Available online at www.sciencedirect.com

ScienceDirect

Procedia Social and Behavioral Sciences 2 (2010) 7660–7661

Procedia
Social and Behavioral Sciences

Sixth International Conference on Sensitivity Analysis of Model Output

URANIE : The CEA/DEN Uncertainty and Sensitivity platform

Fabrice Gaudier*

*CEA-Saclay, DEN, DM2S, SFME, LGLS, F-91191 Gif-sur-Yvette, France.

Abstract

Mathematical models, designated to simulate complex physical processes, are often used in scientific and engineering studies. In nuclear applications, these models, integrated in computation codes, are very complex and very high consuming CPU time. We present the "Uncertainty and Sensitivity» platform Uranie developed by the CEA to perform Uncertainty Quantification, Verification and Validation codes, and Sensitivity Analysis. Uranie was used in several nuclear studies like performance assessment with ANDRA, with neutronics and thermal-hydraulics codes, nuclear fuel thermal behaviour.

Keywords: Uncertainty, Senstivity, software platform, nuclear codes.

1. Main text

The "Uncertainty and Sensitivity" platform Uranie developed by the CEA aims to regroup methods and algorithms about Uncertainty and Sensitivity Analysis, Verification and Validation codes in the same framework. Uranie is based on the data analysis framework ROOT, (http://root.cern.ch) an object-oriented and petaflopic computing system developed by CERN. This framework offers several useful features as advanced visualization, powerful data storage and access in several formats (binary, SQL, distant access), a C++ interpreter, and so on.

Uranie is built in a modular way with several libraries (Figure 1) devoted for a particular task in the Uncertainty and Sensitivity (US) analysis. In the article, we then describe the mainly libraries of the Uranie platform.

* Corresponding author. Tel.: +33 1 69 08 11 72; fax: +33 1 69 08 96 96.
E-mail address: fabrice.gaudier@cea.fr.

doi:10.1016/j.sbspro.2010.05.166

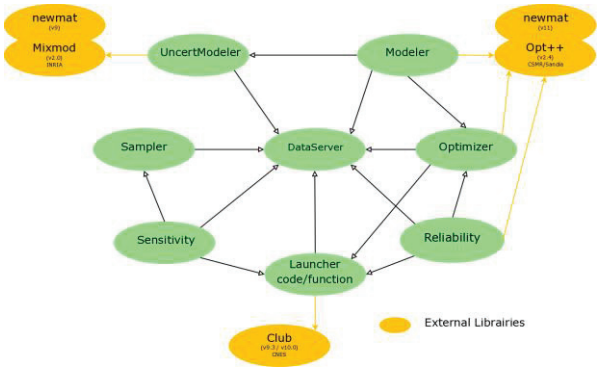

Figure 1 : Functional diagram of Uranie

The main library defines the TDataServer object which contains all the information about the uncertain variables for the US analysis. Then, this TDataServer object flows through the other libraries in order to apply the methods of the study.

The second library, the Sampler library, is devoted to generate a design of experiment (deterministic/statistical) from characteristics of the uncertain variables. Several methodologies are implemented:

- qMC ("quasi Monte-Carlo") sequences (Sobol, Halton);
- SRS (“Simple Random Sampling”), LHS (“Latin Hypercube Sampling”), ROA ("Random Orthogonal Array"), Archimedean Copulas;
- MCMC ("Markov Chain Monte-Carlo") method for Gaussian mixture.

The Launcher library is devoted to manage the computation on a PC (sequential) or on a cluster (distributed). The goal is to construct the Y matrix jointed in the X matrix of the design of experiment. We can launch either the original computation code or an analytical function as surrogate models. The surrogate models can be built by the modeller library or written by the user following a prototype.

The Modeler library is devoted to build a surrogate model from input to output attributes contained in a database. The surrogate models implemented in Uranie are polynomial, polynomial Chaos expansion and neural networks. We plan to implement the kriging methodology soon. After building the surrogate model, it can be saved in several languages like C/C++, FORTRAN, PMML (“Predictive Model Markup Language” is the leading XML standard for save statistical and data mining models) for using it in the US analysis instead of the computation code with a very low CPU time computation.

The Reliability library is devoted to perform a reliability analysis. At present time, this library is not implemented, but we plan to implement the SORM/FORM methodology. The optimizer library is devoted to perform a Verification and Validation code or to find the optimum of a computation code or analytical function. We can also perform multi-criteria optimization with Genetic Algorithms. The goal of the UncertModeler library is to examine how well a sample of data agrees with a given distribution as its population with goodness-of-fit techniques.

The last library, the Sensitivity library, contains several methods to make the sensitivity analysis between the two X and Y matrix like Regression method (Pearson, Spearmann), Screening method (Morris) and Sobol indexes (Sobol’s methodologies, FAST).

ROOT (and therefore Uranie) has a C++ interpreter which allows us to integrate easily new algorithms or to customize complex treatment with several objects in a function with few parameters. The C++ interpreter is the first level of the user interface. The second level user interface is an XML file; this file contains the description of the uncertain variables and the different steps to apply for US analysis. The XML interface allows us to integrate easily Uranie modules in an industrial platform.