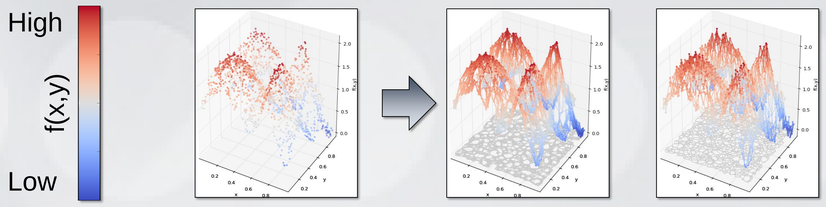
Data Exploration for Nuclear Safety Analysis

Dan Maljovec[1,2], Bei Wang[1], Paul Rosen[3], Diego Mandelli[2], Andrea Alfonsi[2], Giovanni Pastore[2], Cristian Rabiti[2], Valerio Pascucci[1]
[1]SCI Institute, University of Utah, [2]Idaho National Laboratory, [3]University of South Florida

Objective: Understand Main Drivers of Nuclear Simulations through Visualization

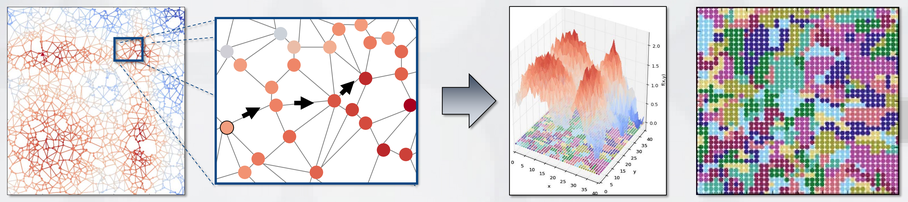
1. Apply Structure

*Impose a **neighborhood graph** on the input domain points*



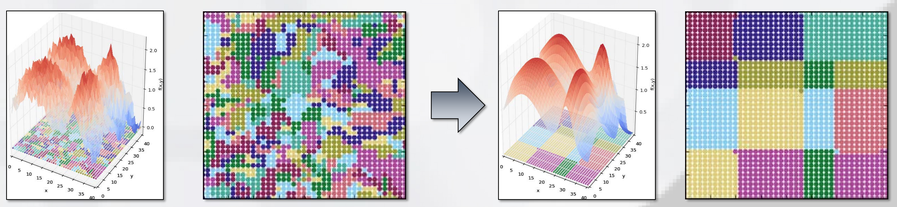
2. Partition the Data

*Use the edges of the graph to estimate **gradient flow***



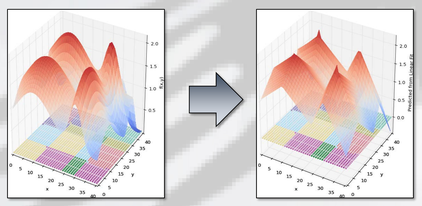
3. Noise/Complexity Reduction

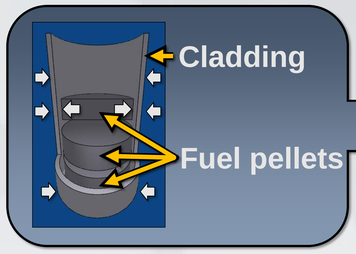
*Construct a **hierarchy** for **simplifying** the domain*



4. Build Local Models

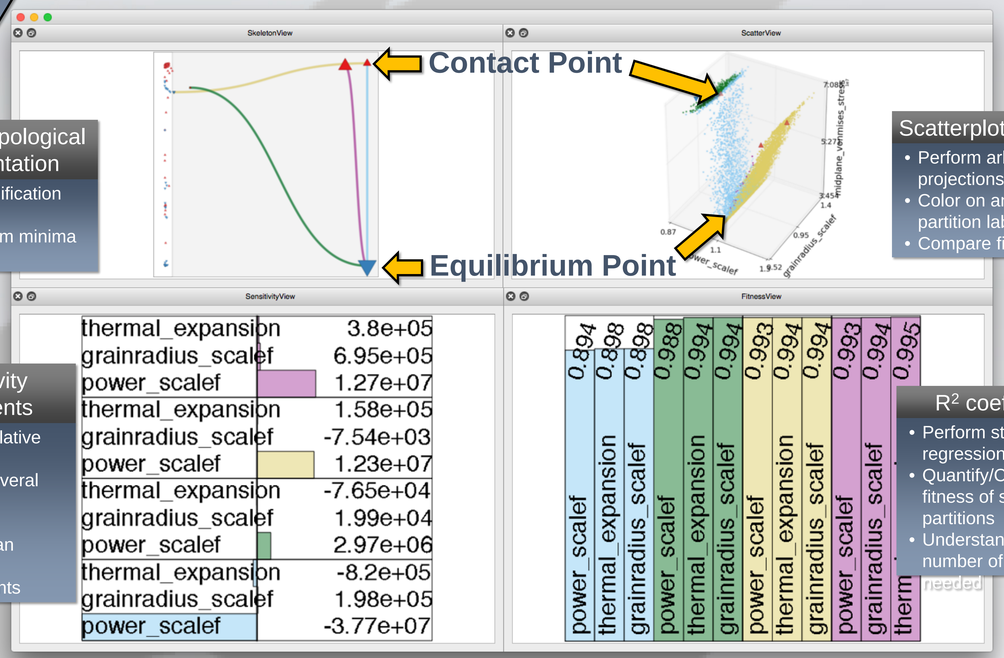
*Build a **linear regression** model for each identified partition*





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

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

R^2 coefficients
- Perform stepwise regression
- Quantify/Compare the fitness of separate partitions
- Understand the number of variables needed

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.