This study is a part of the European project ArtiSane-Food that aims at controlling food-borne pathogens in artisanal fermented food of meat and dairy, origin produced in the Mediterranean region. As a participating country one of the main objective for France is to allow the continuation of the production of raw milk soft cheeses, which is today potentially at risk due to future European regulations. At the French national level this project is in collaboration with ANSES, CNIEL, CentraleSupélec - Université Paris-Saclay and organisations from the dairy industry.

The primary goal is to establish efficient intervention strategies, in order to “economically” reduce the risk of Haemolytic Uremic Syndrome (HUS) caused by Shiga-Toxin producing Escherichia coli (STEC).

Intervention strategies in cheese making:
• Pre-harvest milk sorting:
  - STEC and E. coli strains follow same fecal route!
  - A bulk tank of milk is tested with probability $p_{batch}^\text{pre}$
  - Farms with E. coli conc. $> P_{batch}^\text{pre}$ are rejected
  - Cost of testing and rejecting bulk tank milk

• Post-harvest cheese sampling:
  - A batch of cheese is tested with probability $p_{cheese}^\text{post}
  - From a single batch $n_{sample}$ cheeses are tested for presence of STEC
  - Cost of testing and rejecting cheese batches

The aim is to find the optimal values of the process intervention parameters $[P_{batch}^\text{pre}, p_{batch}^\text{pre}, p_{cheese}^\text{post}, n_{sample}]$, that minimize the risk of HUS and the costs ($C_{post}$ and $C_{cheese}$).

We consider the bi-objective optimization problem

\[
\min_{x \in \mathbb{R}^n} f(x)
\]

where $f = (f_1, f_2)$.

- Not necessarily has a unique solution $x^\text{opt} \in \mathbb{R}$, in presence of conflicting objectives
- The solution set $\mathcal{P}$ consists of Pareto optimal points $\mathcal{P} = \{ x \in \mathbb{R} : \exists y \in \mathbb{R}^n, f(x) < f(y) \}$

With PALS using significantly less (100 × 300) evaluations, the user can provide the following insights
- Most of the dominated (red) points are well classified
- The points corresponding to $\mathcal{P}$ remain unclassified (blue)

Quantitative Risk Assessment (QRA)

**Problem Statement**

The primary goal is to establish efficient intervention strategies, in order to “economically” reduce the risk of Haemolytic Uremic Syndrome (HUS) caused by Shiga-Toxin producing Escherichia coli (STEC) present in raw-milk soft cheese.

Intervention strategies in cheese making:

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  - STEC and E. coli strains follow same fecal route!
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References

