Dynamic Parameter Sensitivities:
Summary of Computation Methods for
Continuous-time Modelica Models

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Abstract

Applications of Sensitivity Analysis (SA) encouraged several Modelica platforms to independently provide facilities for externally computing Dynamic Parameter Sensitivities (DPS). FMI specifies an optional function call for evaluating directional derivatives. On the other hand, mathematical foundation for uniform representation of DPS at the Modelica language level has been established. This has resulted in a platform-independent approach demonstrated through example libraries: The ADGenKinetics and the ADMSL libraries.

This paper summarizes couple of methods for computing DPS including:

1. finite difference methods

2. platform-dependent approaches via specialized solvers coupled with specific simulation environments

3. a general approach via equation-based algorithmic differentiation for computing DPS directly at the model / library level with Modelica syntax

The paper neutrally hints that already conducted efforts may converge to the integration of language facilities for DPS without neglecting mathematical difficulties. Surprisingly, many of what could be thought to be algorithmic obstacles have intuitive solutions throughout a minimalist implementation approach.

The PSTools Library

Having DPS at the model level simplifies many applications, e.g. Figure 1. The application
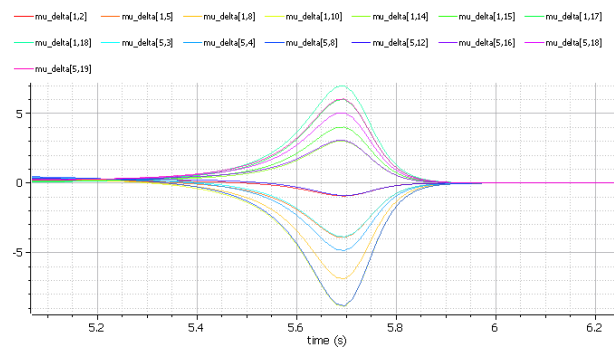

Figure 1. Parameter sweeping study based on one DPS-enabled simulation with two parameters. Instead of running multiple simulations, Taylor series expansion is exploited

is an example taken from the PSTools library. The PSTools library provides the following services for arbitrary Modelica models and libraries via generic models:

- Several demonstrative examples for computational methods of DPS that serve as examples for computing DPS analytically or numerically

- Generic models for computing DPS based on advanced finite difference methods

- Using analytically or numerically computed DPS, further mathematical tools for applications of DPS are accessible through generic models