DESC quasi-symmetry optimization

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The DESC stellarator optimization code takes advantage of advanced numerical methods to search the full parameter space much faster than conventional tools. Global pseudo-spectral methods with a unique choice of basis function and force balance residuals give quick and accurate equilibria. Only a single equilibrium solution is needed at each optimization step thanks to automatic differentiation, which efficiently provides exact derivative information. A Gauss-Newton trust-region optimization method uses second-order derivative information to take large steps in parameter space and converge rapidly. With just-in-time compilation and GPU portability, high-dimensional stellarator optimization runs take orders of magnitude less computation time with DESC compared to other approaches. This talk will present the theory of the DESC fixed-boundary local optimization algorithm along with demonstrations of how to easily implement it in the code. Example quasi-symmetry optimizations will be shown and compared to results from conventional tools. Three different forms of quasi-symmetry objectives are available in DESC, and their relative advantages are discussed in detail. In the examples presented, the triple-product formulation yields the best optimization results in terms of minimized computation time and particle transport. The talk will conclude with an explanation of how the modular code suite can be extended to accommodate other types of optimization problems.