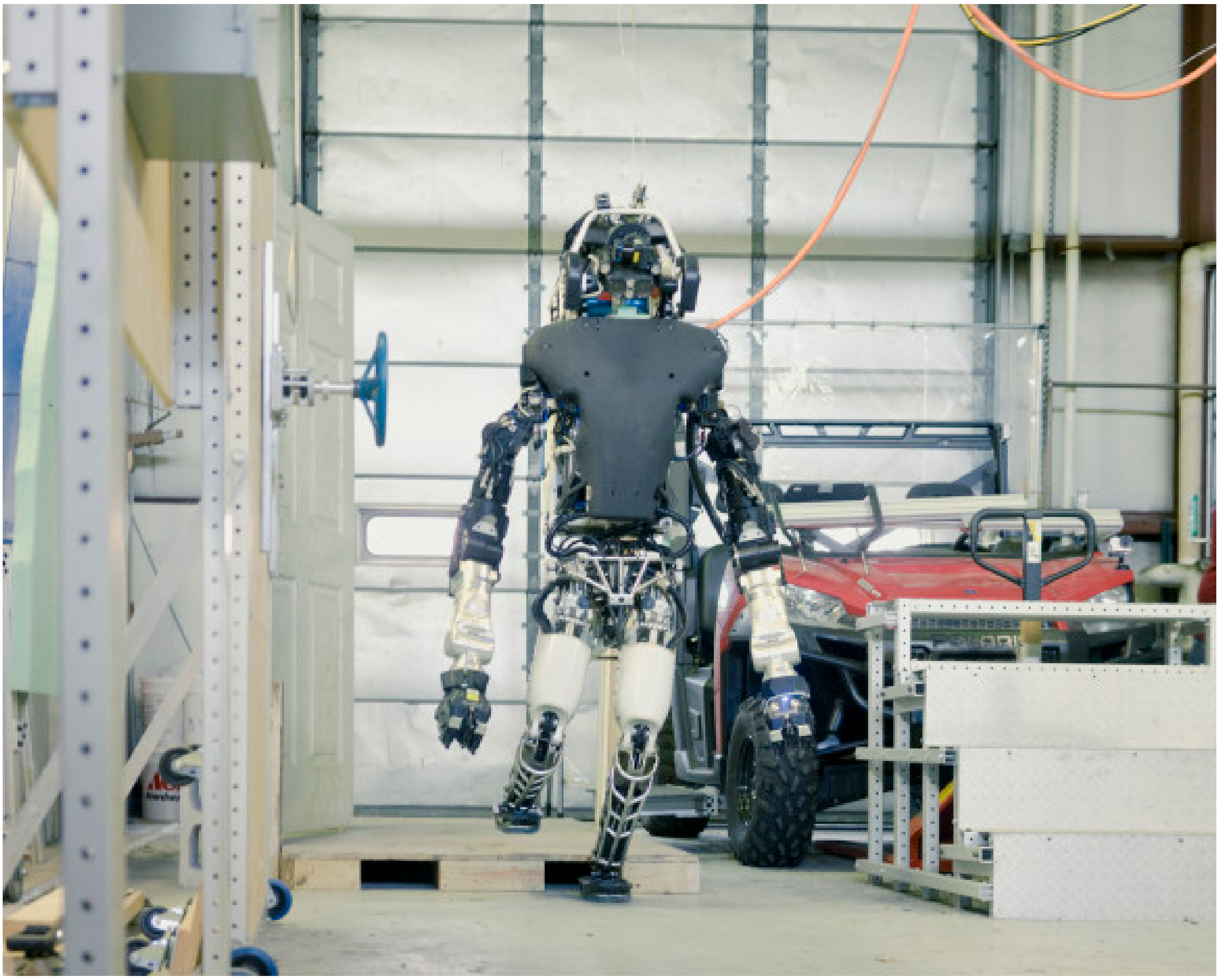
EMILY DREYFUSS 05.21.15 9:30 AM

MIT'S HUMANOID ROBOT GOES TO ROBO BOOT CAMP



HARRY GOULD HARVEY IV/WIRED

AS RUSS TEDRAKE flings up the garage door to the dusty MIT lab, light whooshes in, revealing a 360-pound humanoid robot hanging from a rope. The hulky human form sways as the Cambridge breeze blows into the room.

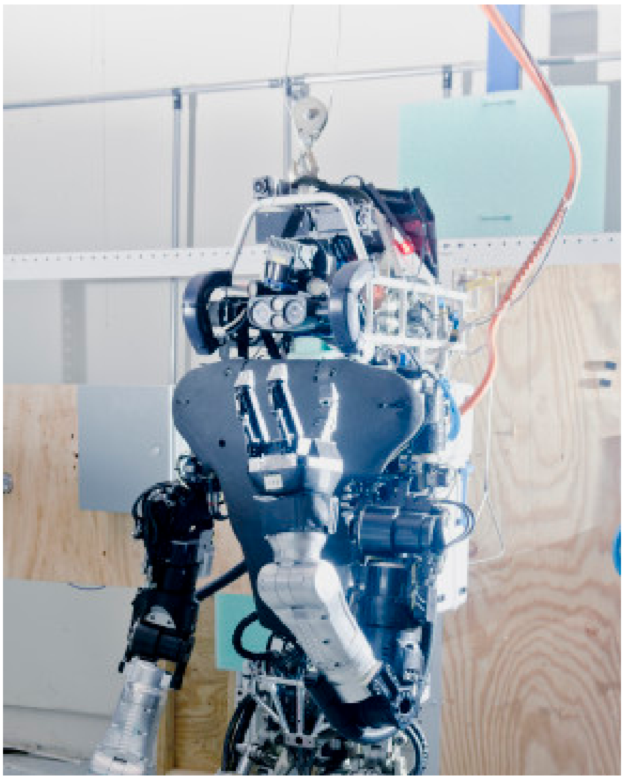
The deactivated dangling thing looks like a metal rag doll, vulnerable and grotesque. But this is Atlas, one of the most sophisticated robots in the world. “The control system for a fighter jet is way simpler than this,” says Tedrake, leader of the Atlas team at MIT’s Computer Science and Artificial Intelligence Laboratory.

As one of the Darpa Robotics Challenge’s 25 robot finalists, Atlas will be representing Tedrake’s team at the 2015 challenge in Pomona, California in two weeks. Its purpose in life—along with the other finalists—is to be the best search-and-rescue robot possible. In terrain too dangerous for humans to traverse, a robot that can lift hundreds of pounds and work power tools could save lives without endangering others. The challenge will put those skills to the test.

MIT’s Atlas won’t be the only one with the weight of the world on its shoulders come June. Tedrake’s group is competing against five other Atlases, each running different software and with a few physical modifications to the same body type. Google-owned robotics company Boston Dynamics made Atlas—except for its hands, which come from Robotiq—and donated it to MIT for the competition. In order to win $2 [illegible] n a valve, cut [illegible] averse rocky, [illegible] s to drive a car.

Stage Fright

In a big garage near MIT, three PhD candidates sit at a massive control center, ready to activate their robot: Pat Marion, lead operator; Andres Valenzuela, “wingman;” Greg Izatt “second wingman.” Watching over them is postdoc Scott Kuindersma, aka the “flight director.”



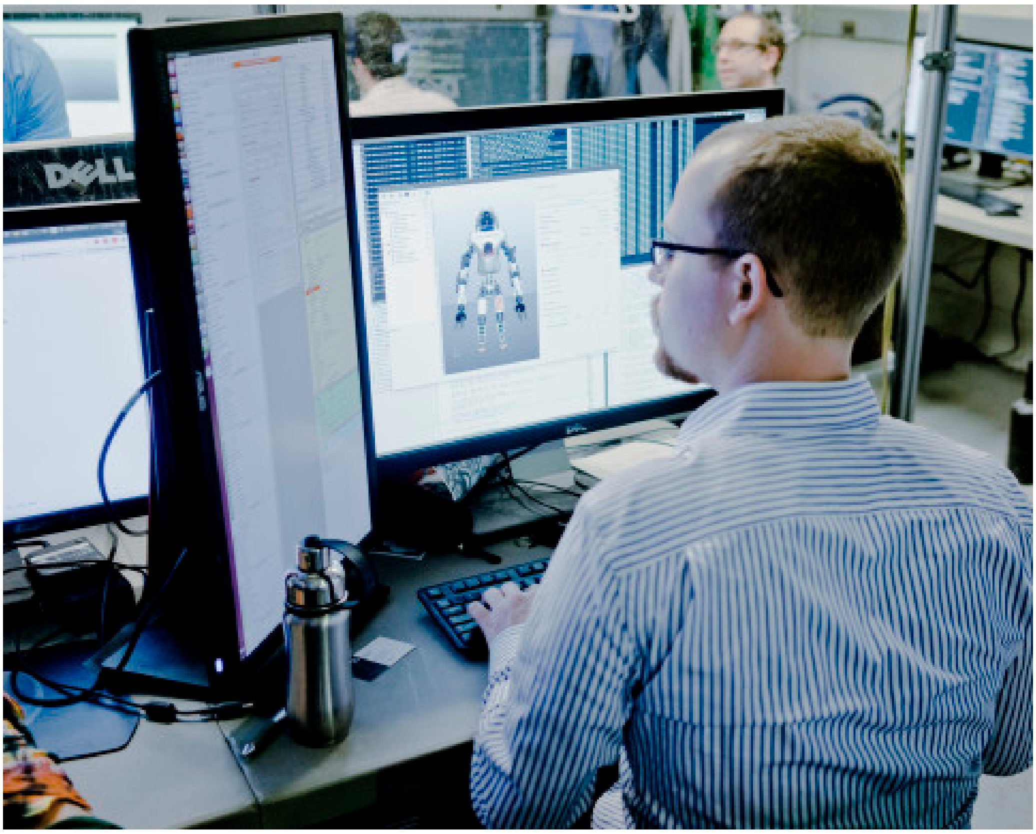
HARRY GOULD HARVEY IV/WIRED

On their screens they can see Atlas and what Atlas sees. But they can't see the robot. It's behind a closed door across the room, tied to cables that'll catch it if it falls. Atlas' first task at the challenge and in this demo is to open that door. Tedrake explains that they have moved the location of the handle since the last test: The team only has one week left to test every possible problem that Atlas could encounter during the challenge.

If the humans were controlling Atlas directly from the command center, this would be no big deal, but the MIT team designed for autonomy. So they don't have a joystick that would make the robot open the door. All the team can do is send their robot the command to find the handle and open it. It's up to the robot's software to figure out how.

This proves difficult. What Tedrake says normally takes Atlas a few minutes now takes ten. "The robot got camera shy," Tedrake jokes. First, things are fine. The robot sees the handle and sends the team in the back a projected route of attack, suggesting it move its left hand to the handle, grasp, and then pull. "Looks good," Marion says. He OKs the move.

Atlas reaches for the handle with a claw-like hand but misses, grasping at air.



HARRY GOULD HARVEY IV/WIRED

The team starts over, telling Atlas to reset. But this time it exerts too much force. Sensors in the feet pick up backward movement—the robot is pushing so hard on the closed door that it's pushing itself away from it. As the team tries to adjust, a loud noise erupts from behind the still-closed door. On screen, the robot is shaking. Almost in unison, the PhD students and post-docs running the controls yell, "Recover button, now!"

Marion types a fast command into his keyboard and the robot goes still. If he hadn't shut down in time the robot would have fallen.

On the third try, Atlas grasps the handle and pushes through the door. Everyone exhales.

Autonomy

The MIT team members don't know how their software will compare with what the other five Atlas teams are running, but they are banking on one advantage: autonomy. Yes, the same thing that just left their robot scratching its head at a doorknob for ten minutes.

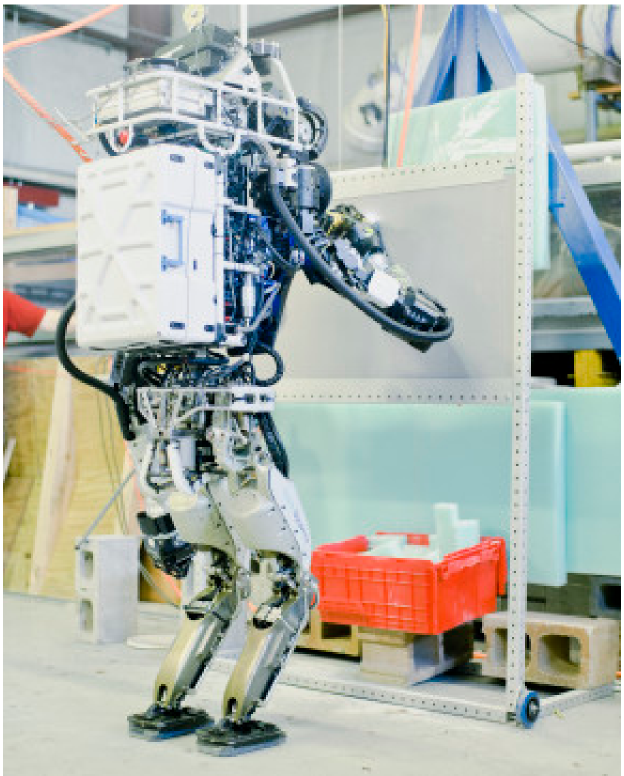
Eventually the MIT Atlas demos all the tasks (except driving, because Cambridge law forbids a robot from getting behind the wheel). It turns a valve. It uses a power drill to cut a hole in drywall, which looks disconcertingly like Atlas is wielding a large-caliber gun. It even handles a surprise task: walking over to a table and picking up a phone. That's harder than it sounds. The robot has to turn around and look for an object. Its sensors pick up something where moments before there was nothing. The question is, what is it?

"The robot sees abstract points," Tedrake explains. "The human operator helps by defining them." What this looks like on the screen is a bunch of pixels in a vaguely table-shaped agglomeration. Marion and Valenzuela try to make sense of them; once they think they know what they are looking at, they pick from a materials list in their controls and overlay geometric shapes of "lumber" or "plastic" on top of the object. Though the robot has never seen a phone before, the team is able to tell it where the receiver is. In less than three minutes, Atlas is standing before us pretending to talk on the telephone. It brings the receiver up to its "head" and poses for photos.

Autonomy, then, seems to be paying off. Part of the task will involve rolling blackouts; for some period of time the robots won't have contact with their human operators. For robots that are entirely dependent on teleoperation, this will mean crucial lost time. In theory, MIT's Atlas will just keep on trying to execute its most recent command—drill a hole, pick up that telephone receiver. So the team is hoping that even if other teams beat them on other counts—like stability, which apparently is a challenge even when Atlas is opening a door—they'll win by navigating the blackouts.

Stability

But that lack of stability is a serious problem for Atlas and other bipedal robots. Think how long it takes a human to learn to walk—even Isaac Asimov, great teller of robot tales, warned that the "controlled imbalance" of two-legged locomotion would be a real challenge for robotics. And it is. In competition, there won't be any safety ropes. If Atlas falls? "We don't think in the real competition we'll survive a fall," Tedrake says. "One thing we haven't done is get back up from a fall. The robot is capable of it, but we decided to spend our effort trying not to fall."



HARRY GOULD HARVEY IV/WIRED

This is an incredibly risky move. A fall will force Atlas to leave the testing area, recalibrate, and then come back to finish the tasks. Without a protective exoskeleton, Atlases are vulnerable to injury; some of the other teams have robots with wheels instead of legs. Look at it this way: Who's more stable, R2-D2 or C-3PO?

And that could stand in the way of Atlas' performance at the finals. The only task left on the punch list is walking up stairs. Tedrake and his team designed their software to let Atlas climb a ladder, but DARPA changed the rules. Honestly, Tedrake admits, if he'd known it was going to be stairs and that the rocky-terrain task was optional, he might have put wheels on the thing. Legs are Atlas's biggest liability.

And they prove it as soon as the robot attempts to take a first step.

Here's what happens: Atlas approaches the set of three steps confidently. In the back of the room, its three human operators prepare to ascend. Marion helps Atlas understand where exactly the stairs are by taking its abstract data points and defining it as a concrete object. Valenzuela uses Atlas' sensors to make sure they are approaching the steps from the right height. Izatt verifies that everything lines up. Marion places potential foothold positions on the robot's internal map of the stairs. The robot sends Marion an animation of the route it plans to take, and the team OK's it. Atlas lifts its leg and begins to shift its weight forward.

Boom. Crash. On the screen, Atlas crumples and rolls down the stairs. Tedrake, watching the robot at the steps, sees it happen. "He hit his shin!" he calls out. From its splayed position on the stairway, the support wires snap Atlas into hanging position.

The team huddles; what happened? The stairs were patterned. Atlas was in a good starting position.

Ah. The footholds were wrong. The team told Atlas to put its feet too close to the edge of each step.

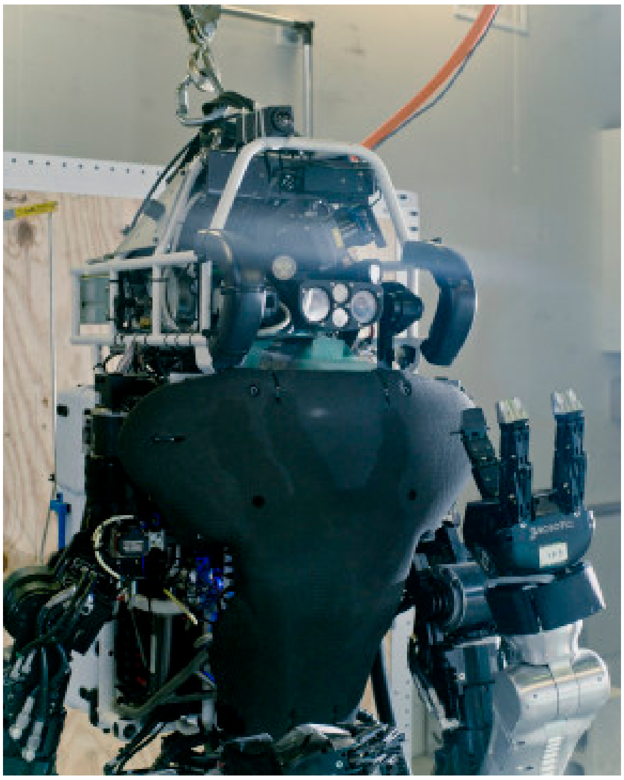
"This is the worst walking we've seen," Tedrake says later. The problem? Atlas has a bum hip. The news comes in from Boston Dynamics in the middle of the demo. Earlier in the day the team sent some readings; Atlas' maker assures the engineers that they'll spring for a full hip replacement before competition on June 5.

So sure, all of Atlas' parts will be in perfect order before it tries to turn its first valve. Though this is comforting, other realities of the competition are not: On game day, Atlas will have to run on battery power alone. The team has only seen Atlas run on batteries for one hour so far. They have no idea how long it will be able to last.

The Right Problem

The idea behind Atlas' humanoid design is that a robot trying to navigate a world built by and for humans should probably be human-shaped. If, for instance, the robot was going to go into a nuclear plant to stave off a meltdown, doesn't it make sense for the robot to be human height and have human-like appendages, since all the buttons and tools it will need to interact with were built for us?

Maybe. "I won't sell you on that," Tedrake says. Track wheels would be more stable than legs, for example. "It lumbers around so awkwardly, while we humans move so ably. Biology has some control solutions that far exceed what our technology can yet do." In a way, that's the beauty of the challenge.



HARRY GOULD HARVEY IV/WIRED

“I find myself feeling sorry for the robot sometimes,” Valenzuela says when the tests are over. Valenzuela has a four-month old son, and in some ways his child is much more advanced than Atlas. Even though Atlas can walk and his son cannot, and even though Atlas can drive a car and his son won’t be able to do that for 16 more years, his son can recognize objects without any help. Atlas uses lasers and cameras to survey its surroundings—arguably cooler than a four-month-old—but it needs its human operators to explain what that data means.

In a few days, Atlas will get packed onto the back of a truck and shipped to California. Its humans will join it a week before the competition. For now, though, Atlas is hanging snugly from his noose, limp.

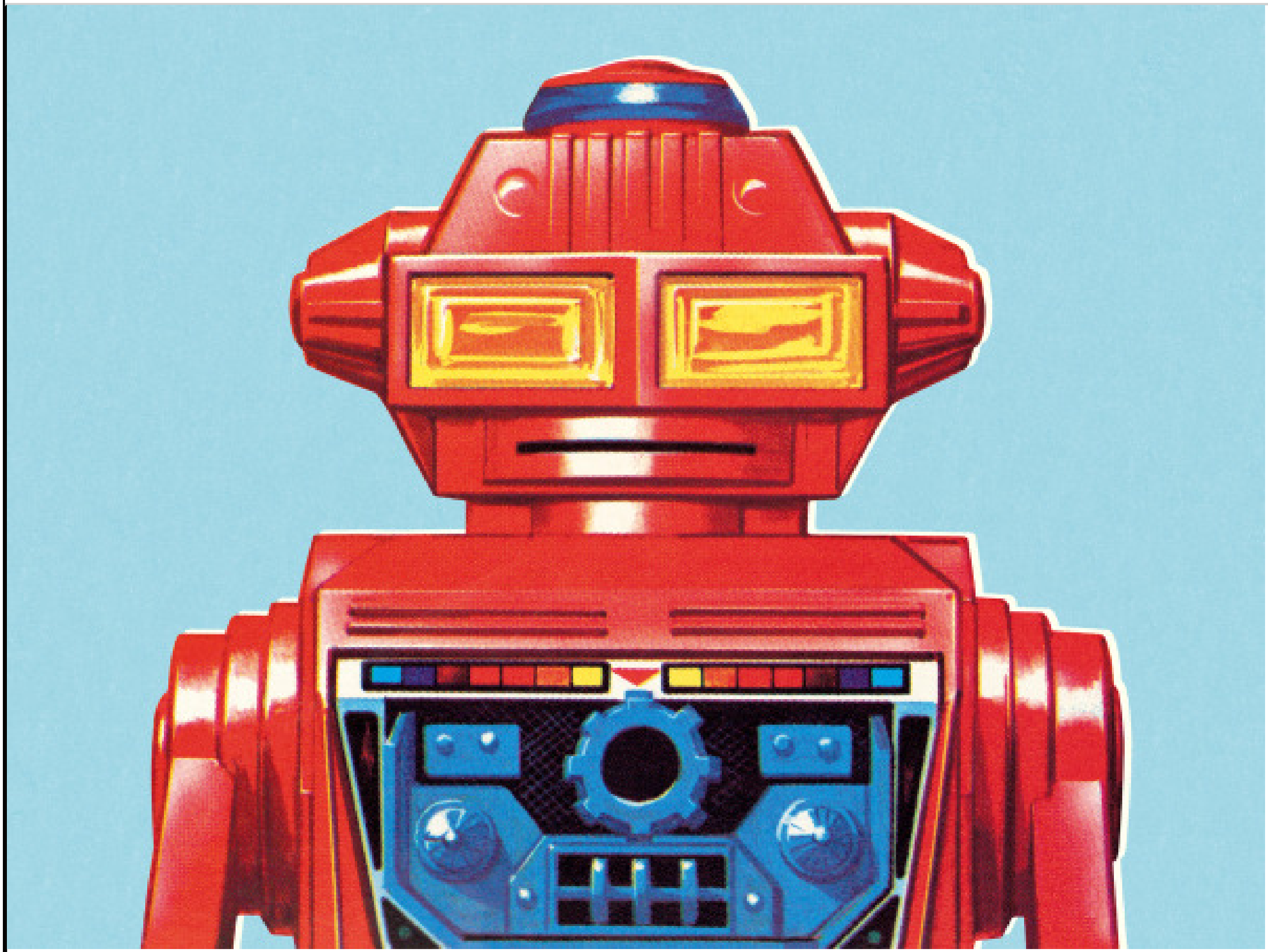
“Do you ever feel like when he falls, you fall?” I ask.

“I felt a bit like that today,” Tedrake says. Next week, there will be no support wires to keep the robot from falling. It’ll have to walk on its own two feet.

#ATLAS #BOSTON DYNAMICS #DARPA ROBOTICS CHALLENGE #MIT #ROBOTS #SCIENCE

VIEW COMMENTS

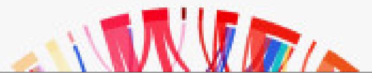
MORE SCIENCE

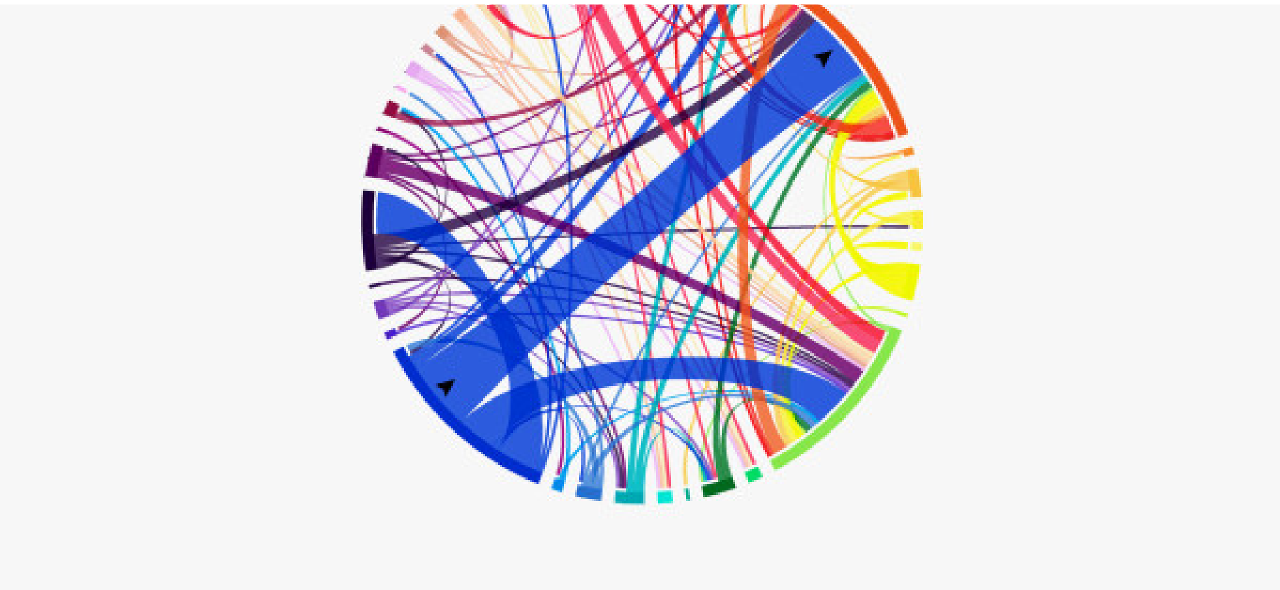


SCIENCE BLOGS

***Rise of the Robots*: How Far Will They Go?**

11 HOURS

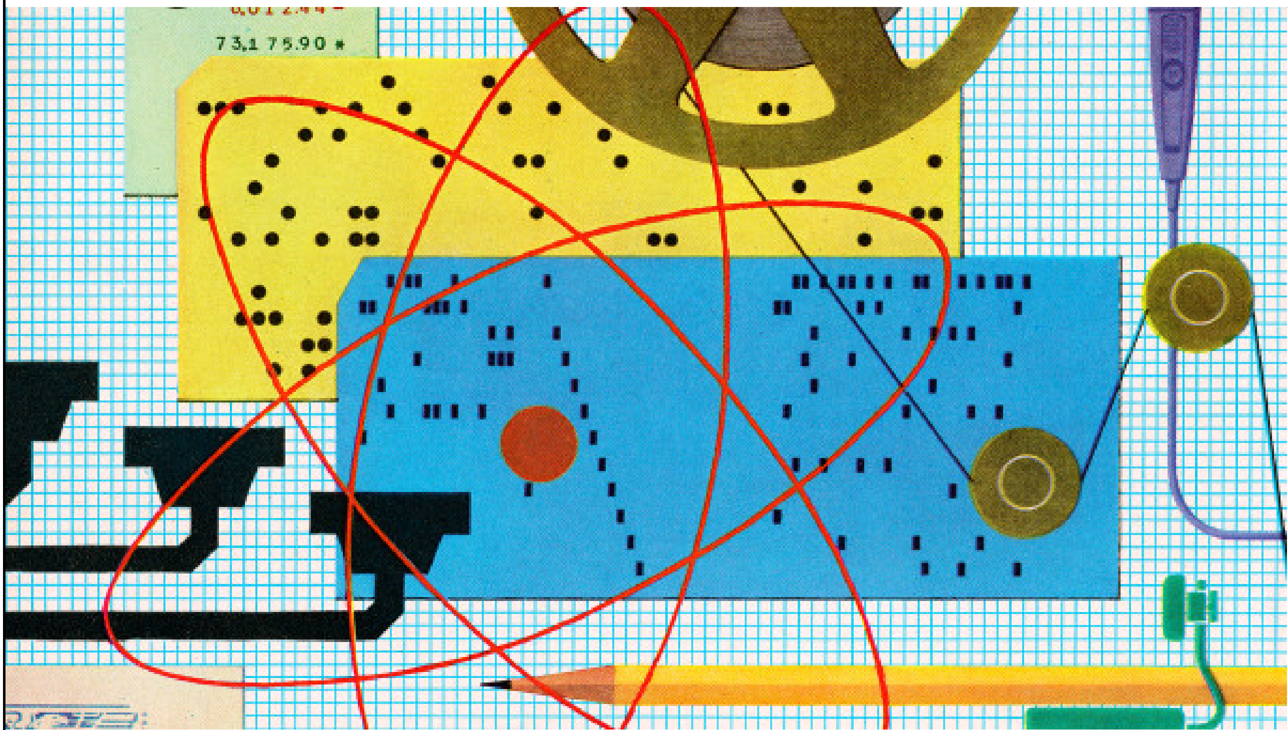




DATA

Using News Reports to Track Wildlife Black Markets

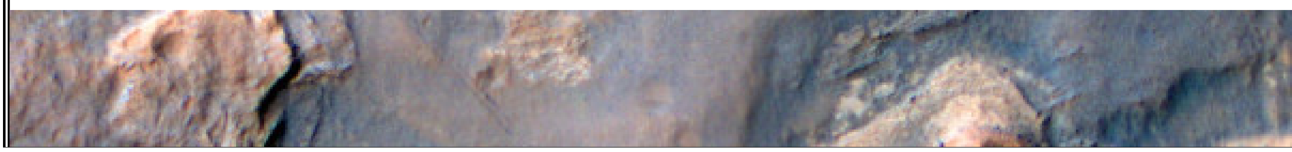
13 HOURS



RESEARCH

The Web Will Either Kill Science Journals or Save Them

22 HOURS



SPACE

These Amateur Maps of the Curiosity Rover Rival NASA's

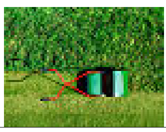
22 HOURS

PHYSICS

A Private View of Quantum Reality

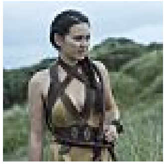
2 DAYS

WE RECOMMEND



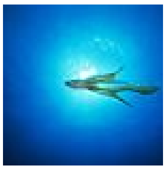
DAVEY ALBA

The Roomba for Lawns Is Really Pissing Off Astronomers



LAURA HUDSON

Game of Thrones Recap: The Rise of the Sand Snakes



MATT SIMON

Absurd Creature of the Week: The Octopus That's Pretty Much Just a Swimming Blanket

BRIAN BARRETT

Longer-Lasting Batteries Are Almost Here (Really!)

FOLLOW US ON YOUTUBE

Don't miss out on WIRED's latest videos.

FOLLOW

SUBSCRIBE

ADVERTISE

SITE MAP

PRESS CENTER

FAQ

CUSTOMER CARE

CONTACT US

NEWSLETTER

WIRED STAFF

JOBS

RSS