

Reinforcement Learning in Particle Accelerators: a practical example (2/2)

Tuesday 25 March 2025 11:30 (1 hour)

Proposal: Reinforcement Learning for Particle Accelerator control: A real-world example

Hour 1: Introduction to Reinforcement Learning for Particle Accelerators

- **Basic Concepts:**
 - Overview of Reinforcement Learning (RL) fundamentals.
 - Definitions and distinctions:
 - Model-free vs. model-based.
 - Off-policy vs. on-policy approaches.
- **Applications and Considerations:**
 - Discussion of problem types and environmental variables affecting model selection in practical scenarios.
 - Analysis of drawbacks and benefits of different RL architectures.
- **Practical examples:**
 - Real-world examples of RL in particle accelerators (e.g., CERN).
 - Case study introduction: Optimization of RF triple splittings in the Proton Synchrotron (PS).

Hour 2: Optimizing RF Triple Splittings with Reinforcement Learning

- **Problem Definition:**
 - Explanation of PS RF operations and the triple splitting optimization challenge for LHC-type beams.
 - Overview of the physics and parameters involved in optimization.
- **Optimization Approach:**
 - Justification for choosing RL and specific RL architectures.
 - Step-by-step walkthrough:
 - Initial simulations and trials.
 - Challenges and lessons learned.
 - Final operational solution deployed in the control room.

Exercise Session: Training RL Agents for RF Optimization (1 hour)

- **Objective:**
 - Train RL agents to optimize RF double splitting settings in simulation for improved beam quality.
- **Implementation:**
 - Use SWAN notebooks with provided skeleton code.
 - Define a custom gymnasium environment for the double splitting problem, given:
 - Pre-implemented simulation data loaders.
 - Basic loss function for optimization.

Attended school

tCSC 2024 (Split)

Number of exercise hours

1

Number of lecture hours

2

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