Engine Calibration: Engine Map Parameterization and Multi-Objective Optimization

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Abstract: Nowadays, automotive manufacturers are submitted to strong constraints in engine calibration such as : low fuel consumption, emission-control legislation and driver requests for driving comfort and performances. These constraints lead to an increasing complexity of the engines and thus an increasing number of parameters to be tuned, making the empirical engine calibration by a scan of parameter values impossible at engine test-bench. New methodologies in automated engine calibration based on statistics and optimization have emerged in order to limit the number of experimental tests to be run.

The optimization problem of engine calibration consists in the determination of engine tuning parameters that minimize the cumulated fuel consumption and pollutant emissions on a driving cycle generally associated with legislation norms. This cycle is decomposed in a set of stationary operating points of the engine characterized by its speed and its torque (the transient behaviors of the engine are not taken into account in the stabilized calibration). Then, the optimal tuning parameters of the engine should be defined for each operating points, the functions defining these parameters on the whole engine operating domain are called the engine maps. These two-dimensional optimal engine maps are then integrated in the engine control unit in the vehicle.

We illustrate the difficulties associated with this application and propose adapted optimization methodologies: LoLiMoT models for engine map parameterization in order to handle intrinsic constraints on the map regularity, multi-objective optimization method based on CMA-ES approach. Finally, application on real dataset obtained at IFP automated test-bench for a diesel engine are presented.

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