Based on input-output time-domain raw data collected from a complex simulator, the Mixed Interpolatory Inference (MII) process approach allows to infer a reduced-order linear or nonlinear (e.g. bilinear or quadratic) time invariant dynamical model of the form

\[
\begin{align*}
\dot{\hat{x}} &= \hat{A}\hat{x} + \hat{B}\hat{u} + \hat{f}(\hat{x}, \hat{u}) \\
\hat{y} &= \hat{C}\hat{x} + \hat{D}\hat{u} + \hat{g}(\hat{x}, \hat{u})
\end{align*}
\]

that accurately reproduces the underlying phenomena dictated by the raw data. In (1), \(\hat{x}(\cdot) \in \mathbb{R}^r\), \(u(\cdot) \in \mathbb{R}^{n_u}\) and \(\hat{y}(\cdot) \in \mathbb{R}^{n_y}\), denote the reduced internal, input and approximated output variables respectively. Moreover, \(\hat{f}\) and \(\hat{g}\) denote either quadratic or bilinear functions.

The approach is essentially based on the sequential combination of rational interpolation (e.g. Pencil, Loewner, AAA) with a linear least square resolution.

With respect to intrusive methods, no prior knowledge on the operator is needed. In addition, compared to the traditional non-intrusive operator inference approaches, the proposed rationale alleviates the need of measuring and storing the original full-order model internal variables. It is thus applicable to a wider range of applications than the standard intrusive and non-intrusive methods. It is therefore very close to the identification field.

The MII is successfully applied on different numerically challenging application related to pollutant dispersion. First (i) a large eddy simulation of pollutants dispersion case over an airport area, and second (ii) a flow simulation over a building, both involving multi-scale and multi-physics dynamical phenomena.

Despite the simplicity of the resulting low complexity model, the proposed approach shows satisfactory results to predict the pollutants plume pattern while being significantly faster to simulate.