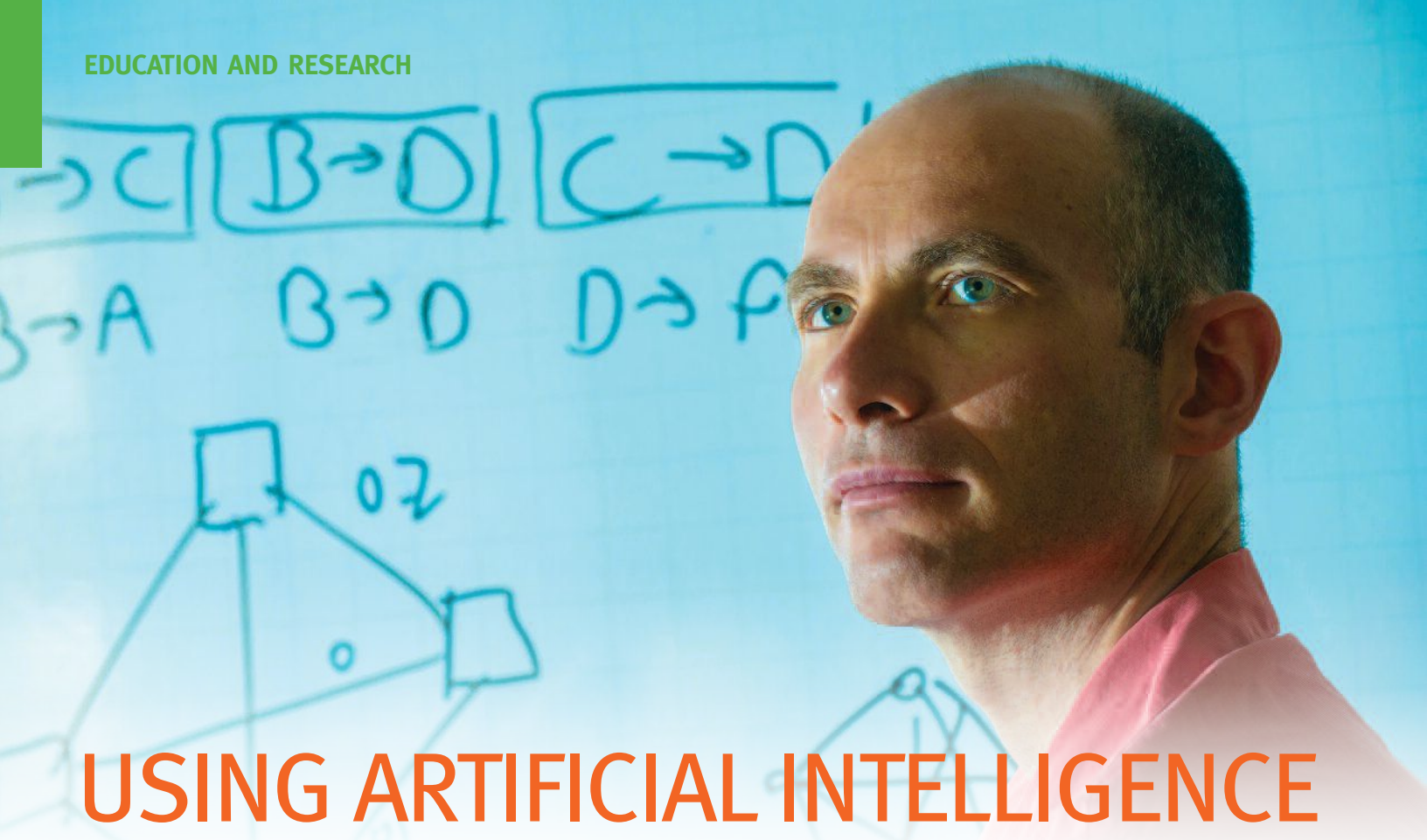


USING ARTIFICIAL INTELLIGENCE IN LEARNING AND RESEARCH

DR. YA'AKOV (KOBI) GAL acknowledges there is a lot in the news these days about the dangers of artificial intelligence and computers capable of learning.

"I think we're safe indefinitely. The future is in building machines that can cooperate with humans and share the problem-solving. We're not trying to build computers that replace or harm people. The future lies not in trying to outwit each other, but in understanding what people can do better and what computers can do better."

Dr. Gal is uniquely positioned to address this issue. From his undergraduate years onward he combined the studies of psychology, computer sciences and statistics. Before joining BGU's Department of Information Systems Engineering in 2010, he spent 10 years at Harvard and MIT, studying artificial intelligence (AI) and integrating it with methods from the learning sciences. He continues to spend his summers at Harvard, collaborating on AI learning research, and heads the Human-Computer Decision-Making Lab at BGU.

> "My dream is to use computer science to help bring the power of technology to promote education in minority communities."
>
> — DR. KOBI GAL

"The first part of my work is finding good problems, which every scientist looks for," he says. 'Good' means 'difficult,' because otherwise it would have already been solved. But I'm not a mathematician solving problems for the sheer joy of it. Solving one also has to make the world a better place. I look for problems that will do this in the space of how people interact with machines."

Israel is an ideal place for this work, Gal says. "We're a small country with many 'good' problems, so it's easy to find a goal and try to make an impact."

Reflecting his multiple interests, Gal aims to augment existing education technology and facilitate learning. One example is building computer tutors that monitor and support collaborative learning.

"We know group learning works much better than individual learning because students help each other identify mistakes and collaborate on problems rather than compete. The future of education is to make it less of a lecture hall and more a marketplace of ideas."

One project, worked on with several colleagues, is to support group learning in Bedouin classrooms. "Minority communities don't have

access to private tutors and expensive accessories," he points out. "And in a class of 40, if you have 10 groups working simultaneously, how can a teacher give feedback to all the groups?

"We try to build computers that act like a friendly parrot sitting on the shoulder. They don't interrupt the learning, but try to identify critical moments, such as when a student has made an important argument, or when the group is off topic. If they're experimenting with a geometry problem, for example, the algorithm may decide to nudge the group forward by inserting an argument or pointing out someone's claim that was overlooked."

The tools are currently used in Jerusalem and Nazareth classrooms, but it's too early to evaluate results, Gal says. With funds from the Treasury Office the team is working on an off-the-shelf product to advance group learning in different countries. "My dream is to use computer science to help bring the power of technology to promote education in minority communities."

The approach can be applied virtually, so students need not be in the same place. An experiment bringing together students in East and West Jerusalem is in the works. "A single street can separate two kids with different lives," Gal observes. "A big problem is to address this lack of integration. If we get Arab and Israeli students to work together—every bit helps."

In his own classrooms, where he teaches AI, probability theory and computer science, Gal centers learning on group interaction and creates environments where "students can think like scientists, create models, run trials, and make mistakes." To actively engage students he uses the "flipped classroom principle," where students study the basic subject matter at home, using online lectures or material, and then experiment together in the classroom.

SUPPORTING CITIZEN SCIENCE

Dr. Gal is also putting his unusual skillset to work in a new sphere that thrills him: citizen science. "Some scientific problems cannot be solved by researchers alone, and require a mass of people to find answers. The idea is that scientists can outsource such problems to motivated volunteers." Thanks to the Internet, this phenomenon has developed on a mass scale. There are at least 40 such projects on today's Worldwide Web.

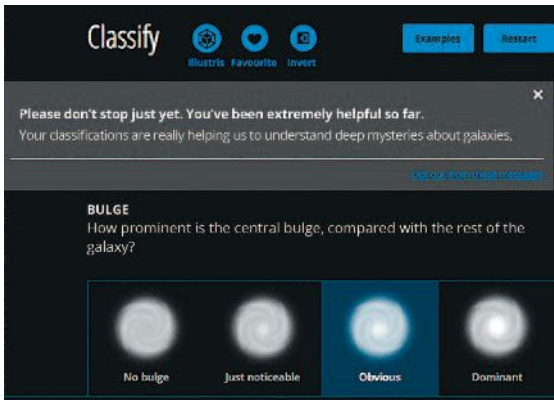
One compelling example is Galaxy Zoo (galaxyzoo.org). Thousands of images of celestial bodies have been taken by the Hubble space telescope and other means, and continue to be taken. However, they can't be computer-classified because the picture quality is too low for computers to discern features automatically, Gal explains. So the images are put online, volunteers see a quick tutorial on how different galaxies look, and proceed to classify the images.

"The big problem is that there is huge dropout," Gal says. "People do three or four classifications, lose motivation, leave, and never come back. Imagine if you could move that distribution to the right a little and keep people for three or four more classifications. A small increase in the classifying done by the average volunteer would have a significant impact on the performance of the overall project."

Gal's team, in collaboration with Microsoft Research in Redmond, Washington, collaborated with Galaxy Zoo to enhance user engagement in the project by combining intervention methods with machine learning. To predict when someone is about to leave a project, the computer looks at the person's history and "dwell time" to make an accurate prediction.

Volunteers were interviewed to help the group understand why they leave. It was found that some stop because they're afraid of making mistakes. Such people get a pop-up message saying in effect, "we use statistical techniques to get the most from every answer so don't worry about being right—just tell us what you see."

The message to a group with a different pattern reinforces how helpful the work is: "You're doing a great job, please stay and help us discover the mysteries of the galaxies." Another stresses community: "You're a part of work that's solving the mysteries of the galaxy!"



Screen shot of Galaxy Zoo message to keep citizen scientists on site longer

A volunteer's work is disrupted only when the computer judges it necessary. Gal found that using the messages randomly does not work. To make a difference, the timing of a message pop-up must be intelligent, appearing at the moment in which the model predicts the user will disengage with the system.

Doing this work at BGU and in Beer-Sheva suits him very well. "I especially like how the campus intertwines with the city itself and is an important component of it. Beer-Sheva's college-town atmosphere is unique in Israel," he says.

Dr. Gal looks forward to BGU's forthcoming connection with the Israeli military units soon to be based near campus, as well as to the adjacent industrial park. As the Negev develops, the region offers more job opportunities, serving as another magnet that draws the best students to the University.

"BGU is a lifeline for the city—the place to be a pioneer." ■