Differential-Algebraic Operators with Normally Solvable Linearizations and Optimization with DAEs

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Abstract: We consider the cost

$$\mathcal{J}(x) := \int_{t_0}^{t_f} h(x(t),t) + g(x(t_f))$$

to be minimized on functions $x : \mathcal{I} \to R^m$, $\mathcal{I} := [t_0, t_f]$, belonging to a certain function space X, subject to the general DAE constraint,

$$f(x'(t), x(t), t) = 0, \quad t \in \mathcal{I},$$

and the initial condition $Cx(t_0) = z_0 \in R^n$. The DAE has k rows, possibly $k \neq m$. The nature of the associated differential-algebraic operator

$$\begin{aligned} F: & \qquad \mathrm{dom} F \subseteq X \to Y, \\ (Fx)(t): & = \quad f(x'(t), x(t), t),\ t \in \mathcal{I}, \quad x \in \mathrm{dom} F, \end{aligned}$$

is significant for obtaining suitable extremal conditions and indirect solution methods by means of well-posed boundary value problems. The existence of the derivative $F'(x_*)$ and its normal solvability is crucial on this score. We investigate settings in several function spaces X and Y and provide new criteria of normal solvability in terms of the original data.

REFERENCES:

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