Mission report: Workshop on “Artificial Intelligence and Radiation Protection” in Attica, Greece (April 18-19, 2024)

Anna Selivanova

This research stay was related to a participation in the Workshop on “Artificial Intelligence and Radiation Protection”. The AI Workshop was conducted in the National Centre of Scientific Research "Demokritos" in Attica, Greece. The AI Workshop was organized within the PIANOFORTE partnership and also within the NERIS platform (https://eu-neris.net/all-documents/root/326-ai-workshop-announcement-registration/file.html).

My organization, the National Radiation Protection Institute (SURO), is a public research institution, specializing on protection against ionizing radiation and research activities in the security research, research on exposures to artificial and natural radiation sources and research on medical exposures. SURO is now planning to implement AI solutions in various research areas that employ numerical methods, among others. My professional interests include various numerical methods, particularly in modeling the atmospheric transport of radionuclides, with a focus on emergency preparedness.

The Workshop program covered such topics as: radiation dosimetry, emergency preparedness, radioecology and radiobiology, medical applications, presentations of projects including AI and discussions on selected applications. The Workshop began with basics of machine learning and deep neural networks, including an overview of AI applications in the radiation protection (RP) field. Recognized experts on radiological protection (RP) additionally shared with participants their experiences regarding challenges associated with the general use of AI. These challenges include assessments of data quality, uncertainties, explainability, robustness, unbiasedness, and others.

For me, the most interesting topics were related to numerical calculations and computational dosimetry, such as the comparison of dose models (occupational/medical exposure) and the modeling of atmospheric dispersion. For example, all dose models (deterministic, deep learning – DL, and stochastic – MC) are accurate. However, DL models, while very accurate (comparable with stochastic models) and fast, are less robust and highly dependent on data.

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A further useful application of artificial neural networks (ANN) involves the modeling of atmospheric dispersion. ANNs have already been employed as surrogate dispersion models under steady conditions. To train ANNs for this purpose, the following steps are necessary:

- Creation of a comprehensive database (e.g., a CFD database describing various conditions),
- Training on the available data, optimizing the ANN, and selecting the most suitable options,
- Evaluation of the quality, accuracy, and stability of the simulations.

In the ANN topology of surrogate dispersion models, the input layers mainly consist of the source location, source strength, wind direction, wind velocity, and other relevant parameters. The output layers provide data such as the concentration of contaminants, corresponding coordinates, and time. The primary advantage of these models is their very fast calculation time, which is crucial for emergency preparedness, where real-time response can be achieved. Nevertheless, such applications require site-specific ANNs that are well-trained in advance. Moreover, training databases need a large amount of data under different meteorological conditions, obtained from both modeling and field measurements.

AI can also be effectively implemented for communication purposes, for example, as a chatbot during radiation emergencies. Various user behaviors can be defined in advance, allowing the chatbot to provide personalized responses for each user type. Consequently, an empathetic communication tool can be created based on predefined rules. The creation of such tool therefore requires a multidisciplinary team of experts. This chatbot can be available online non-stop for a very diverse audience. Nevertheless, the chatbot cannot fully substitute a human expert but can be used as an auxiliary means in crisis communication.

Attending the AI Workshop was a highly positive experience, providing an extremely useful opportunity to become acquainted with AI applications, discuss advantages and relevant challenges with experts, and establish new contacts. SURO will adapt the acquired knowledge for future scientific research and projects.

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