Postdoctoral Research Fellow opportunity in Machine Learning

Duration: 18 months

Location: Institute of Radiological Protection and Nuclear Safety, Fontenay-aux-Roses, France

About This Opportunity

This post-doctoral position is only open for young scientists (less than 3 years after the PhD). The post-doctoral position is financed within the frame of an awarded Exploratory Research Project of IRSN: MASH (MAchine learning for Spectrometry with Hybrid methods) - unfolding of the neutron incident spectrum in the detector from measured data. The aim of this project is to contribute to the development of a new approach to reconstruct the incident neutron spectrum from neutron detector output with methods based on Machine Learning.

Calculation codes used in the field of nuclear safety or radiation protection require reliable measured data to be verified and validated. The energy distribution of the neutron fluence is a key data, for instance, for the management of any criticality accident to evaluate the radiation dose received by the personal. But such data needs, not only reliable measurements, but also a robust and efficient numerical method to exploit the experimental raw data. Indeed, the energy distribution of the neutron fluence is determined via a resolution of inverse problems using the simulated response functions of the detectors. However, the numerical approaches that are used nowadays and which have not evolved for several decades, have many limitations. For instance, they still rely on iterative algorithms that require a minimum prior knowledge of the emitted spectrum. Approaches based on the use of artificial neural networks, for example, have already been studied in the past [1], but without leading to applications in this field. While these methods are attractive, because they allow to get rid of the assumptions necessary for iterative methods, the calculation costs are prohibitive to achieve acceptable levels of accuracy.

In this project, the aim is to focus on the recent inverse problem solving methods based on deep learning in particular. The database to be used for the learning stage have to be built by the post-doc, and will have to use neutron transport simulation tools (such as MCNP…). This stage have to be prepared wisely in order to cover a large domain of applicability while keeping the mass of real simulated data reasonably small. Different architectures will have to be tested and analysed in order to understand the flaws and the benefits of the learning methods. Hybrid methods, where the machine learning techniques aims to compensate the Bayesian approaches deficits, are of a particular interest and will have to be studied. At the end of this research project, the best method will be tested on measurements performed at the U.S. Department Of Energy facilities, during which the participation of the post-doc is foreseen.

This post-doctoral project will be mainly performed at IRSN, Fontenay-aux-Roses, within two different laboratories: the laboratory of Neutronics and the laboratory of Dosimetry of ionizing radiations. Technical exchanges with IRSN experts on the machine learning and/or experts from other institutes are also planned.

Profile: We are seeking to appoint a PhD qualified in Machine Learning and Artificial Intelligence techniques, with fluency in physics, or a PhD qualified in interaction of Radiation with Matter, with fluency in machine learning techniques. Some experience with machine learning techniques, or similar, and scripting tools for pre- and post-processing of the data is required. Some knowledge in interaction of Radiation with Matter is required, and more particularly in neutron transport physics is desired.

Interested candidates can send: (i) a detailed curriculum vitae; (ii) a motivation letter related to the position's profile; (iii) electronic copies of scientific publications; and (iv) the names of two potential references to the following contact person: Mariya Brovchenko (mariya.brovchenko@irsn.fr)

[1] https://inis.iaea.org/collection/NCLCollectionStore/_Public/36/080/36080730.pdf?r=1&r=1