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Directional differentiability for solution operators of vectorial sweeping processes with applications in optimal control

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We study directional differentiability properties of solution operators of rate-independent evolution variational inequalities with full-dimensional convex polyhedral admissible sets. It is shown that, if the space of continuous functions of bounded variation is used as the domain of definition, then the most prototypical examples of such solution operators - the vector play and stop - are Hadamard directionally differentiable in a pointwise manner if and only if the admissible set is non-obtuse. We further prove that, in those cases where they exist, the directional derivatives of the vector play and stop are uniquely characterized by a system of projection identities and variational inequalities and that directional differentiability cannot be expected in the obtuse case even if the solution operator is restricted to the space of Lipschitz continuous functions. Our results can be used, for example, to formulate Bouligand stationarity conditions for optimal control problems involving sweeping processes.

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