

Data Exploration for Nuclear Safety Analysis

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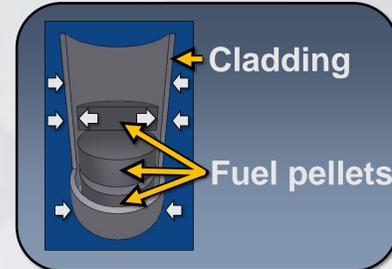
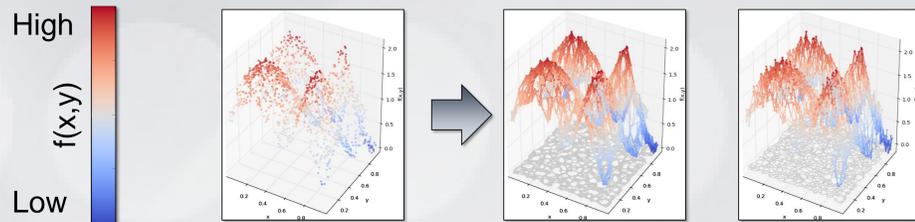
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Objective: Understand Main Drivers of Nuclear Simulations through Visualization

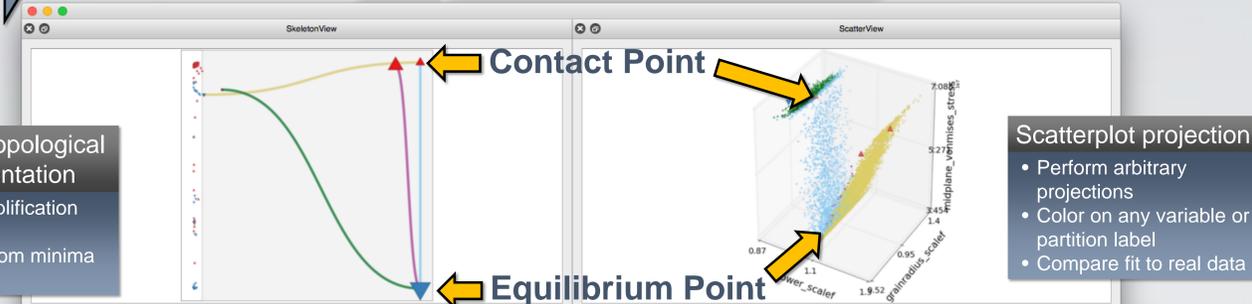
1. Apply Structure

Impose a neighborhood graph on the input domain points



Analysis of Nuclear Fuel Data using RAVEN

Analysis of the main drivers of the maximum Von Mises stress occurring in the cladding of a nuclear fuel rod



Abstract topological representation

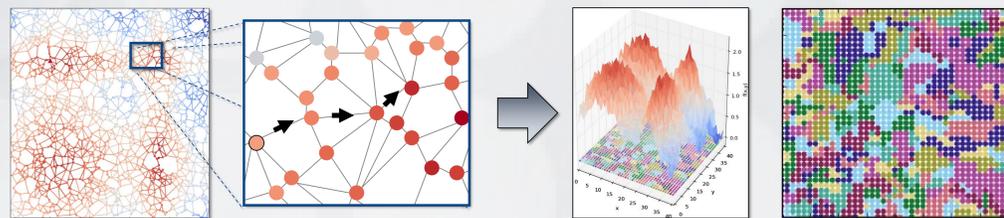
- Adjust simplification level
- See flow from minima to maxima

Scatterplot projection

- Perform arbitrary projections
- Color on any variable or partition label
- Compare fit to real data

2. Partition the Data

Use the edges of the graph to estimate gradient flow



Sensitivity coefficients

- Compare relative sensitivities
- Visualize several metrics:
 - Pearson
 - Spearman
 - Linear coefficients

R² coefficients

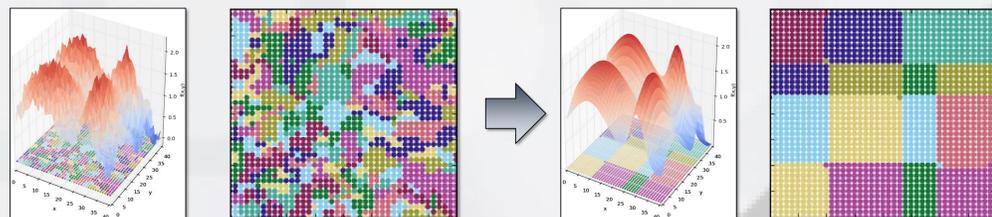
- Perform stepwise regression
- Quantify/Compare the fitness of separate partitions
- Understand the number of variables needed

Sensitivity coefficients	
thermal_expansion	3.8e+05
grainradius_scale	6.95e+05
power_scale	1.27e+07
thermal_expansion	1.58e+05
grainradius_scale	-7.54e+03
power_scale	1.23e+07
thermal_expansion	-7.65e+04
grainradius_scale	1.99e+04
power_scale	2.97e+06
thermal_expansion	-8.2e+05
grainradius_scale	1.98e+05
power_scale	-3.77e+07

R ² coefficients	
power_scale	0.894
thermal_expansion	0.898
grainradius_scale	0.898
power_scale	0.988
thermal_expansion	0.994
grainradius_scale	0.994
power_scale	0.993
thermal_expansion	0.994
grainradius_scale	0.994
power_scale	0.993
grainradius_scale	0.994
therm	0.995

3. Noise/Complexity Reduction

Construct a hierarchy for simplifying the domain



Risk-Informed Safety Margin Characterization (RISMC)

Next Step: Risk Monitoring Toolkit

Mitigate risk by minimizing the probability of failure through manipulation of: probability distributions, the limit surface, etc.

4. Build Local Models

Build a linear regression model for each identified partition

