Assimilating fission-code FIFRELIN using Machine Learning

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Abstract: The CEA and furthermore the laboratory where the work has been carried develop several codes of nuclear fission including FIFRELIN. FIFRELIN is a Monte-Carlo code which describes the fission process in two steps. Firstly, the fission fragments are generated according to their mass, nuclear charge, kinetic energy, excitation energy, angular momentum and parity. Secondly, the de-excitation of the fragments is performed. FIFRELIN relies on four free parameters and outputs are calculated with their respective statistical uncertainty. Those free parameters are tuned in order to reproduce the average neutron multiplicity. In this work, FIFRELIN which relates input data to output data is considered as a black box. This work's goal is to find a suitable list of free parameters in order to obtain specific output data. Due to the Monte-Carlo method, the computation times are relatively high in regards on the uncertainty. In fact, an execution of FIFRELIN with reasonable uncertainty takes more than five minutes. Therefore, finding the good free parameters can take a long time since the input space is too big to be explored randomly. In this talk we propose to use Machine Learning to overcome such issue. Due to the small size of the database used to train models and the almost linear variation between inputs and outputs the Machine Learning algorithm used is the Krigeage. Actually the method works well; with a small amount of time – less than a few hours starting from scratch using 20 CPU – the algorithm developed produces a list of the four free parameters that gives the desired outputs data using FIFRELIN.