# machine learning and data fusion for enhanced radiation detection, localization, and mapping

R. J. Cooper

Lawrence Berkeley National Laboratory

Berkeley, CA, USA

Email: [rjcooper@lbl.gov](mailto:rjcooper@lbl.gov)

The detection, localization, and mapping of radiological and/or nuclear material in real-world environments is central to a broad range of applications including nuclear security and safety, nuclear non-proliferation, and environmental management. Major challenges include the observation and identification of weak radiation signals in the presence of large and highly variable backgrounds, the localization of radiological/nuclear sources in complex, cluttered environments, and the efficient and accurate mapping of radiological contamination over wide areas.

Advances in these areas have traditionally been driven by innovations in radiation detector technology. More recently, however, the increasing availability and accessibility of novel sensors and advanced computational methods have enabled improvements in existing detection capabilities, as well as the development and demonstration of entirely new concepts.

Lawrence Berkeley National Laboratory (LBNL) is engaged in various research activities which leverage novel sensing technologies, data fusion, Machine Learning (ML), and Artificial Intelligence (AI) to develop new concepts in radiation detection and imaging.

This presentation will use selected examples to describe ways in which data fusion and ML and AI approaches are being exploited to enable the development and demonstration of new methods for the detection, localization, and mapping of nuclear radiation. These examples will include new algorithms for high-sensitivity radiological anomaly detection and isotope identification [1,2], the fusion of video, Lidar, and radiological data for real-time three-dimensional radiation mapping [3], and the automatic detection and tracking of objects for nuclear material accountancy and improved radiological anomaly detection [4].

References

1. K. Bilton *et al*., Non-negative matrix factorization of gamma-ray spectra for background modeling, detection, and source identification, IEEE Trans. Nucl. Sci., 66 5 (2019) 827-837.
2. K. Bilton *et al*., Neural network approaches for mobile spectroscopic gamma-ray source detection, J. Nucl. Eng. (2021) 2 190-206.
3. K. Vetter *et al.,* Advances in nuclear radiation sensing: enabling 3-D gamma-ray vision, Sensors, 19 (2019), 11, 2541.
4. M.R. Marshall *et al.,* 3D object detection in panoramic video and LIDAR for radiological source-object attribution and improved source detection, IEEE Trans. Nucl. Sci., 68 2 (2021) 189-202.