

# MANUAL

RAVEN-SRS

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## RAVEN Software Requirements Specification

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# 1 Introduction

RAVEN is a flexible and multi-purpose uncertainty quantification (UQ), regression analysis, probabilistic risk assessment (PRA), data analysis and model optimization software. Its broad spectrum of application determined the need of an integrated design (see RAVEN SDD document for details) of the software aimed to integrate multiple requirements.

This document is aimed to report and explain the RAVEN software requirements.

## 1.1 Dependencies and Limitations

The software should be designed with the fewest possible constraints. Ideally the software should run on a wide variety of evolving hardware, so it should follow well-adopted standards and guidelines. The software should run on any POSIX compliant system (including Windows POSIX emulators such as MinGW). The software will also make use of artificial intelligence and numerical libraries that run on POSIX systems as well. The main interface for the software will be command line based with no assumptions requiring advanced terminal capabilities such as coloring and line control.

In order to be functional, RAVEN depends on the following software/libraries.

- h5py-2.7.1
- numpy-1.12.1
- scipy-1.1.0
- scikit-learn-0.19.1
- pandas-0.20.3
- xarray-0.10.3
- netcdf4-1.4.0
- matplotlib-2.1.1
- statsmodels-0.8.0
- python-2.7
- hdf5-1.8.18
- swig
- pylint

- coverage
- lxml
- psutil
- pyside
- pillow



## 2 References

- ASME NQA 1 2008 with the NQA-1a-2009 addenda, “Quality Assurance Requirements for Nuclear Facility Applications,” First Edition, August 31, 2009.
- ISO/IEC/IEEE 24765:2010(E), “Systems and software engineering Vocabulary,” First Edition, December 15, 2010.
- LWP 13620, “Managing Information Technology Assets”

## 3 Definitions and Acronyms

### 3.1 Definitions

- **Baseline.** A specification or product (e.g., project plan, maintenance and operations [M&O] plan, requirements, or design) that has been formally reviewed and agreed upon, that thereafter serves as the basis for use and further development, and that can be changed only by using an approved change control process. [ASME NQA-1-2008 with the NQA-1a-2009 addenda edited]
- **Validation.** Confirmation, through the provision of objective evidence (e.g., acceptance test), that the requirements for a specific intended use or application have been fulfilled. [ISO/IEC/IEEE 24765:2010(E) edited]
- **Verification.**
  - The process of evaluating a system or component to determine whether the products of a given development phase satisfy the conditions imposed at the start of that phase.
  - Formal proof of program correctness (e.g., requirements, design, implementation reviews, system tests). [ISO/IEC/IEEE 24765:2010(E) edited]

### 3.2 Acronyms

**API** Application Programming Interfaces

**ASME** American Society of Mechanical Engineers

**CDF** Cumulative Distribution Functions

**DET** Dynamic Event Tree

**DOE** Department of Energy

**HDF5** Hierarchical Data Format (5)

**LWRS** Light Water Reactor Sustainability

**NEAMS** Nuclear Energy Advanced Modeling and Simulation

**NHES** Nuclear-Renewable Hybrid Energy Systems

**INL** Idaho National Laboratory

**IT** Information Technology

**M&O** Maintenance and Operations

**MC** Monte Carlo

**MOOSE** Multiphysics Object Oriented Simulation Environment

**NQA** Nuclear Quality Assurance

**POSIX** Portable Operating System Interface

**PDF** Probability Distribution (Density) Functions

**PP** Post-Processor

**PRA** Probabilistic Risk Assessment

**QA** Quality Assurance

**RAVEN** Risk Analysis and Virtual ENviroment

**ROM** Reduced Order Model

**SDD** System Design Description

**XML** eXtensible Markup Language

## **4 System Requirements: RAVEN**

### **4.1 Minimum Requirements**

#### **4.1.1 Minimum Requirements**

##### **4.1.1.1 R-M-1**

Computer: Any POSIX (and POSIX-like) system

##### **4.1.1.2 R-M-2**

RAM: 2 GB per core execution (depending on the type of analysis and data generated)

##### **4.1.1.3 R-M-3**

Disk: 10 GB (size depending on the type of analysis and data generated)

##### **4.1.1.4 R-M-4**

Compilers: GCC, Clang, or Intel

##### **4.1.1.5 R-M-5**

Language: Python 2.7

##### **4.1.1.6 R-M-6**

Version Control: Git

## **4.2 Functional Requirements**

### **4.2.1 Framework, I/O, Execution Control**

#### **4.2.1.1 R-F-1**

RAVEN shall allow support for user-defined instructions for controlling the execution stages of a simulation.

#### **4.2.1.2 R-F-2**

RAVEN shall allow for user-defined resource allocation for driving external applications.

#### **4.2.1.3 R-F-3**

RAVEN shall support a programmatic method for building up and/or downloading the necessary compiled objects/dependencies necessary for a simulation.

#### **4.2.1.4 R-F-4**

RAVEN shall provide the ability to resume a previous simulation using data generated and exported by RAVEN itself.

#### **4.2.1.5 R-F-5**

RAVEN shall allow for user-defined output types for simulation data.

#### **4.2.1.6 R-F-6**

RAVEN shall allow for a standardized method for importing simulation data not previously generated by the system itself.

## **4.3 Usability Requirements**

### **4.3.1 Risk Evaluation**

#### **4.3.1.1 R-RE-1**

RAVEN shall support 1-Dimensional probability distributions including generating random numbers from them.

#### **4.3.1.2 R-RE-2**

RAVEN shall support N-Dimensional probability distributions. It shall support multivariate normal distributions and distributions defined by tabular data.

#### **4.3.1.3 R-RE-3**

RAVEN shall support a variety of samplers that use probability distributions to sample the input space.

### **4.3.2 Risk Analysis**

#### **4.3.2.1 R-RA-1**

RAVEN shall support adaptive sampling that use already gathered samples to determine where to locate new samples.

#### **4.3.2.2 R-RA-2**

RAVEN shall support importing/exporting data in CSV format.

#### **4.3.2.3 R-RA-3**

RAVEN shall support generating plots from the data it generates.

#### **4.3.2.4 R-RA-4**

RAVEN shall be able to generate Reduced Order Models from its data and use them to predict responses from a system.

#### **4.3.2.5 R-RA-5**

RAVEN shall be able to perform basic statistical analysis of generated data.

#### **4.3.2.6 R-RA-6**

RAVEN shall be able to perform advanced post processing of generated data, using data mining methodologies.

#### **4.3.2.7 R-RA-7**

RAVEN shall be able to compute probability of failure based on generated data and goal functions

### **4.3.3 Risk Mitigation**

#### **4.3.3.1 R-RM-1**

RAVEN shall be able to choose the values of a set of input parameters that minimize/maximize a goal function that depends on system output figure of merits and input parameters.

## **4.4 Performance Requirements**

### **4.4.1 Infrastructure Support**

#### **4.4.1.1 R-IS-1**

RAVEN shall be able to parallelize running external codes.

#### **4.4.1.2 R-IS-2**

RAVEN shall be able to run external codes by supplying them with the needed input files and collecting the output data.

#### **4.4.1.3 R-IS-3**

RAVEN shall support storing and retrieving data in a HDF5 database.

#### **4.4.1.4 R-IS-4**

RAVEN shall be able to provide data to a user provided python function, and retrieve the data from that.

#### **4.4.1.5 R-IS-5**

RAVEN shall be able to perform various calculation tasks (simulation and post processing), and transfer data to the next task.

#### **4.4.1.6 R-IS-6**

RAVEN shall be able to run external codes in parallel on shared memory machines.

#### **4.4.1.7 R-IS-7**

RAVEN shall be able to run external codes in parallel on distributed memory machines.

#### **4.4.1.8 R-IS-8**

RAVEN shall be able to run internal models in parallel on shared memory machines.

#### **4.4.1.9 R-IS-9**

RAVEN shall be able to run internal models in parallel on distributed memory machines.



## **4.5 System Interfaces**

### **4.5.1 Interface with external applications**

#### **4.5.1.1 R-SI-1**

RAVEN shall be able to be coupled with external applications via input files.

#### **4.5.1.2 R-SI-2**

RAVEN shall be able to be coupled with external applications via Python API.

## **4.6 System Operations**

### **4.6.1 Human System Integration Requirements**

The command line interface shall support the ability to toggle any supported coloring schemes on or off pursuant to section 508 of the Rehabilitation Act of 1973.

### **4.6.2 Maintainability**

- The latest working version (defined as the version that passes all tests in the current regression test suite) shall be publicly available at all times through the repository host provider.
- Flaws identified in the system shall be reported and tracked in a ticket or issue based system. The technical lead or any COB member will determine the severity and priority of all reported issues. The technical lead will assign resources at his or her discretion to resolve identified issues.
- The software maintainers will entertain all proposed changes to the system in a timely manner (within two business days).
- The RAVEN software in its entirety will be made publicly available under the Apache version 2.0 license.

#### **4.6.3 Human System Integration Requirements**

The regression test suite will cover at least 80% of all lines of code at all times. The results of the regression tests will be stored in the Continuous Integration System.

### **4.7 Information Management**

The RAVEN software in its entirety will be made publicly available on an appropriate repository hosting site (e.g. GitHub). Backups and security services will be provided by the hosting service.

## **5 Verification**

The regression test suite shall employ several verification tests using comparison against analytic solutions (when possible) and convergence rate analysis.

## **Document Version Information**

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