Powering The Nuclear Fleet with **Artificial Intelligence** Webinar Series

INTECHBREW

Webinar I

BWR Reload Planning & Cycle Management with Machine Learning

Topics

5 min — **Introduction to Blue Wave AI Labs**

20 min — **Core Design Evolution Over Time, Challenges, and Opportunities**

Constraints on reload core design: Moisture Carryover (MCO); Eigenvalue (un)predictability; thermal limit biases; impacts from new fuel types, transitions, and mixed cores

Opportunities for fuel cost savings: reduction in reload batch size and enrichments, improved coastdown, Cycle startup Sequence optimization, reload core design optimization

20 min — **Predicting MCO and Eigenvalue with Machine Learning**

First, we'll present an overview of supervised machine learning and model architectures relevant to the problems at hand, such as fully-connected artificial neural networks and convolutional neural networks (CNNs). Then we'll turn to training data requirements, necessary data types and data volume.

We'll also look at the training process, validation strategies, and uncertainty quantification. Finally, we will present model performance and accuracy with benchmarks from several BWRs in the domestic fleet.

15 min — **BWnuclear.ai Demo and Real-world Use Cases**

BWnuclear.ai is a cloud-based platform developed in close collaboration with utility stakeholders that gives on-demand and real-time access to our AI/ML models. We will give a demonstration of this platform and how it integrates seamlessly into your existing reload core design and cycle management processes.

Use Cases: This will include real-world application of BWnuclear.ai to reduce fresh fuel purchases, manage unanticipated operational challenges (such as fuel failures), and evaluate unique situations (e.g. new fuel types, inclusion of HBLUAs, and the like).

Topics (Webinar II)

30 min

Heuristics and Learnings for Future Core Design

Neural networks are often referred to as "black boxes." We will discuss a range of techniques to pier inside our models to gain deeper insight. One technique is through feature engineering and a physical understanding of the underlying mechanism. This allows us to develop models with parameters that operators can control, giving the models not only predictive power but, just as important, *corrective power*.

Topics such as Model Explainability, Feature Importance, and feature space construction will be covered.

30 min

Methodology for Thermal Limit Bias Predictability

Accurately capturing the three-dimensional power distribution within a reactor core is vital for many reasons. Chief among them are (1) ensuring safe and economical operation of the reactor, (2) compliance with Technical Specifications, and (3) fuel cycle planning (safety, control, and performance evaluation).

Offline (that is, during cycle planning and core design), a three-dimensional neutronics simulator is used to estimate the reactor's power, moderator, void, and flow distributions– from which margin to thermal limits and fuel exposures can be approximated. *Online*, this accomplished with a system of neutron detectors that is designed to capture enough information to infer the full nodal power distribution. In BWRs, an array of fixed in-core detectors (LPRMs) is used and supplemented with movable in-core detectors (TIPs), to measure the local power distribution. These detectors provide perhaps the most fundamental set of measurements within a reactor core.

Certain problems with this process (from measurement/detector issues all the way to the power adaption process) pose significant challenges to operators and limit the ability to design reload cores economically (engineering in insufficient margin or more margin than required).

We will present on how ML is being used to solve these problems, improve the accuracy of online local power measurements, and decrease the bias between offline and online power distributions – thereby leading to a greater ability to design safe and economical reload cores.

Blue Wave is delighted to be presenting this webinar hosted by **inTechBrew** and the Nuclear Institute Digital SIG!

Want to learn more on AI applied to nuclear?
Join us on September 28th, 1pm BST!

Scan the QR code to register