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Fast Poincaré maps for magnetic fields using symplectic neural networks[1] QI TANG, JOSHUA BURBY, Los Alamos National Laboratory — Field-line Poincaré maps are powerful tools for analyzing the global behavior of magnetic fields in magnetic fusion devices. In some special cases, the Poincaré map may be derived by hand, but in most practical applications the map is approximated by numerically integrating the streamlines for the magnetic field. We present a new method for computing approximate Poincaré maps based on a novel neural network architecture called the Hénon Network. A Hénon Network is trained in a supervised fashion by showing it results from fourth-order Runge-Kutta field-line following simulations. After training, the network's input-to-output mapping gives an exactly-flux-conserving (i.e. symplectic) approximation of the Poincaré map. Moreover, evaluating such a neural approximation of the Poincaré map is orders of magnitude faster than evaluating an approximation based on field-line following.

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