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Elastic Model Calibration using Dakota

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In computational simulation applications, model calibration is the process of learning model inputs by coupling experimental data with model outputs. Often, computer model outputs are functional in nature, producing an output measured over space and/or time.

There has been considerable effort in statistics to develop methods that can analyze functional data objects without loss of information, the methodology is known as functional data analysis. An excellent introduction to this field is given in several books including [1]. An interesting aspect of most functional data is that the underlying variability can be ascribed to two sources. These two sources are termed the amplitude (or y or vertical) variability and the phase (or x or horizontal or warping) variability. Capturing these two sources of variability is crucial when modeling and monitoring functional data in a process control architecture, and can greatly affect the construction of statistics. In this work, we refer to functional data that contains both amplitude and phase variability as *elastic*.

While standard calibration solutions are still applicable to misaligned functions, we demonstrate that using functional metrics that consider the misaligned nature of the data can produce more efficient calibration solutions. Specifically, we use elastic functional data analysis methods [1] to construct a metric to measure the distance between functions. One of the strengths of this approach is the alignment procedure ensures the isometry property holds and calibration is done using a proper distance.

We present a simple framework for model calibration when the model responses are misaligned functional data utilizing these metrics within the Dakota software for calibration. We demonstrate the techniques to emulate and calibrate a optical emission model using data from small scale conventional explosions.

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