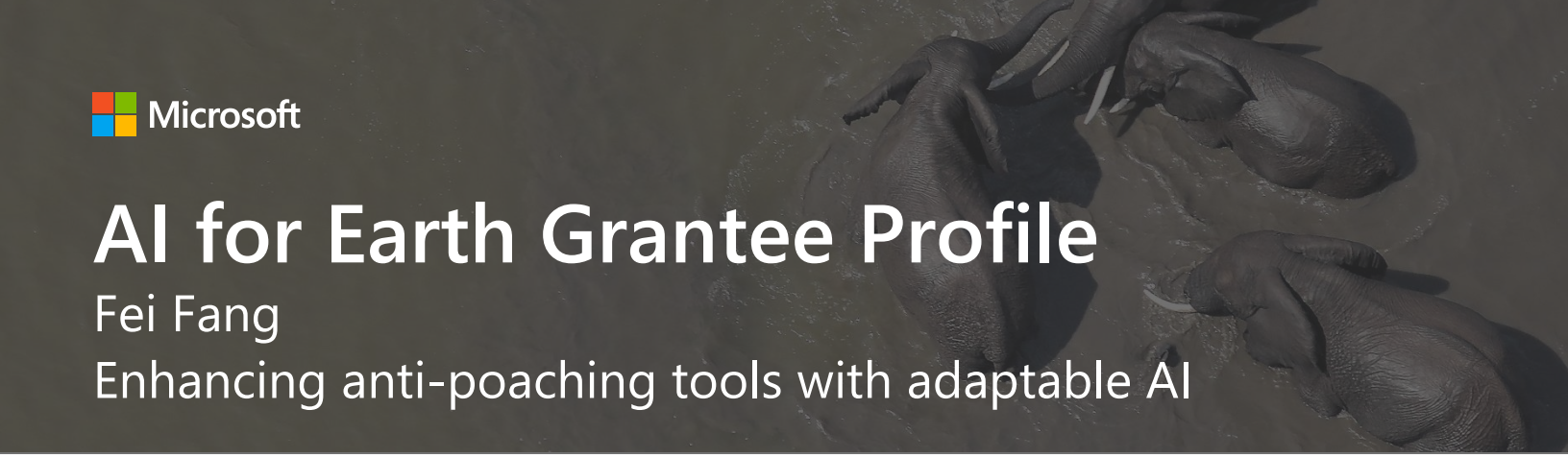

Microsoft

AI for Earth Grantee Profile

Fei Fang

Enhancing anti-poaching tools with adaptable AI

Summary

Poaching is one of the greatest threats to wildlife conservation and is very difficult to prevent. Rangers have had to develop their own skills and intuitions through years of field experience, and they lacked modern technological tools that could help them make better decisions. PAWS, developed by Dr. Fei Fang of Carnegie Mellon University, is an AI tool that uses machine learning and behavior modeling to help rangers plan more effective patrol routines. Through a Microsoft AI for Earth grant, Dr. Fang took the next step in developing PAWS by adding real-time interactive tools that can take new information from the rangers on patrol and offer updated strategies for tracking down poachers.

Countering poaching with adaptable AI

Population drops in key wildlife species are of great concern. They can lead to undesirable consequences, including the breakdown of the local ecosystem. For example, as the apex predators in their environments, tigers play an important role in maintaining a healthy balance in the ecosystem. However, the global tiger population has dropped over 95 percent since 1900 and has resulted in three out of nine species extinctions.

> The global tiger population has dropped over 95 percent in the last century, resulting in three out of nine species extinctions.

Poaching to meet demand for tiger parts used in folk medicine or as status symbols is the most direct threat to tiger populations, which are already under pressure from habitat loss and competition with humans for land use.

Wildlife conservation, including the creation of wildlife refuges and national parks, is intended to help protect and preserve the population of endangered species. Poaching is one of the greatest threats to wildlife conservation—for example, up to 35,000 African elephants were killed in the last year alone, leaving an estimated population of 415,000 in the wild. Poaching is difficult to counter for three reasons:

- Wildlife refuges cover large areas, often with challenging terrain that makes them difficult to patrol. They also have many access points for poachers, from roads and abutting settlements to rivers and lakes.
- Poaching hotspots are not static. Poachers will move in response to patrol activities and routines as well as animal movements. Not only do rangers need to know what areas to patrol, they also need to plan for varying the frequency and routes of patrols so that poachers will be less able to avoid them.
- It's not sufficient to simply follow a route. Poachers will be working off the beaten path, sometimes leaving telltale footprints or markings on trees for their own purposes, and even sometimes attempting to leave false signs or trails to mislead any patrols. The rangers need to recognize signs of poaching activity and decide when to pursue those signs off the path to discover hidden snares or to catch poachers in the act.

Modeling poaching behavior with machine learning

Traditionally, once rangers are out on patrol, they have to rely on their own experience to make decisions in the field. If they see signs of human activity, such as footprints or tree markings, they have to decide whether it's worth further investigating those signs to pursue poachers. Less experienced rangers might simply have no idea what to do. More experienced rangers run the risk of falling into predictable behavior patterns that could help poachers learn to leave better false trails or avoid the rangers.

Until recently, rangers lacked any analytics tools to help them review new information on the spot and decide whether and how to pursue it. This is now changing thanks to the Protection Assistant for Wildlife Security (PAWS) developed by Dr. Fei Fang, an assistant professor at the Carnegie Mellon University (CMU) Institute for Software Research.

PAWS is an artificial intelligence computational tool based on machine learning, game theory, and behavior modeling to help rangers protect wildlife from poaching. Working off historical data on previous patrols and poaching activity collected by rangers, it uses machine learning to create a model of poaching behavior and predict where poachers would place snares. This model is combined with game theory and models of terrain to develop effective patrolling strategies, including recommendations for patrol routes and suggested frequencies for each of the routes.

Development of PAWS has included field testing in Queen Elizabeth National Park in Uganda, in collaboration with the Wildlife Conservation Society and the Uganda Wildlife Authority. PAWS patrols were outputted onto a GPS unit as a series of waypoints. Using the set of waypoints on the GPS as a directional guide, wildlife rangers executed their patrol and searched for signs of illegal activity. Additional deployment and testing has been

done in China and Malaysia, while current work involves collaboration with the World Wildlife Fund for Nature on managing tiger conservation in southeast Asia.

Bringing real-time adaptability to rangers through AI

PAWS lacked real-time interactivity. It could plan out routes ahead of time for rangers to follow, but while on patrol, rangers could not feed new information into the system—such as recent signs of poachers—and receive updated advice on how to modify their patrol. Thanks to a Microsoft AI for Earth grant, Dr. Fang enhanced PAWS with such capability.

> With AI and machine learning, field observations can be used to generate new patrol policies in real time, adapting strategies to the signs of poacher activity.

Developing and training an algorithm to model the behavior of poachers is an intensive process. Creating models to predict poaching hotspots requires a substantial amount of data—signs of animal activity, including which areas show higher levels of activity that would attract poachers; signs of human activity in general, such as footprints or items left behind; signs of poaching activity, such as snares or campsites found, or trees marked; terrain information, from elevation changes to land types and water sources that animals would visit; and locations of rivers, lakes, human settlements, and roads that could provide access points for poachers.

The more types of information collected and the greater the amounts, the more accurate and useful the models can become. Collecting and processing this vast amount of data requires large amounts of storage and computing power—more than is generally available or cost-effective for on-premises servers, especially for the often resource-strapped wildlife conservation and protection organizations in the field.

Through the AI for Earth grant, Microsoft Azure provided the computing resources to produce better patrol strategies for responding to the kinds of human activity signs that rangers encounter in the field. With the advanced AI and deep reinforcement machine learning algorithms on Azure, Dr. Fang created patrol policies that can take into account new observations from the field. And since the tools are cloud-based, the model can be quickly updated and adapt strategies in real time based on the new information.

Going forward

So far, the machine learning algorithms have been used to predict poaching activity on a site-by-site basis. The team will soon have bigger data sets covering multiple conservation sites and hopes to process that data on a larger scale and in more coherent ways. Eventually, this work could lead to a mobile app that advises rangers

during their patrols. At the beginning, they would be advised where to patrol, and then along the way if they observed anything, the app could advise them what to do next, such as whether to follow a footprint or continue the normal patrol route. This is a long-term goal and in the conceptual phase.

About Dr. Fei Fang

Dr. Fei Fang is an assistant professor at the Carnegie Mellon University Institute for Software Research. Before joining CMU, she was a Postdoctoral Fellow at the Center for Research on Computation and Society (CRCS) at Harvard University. Her research is mainly in the field of AI and multi-agent systems, focusing on integrating machine learning and computational game theory to address challenges in security and environmental sustainability. Her work in the field has included development of SPOT (Systematic POacher deTector), an application that uses machine learning to analyze thermal infrared video taken by camera drones in near real time and detect animals and poachers, and development of PAWS.

Resources

Websites

Dr. Fang's faculty page at CMU
Fei Fang home page
PAWS project page at CMU—Societal Computing
AI for Earth

Publications

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