Forefront

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Seeing the art in algorithms

FROM MINING TO MANUFACTURING, ALL SORTS OF PROBLEMS CAN BE UNRAVELED WITH MATHEMATICAL WIZARDRY

SOME HAVE CALLED THE mathematical craft used to develop algorithms — sets of rules that define problems within a finite number of steps — more than raw expertise. They have called it art. Like a world-renowned symphony, a significant algorithm may take years to refine. Once complete, an algorithm's performance is judged in part on its efficiency and speed in solving problems. But beyond that, those especially well versed in the algorithmic arts judge its performance in much the same way a newly written symphony is reviewed — they assess its fundamental elegance and integrity.

"Developing algorithms is not just a technical creation," says Berkeley industrial engineering faculty member Dorit Hochbaum. "There's an art to getting from the messy, real-world problem to a clear-cut model that captures the problem's most important aspects."

Hochbaum develops algorithms that can be used to solve a wide array of real-world problems — electronic circuit testing, site placement for a city's emergency facilities, routing problems in factories, scheduling for semiconductor manufacturing processes, logging management to preserve habitat, or even taxonomic classification for biologists.

The example most often used to illustrate how algorithms work is called the traveling salesman problem, which begins with a lone salesman who must visit a specified number of cities within a specified time. The dilemma is finding the most efficient and cost-effective route.

If you begin with just eight cities, says Hochbaum, there are less than 1,000 possibilities. But once you extrapolate to 70 cities, a more realistic scenario for today's mega-corporations, and factor in the cost of travel and lodging, the number of possibilities are staggering.

"It's more than the number of molecules in the universe," says Hochbaum. This sort of problem is called "intractable." In theory, it's solvable, but by the time a solution is found, so much time has elapsed the solution is rendered useless.

"Even in the early 1970s, it was almost impossible to solve the traveling salesman problem using 60 or 70 cities," says Hochbaum. "But now we can, and the number of cities for which we can solve the problem continues to grow."

For Hochbaum, the beauty of algorithms