AI Assisted Radiological Hazard Management in Nuclear Facilities

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Objective

To develop a methodologies for supporting safety, security, safeguards, and sustainability (4S) across the nuclear fuel cycle and facility operations. This includes fuel cycle optimization, threat detection, anomaly identification, and waste characterization.

Background

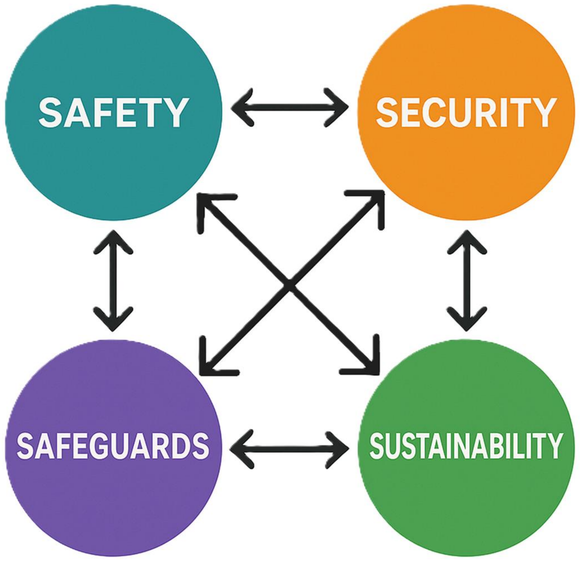
AI is currently being explored for a wide range of applications but often focuses on accomplishing a singular task/mission. Integrating AI systems in various nuclear facilities has the potential to greatly improve aspects of the fuel cycle but needs to be carefully implemented to avoid detrimental consequences.

The fuel cycle varies from between countries. Closed versus open fuel cycles can have rather different implications for the 4S. Reprocessing introduces a much higher risk factor for safeguards and safety but improves sustainability.

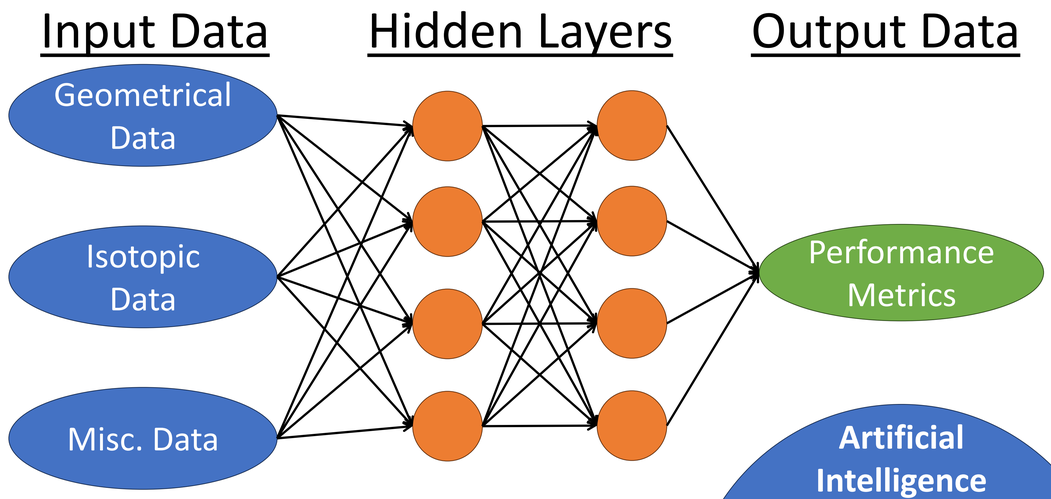
Facility Type	Primary Concern	Lower Priority
Mining & Milling	Sustainability	Security, Safeguards
Conversion		4S
Enrichment	Safeguards, Security	Safety, Sustainability
Fuel Fabrication	Safety, Sustainability	Security, Safeguards
Power Reactor	Safety, Sustainability	
Reprocessing	Safeguards, Sustainability	
Interim Storage	Safety	Sustainability
Final Disposition	Safety	

4S Considerations

Although the four pillars are often considered independently, they are all interconnected. Changes to a facility or fuel cycle may improve one pillar, while being detrimental to another. It can be difficult to balance the effects on all four pillars when attempting to optimize one particular system. AI that has been trained on the connections between the pillars can monitor for undesirable consequences when improvements are being made.



AI *inside* Nuclear Facilities	AI *outside* Nuclear Facilities
• Threat detection • SNM diversion detection • Radiological release monitoring • Maintenance prediction • Automated waste characterization	• Reactor design optimization • Alternative fuel treatment strategies • Repository location selection • Vulnerability identification • Licensing expedition



Classical Programing

$$Rules + Data \rightarrow Answers$$

Machine Learning

$$Data + Answers \rightarrow Rules$$

Neural Network

$$Input \rightarrow Neural\ Network \rightarrow Output$$

Ethical Considerations

Both nuclear and AI are often misunderstood by the public in part due to their technical nature, but also because of the secrecy due to security and proprietary technologies concerns. For years, the nuclear industry has been working improve public sentiment. Without transparency, mass adoption of AI into the nuclear industry may rejuvenate public fear of nuclear energy.

Additionally, neural networks are often considered to be black boxes. Reliance on these models opens the door to misinterpretations and false flags. It will be important that, whenever implemented, there remains human oversight to verify the decisions that are being made by the models.

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