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This robotic hand learned to solve a Rubik's Cube on its own

By Peter Holley, Washington Post on 01.07.20

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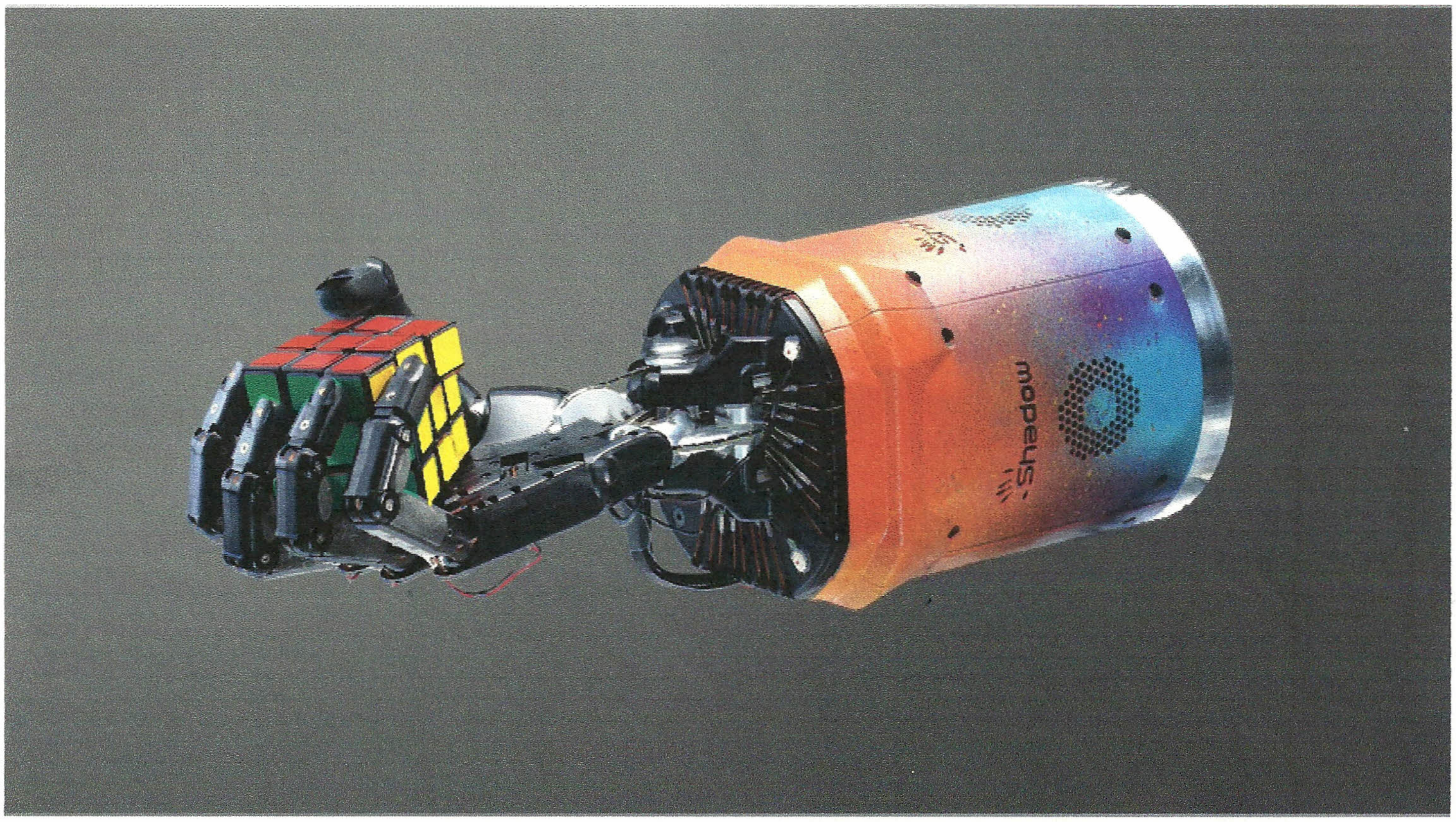


Image 1. This robotic hand learned to solve a Rubik's Cube on its own — just like a human. Photo courtesy: OpenAI/The Washington Post

Solving a Rubik's Cube is hard enough for most people.

Solving a Rubik's Cube with one hand is even harder.

Harder still: designing a lone robot hand capable of solving a Rubik's Cube all by itself. Such a machine would require unprecedented dexterity and coordinated finger joint movements, as well as the ability to learn a new task over time and independently the way a human would.

This week, researchers at OpenAI — a well-known San Francisco-based research lab focused on developing benevolent artificial intelligence — announced that they'd done just that, setting a new robotics benchmark in an era of increasingly sophisticated, intelligent machines.

In a statement hailing their achievement, researchers said the robotic hand, which they've dubbed "Dactyl," moves robots one step closer to "human-level dexterity."

"Solving a Rubik's Cube requires unprecedented dexterity and the ability to execute flawlessly or recover from mistakes successfully for a long period of time," the statement said. "Even for humans, solving a Rubik's Cube one-handed is no simple task — there are 43,252,003,274,489,856,000 ways to scramble a Rubik's Cube."

With this result, the statement added, researchers move closer to creating "general purpose robots with a technique that should allow for robustly solving any simulatable dexterous tasks."

The multicolored, 3-D puzzles have befuddled game-playing humans since the 1970s, but Rubik's Cubes have more recently proved a useful tool for measuring the capabilities of artificial intelligence.

One reason, researchers say: there are billions of potential moves available to a Rubik's Cube player, with the puzzle's six sides and nine sections, but only one goal: each of the cube's six sides displaying a solid color. Finding a solution to a puzzle with that degree of complexity, and among billions of potentialities, involves a degree of abstract thinking that, researchers say, begins to approximate human reasoning and decision-making.

For years now, researchers have been programming robots to solve Rubik's Cubes as quickly as possible. But more recently, they've begun prioritizing self-learning over speed. In July, the University of California at Irvine announced that an artificial intelligence system solved a Rubik's Cube in just over a second, besting the current human world record by more than two seconds.

The system, known as DeepCubeA — a reinforcement-learning algorithm programmed by UCI computer scientists and mathematicians — solved the puzzle without prior knowledge of the game or coaching from its human handlers, according to the university.

Highly skilled humans are able to tackle a Rubik's Cube in about 50 moves, but the AI system is able to solve the cube in about 20 moves, usually in the minimum number of steps possible, researchers said.

The UCI algorithm relies on a neural network — a set of algorithms designed to find underlying relationships by mimicking how the human brain processes information. The algorithm also relied on machine learning techniques, a system that allows AI to learn by identifying patterns and using inference with minimal human intervention.

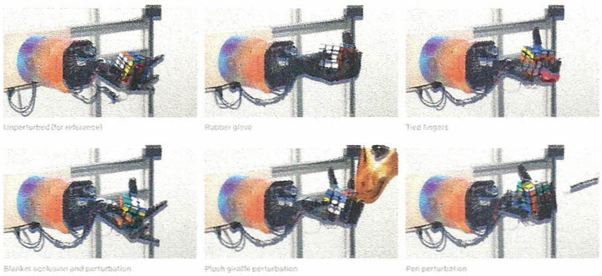
To prepare Dactyl for Rubik's Cube success, OpenAI's researchers say they didn't "explicitly program" the machine to solve the puzzle. Instead, the robot was trained using virtual simulations before it was presented with challenges in the physical world that tested its ability to learn.

The goal, researchers say, was to create a robot that learns the way humans do — through trial and error. Eventually, those robots could be used to complete tasks — in a warehouse or perhaps on the surface of a new planet — with more autonomy. Before it could solve the puzzle, Dactyl was forced to learn how to hold and move the cube on its own. As Dactyl improved at each stage of learning, its algorithm growing more adept, the challenges intensified.

"For example," researchers said, "we put a rubber glove on the hand, we tied some of its fingers together, we used a blanket to occlude and perturb the hand, and we poked the Rubik's Cube with different objects all while it continued to try to solve the Rubik's Cube," the researchers said.

The system had never seen anything similar to these situations during training, researchers added.

OpenAI posted a video on YouTube showing Dactyl at various points in the robot's training arc. The video captures the machine learning from scratch as it awkwardly fumbles with a Rubik's Cube and later handling the puzzle with much more control and precision.



The video's narrator says Dactyl's accomplishment could also change how researchers view training general purpose robots. Instead of thinking about creating complex algorithms for different environments, the narrator says, roboticists can instead focus on designing complex scenarios in which the machines can learn.

"At some point," the narrator adds, "then it would be more down to the imagination what robots could actually accomplish."

"The hope is to build robots that can do many different tasks to increase the standard of living and give everybody a better life," the narrator adds.

Quiz

1 Which of the following sentences from the article BEST develops a central idea of the article?

(A) "Even for humans, solving a Rubik's Cube one-handed is no simple task — there are 43,252,003,274,489,856,000 ways to scramble a Rubik's Cube."

(B) With this result, the statement added, researchers move closer to creating "general purpose robots with a technique that should allow for robustly solving any simulatable dexterous tasks."

(C) One reason, researchers say: there are billions of potential moves available to a Rubik's Cube player, with the puzzle's six sides and nine sections, but only one goal: each of the cube's six sides displaying a solid color.

(D) The UCI algorithm relies on a neural network — a set of algorithms designed to find underlying relationships by mimicking how the human brain processes information.

2 OpenAI's Dactyl solved the Rubik's Cube by learning to think the way a human would.

Which two details BEST support the central idea above?

1. *In July, the University of California at Irvine announced that an artificial intelligence system solved a Rubik's Cube in just over a second, besting the current human world record by more than two seconds.*
2. *Highly skilled humans are able to tackle a Rubik's Cube in about 50 moves, but the AI system is able to solve the cube in about 20 moves, usually in the minimum number of steps possible, researchers said.*
3. *Before it could solve the puzzle, Dactyl was forced to learn how to hold and move the cube on its own. As Dactyl improved at each stage of learning, its algorithm growing more adept, the challenges intensified.*
4. *The video captures the machine learning from scratch as it awkwardly fumbles with a Rubik's Cube and later handling the puzzle with much more control and precision.*

(A) 1 and 2

(B) 1 and 3

(C) 2 and 4

(D) 3 and 4

3 Why did the author conclude the article by quoting the narrator from the Dactyl YouTube video?

(A) to highlight some of the ways that Dactyl could change robotics and robotics research

(B) to demonstrate how OpenAI's Dactyl is different from UCI's DeepCubeA

(C) to highlight some of the challenges that Dactyl might encounter in the future

(D) to demonstrate how popular Dactyl's accomplishment became on the internet

4 Which of the following statements BEST represents OpenAI's approach toward training Dactyl?

(A) OpenAI wanted Dactyl to focus on calculations that identify patterns and use minimal human intervention.

(B) OpenAI wanted Dactyl to self-learn by giving the robot several different challenging scenarios to overcome.

(C) OpenAI wanted Dactyl to be a robot that can solve a Rubik's Cube faster than a human could.

(D) OpenAI wanted Dactyl to have agile finger movement and rely on reinforcement-learning algorithms.