Exploring Unilaterality and Asymmetry in Variational Analysis

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Pathologies and nonsmooth phenomena are omnipresent in operations research. Dealing with these phenomena and performing efficient mathematical analysis requires rough approximations of complex situations. Two main paradigms prevail in the development of the theory: the convex paradigm and the semi-algebraic (tame) paradigm. Both paradigms provide rigid structural properties that allow us to obtain wide-ranging conclusions.

This 4-year project is positioned in the broad field of Variational Analysis and proposes a novel approach to exploring structure. The starting point is the observation that although convexity and tameness have different origins, they both rely on orientation. This leads to the idea that exploring some form of asymmetry could provide sufficient grounds for a consistent theory beyond the realms of these paradigms. The proposal contains two independent lines of research, which ultimately relate to this driving idea.

The first line of research is devoted to the determination of an evolution system based on the knowledge of its stationary state and of some quantity related to its macroscopic behavior. Although these data seem too modest to describe fully a phenomenon, we claim that it is still possible to do so in a reasonable number of situations, namely the ones with an intrinsic lack of symmetry. According to our working assumption, lack of symmetry is an advantage rather than an inconvenience.

Based on this assumption, the second line of the project proposes a systematic study of spaces with asymmetric distances. Very little is known on this rather peculiar topic (most classical mathematical or physical theories require and explore some sort of symmetry). We anticipate that asymmetry will be of increasing relevance in the future.

The proposal is mostly of theoretical nature. Nevertheless, spin-off results to leading to concrete applications can also be expected