Derivative Arrays and the Behavior Approach for DAEs with Time-Delays

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In this talk we consider linear time-variant differential-algebraic equations with time-delays of the form

$$E_0(t)\dot{x}(t) + E_1(t)\dot{x}(t-h) = A_0(t)x(t) + A_1(t)x(t-h)$$

with state vector $x \in \mathbb{R}^n$ and constant delay $h \in \mathbb{N}$. Depending on the choice of the matrices E_0, E_1, A_0, A_1 we can distinguish three types of delay systems that mainly differ by their propagation of discontinuities in the solution. In literature these different types are usually treated separately. We will discuss these types and we will show how we can use derivative arrays as a unified tool to find important characteristic values for all three types of equations. In the second part of the talk we will discuss the behavior approach where we can study delay differential-algebraic equations via the analysis of differential-algebraic equations without delays. If time permits we will also discuss how to treat control problems where the dynamics include time-delays by the behavior approach.