AIRBUS

Institute of Flight System Dynamics

Master's Thesis Project

Automated Parameter Design in Global Optimization Algorithms

In modern airliners and fighter aircraft, the Flight Control System (FCS) plays a key role in the safety, performance, and reliability of the aircraft. The primary function is to allow the pilot to control the aircraft safely with desired handling/flying qualities. After a design phase, any FCS needs to be verified and validated by a thorough and complex Flight Mechanics clearance process. This model-based assessment aims to cover the combination of all possible aircraft operational states and flight conditions, which translates into a high number of parameters that need to be analysed. A modern way to tackle the high-dimensional parameter space is optimizing for the worst-case by means of global optimization and verifying that this worst-case scenario satisfies the safety requirements of the FCS. Thereby, the integrity of the system under all parameter combinations shall be ensured. In practice, the result of the assessment using global optimization algorithms is closely coupled to the definition of hyperparameters of the global search algorithms.

This thesis aims at implementing an automated methodology to select suitable parameters for a global optimization algorithm at runtime. As of now, these parameters are specified by the user at the beginning of the optimization and generally held constant throughout it. This specification is based on engineering judgment or literature values. However, values might heavily depend on the problem structure, the initial guess, and how the problem is evolving. Therefore, for instance, bi-level optimization, ideally in a non-synchronized manner, provides means to cope with problems based on the parameters encountered along the way and to update them. Consequently, dedicated update criteria in the optimization based on the evolution of the global optimization must be developed. For the evaluation of these criteria, performance is normally significantly improved by using sensitivity/gradient-based updates. Furthermore, the integration of such algorithms into a distributed optimization architecture shall be investigated.

Work Packages

- Literature review on bi-level/Bayesian optimization, convergence properties of global optimization, and sensitivities.
- Analysis of real global optimization results and derivation of suitable evolution criteria.
- Derivation of hyperparameter tuning methods and their applicability in clearance assessments.
- Concept development for algorithms and criterion evaluation routines.
- Analysis of code parts that may be described by sensitivities and analytic gradients to be used within hyperparameter tuning.
- Incorporation and testing of the algorithm.
- Documentation and presentation of results.

Qualifications

- Good programming skills in Java or similar.
- Experience with the Linux OS.
- Experience in optimization, specifically global optimization.
- Experience in OpenMPI or similar.
- Independence and intrinsic motivation.

Benefits

- An innovative topic applicable to relevant industry projects.
- Paid Master's Thesis program at Airbus Defence and Space GmbH.

Organization

- Timeframe: Start: Any time, Duration: 6 months
- Supervisors: Dr. Patrick Piprek, patrick.piprek@airbus.com, Fabian Hackmann, M.Sc., fabian.hackmann@tum.de