

The graphical user interface of OpenTURNS, a UQ software in simulation

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Extra slides

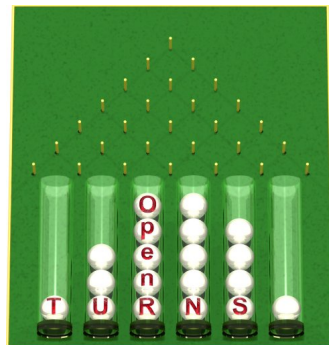
Demo backup

OpenTURNS

- ▶ Uncertainty quantification, uncertainty propagation, sensitivity analysis and metamodeling
- ▶ Partners : EDF, Phiméca, Airbus, IMACS
- ▶ www.openturns.org
- ▶ Licence LGPL
- ▶ Linux, Windows

Programming:

- ▶ Python module
- ▶ C++ Library



SALOME

- ▶ Integration platform for pre and post processing, and 2D/3D numerical simulation
- ▶ Features : geometry, mesh, distributed computing
- ▶ Visualization, data assimilation, uncertainty treatment
- ▶ Partners : EDF, CEA, Open Cascade
- ▶ Licence : LGPL
- ▶ Linux, Windows
- ▶ www.salome-platform.org



The graphical user interface of OpenTURNS

- ▶ Main goal : provide a graphical interface of OpenTURNS in SALOME
- ▶ Features
 - ▶ Uncertainty quantification (distribution fitting), central tendency, sensitivity analysis, probability estimate, meta-modeling
 - ▶ Generic (not dedicated to a specific application)
 - ▶ GUI language : English, French
- ▶ Partners : EDF, Phiméca
- ▶ Licence : LGPL
- ▶ Schedule :
 - ▶ Since summer 2016, one EDF release per year
 - ▶ On the internet : 2018

GUI : the demo

Demo time.

GUI : outline

- ▶ From scratch : 3 inputs, 2 outputs, sum, central dispersion study with default parameters
- ▶ Open axialStressedBeam-python.xml : central dispersion with sample size 1000, Threshold $P(G < 0)$ with $CV=0.05$
- ▶ Import crue-4vars-analytique.py : S.A. with sample size 1000, sort by size

UQ, the easy way

Main goal : make UQ easy to use

- ▶ classical user-friendly algorithms with a state-of-the-art implementation,
- ▶ default parameters of the algorithms whenever possible,
- ▶ an easy access to the HPC resources,
- ▶ an automated connection to the computer code.

Produce standard results :

- ▶ numerical results e.g. tables,
- ▶ classical graphics.

Overview (1/2)

Inputs from the user :

- ▶ Physical model : symbolic, Python code or SALOME component
- ▶ Probabilistic model : joint probability distribution function of the input.

Then :

- ▶ Central dispersion: estimates the central dispersion of the output Y (e.g. mean).
- ▶ Threshold probability: estimates the probability that the output exceeds a given threshold S .
- ▶ Sensitivity analysis: estimates the importance of the inputs to the variability of the output.

Overview (2/2)

Probabilistic modeling :

- ▶ Distribution fitting from a sample
- ▶ Dependence modeling (Gaussian copula)

Meta-modeling :

- ▶ Polynomial chaos (full or sparse)
- ▶ Kriging

Fields

Field example :

- ▶ Input : 4 independent random variables
- ▶ Output : height of the river Garonne on a 100 km segment
- ▶ Computer code : TELEM2D
- ▶ Quantity of interest : pointwise average over 70 000 random simulations

Roadmap :

- ▶ Now : massive Python/OpenTURNS scripting
- ▶ 2017-2018 : in the gui



The end

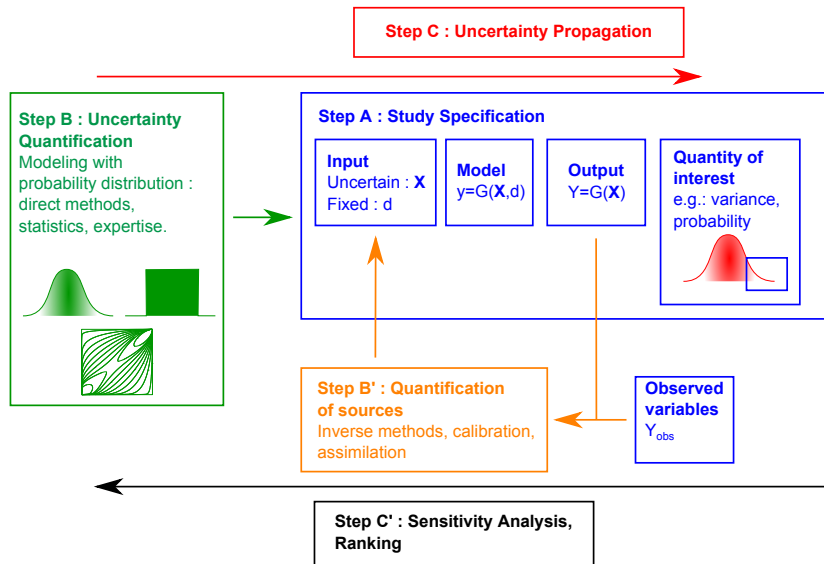
Thanks !

Questions ?

Interactive uncertainty visualization with Paraview



Methodology



Software architecture

Two entry points:

- ▶ interactive,
- ▶ Python.

Advantages of the Python programming of the GUI:

- ▶ unit tests,
- ▶ going beyond the GUI



Symbolic physical model

The screenshot shows the OTGui application window. The title bar reads "OTGui". The menu bar includes "File" and "View". Below the menu bar is a toolbar with icons for opening, saving, and printing. The left sidebar displays a tree view of the project structure:

- Crue Analytique
 - physicalModel_0
 - Deterministic study
 - Probabilistic study
 - Designs of experiment

The main area is divided into two sections: "Inputs" and "Outputs".

Inputs

	Name	Description	Value
1	Q	Débit (m ³ /s)	0
2	Ks	Strickler (m ^{1/3} /s)	30
3	Zv	Côte aval (m)	50
4	Zm	Côte amont (m)	55
5	Hd	Hauteur de la digue (m)	8
6	Zb	Côte de la berge (m)	55,5
7	L	Longueur de la rivière (m)	5000
8	B	Largeur de la rivière (m)	300

Below the inputs table are buttons for "+ Add" and "- Remove".

Outputs

	Name	Description	Formula	Value
1	H	Surverse (m)	$(Q / (Ks * B * \sqrt{(Zm - Zv) / L}))^{(3.0 / 5.0)} + Zv - Zb - Hd$	-13,5

Below the outputs table are buttons for "+ Add", "- Remove", and "Evaluate".

Probabilistic model



Limit state study : definition of the threshold

Definition of the failure event :

Output	Operator	Threshold
H ▼	< ▼	-10

Limit state study : algorithm parameters



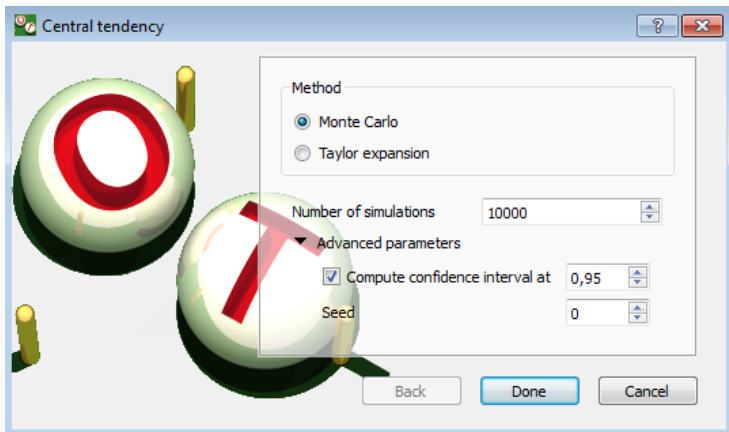
Limit state study : summary

Summary	Histogram	Convergence graph	
Output H			
Number of simulations: 26			
Estimate	Value	Confidence interval at 95%	
		Lower bound	Upper bound
Failure probability	0.807692	0.656203	0.959182
Coefficient of variation	0.0956949		

Limit state study : histogram



Central tendency : algorithm parameters



Central tendency : summary results

Moments estimate

Estimate	Value	Confidence interval at 95%	
		Lower bound	Upper bound
Mean	-11.0178	-11.0417	-10.9938
Standard deviation	1.22309	1.20637	1.24028
Skewness	0.20005		
Kurtosis	3.01907		
First quartile	-11.8721		
Third quartile	-10.2129		

Probability **Quantile**

Central tendency : summary results

Result table

Summary

PDF/CDF

Box plots

Scatter plots

Output

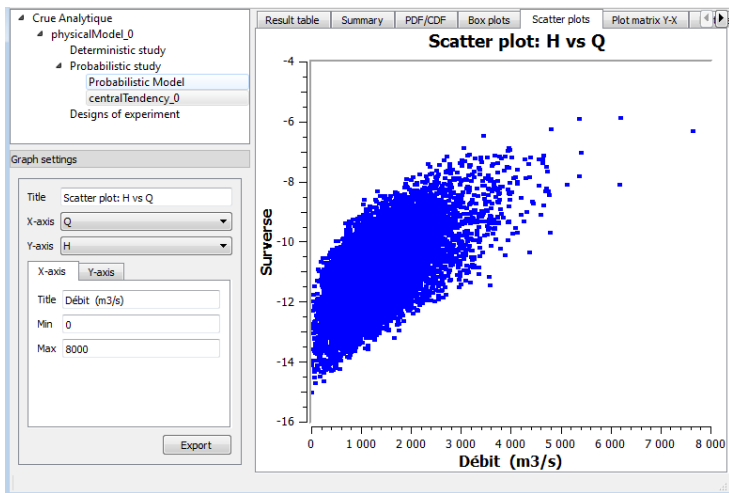
H ▼

Number of simulations: 10000

Minimum and Maximum

	Variable	Minimum	Maximum
Output	H	-15.0155	-5.88758
Inputs at extremum	Q	7.97827	6187.43
	Ks	27.132	25.5926
	Zv	49.1681	50.9071
	Zm	54.5469	55.3994
	Hd	8.76082	8.49391
	Zb	55.5436	55.4935
	L	4999.26	4997.37
	B	303.187	300.871

Central tendency : scatter plots



Sensitivity analysis : Sobol' indices

