

# Robots at your service

## ASU researchers are helping robots learn everyday tasks

By Penny Walker, ASU News  
May 23, 2025

**Editor's note:** This story was featured in the [summer 2025 issue of ASU Thrive](#).

By Daniel Oberhaus

Over the past decade, robots have become an increasingly important part of our daily lives. Autonomous vehicles shuttle us from point A to point B, drones deliver lifesaving medicine to remote towns, sidewalk robots deliver groceries, industrial robots package online orders and robotic surgeons perform lifesaving operations. These are specialized use cases, but each represents an important step toward general-purpose robots that can coexist with us in the most intimate of settings: our own homes.

For roboticists like [Nakul Gopalan](#), an assistant professor in the School of Computing and Augmented Intelligence — one of the largest computer science programs in the country and home to 1 in 12 Arizona State University students — the challenge of building an automaton that is safe and effective enough for domestic use is something of a final frontier that makes freeway driving feel tame by comparison.

“Every factory floor is precisely measured for automation so that a robot can assemble objects with millimeter precision on the assembly line,” Gopalan says. “But inside our houses, there’s no precise location for anything — objects move, and there is visual clutter everywhere. If I ask a robot to grab an object that has moved or is hidden behind other objects, it’s just going to break things.”

Although millions of Americans already cohabit with robotic vacuum cleaners, what Gopalan is imagining is something closer to Rosie out of “The Jetsons”: a general-purpose bot that can safely and reliably help with a variety of domestic tasks. It may sound whimsical, but the robots being developed by Gopalan and his collaborators are designed to address an acute problem: the lack of caretakers for a rapidly aging global population.

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[u](#).

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### Alfred, a butler

Even if a robot is able to learn by example, there is still the challenge of how to tell the robot what, exactly, you’d like it to do. Today, robots are programmed by specialist software engineers who are fluent in computer code. But less than 1% of people know how to write code, which means that any general-purpose robot in the home is going to need to learn how to speak our language.

And this, says [Siddharth Srivastava](#), an associate professor of computer science and engineering in the Ira A. Fulton Schools of Engineering and director of the Autonomous Agents and Intelligent Robots Lab, is more challenging than it first appears because it requires teaching robots how to generalize across situations.

Consider something as simple as asking a robot to make a cup of coffee. For a human, we interpret the task the same way each time we make it. It doesn't matter if the beans were in a cupboard before and today they were on the counter.

But for a robot, if you change any element, it is the equivalent of learning a brand-new task because the robot does not have general concepts for relationships such as "the container that has coffee beans" and the "location of the coffee mug," and for acts such as "pour," "pickup" or "place." It doesn't help that from the robot's perspective, making coffee appears to be one cohesive sequence of motions and not individual steps.

To overcome this problem, Srivastava and his colleagues designed a method that allows robots to "invent" their own logical concepts with clear meanings in the real world.

Their prototype robot, Alfred, is able to develop concepts like "placement" that allow it to set a dinner table without being shown how. But this capability destines Alfred to be more than a robotic busser; it opens a path to a truly generalizable robot. The way it learns can be applied to chores that are dangerous or unpleasant, like folding laundry or delivering medicine in a hospital.

Getting Alfred to accomplish these types of jobs reliably every time is the next step, Srivastava says.

## The robotic prosthesis

At ASU, Associate Professor [Heni Ben Amor](#) successfully built a basketball-playing robot that was able to teach itself how to shoot hoops in a matter of a few hours. After this achievement, Google invited him to work with DeepMind, one of Google's AI divisions, in 2023, for his sabbatical, to [build the world's best table tennis robot](#).

While Ben Amor's robots may seem like novelties, they are a test bed for robots that can react fast enough to keep up with humans — a critical prerequisite for living side by side with them in our daily lives.

Table tennis, which requires split-second decisions involving complex, real-world physics, is the perfect test case. The team adapted the techniques behind the table tennis and basketball robots to create a prosthetic limb for people with lower-leg amputations. This impacts real lives, as each day, around 400 people in the U.S. undergo a lower-extremity amputation because of medical issues such as diabetes or trauma.

The problem is that modern prosthetics aren't able to adapt to the individual's locomotion and gait.

Ben Amor's smart prosthesis minimizes musculoskeletal stress on the wearer by adapting to their gait and the terrain in real time.

The team patented its prosthetic in 2024 and has been working with Mayo Clinic and a local startup called SpringActive to bring the technology out of the lab and into the real world.

## Nanny Ogg, a sandwich maker

By 2050, projections indicate that there will be just one working person for every two people over the age of 65, which will result in an acute lack of caretakers for our rapidly aging population. Robots can help fill this gap by taking over critical caretaking tasks such as meal preparation that will allow seniors to age in place.

For the past year, Gopalan and his team have been working on this problem by inviting people into their lab to teach Nanny Ogg — a robotic arm suspended from the ceiling — how to make a sandwich using a specialized joystick to cut cheese, slice bread and spread butter using the robotic arm.

“Applying butter on bread is actually pretty hard if you think about it because the knife has to make contact with the bread and you have to make sure the butter sticks to the bread,” Gopalan says. “Humans do it with a lot of visual and tactile information, but right now a robot has to do it with only visual information.”

The key, Gopalan says, is ensuring the robot can learn how to prepare new recipes from limited examples. Today, most robots are hard-coded with instructions in advance by specialist software engineers. But if Grandma decides she doesn’t want mayo on her sandwich sometimes, the robot needs to be able to adapt to this new instruction from someone who may have never written code or even interacted with a robot.

“In our lab, we want to see how the average person who doesn’t have experience in robotics prefers to teach the robot,” Gopalan says.

Gopalan’s sandwich bot can make recipes with as few as five demonstrations from a non-expert user, but this is just the beginning.

## A robot for everyone

ASU robotics researchers are optimistic that robots able to function more like a personal butler than specialized task-doer will be an integral part of daily life within the next decade.

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## Providing research for the public good

**Safe evacuations.** Researchers at ASU developed a collision-avoidance algorithm for robots and shared it in the public domain. It became the foundation for Pathfinder by the startup Thunderhead Engineering, which simulates how people evacuate buildings so architects can test evacuation strategies in stadiums, skyscrapers and trains before construction begins.

**Space-bound.** NASA’s Jet Propulsion Laboratory and ASU are developing robotic arms for cube-shaped satellites that could autonomously assemble larger structures in space, such as solar arrays and antennas.

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“The work at ASU is very exciting and sort of democratizes robots by allowing everyone — whether a worker in a factory, a nurse in a hospital or someone in their home — to engage with the robot in a safe and meaningful way,” Ben Amor says.

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## About the author

A former staff writer at Wired magazine, David Oberhaus is an ASU alumnus, '15 BA in English (creative writing) and philosophy, and a graduate of Barrett, The Honors College.

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*This story originally appeared on [ASU News](#).*

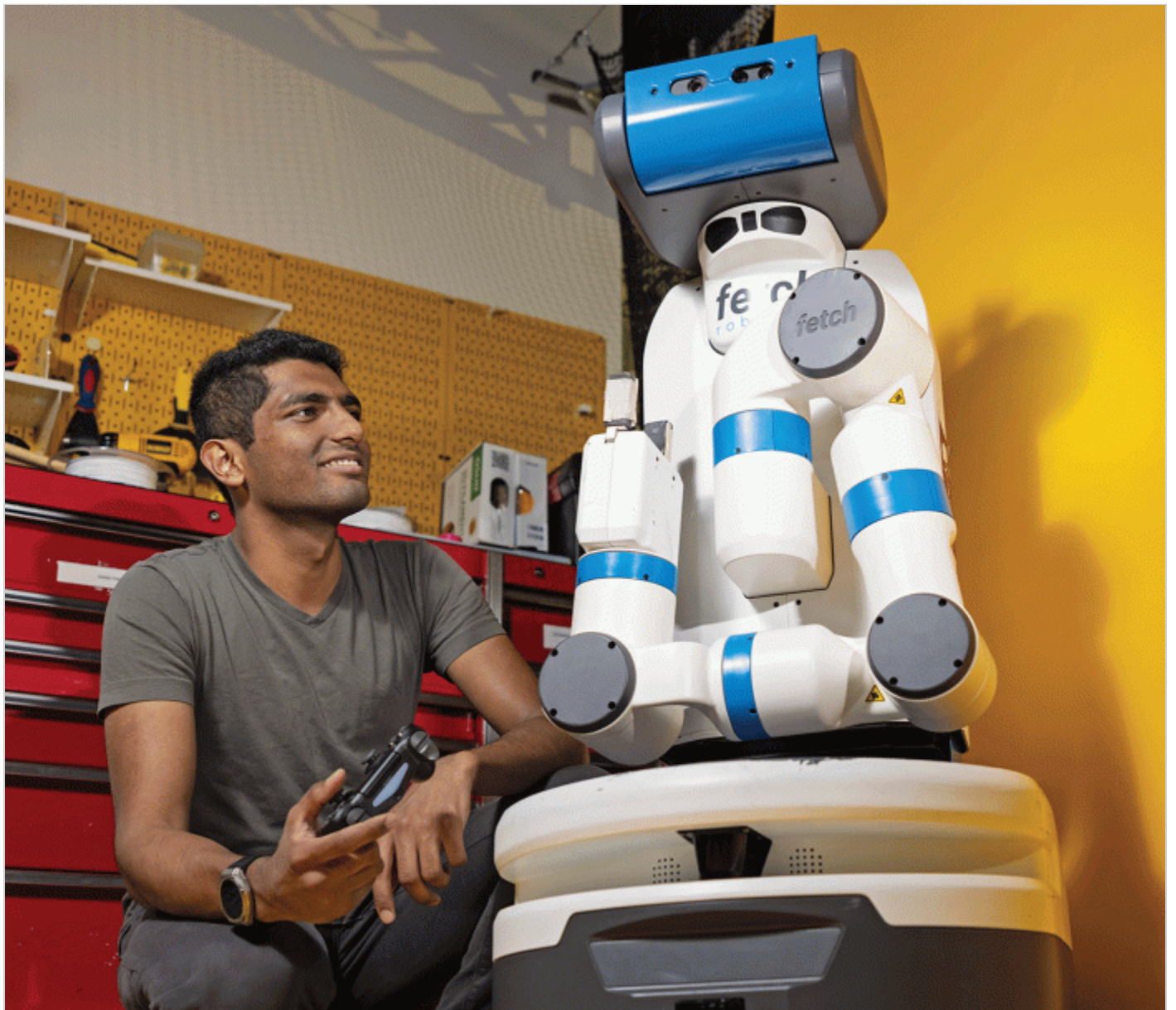
## Main image



Siddharth Srivastava, associate professor in the School of Computing and Augmented Intelligence, with Alfred, the robot butler. Photo by Sabira Madady/ASU

## Text image(s)





Jayesh Nagpal, '24 MS in robotics and autonomous systems and a current graduate student, uses a game controller to move Alfred, the robot. Photo by Sabira Madady/ASU



Heni Ben Amor developed a transformational prosthetic limb that can keep up with the speed of someone walking. Photo by Sabira Madady/ASU



Nakul Gopalan creates robots that can take instruction from everyday people. Photo by Sabira Madady/ASU