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Title: *"Surrogate-based optimisation of low-thrust trajectories"*
Abstract. In this work the use of a surrogate model to estimate the cost of low-thrust transfers and to globally optimise low-thrust trajectories is presented. The paper will show how surrogate models can be used to obtain a quick estimation of the cost and time of flight required for any low-thrust trajectory rendezvous. The data points for the construction of the surrogate model are generated by solving a two-point boundary value problem (TPBVP) defined by a set of initial and final non-singular orbital elements. For the solution of the TPBVP, a direct transcription method based on Finite Orbital Elements (FOE) is used. Finite Orbital Elements are based on an asymptotic analytical solution of the motion under a low-thrust acceleration. The resulting surrogate model has a wide range of possible applications and overcomes some limitations of analytical formulas, currently available in the literature, for the estimation of the cost of low-thrust transfers. In fact these formulas often consider the variation of a single or a small group of orbital elements at a time and do not consider the angular position of the spacecraft on its orbit.

It will be shown how the proposed surrogate model can be used to globally optimise low-thrust trajectories in conjunction with higher fidelity, expensive models. In this case, the surrogate model is adaptively updated during the optimisation process and the higher fidelity model is evaluated only when required. This form of adaptive surrogate-based global optimisation is applied to the deisgn of GTO-GEO low-thrust transfers using an expensive high fidelity model including perturbations from the Earth's aspherical potential, drag and third body. The results are compared to those obtained using a traditional nonlinear programming method for low-thrust optimisation, that provides only locally optimal solutions, strongly dependent on the initial guess.

Joint work with Massimiliano Vasile.