7.

THE ULTIMATE VIRUS FIGHTER

A rare genetic mutation might inspire the first broad-spectrum antiviral

Viruses are notorious for evading man-made drugs, but they are powerless against a rare mutation in the gene *ISG15*. A person who possesses this mutation is better at fighting off most (if not all) of the viruses that plague humankind—but probably fewer than one person in 10 million has it. Dusan Bogunovic of the Icahn School of Medicine at Mount Sinai thinks it may be possible to develop a drug that mimics this mutation. If he is right, he may be on the verge of developing a pill that will temporarily bestow the ability to fight off a virus—any virus—without getting sick. The medication should also grant the person who takes it lifelong immunity to any strain encountered while on the drug (unless the virus mutates, as the flu does).

To figure out how the mutation suppresses viruses and how a drug might imitate it, Bogunovic and his team recruited six people with this defect, sequenced their DNA, and isolated blood and skin cells from several of them. The researchers then exposed skin cells from three of the people to multiple viruses, including influenza and herpes. After 24 hours, their cells contained orders of magnitude fewer copies of viral particles than normal cells. The reason, the team explained this past May in *Nature Communications,* is that the *ISG15* mutation knocks out a function that helps to dampen inflammation. Inflammation helps the body fight viruses, so these people "are just a little more ready than you or I for the virus that infects them," Bogunovic says. As a result, their body fights invading viruses and develops immunity before the virus can replicate enough to make them sick.

Bogunovic wants to find a drug that can mimic the effects of the *ISG15* mutation. "By tuning our system ever so slightly, we could tame the first burst of infection," he explains. Bogunovic's group is now screening 16 million compounds in search of a promising antiviral drug. Once it finds candidates, it will need to fine-tune their chemistries, perform toxicology and animal tests, and, finally, run human clinical trials. Success is by no means guaranteed. Some people with the *ISG15* mutation have occasional seizures and the beginnings of lupuslike autoimmunity; any drug would need to avoid such side effects (the researchers say taking the drug short term may help with that). Bogunovic is currently in negotiations to start a biotech company based on his research. "Nothing is impossible," he says. "It's a process, but I think a very exciting one." —*A.S.*

8.

SIGHT-READING SOFTWARE

An approach to artificial intelligence that enables computers to recognize visual patterns better than humans

If someone showed you a single character from an unfamiliar alphabet and asked you to copy it onto a sheet of paper, you could probably do it. A computer, though, would be stumped—even if it were equipped with state-of-the-art deep-learning algorithms such as those that Google uses to categorize photographs. These machine-learning systems require training on enormous sets of data to make even rudimentary distinctions between images. That may be fine for machines in the post office that sort letters by zip code. But for subtler problems, such as translating between languages on the fly, an approach learned from a handful of examples would be much more efficient.

Computers are closer to making this leap because of a machine-learning framework called Bayesian program learning, or BPL. A team of researchers at New York University, M.I.T. and the University of Toronto has shown that a computer using BPL can perform better than humans at recognizing and re-creating unfamiliar handwritten character sets based on exposure to a single example. ("Bayesian" refers to a kind of probabilistic reasoning that can be used to update uncertain hypotheses based on new evidence.)

The BPL approach to machine learning is fundamentally different than deep learning, which roughly models the human brain's basic pattern-recognition capabilities. Instead BPL takes inspiration from the ability of the human brain to infer a set of actions that might produce a given pattern. For example, it would recognize that the letter A can be built out of two angled strokes connected at the top, with a short, horizontal stroke in the middle. "The computer represents the A by assembling a simple program that generates examples of that letter, with different variations every time you run the code," says Brenden Lake, a Moore-Sloan Data Science Fellow at N.Y.U. who collaborated on the research. Bayesian processes allow the software to cope with the uncertainty of re-creating unfamiliar letters out of smaller, previously known parts (for example, the horizontal stroke in an A).

This kind of machine learning is more versatile, as well as more efficient. The same processes that BPL software uses to deconstruct and then re-create an unknown letter could someday power AI applications that can infer cause-and-effect patterns in complex phenomena (such as the flow of a river) and then use them to address completely different systems. Human beings regularly employ this kind of abstract "lateral thinking"; BPL could unlock similar capabilities for computers. "We're trying to get computers to be able to learn concepts that can then be applied to many different tasks or domains," Lake says. "That's a core aspect of human intelligence." —*J.P.*