with the same goal: harnessing artificial intelligence (AI) to augment—or even replace—the role of humans in the scientific process (see graphic, p. 21). “AI-powered biotech” is how it has been described, but Zymergen’s co-founders cringe at the term. “AI sounds like a robot playing chess,” says Aaron Kimball, the company’s chief technical officer. “I’m comfortable with ‘ML,’” Hoffman says, referring to machine learning, the branch of computer science that accounts for nearly all recent progress in AI. “That gets at what we do.”

WHAT ZYMERGEN ACTUALLY DOES is tune up industrial microbes that produce ingredients for biofuels, plastics, or drugs. Seeking to boost production, companies send their workhorse strains to Zymergen. The robots then explore and tinker with each microbe’s genome in a bid to engineer a version that makes its product compound more efficiently.

The problem is that the microbes that arrive at Zymergen are already “highly optimized,” Hoffman says. After years of research and breeding, the cells are very good at what they do. So squeezing out more efficiency requires exploring the genome deeply, conducting experiments, and following the data wherever they lead—doing science, in other words.

Zymergen is trying to accelerate that science. In traditional biology, Hoffman says, “you’ve got a person standing at a bench testing a limited number of hypotheses. Call it 10 per month.” Robots can do that physical part of the process faster—the machines at Zymergen run as many as 10,000 experiments per week. But robots only follow orders: Giving them the right orders is the real bottleneck.

When I ask how his algorithms design experiments, Kimball begins with a simple premise. “You’ve got the original microbe here with about 5000 genes. Let’s say there are 10 ways you could change a given gene. So that’s 50,000 things you could be doing.” The experimental “campaign” begins by creating 1000 strains, each with a single deliberate mutation, he says. “Each one lives in a droplet. You feed it sugar, let it cook for a while, and then measure how much product you get.” Maybe 25 strains will produce slightly more of the target chemical. Those strains become breeding stock for the next round of experiments, and the rest go into the freezer.

But the path to discovery is anything but straight. Finding just the right combination of mutations requires a long, torturous exploration of the genetic “landscape,” Kimball says. And just blindly walking uphill toward peaks of efficiency almost never leads to a major summit. That’s because if you just combine all the mutations yielding small improvements into a single microbe, they don’t add up to a big gain. Instead, the microbe becomes “sick,” he says, far less fit.
AI in Action: Al’s early proving ground: the hunt for new particles
Adrian Cho

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