Smartphones to battle crop disease

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EPFL and Penn State University are releasing an unprecedented 50,000 open-access photos of plant diseases. The images will be used to build an app that will turn smartphones into plant doctors, helping growers around the world.

Crop diseases, a major cause of famine, have always been diagnosed by visual inspection, though microscopes and DNA sequencing are also used today. But the first line of defense is still the keen eye of farmers around the world, many of which do not have access to advanced diagnostics and treatment advice. To address this problem, scientists from EPFL and Penn State University are releasing 50,000 open access images of infected and healthy crops. The images will allow machine-learning experts to develop algorithms that automatically diagnose the disease of a crop. The tool will then be put into the hands of farmers - in the form of a smartphone app.

The entire world depends on a stable food supply. Global population is predicted to reach 9 billion by 2050, and the need for food security is becoming increasingly urgent. Meanwhile, crop diseases continue to plague humanity, causing mass starvations. The challenge, then, is to grow enough food while ensuring that we don't lose it to pests and diseases.

The Irish potato famine alone (1845-1847) killed over a million people when the water mold *Phytophthora infestans* caused a blight that decimated the country's crop. Today, the Food and Agriculture Organization of the United Nations estimates that crop disease annually

reduce potential yields by as much as 40%.

Marcel Salathé at EPFL and David Hughes at Penn State University are now fortifying the first line of defense against crop disease by exploiting the ubiquitous smartphone. The scientists are releasing an open-source database containing 50,000 images of infected and diseased plants.

The idea behind the initiative is to provide software developers with the "raw materials" to build machine-learning algorithms. Machine learning is a computational way of detecting patterns in a given dataset in order to make inferences in another, similar dataset. Fueled by breakthroughs in algorithm development, cheap computing, and cheap storage of very large data sets, the results of machine learning have permeated our everyday digital experiences, from face-recognition in photos and videos, to recommender systems in online shops.

What Salathé and Hughes want to do is to apply these techniques that were developed by computer scientists to the problem of recognizing and diagnosing crop diseases. Algorithms with sufficient accuracy will be incorporated into smartphone apps, allowing farmers to snap pictures of their infected crops and get instant diagnosis and treatment advice.

For the two scientists, this is a natural evolution of their website, PlantVillage. PlantVillage is one of the world's largest free libraries of science-based knowledge on plant diseases. It covers 154 types of crops and over 1,800 diseases - and it is still growing. "In addition to being a library, PlantVillage is a network of experts who help people around the world find solutions to their problems," says Marcel Salathé. "Our goal is to let the smartphone do most of the diagnosis, so that human experts can focus on the unusual and difficult cases."

The smartphone app is the next step in this evolution, utilizing the imaging capabilities and connectedness of smartphones to automate the

recognition of plant diseases. "The beauty of the phone is that it penetrates society from community gardens in Brooklyn to smallholder farms in Burkina Faso," says David Hughes. With an expected 5 billion smartphones in the world by 2019, mobile apps have an enormous potential to transform how food is grown.

The bottleneck in the process is training algorithms to recognize diseased and healthy crops. Despite how affordable and accessible digital photography has become, finding enough publicly available images of crop diseases to train algorithms has been impossible until now.

"By providing all these images with open access, we are challenging the global community in two ways," says Hughes. "We are encouraging the crop-health community to share their images of diseased plants, and we are encouraging the machine learning community to help develop accurate algorithms."

"The next step", Salathé adds, "is to combine the enormous expertise in data science around the globe with our open access data sets in the form of online competitions to develop the best algorithms to diagnose plant diseases. In the very near future, we'll launch the first online competition based on this growing data set that we make available today."

"This is a truly exciting venture," says Hughes. "The internet and mobile platforms have transformed many aspects of human society. Through these online competitions and crowdsourcing, we want to transform that cornerstone of human societies - how we grow food."

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