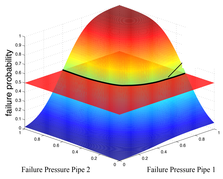
Risk Analysis Virtual ENvironment - RAVEN

Idaho National Laboratory

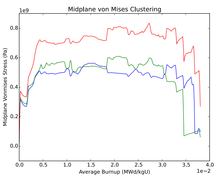
Cristian Rabiti (Cristian.Rabiti@inl.gov), Software Manager

Andrea Alfonsi (Andrea.Alfonsi@inl.gov), Team Leader



RAVEN

https://github.com/idaholab/raven



RAVEN is a multi-purpose framework for uncertainty quantification, regression analysis, probabilistic risk assessment, data analysis and model optimization.

RAVEN major capabilities

Sampling of physical models (e.g. codes) for UQ, DPRA and reliability analyses

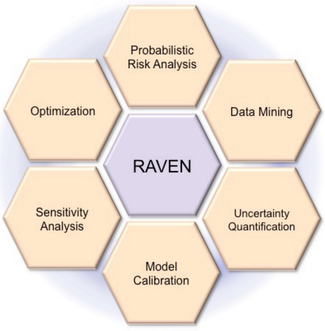
Generation and use of surrogate models (artificial intelligence) and synthetic time-series

Ensemble Modeling (calculation flow embedding)

Parameter Optimization

Data processing and analysis:

- Time dependent and steady state statistical estimation and relational analysis (e.g. mean, variance, sensitivity coefficients, etc.)
- Time dependent and steady state data mining, clustering and dimensionality reduction



User cases:

Uncertainty Quantification

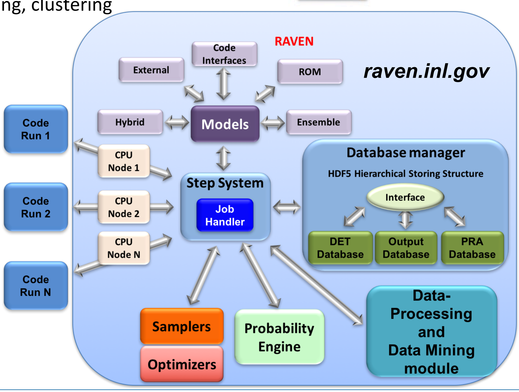
Sensitivity Analysis / Regression Analysis

Probabilistic Risk Assessment (PRA)

Reliability Analysis

Data Mining Analysis

Model/Parameter Optimization



Development Team

Dr. Andrea Alfonsi

Dr. Paul Talbot

Dr. Diego Mandelli

Dr. Congjian Wang

Dr. Joshua Cogliati

Assessing Team

Dr. Aaron S. Epiney

Dr. Carlo Parisi

RAVEN is designed to perform parametric and probabilistic analysis based on the response of complex system models (e.g. codes). It is capable of investigating the system response as well as the input space using standard sampling schemes (e.g. Monte Carlo, etc.), but its strength is focused toward system feature discovery, such as limit surfaces using supervised learning techniques (artificial intelligence algorithms). The generated data can be analyzed using advanced statistical and clustering techniques both for time dependent and steady state problems. RAVEN is able able to optimize large parameter spaces using its optimization algorithms.

RAVEN provides a set of basic and advanced capabilities that ranges from data generation, data processing and data visualization

Computing Environment

- Parallel computation capabilities (multi-thread and multi-core)
- Supported operating systems: MAC (any), Linux (Ubuntu, Fedora, and Windows
- Workstation and high performance computing (HPC) systems

Forward probagation of uncertainties

- Monte Carlo sampling
- Grid sampling
- Stratified Sampling
- Factorial design
- Response surface design
- Generalized Polynomial Chaos (gPC) with sparse grid collocation (SGC)
- Generalized Polynomial Chaos (gPC) with sparse grid collocation (SGC) using the High Dimensional Model Representation expansion (HDMR)
- General combination of the above sampling strategies

Advanced Sampling Methods

- Moment driven adaptive gPC using SGC
- Sobol index driven HDMR integrated using SGC over gPC basis
- Adaptive sampling for limit surface finding (surrogate and multi grid based accelerations)
- Dynamic event tree-based sampling (Dynamic Event Trees, Hybrid Dynamic Event Trees, Adaptive Dynamic Event Trees, Adaptive Hybrid Dynamic Event Trees)

Model capabilities

- Generic interface with external codes
- Custom code interfaces (Software (s) available: MAAP, DYMOLA, RELAP5-3D, MOOSE, etc.)
- Custom ad-hoc external models (build in python internally to RAVEN)

Creation and use of surrogate models

- Support Vector Machine
- Gaussian process models
- Linear models
- Decision trees
- Naive Bayes
- Neighbors classifiers and regressors
- Multi-dimensional interpolators
- High dimension model reduction (HDMR)
- Morse-Smale complex
- Dynamic Mode Decomposition

Data analysis capabilities

- Data regression, clustering and dimensionality reduction
- Custom generic post-processors
- Time-dependent data analysis (statistics, clustering and time warping metrics)
- Data plotting and visualization

Data managment

- Data importing and exporting
- Databases and high performance in-memory data storage

www.inl.gov

Idaho National Laboratory