Al-Khwarizmi and the NBA

Algorithms—especially big algorithms as measured by their impact on applications—are the crowning achievement of our field. These powerful recipes crunch away on signals and data to produce useful results. One of the most famous is the Kalman filter, calling for a state-space model, some covariance matrices, and some data. With careful numerics, this recipe leads unfailingly to the final product, namely, optimal estimates of states that could not be measured otherwise. Homework problems provide ample numerical evidence that the algorithm works exactly as advertised. The algorithm is a gem.

Dennis Bernstein and Tommy Gravdahl, from the Norwegian University of Science and Technology.

Wei Zhang of the University of Western Sydney and Dennis Bernstein.

Unfortunately, my more experienced colleagues periodically warn me of the dangers of such algorithms. Like Circe instructing Ulysees, their advice typically sounds something like, "If you want to control a system, you need to understand it." This is the kind of warning that seems missing from the shelves of glossy books lining my office. With their rosy and rigorous analyses of the algorithms we know and love, these tomes lack the labels adorning tobacco products, which try but fail to discourage the addicted consumer.

"Understanding," they say. What, exactly, is "understanding"? I like the fact that engineering doesn't bog itself down in the philosophical questions that plague physicists. Three dimensions or 20? Missing matter? One universe or a zillion? No matter. We take a pragmatic view: what works, works; what's useful is useful. Understanding, shmunderstanding. Just control the darn thing.

The funny thing about applying an algorithm like the Kalman filter, however, is that it's usually difficult to satisfy the "assumptions" that the algorithm is based on. The dynamics are sort of, well, fuzzy—not to mention nonlinear—and real noise never seems to fit the assumptions, not that we know what the statistics are, anyway.

But research forges onward, as optimistic as ever. We look for better algorithms that are more general, more robust, and more intelligent to overcome what we don't quite "understand." The better the algorithm, we believe, the less we need to "understand." Forget the physics. Algorithms will save us.

The "assumptions" that all algorithms depend on are, of course, never satisfied by anything real. They're figments of our imagination, albeit useful figments as long as we view them as approximations. How good those approximations need to be to make the leap from our imagination to real systems that support lives and livelihoods requires—understanding. But don't let this discourage you—you never know when you might find the *next* big algorithm.

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