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On the design of solar gravity driven planetocentric transfers using artificial neural networks

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The sun's gravity can be used to efficiently transfer between different planetocentric orbits. Such transfers cannot be designed in a two-body dynamical system, nor do analytical methods exist to identify such transfers. This dissertation presents a method to efficiently identify transfers between a specified departure and target orbit. This method is applied to a well known problem: transfers from inclined low-earth orbits to the geostationary orbit.

Motivated by the large observed control authority of the sun for geocentric transfers, a new mission architecture is defined. This architecture allows the injection of multiple spacecraft around Mars in different target orbits, enabled by solar gravity driven orbital transfers. The efficient design of applications for a wide variety of departure and target orbits, requires an understanding of a large area of the phase space. This dissertation showcases how an artificial neural network architecture can accurately predict the solar gravity driven transfers, for a significantly large section of the phase space. The developed architecture is then used to efficiently identify transfers for several different applications. Multiple revolution transfers with maneuvers at intermediate periareions are identified that arrive at Phobos or Deimos. Furthermore, transfers are designed that transfer to both Phobos and Deimos in a single trajectory.

In addition to addressing solar perturbed planetocentric transfers, this dissertation shows how the developed artificial neural network framework can be applied to a different problem, with different dynamics. As an example, the dissertation develops an artificial neural network architecture that can predict heteroclinic connections in the Earth-Moon circular restricted three-body problem.