Finding discrete symmetry groups via Deep Learning

Pablo Calvo-Barlés,* Sergio G. Rodrigo,† and Luis Martín-Moreno‡

Instituto de Nanociencia y Materiales de Aragón (INMA),

CSIC-Universidad de Zaragoza, 50009 Zaragoza, Spain

Eduardo Sánchez-Burillo§

PredictLand S.L., 50001 Zaragoza, Spain

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Symmetries play an essential role in the understanding of physical theories. A paradigmatic example is the conservation laws arising from continuous symmetries in classical mechanics. Discrete symmetries, such as parity or time reversal, do not depend on any continuous parameter and are key in the study of degeneracies in the energy spectrum of quantum mechanical systems, for instance. Unveiling hidden discrete symmetries is of enormous interest in many fields of physics.

If a given system presents discrete symmetries, there is a group of transformations acting on the physical parameters that leave the measurements invariant. Calculating the parameters from a given measurement is thus a multivalued problem. Here we introduce a novel neural network architecture called Symmetry Seeker Neural Network (SSNN) that, provided only with experimental or numerical data, is capable of finding all these symmetry-related multivalued solutions and the corresponding representation of the group of symmetry transformations.

We believe that SSNN is a powerful tool because it is highly non-trivial to discover symmetries on data sets (specially if it is high-dimensional). The SSNN algorithm is of general applicability. We provide several examples in the field of mathematics, quantum chemistry and nanophotonics.

* pcalvo@unizar.es

† sergut@unizar.es

‡ lmm@unizar.es

§ eduardo.sanchez@predictland.com