National Aeronautics and Space Administration

Automated Launch Period Selection

Principal Investigator: Mark Jesick (392)

Program: FY21 R&TD **Strategic Focus Area: Innovative Spontaneous Concepts**

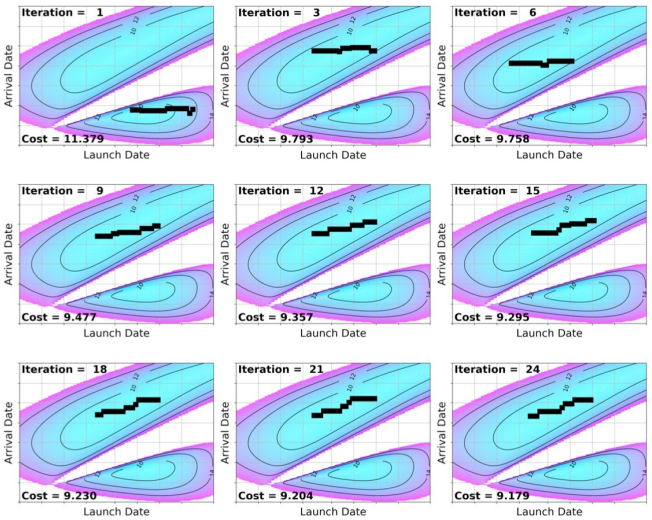
ALPS

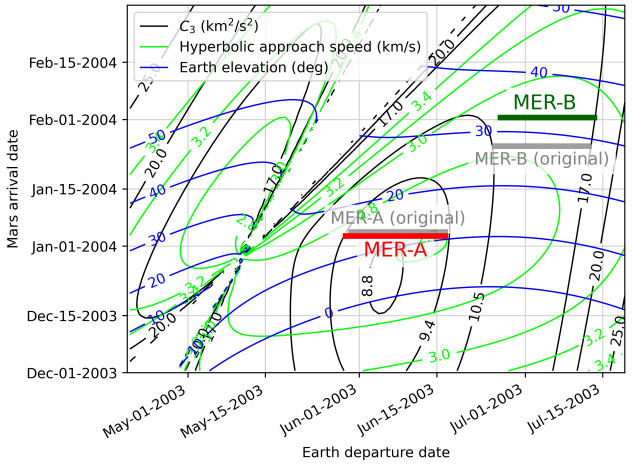
Project Objective:

Design an algorithm that can rapidly, reliably, and autonomously select feasible launch periods; and implement the algorithm in software that is useful for mission designers.

Benefits to NASA and JPL:

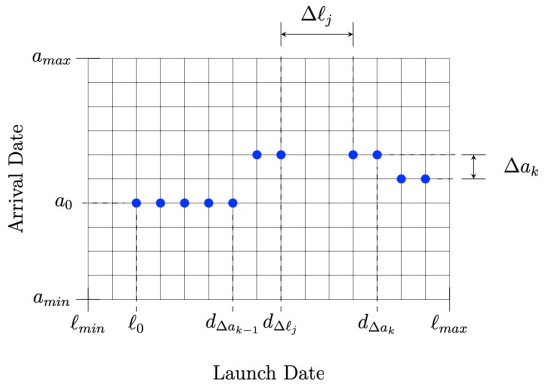
The ability to select launch periods in a systematic, optimal, and automated way will benefit future missions, from concept inception through proposal development to pre-launch flight missions, by reducing the time required to select the launch period and by improving the performance or duration of the launch period. Such automation is especially well suited for JPL's Discovery and New Frontiers proposals and Team X studies, where mission goals may not be fully formed and when constraints change frequently. Furthermore, launch periods for future flight missions may be improved, extended, or, if the launch readiness date slips, quickly redesigned. The newly developed automated launch period selection tool is applicable to all missions, regardless of destination or propulsion system.





Results:

- Formulated general launch period selection problem in a parameter optimization framework.
- Implemented ALPS algorithm in Python, with a user-friendly interface and extensive documentation.
- Designed ALPS to be applicable to all missions, regardless of destination, propulsion system, spacecraft dynamics, etc.
- Enabled customization of the objective function. Users can maximize launch period duration, extremize launch or arrival dates, and extremize performance parameters (like Earth departure energy and arrival speed), or define custom cost functions.
- Developed simple interface to specify constraints. Users can specify lower and upper bounds on the launch and arrival dates, bounds on the launch period length, bounds on performance parameters, or bounds on user-defined constraint functions.
- Handled launch period discontinuities in both the launch dates and arrival dates, bounded in duration to a user-specified range.
- Allowed arrival date gap locations to float or be distributed evenly through the launch period.
- Provided utility function for users to plot launch periods duration optimization.
- Devised interpolation strategy to enable optimization of semi-sparse input datasets, in addition to dense data.
- Implemented differential evolution algorithm with constraint handling.
- Successfully demonstrated the efficacy of ALPS by optimizing over a dozen example problems.
- Applied ALPS to the launch selection problem for several past, present, and future missions, like the Mars Exploration Rovers, Mars 2020, Europa Clipper, the Mars Sample Return Lander, and VERITAS.



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