SOLVING THE "PROBLEM-SOLVING" PROBLEM

Northwestern Engineering's Nikos Hardavellas shares five tips for approaching complex challenges.



"Studying a problem at its smallest, largest, and intermediate sizes can reveal patterns that are otherwise hidden. Those measurements often reveal how performance changes as the problem grows and where bottlenecks emerge."

Nikos Hardavellas Professor of Computer Science and Electrical and Computer Engineering

The most difficult problems often involve competing priorities, hidden dependencies, and countless variables, all of which can obscure the fundamental challenge and make solutions harder to uncover.

Northwestern Engineering's NIKOS HARDAVELLAS confronts complicated systems every day. His research explores how to overcome computer performance bottlenecks and build more efficient systems, from designing computer architecture for speed to developing future user experiences in photonic and quantum computing.

Drawing on that expertise, Hardavellas, professor of computer science and electrical and computer engineering, shares his five-step approach to solving difficult problems more effectively.

1. Define the Problem Before You Solve It

Vague goals, such as "make it faster" or "make it stronger," are rarely useful. Instead, start by identifying exactly what you want to achieve and any hurdles in the way. The more clearly the problem is defined, the easier it becomes to find the right solution. Progress often begins by isolating the key factor driving the problem, allowing for focus on the root cause rather than its symptoms.

2. Measure at the Extremes

A system that performs well on a simple task may struggle when scaled to dozens of use cases, millions of users, or trillions of calculations. Studying a problem at its smallest, largest, and intermediate sizes can reveal patterns that are otherwise hidden. Those measurements often reveal how performance changes as the problem grows and where bottlenecks emerge.

3. Simplify Until the Important Parts Stand Out

Difficult problems often include variables that add complications without meaningfully affecting the outcome. Create a simpler version of the problem that still captures its essential features by stripping away less important factors and by focusing on the most prominent contributors. Once the simplified version is clear, layers can gradually be added back in. Focus on the variables that matter most to gain a clearer understanding of the problem's core dynamics.

4. Look for Solutions That Already Exist

Many seemingly unique challenges can be reframed as versions of well-studied problems. Scientists and engineers often consider or borrow solutions from decades of existing work rather than build new tools from scratch. Finding the right analogy can reveal proven methods that may already exist for solving much of the problem.

5. Define Success Before You Begin

Before investing months or years pursuing improvements, establish what the best possible outcome might look like. Researchers often create an idealized benchmark that represents a best-case performance scenario. Comparing real-world results against that benchmark helps determine whether additional effort is likely to produce meaningful gains or diminishing returns. That helps focus effort where it can have the greatest impact.

BRIAN SANDALOW

Learn more about the Parallel Architecture Group at Northwestern, led by Hardavellas.