PRACTICAL SESSION - USING THE MYSTIC FRAMEWORK

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EDF - R&D
3 DIFFERENT OPTIMIZATION METHODS

→ Auxiliary files
  → Model.py: Contains the hydraulic physical model and the cost function that calculates the p.o.f of the quantity of interest.
  → Solver_Simulated_Annealing.py: Contains our personal implementation of a simulated annealing solver. 4 schedules are available.
  → Cross_Visualisation.py: Visualisation of the results imported from the three script files.

→ Script files
  → Script_Simulated_Annealing.py: Optimization of the cost function using the simulated annealing solver.
  → Script_Mystic_Framework.py: Optimization of the p.o.f using the mystic framework.
→ 4 parameters $Q, K_s, Z_v,$ and $Z_m$ bounded and constrained only by their mean. $\mu_k = \omega_k \delta_{x_{1,k}} + (1 - \omega_k) \delta_{x_{-1,k}}$,

→ Our cost function returns the CDF $P(f(Q, K_s, Z_v, Z_m) \leq h)$,

→ Parameterization with the position of the two Dirac masses constituting the support of the measure.

$$f(x_{\pm 1,1}, \ldots, x_{\pm 1,p}) = \sum_{i_1 \in \{-1,1\}} \cdots \sum_{i_p \in \{-1,1\}} P(G(x_{i_1,1}, \ldots, x_{i_p,p}) \leq h),$$

$$= \sum_{i_1 \in \{-1,1\}} \cdots \sum_{i_p \in \{-1,1\}} \omega_{i_1,1} \cdots \omega_{i_p,p} 1\{G(x_{i_1,1}, \ldots, x_{i_p,p}) \leq h\}.$$

Where $x_{-1,k}$ et $x_{1,k}$ belongs to $[l_k, E(\mu_k)]$ et $[E(\mu_k), u_k]$. 
The files provided treat the 1D case, the others parameters are set to their means:

\[ K_s = 30, \quad Z_v = 05, \quad Z_m = 54.5 \]

The CDF is globally optimized:

\[ \bar{q}(h) = \inf_{Q \in \mathcal{M}_1([160, 3580])} \frac{P(f(\mu) \leq h)}{E(Q) - 1870} \]

The plot shows the lowest CDF:

\[ \bar{q} : h \mapsto \bar{q}(h) \]
The following scripts optimize the cost function either with a Simulated Annealing solver or a Differential Evolution solver.

→ Script_Simulated_Annealing.py
→ Script_Differential_Evolution.py

The last script Script_Mystic_Framework.py also optimizes with a Differential Evolution solver ...
THE MYSTIC FRAMEWORK

→ Mystic allows a really easy implementation of constraints of any order, the framework is build for OUQ.
→ We set the number of Dirac masses required for every measure. The cost function will depend on the position AND the weight.
→ Every new point generated is transformed to respect the constraint evaluation in the solver:
   → Mean: it translates the measure. Variance-preserving.
   → Variance: Scales the measure, then re-adjust the mean. Mean-preserving.
   → And so on for higher moment orders.
→ Mystic automatically calculates the p.o.f of our model.