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Title: *"New advances in Chaotic Orbit Determination"*
Abstract. Chaotic orbit determination intervenes in many practical problems, such as the chaotic rotation state of a celestial body, the chaotic orbit of a planet-crossing asteroid experiencing many close approaches, or the chaotic orbit of a spacecraft orbiting a giant planet system undergoing many close encounters with its satellites. It is known that chaotic dynamical systems are characterized by the existence of a predictability horizon, connected to its Lyapounov time, beyond which the prediction of the state starting from the initial state of the system is meaningless. In (Spoto and Milani, 2016), the authors applied the differential corrections algorithm for the determination of an orbit and of a dynamical parameter of a simple discrete system, the standard map, with observations distributed beyond the predictability horizon. They defined a computability horizon, a time limit beyond which numerical calculations are affected by numerical instability, and gave a formula for approximating its value. Aiming to push forward the computability horizon inherent in the least squares orbit determination, in this work we tested - in the same case of the standard map the constrained multi-arc method. This method entails the determination of an orbit of a dynamical system when observations are grouped in separate observed arcs. For each arc a set of initial conditions is determined and during the orbit determination process all subsequent arcs are constrained to belong to the same trajectory. We show that using this technique in place of the standard least squares method has considerable advantage, allowing to perform accurate numerical calculations well beyond the computability horizon. Along with the numerical experiments, we also present an analytical proof related to the results obtained in (Spoto and Milani, 2016) for the ordered case. We suppose that the orbit we want to determine belongs to a Moser invariant curve, the number of observations tends to infinity and the partial approximations of the solution tend to the invariant curve with a certain rate.

Joint work with Federica Spoto, Stefano Marò and Andrea Milani