Using Machine Learning for Magnetic Hysteresis of Metal-Organic Frameworks

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Magnetic hysteresis data provide critical information for Material Science applications to characterize the magnetic behavior of synthesized metal-organic frameworks (MOFs), organic metal halide materials, and natural materials. The analysis of magnetic hysteresis yields a wide range of information on the magnetic domain state, magnetic grain size (e.g., single domain vs. vortex state vs. multidomain in ferromagnetic materials), and quantifies the elemental chemistry of materials.The interpretation of the magnetic hysteresis data are typically done by analyzing distribution curves individually (e.g., their shape, the saturation levels) and requires a good understanding of material magnetism. However, projects using magnetic hysteresis measurements typically involve tens to hundreds of specimens whose interpretation is time intensive. At New Mexico Highlands University, two of the PREM Research Thrusts are dedicated to (1) characterizing the magnetic properties and (2) integrating machine learning and material modeling for Material Sciences. Machine learning is another great tool already used in material and geophysical sciences. Unfortunately, only a handful of studies have attempted to integrate machine learning into magnetic material characterization. For this research, we initiated a project dedicated to facilitating the data reduction and interpretation of magnetic hysteresis data using image processing and Euclidean distance algorithms. We will show 1) the first stage of the project involving the construction of a magnetic hysteresis catalog and algorithms development and 2) our ongoing plans for the deployment of this machine learning program to evaluate hysteresis data and the interpretation of the results.

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