Non-convex optimization when the solution is not unique: A kaleidoscope of favorable conditions

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Classical optimization algorithms can see their local convergence rates deteriorate when the Hessian at the optimum is singular. The latter is inescapable when the optima are non-isolated. Yet, several algorithms behave perfectly nicely even when optima form a continuum (e.g., due to overparameterization). This has been studied through various lenses, including the Polyak-Lojasiewicz condition, Quadratic Growth, the Error Bound, and (less so) through a Morse-Bott property. I will present old and new links between all four of these, and touch on implications for fast local convergence of classical algorithms.

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