Abstract

Convex optimization provides a powerful toolkit for robust and efficient solutions of difficult engineering problems. However, it is laborious to extend and generalize the mathematical guarantees of simple convex primitives. In this talk, I will show that much of the analysis and design of optimization algorithms can be automated, and will demonstrate that multiple objectives—such as robustness, accuracy, and speed—can be balanced using tools from dynamical systems. Noting that all iterative algorithms are dynamical systems, I will illustrate how most of the popular methods in optimization can be cast as a family of feedback systems studied in control theory. Leaning on this abstraction enables us to apply powerful, control-theoretic methods to algorithm analysis. I will show how the convergence rates of most common algorithms—including gradient descent, mirror descent, Nesterov's method, etc.—can be verified using a unified set of potential functions. I will then describe how such potential functions can themselves be found by solving constant-sized semidefinite programming problems. I will close with a discussion of how these techniques can be used to search for optimization algorithms with desired performance characteristics, proposing a new methodology for algorithm design.