How to Identify the target variables.

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1 Introduction

This document contains the basis on which the target variables is choosen in 'Lattice Physics Task 1'.

2 Defination of Target Variables

2.1 Infinite Multiplication Factor

Definition: The infinite multiplication factor measures the efficiency of nuclear fuel in sustaining a chain reaction without considering the effect of neutron leakage. It is the ratio of the number of neutrons produced by fission to the number of neutrons lost through absorption within an infinite medium of nuclear material

2.2 Pin Power Peaking Factor

Definition: The pin power peaking factor identifies the ratio of the maximum local power density in the hottest fuel pin (rod) to the average power density across the entire core. It is crucial for thermal and safety analysis to prevent overheating or damage to the fuel.

3 Typical ranges of Target Variables

3.1 Range of Infinite Multiplication Factor

Typical Range:

- $k_\infty > 1$: Indicates that the nuclear system is **supercritical** (sustaining a chain reaction efficiently).
- $k_\infty = 1$: Denotes a **critical** state (perfect balance, no gain or loss in neutron population).
- $k_\infty < 1$: Indicates a **subcritical** state (reaction is not self-sustaining).

3.2 Range of Pin Power Peaking Factor

- **Pressurized Water Reactors (PWRs):**
  - **Typical Range:** 1.2 to 1.6
  - Higher values may occur during abnormal conditions or near the beginning of a fuel cycle, depending on core design and fuel enrichment.
- **Boiling Water Reactors (BWRs):**
  - **Typical Range:** 1.1 to 1.5
  - Lower ranges compared to PWRs due to differences in core design and boiling effects in the coolant.
- **Fast Breeder Reactors (FBRs):**
  - **Typical Range:** 1.1 to 1.4
  - Narrower range due to the uniformity of fast neutron flux and specialized design to manage heat distribution.
- **CANDU Reactors (Canada Deuterium Uranium):**
  - **Typical Range:** 1.2 to 1.3
  - Moderated with heavy water, which leads to more uniform neutron flux and lower peaking factors.
- **High-Temperature Gas-Cooled Reactors (HTGRs):**
  - **Typical Range:** 1.1 to 1.3
  - Lower values due to more uniform distribution of fuel in pebble-bed or prismatic configurations.

4 Selecting Target Variables

Using the Practical Ranges seen above and using describe method on our dataset we can find out that first two columns are our target columns.