fluids, grains flowing from a hopper discharge at a constant rate and form stable arches, clogging the system. Thomas and Durian (PRL 2015) showed that measuring the fraction of flow microstates that cause a clog supports the assertion that the average mass of grains discharged between clogs is an exponential function of outlet diameter. The accompanying physical intuition is that hopper flows are a Poisson process, wherein the flow randomly samples states until it finds one that forms a stable arch. To better understand this, Koivisto and Durian (PRE 2017) found similar scaling of the fraction of flow states versus outlet diameter for both dry and submerged hoppers, suggesting the momentum states are not as dominant as the configuration states for the clogging behavior. We wish to fully characterize the properties of microstates that cause a clog compared to those that continue flowing. We use particle tracking to extract the positions throughout a hopper flow, and construct a method to differentiate between configurations. We apply new machine learning techniques in order to best utilize the data in a highly asymmetric classification problem: to differentiate between the single clogging microstate and the many flow states that preceded it.

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