PHIMECA
Solutions for robust engineering

OpenTURNS day

Overview of recently developed features in Persalys

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Bring Uncertainty Methodology to Engineers

- 4 years ago
  - EDF MRI (now PRISME) wants to maximize the use of OpenTURNS® by its engineer/researcher (and improve an existing GUI) => develop a GUI to make more easy to use
  - Phimeca has already developed an “OpenTURNS GUI” (PhimecaSoft®) which satisfy some needs of EDF R&D but not all.
  - EDF R&D and Phimeca decide to start a specific partnership in order to develop a new GUI based on OpenTURNS® and “Salome Tools” : Paraview, Yacs, ...
- Persalys (previously OT GUI) is available, on Salome website, in EDF Specific Salome version and commercialized by Phimeca

Some expectations regarding the GUI

- As easy to use as possible and, when it is possible, a GUI which can guide the user

- Possibility to use it inside Salome Platform to
  - Use supercomputing resources (e.g. Gaïa, 3 052 Tflops peak, 41 000 cores)
  - Connect to EDF numerical code users (Code_Aster for example)

- Take benefit from the advanced visualization capability from Paraview

- Drive the GUI from a python script usable in an “expert” mode

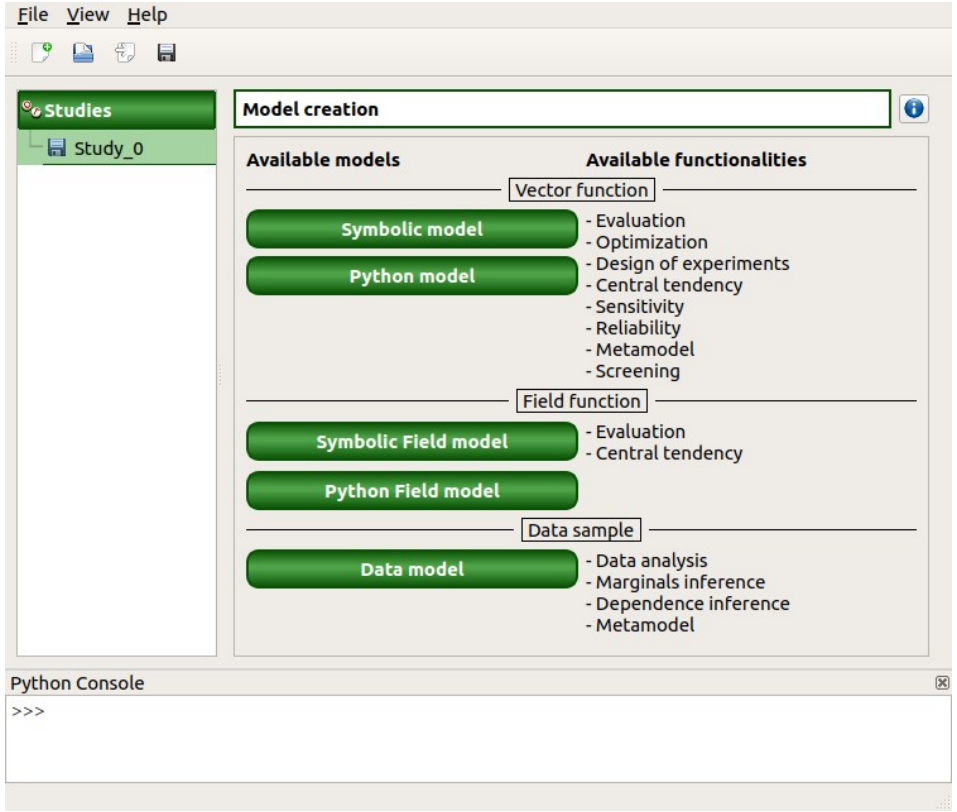
What’s recently added?

- Screening with Morris
- Optimization
- Dependence structure (definition and inference)
- Field 1D
- Distributed evaluations

Opening Persalys

Functionality of Persalys

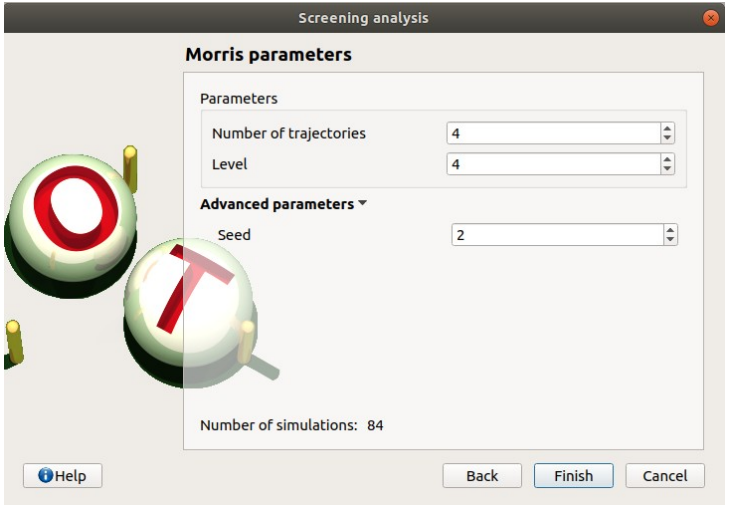
- Documentation (links from the interface)
  - For the graphical interface
  - For the Python interface
  - Links to the OpenTURNS documentation
- Example of a cantilever beam

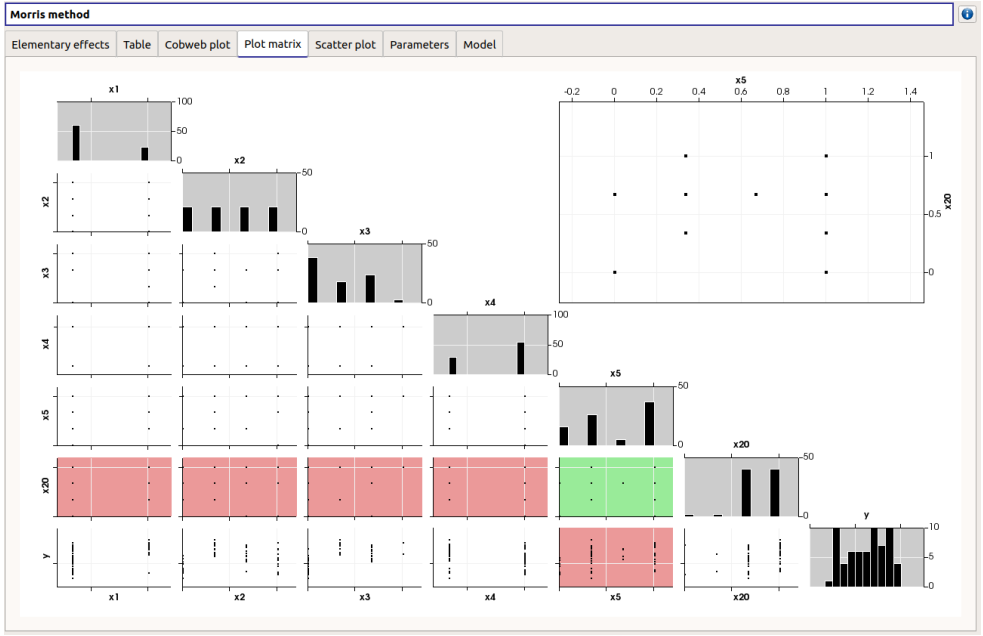


Screening method

Morris method

- Definition of the grid and number of trajectories
- Visualization of the generated design of experiments

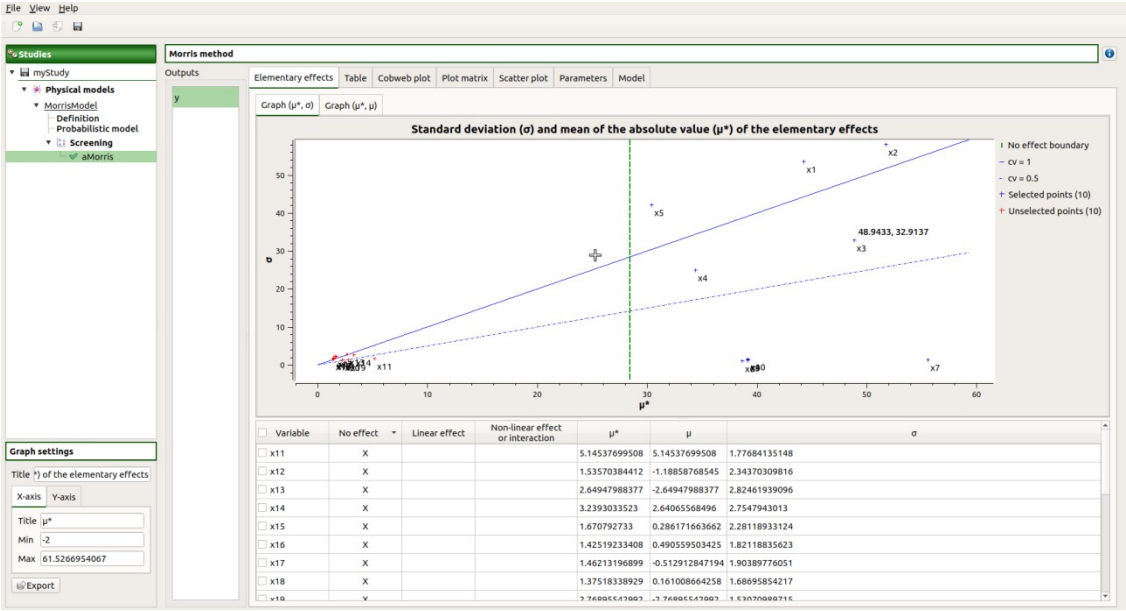




Screening method

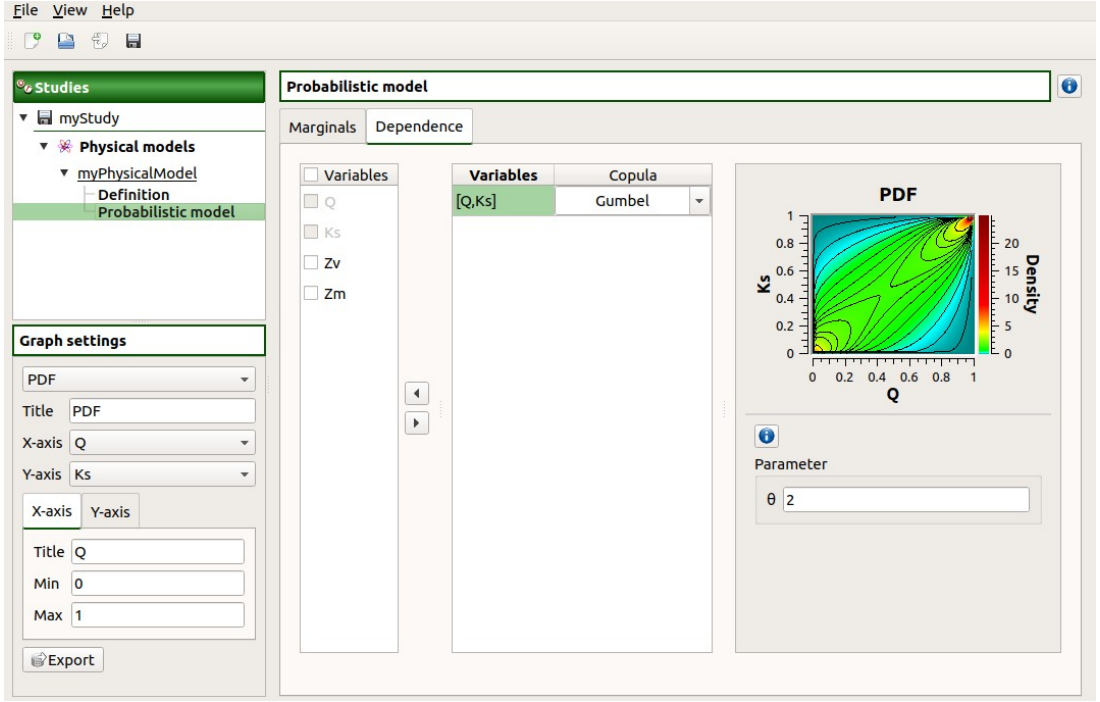
Morris method

- Sort the variables into three groups :
  - no effect
  - linear effect
  - non linear effect or interaction
- Selection of the influent parameters
  - Move the vertical selection cursor
  - Tick the selection box
- Order the table



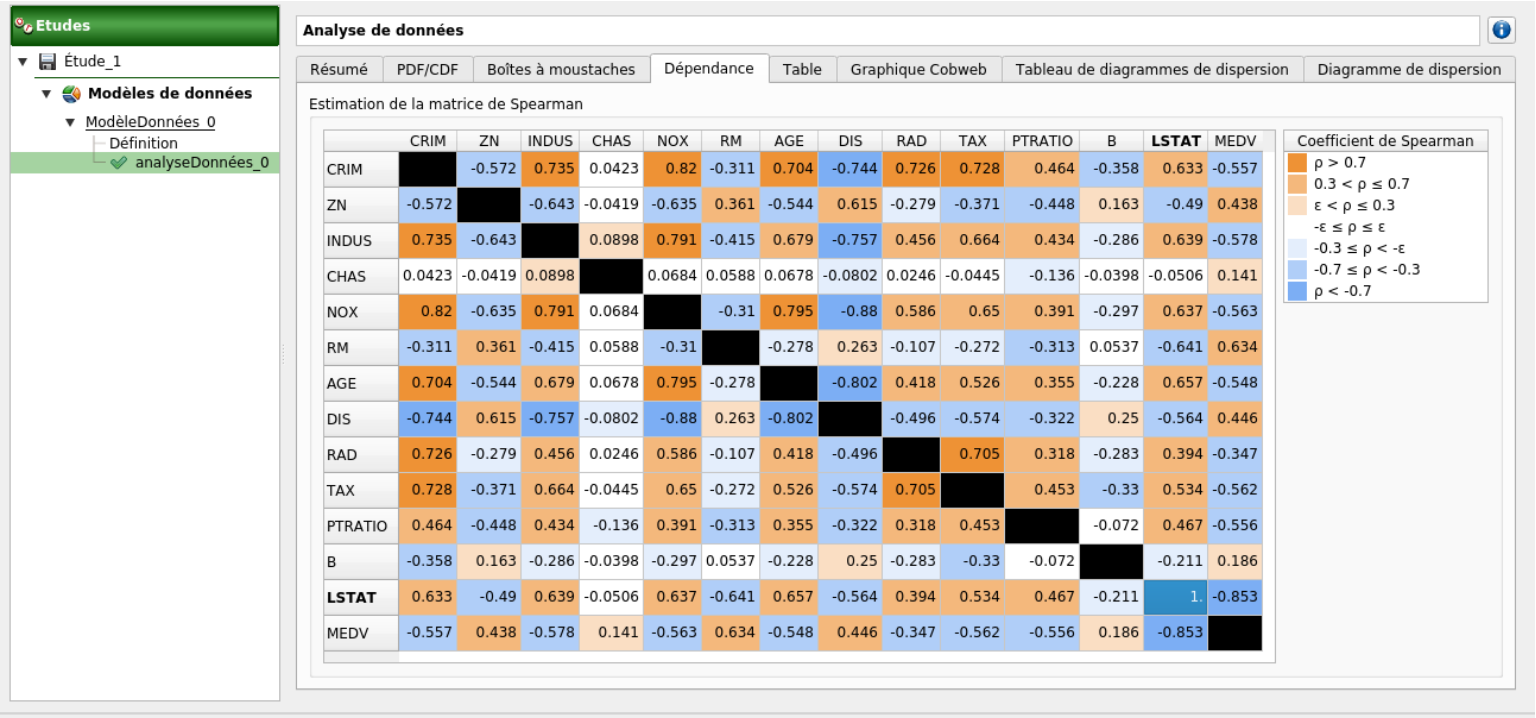
Correlated input variables

- Correlation is added using copulas
  - Define arbitrary groups of dependent variables



Dependence of a sample

Analysis of the correlation of the sample

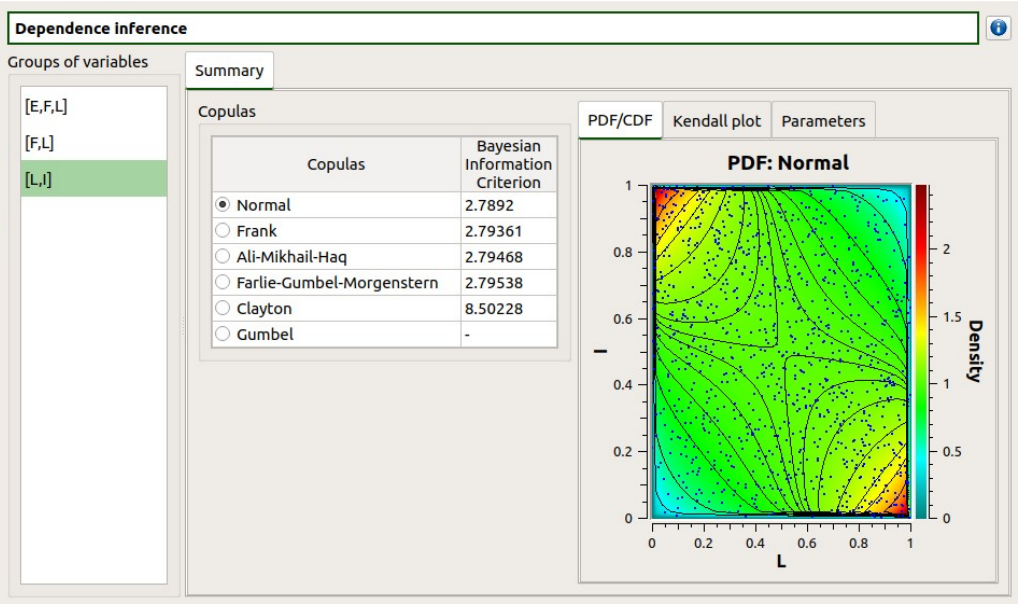


	CRIM	ZN	INDUS	CHAS	NOX	RM	AGE	DIS	RAD	TAX	PTRATIO	B	LSTAT	MEDV
CRIM		-0.572	0.735	0.0423	0.82	-0.311	0.704	-0.744	0.726	0.728	0.464	-0.358	0.633	-0.557
ZN	-0.572		-0.643	-0.0419	-0.635	0.361	-0.544	0.615	-0.279	-0.371	-0.448	0.163	-0.49	0.438
INDUS	0.735	-0.643		0.0898	0.791	-0.415	0.679	-0.757	0.456	0.664	0.434	-0.286	0.639	-0.578
CHAS	0.0423	-0.0419	0.0898		0.0684	0.0588	0.0678	-0.0802	0.0246	-0.0445	-0.136	-0.0398	-0.0506	0.141
NOX	0.82	-0.635	0.791	0.0684		-0.31	0.795	-0.88	0.586	0.65	0.391	-0.297	0.637	-0.563
RM	-0.311	0.361	-0.415	0.0588	-0.31		-0.278	0.263	-0.107	-0.272	-0.313	0.0537	-0.641	0.634
AGE	0.704	-0.544	0.679	0.0678	0.795	-0.278		-0.802	0.418	0.526	0.355	-0.228	0.657	-0.548
DIS	-0.744	0.615	-0.757	-0.0802	-0.88	0.263	-0.802		-0.496	-0.574	-0.322	0.25	-0.564	0.446
RAD	0.726	-0.279	0.456	0.0246	0.586	-0.107	0.418	-0.496		0.705	0.318	-0.283	0.394	-0.347
TAX	0.728	-0.371	0.664	-0.0445	0.65	-0.272	0.526	-0.574	0.705		0.453	-0.33	0.534	-0.562
PTRATIO	0.464	-0.448	0.434	-0.136	0.391	-0.313	0.355	-0.322	0.318	0.453		-0.072	0.467	-0.556
B	-0.358	0.163	-0.286	-0.0398	-0.297	0.0537	-0.228	0.25	-0.283	-0.33	-0.072		-0.211	0.186
LSTAT	0.633	-0.49	0.639	-0.0506	0.637	-0.641	0.657	-0.564	0.394	0.534	0.467	-0.211	1.	-0.853
MEDV	-0.557	0.438	-0.578	0.141	-0.563	0.634	-0.548	0.446	-0.347	-0.562	-0.556	0.186	-0.853	

Dependence of a sample

Inference of the dependence of the sample

- Guided choice according to the BIC



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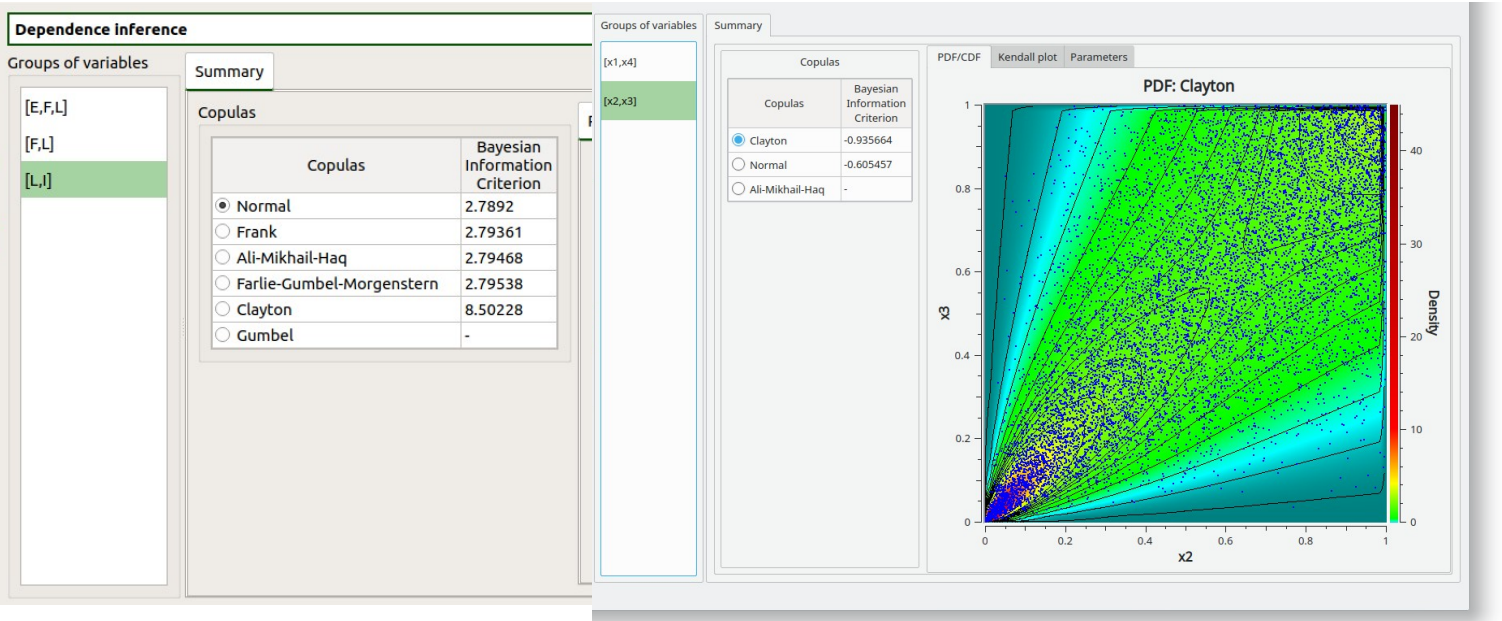
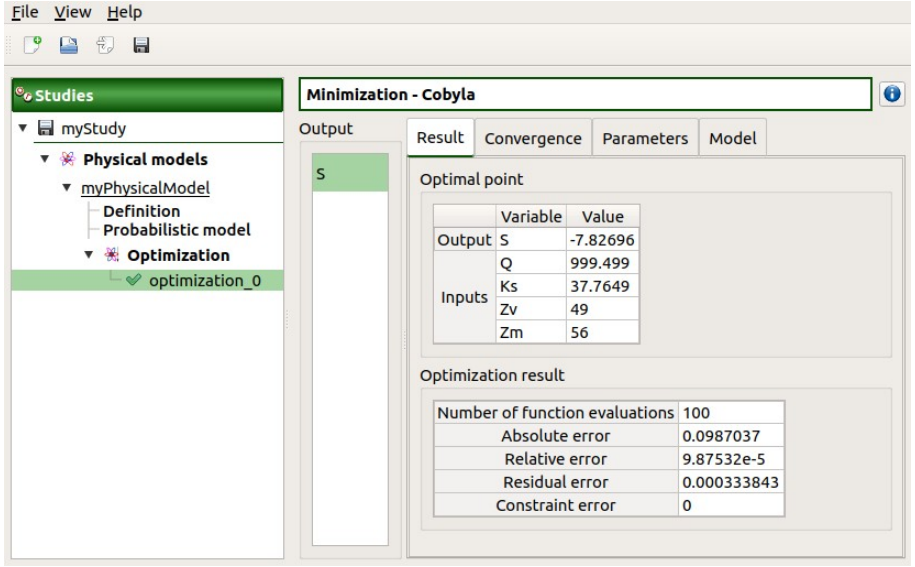
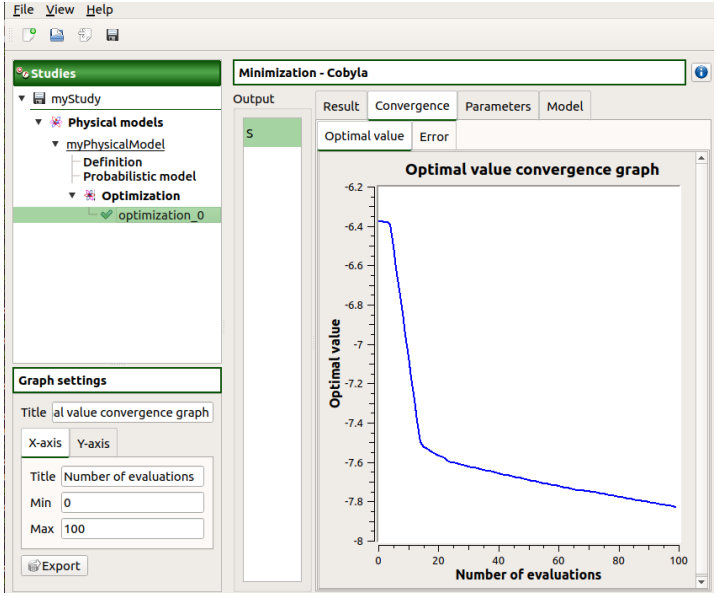


Optimization

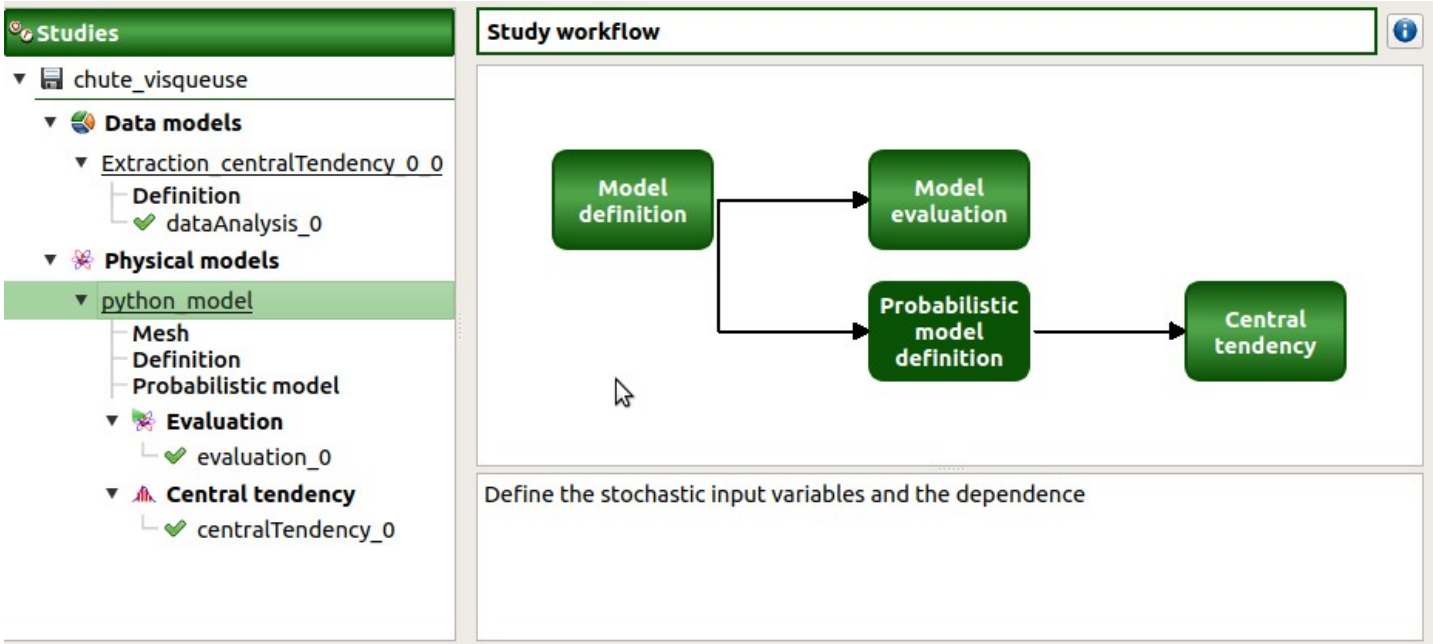
- Bounded optimization of an output without functional constraints
  - Algorithms : TNC, Cobyla, NLopt (more than 40 algorithms)
  - Future work : parameter calibration (least square fit and Bayesian)





Field 1D

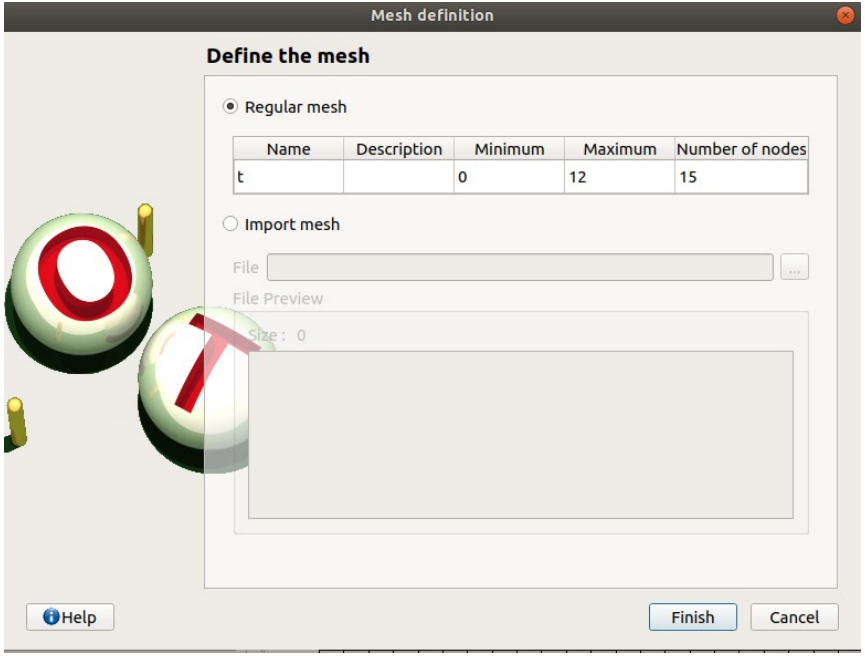
Workflow of the field study

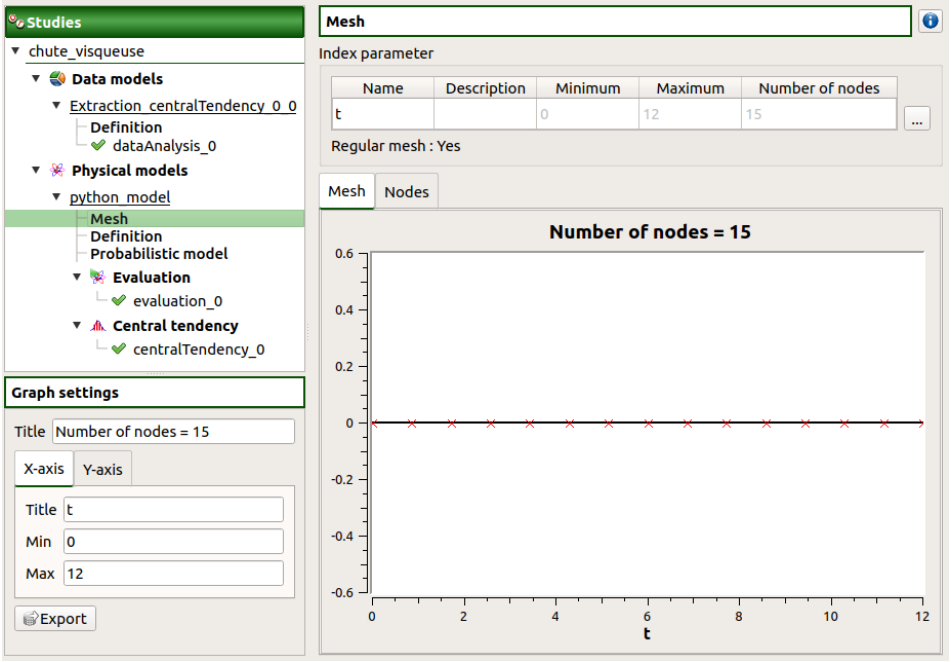


Field 1D

Mesh definition and visualization

- Possible import from text or csv file

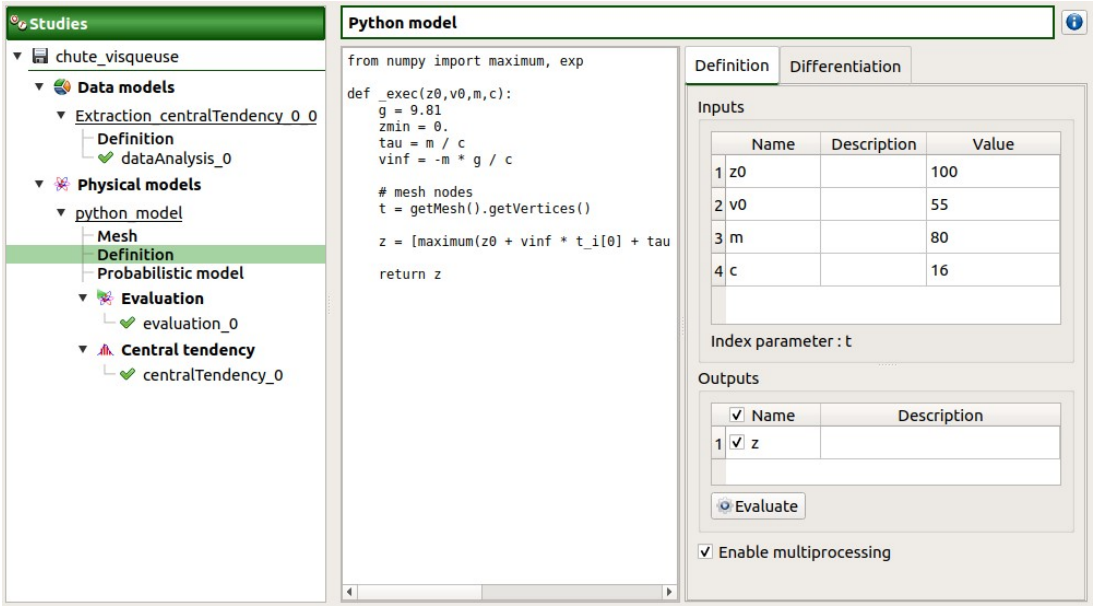


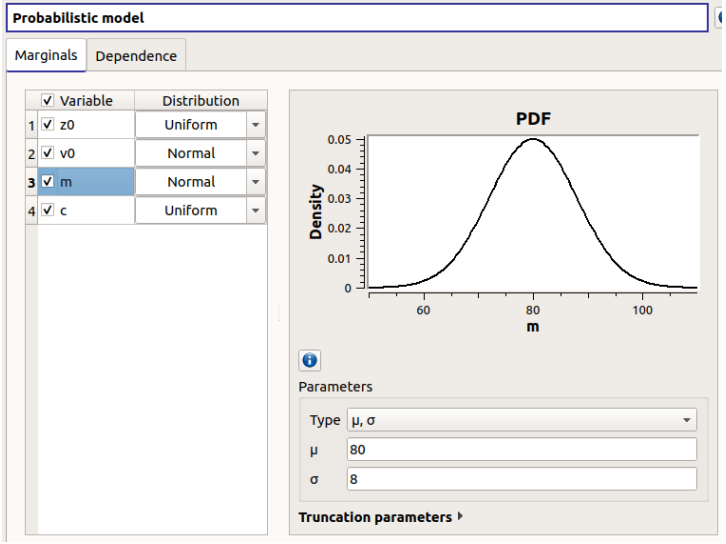


Field 1D

Functional model definition and probabilistic model

- Python or symbolic

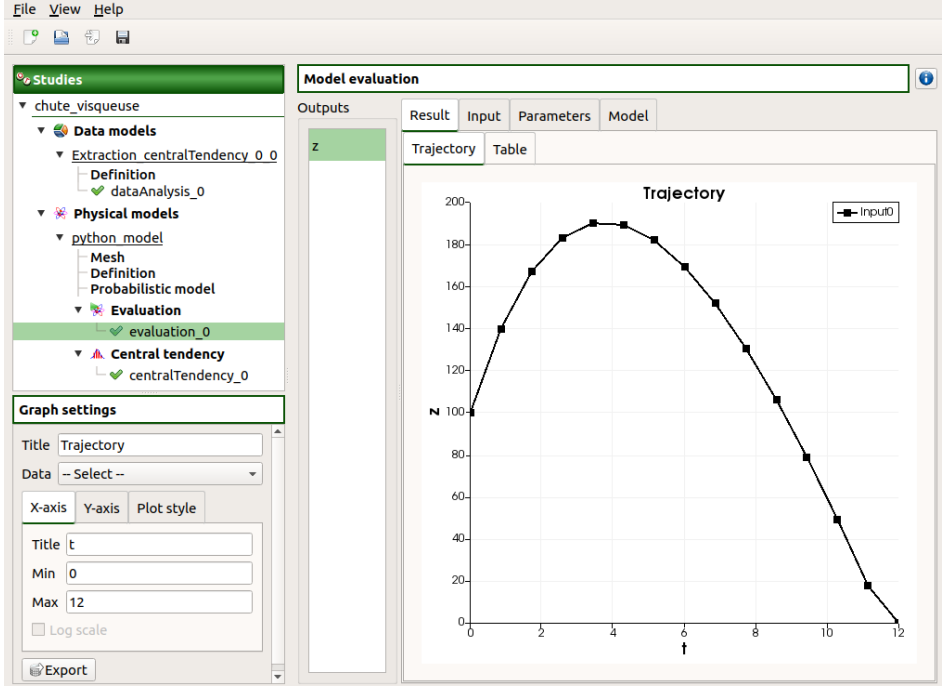




Field 1D

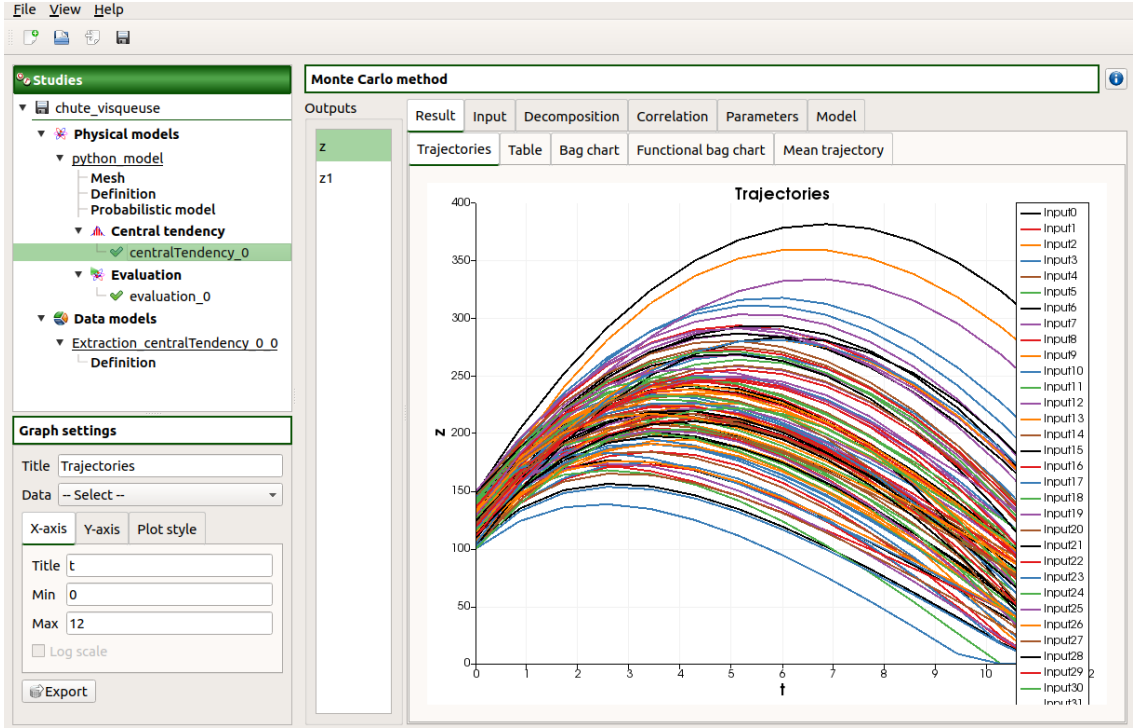
Evaluation for a specific value

- Validation of the model



Field 1D

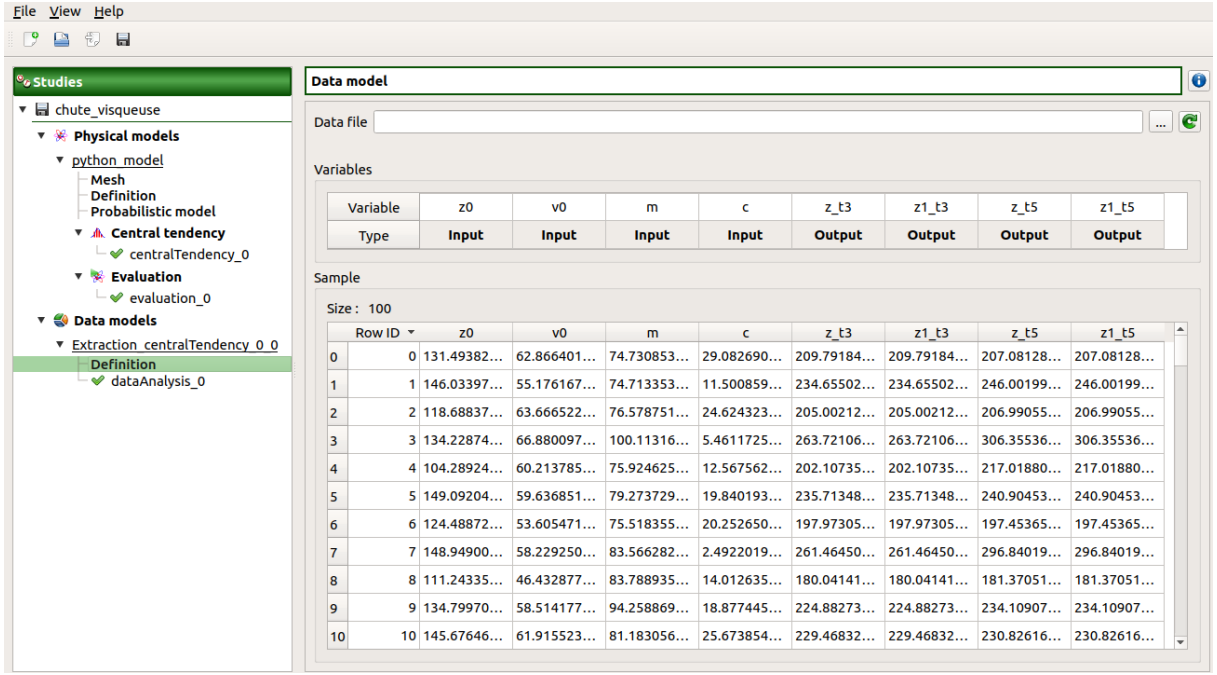
Uncertainty propagation



Field 1D

Extract values at some nodes as data model

- Here extraction of values at nodes 3 and 5



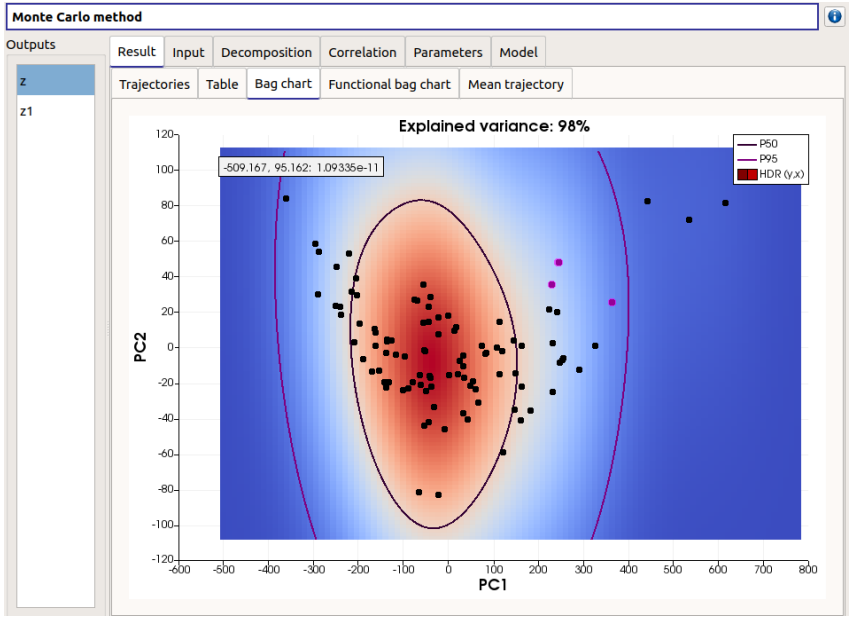
Variable	z0	v0	m	c	z_t3	z1_t3	z_t5	z1_t5
Type	Input	Input	Input	Input	Output	Output	Output	Output

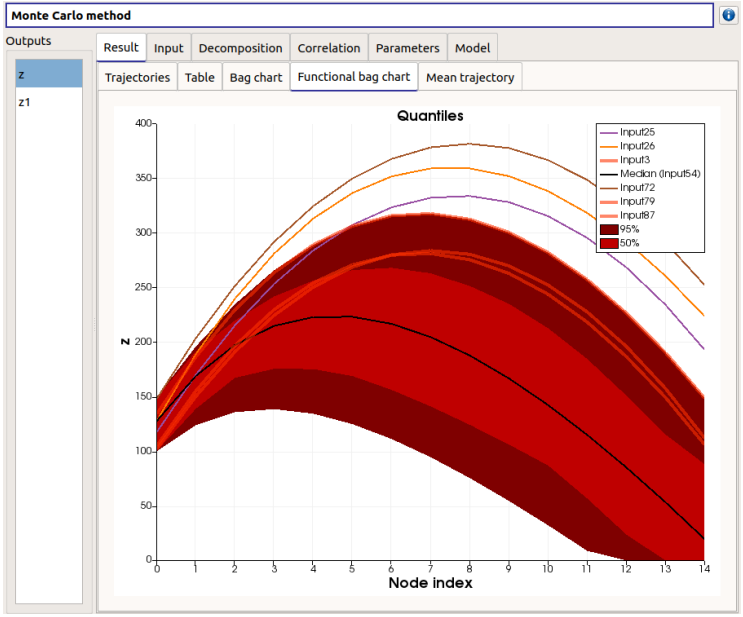
	Row ID	z0	v0	m	c	z_t3	z1_t3	z_t5	z1_t5
0	0	131.49382...	62.866401...	74.730853...	29.082690...	209.79184...	209.79184...	207.08128...	207.08128...
1	1	146.03397...	55.176167...	74.713353...	11.500859...	234.65502...	234.65502...	246.00199...	246.00199...
2	2	118.68837...	63.666522...	76.578751...	24.624323...	205.00212...	205.00212...	206.99055...	206.99055...
3	3	134.22874...	66.880097...	100.11316...	5.4611725...	263.72106...	263.72106...	306.35536...	306.35536...
4	4	104.28924...	60.213785...	75.924625...	12.567562...	202.10735...	202.10735...	217.01880...	217.01880...
5	5	149.09204...	59.636851...	79.273729...	19.840193...	235.71348...	235.71348...	240.90453...	240.90453...
6	6	124.48872...	53.605471...	75.518355...	20.252650...	197.97305...	197.97305...	197.45365...	197.45365...
7	7	148.94900...	58.229250...	83.566282...	2.4922019...	261.46450...	261.46450...	296.84019...	296.84019...
8	8	111.24335...	46.432877...	83.788935...	14.012635...	180.04141...	180.04141...	181.37051...	181.37051...
9	9	134.79970...	58.514177...	94.258869...	18.877445...	224.88273...	224.88273...	234.10907...	234.10907...
10	10	145.67646...	61.915523...	81.183056...	25.673854...	229.46832...	229.46832...	230.82616...	230.82616...

Field 1D

BagChart (from Paraview)

- Shared selection of trajectories between graphs
- Future work : PCA of dimension > 2

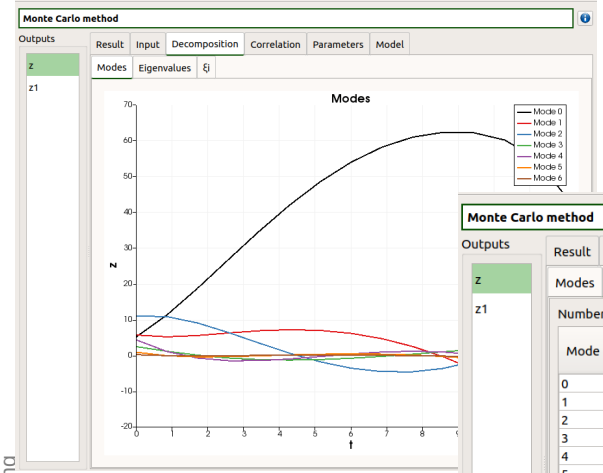


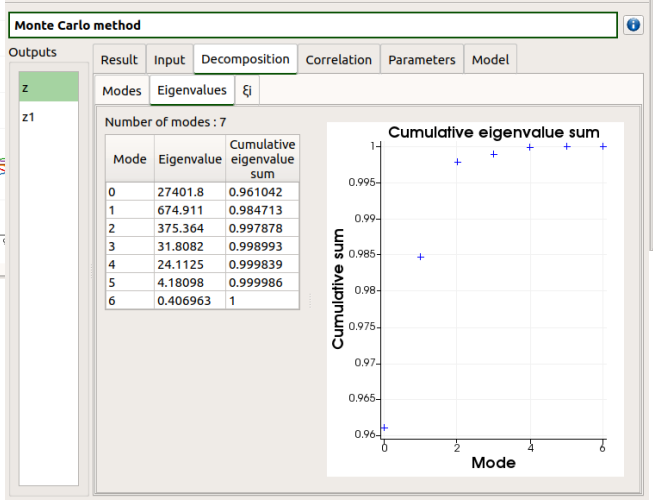


Field 1D

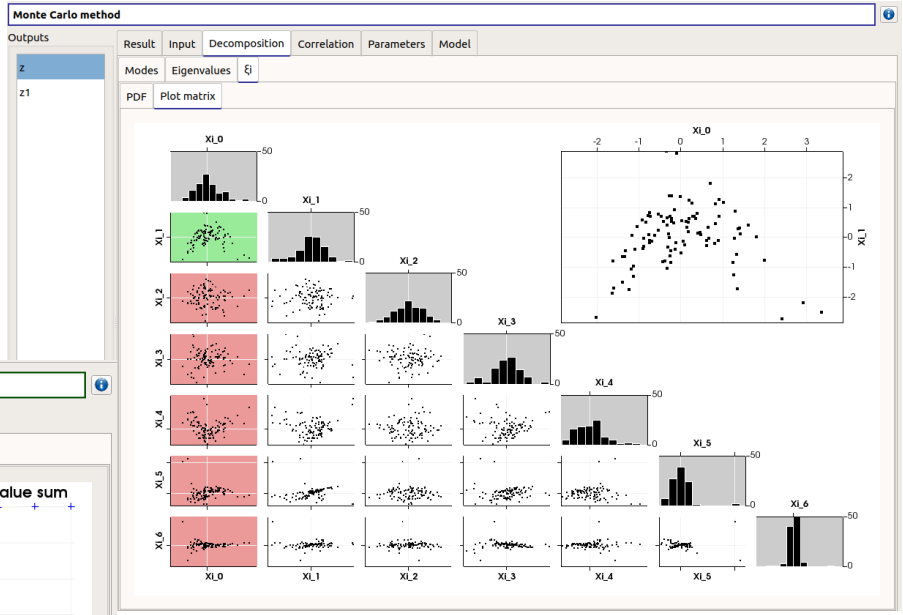
Karhunen-Loève decomposition

- Show modes, eigenvalues and ξ_i



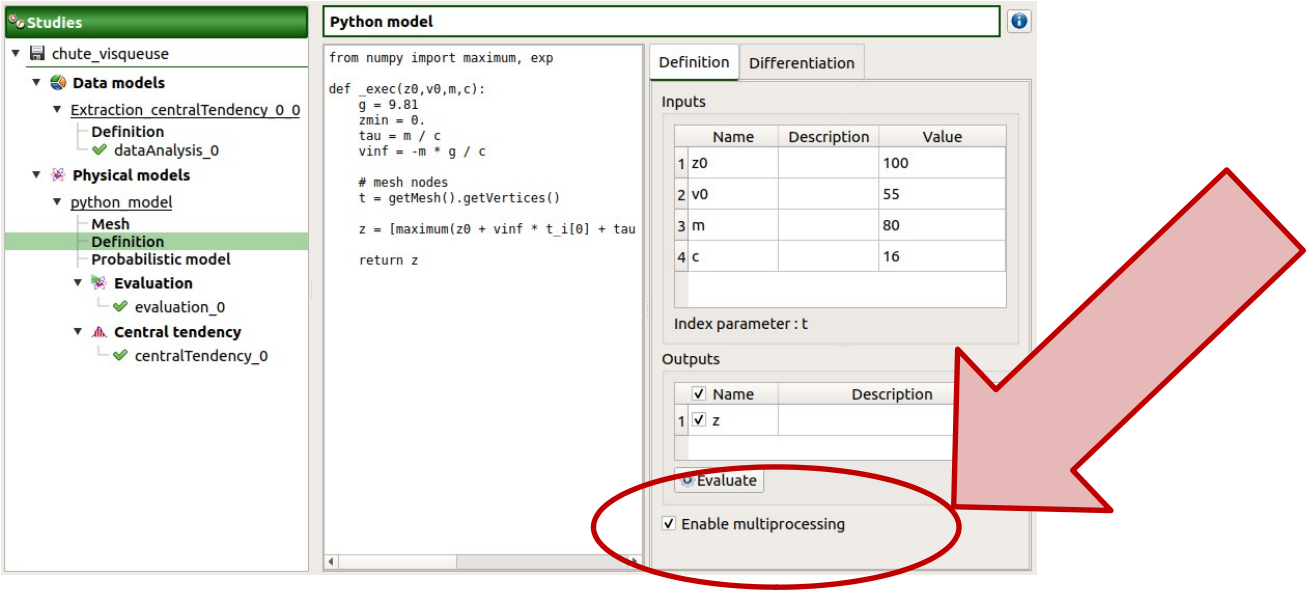


Mode	Eigenvalue	Cumulative eigenvalue sum
0	27401.8	0.961042
1	674.911	0.984713
2	375.364	0.997878
3	31.8082	0.998993
4	24.1125	0.999839
5	4.18098	0.999986
6	0.406963	1



Distributed evaluations

- Multiprocessing available for Python model
  - In local host if on your personal computer
  - On cluster if used within Salome Meca using YACS



Future work

- Parameter calibration
  - Least square and Bayesian
- Field 1D
  - Improve the BagChart with a PCA of dimension > 2
- Study with 2D field