Scientists and engineers constantly face new challenges, despite myriad advances in computing. More sets of data are collected today from earth and sky than there is time or resources available to carefully analyze them. Some problems either don’t have fast algorithms to solve them or have solutions that must be found among millions of options, a situation akin to finding a needle in a haystack.

But all hope is not lost: advances in technology and the Internet have empowered the general public to participate in the scientific process via individual computational resources and brain cognition, which isn’t matched by any machine. Citizen scientists are volunteers who perform scientific work by making observations, collecting and disseminating data, making measurements, and analyzing or interpreting data without necessarily having any scientific training. In so doing, individuals from all over the world can contribute to science in ways that wouldn’t have been otherwise possible.

**The Long and Winding Road**

One of the oldest, yet still active, citizen science projects is the Audubon Society’s Christmas Bird Count, which began in early 1900. In addition to raw data collection or counting, citizen scientists often help detect objects or certain features in data. The SETI Institute (www.seti.org), for example, asks for citizens’ help in finding signals from other living creatures elsewhere in the universe by asking volunteers to...
simply scroll through signals and images, and mark unusual activities and features!

Similarly, astronomers and planetary scientists use various citizen science projects to find planets (Planet Hunters; www.planethunters.org) or classify the surface of the moon (Moon Zoo; www.moonzoo.org) and other galaxies (Galaxy Zoo; www.galaxyzoo.org). Biologists can now analyze more cancer data than ever before (Cell Slider; www.cellslider.net/?utm_source=Zooniverse%20Home&utm_medium=Web&utm_campaign=Homepage%20Catalogue#), study gene function by having the general public track the egg-laying behavior of nematode worms (Worm Watch Lab; www.wormwatchlab.org), and predict protein structure by asking volunteers to play a game (FoldIt; http://fold.it/portal/info/about).

Various projects use the Internet to connect to volunteers’ computers and take advantage of their computing resources (distributed computing). However, some people argue that these projects are in fact more crowdsourcing than citizen science, due to the passive role of participants in the scientific process. A prominent example of such a project is SETI@Home, in which participants’ computers are connected to each other via the Internet to facilitate the Search for Extraterrestrial Intelligence (SETI). Although the challenge for SETI@Home (http://setiathome.ssl.berkeley.edu) is to analyze tremendous amount of telescope radio data, reasons for benefiting from crowdsourcing include finding solutions to problems that require execution of computationally intensive algorithms beyond what a single average machine can provide. The OGR project (www.distributed.net/OGR) is another example: participants provide their computational resources to help search for Optimal Golomb Rulers (OGRs) of different lengths, a difficult optimization problem that has applications in many fields, from crystallography to radar systems.

The US government has recognized the value of citizen science in recent years, and more agencies are benefiting from the general public’s contributions to their missions. In June 2013, the White House’s Office of Science and Technology hosted the Citizen Science Champions of Change event (https://www.whitehouse.gov/champions/citizen-scientists), honoring amateur scientists who conduct scientific work via crowdsourcing and citizen science. This event brought enthusiasts from various agencies and organizations together, many of whom later helped form the Federal Community of Practice for Crowdsourcing and Citizen Science (http://www2.epa.gov/innovation/federal-community-practice-crowdsourcing-and-citizen-science). The FPCCS “meets monthly to share lessons learned and develop best practices for designing, implementing, and evaluating crowdsourcing and citizen science initiatives.” One of the main initiatives it’s currently working on is the development of a citizen science and crowdsourcing toolkit for the federal government (https://www.whitehouse.gov/blog/2014/12/02/designing-citizen-science-and-crowdsourcing-toolkit-federal-government). The US administration, like many other scientists and organizations across the globe, views citizen science as a powerful tool, not only for advancing scientific research but also for inspiring and promoting education in science, technology, engineering, and mathematics (STEM).

Citizen science impacts go beyond the contributions made to different scientific fields of study—they also include contributions to science literacy and economy of societies. In March 2015, the White House issued a Fact Sheet (https://www.whitehouse.gov/sites/default/files/microsites/ostp/citizen_science_backgrounder_03-23-15.pdf) regarding various studies measuring the impact of citizen science projects as well as various steps the US administration is taking for “Empowering Students and Others through Citizen Science and Crowdsourcing.” An array of activities has emerged, from providing free software and tools for enabling development of citizen science projects by students to installing a rain gauge in the First Lady’s kitchen garden at the White House.

In This Issue

This special issue of CiSE highlights both the projects that engage the public in scientific and engineering endeavors and the challenges encountered. In particular, motivating and providing incentives to attract citizens’ participation, keeping them engaged, and evaluating the validity of their data and contributions are issues that must be considered when developing citizen science projects.

The first article by Carol Christian highlights citizen science projects involving Hubble Space Telescope (HST) data. Contributions of astronomy enthusiasts to such projects are mostly related to visual classification, requiring a visual examination of the data along with human cognition. Volunteers have searched millions of HST images, performed classifications, and achieved results covering all areas of astrophysics that would have been very difficult, if not impossible, to reach without such a large number of participants.
The second article by Jenna Jambeck and Kyle Johnsen introduces the Marine Debris Tracker (MDT) project, which enables the general public to take advantage of various technological tools, in particular the MDT mobile apps for iOS and Android, to report and track ocean litter and debris, and visualize the collected data through a Web portal. Their article introduces MDT’s technical design and serves as good model for those interested in developing citizen science projects that require the public to perform data collection, analysis, and visualization.

The next two articles focus on addressing the limitations and concerns in citizen science projects: the quality of citizen scientists’ contributions and motivating the general public to participate, contribute, and remain engaged. The article by Joe Cox and his colleagues presents a framework for measuring the success of online citizen science projects. The authors assess the success of online citizen science projects by evaluating their scientific impact and public engagement. The article by Morais, Santos, and Raddick demonstrates how citizen science participants’ logs, containing information about users’ IDs, their contributions, and participation time, can give insights into why and when volunteers join and leave projects. This information can then be leveraged to motivate and increase volunteer engagement.

Zooniverse (www.zooniverse.org), in collaboration with various scientific and research organizations, maintains a collection of citizen science projects. Scientific American’s citizen science page (www.scientificamerican.com/citizen-science) also showcases a good list of projects. In addition, you can learn about all US government-funded crowdsourcing and citizen science projects via the Wilson Center’s Common Labs Inventory (http://ccsinventory.wilsoncenter.org/browse). If you’ve ever been curious about how to get involved, these are some excellent places to start—give it a try. You might just like it!

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Selected articles and columns from IEEE Computer Society publications are also available for free at http://ComputingNow.computer.org.