Computing advances vital to sustainability efforts; new report recommends problem-focused, iterative approach to researc

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Innovation in computing will be essential to finding real-world solutions to sustainability challenges in such areas as electricity production and delivery, global food production, and climate change. The immense scale, numerous interconnected effects of actions over time, and diverse scope of these challenges require the ability to collect, structure, and analyze vast amounts of data.

A new report from the National Research Council says that advances in computing -- such as ones that allow us to make trade-offs, understand complex systems and their connections, and account for uncertainty -- will be critical to meeting sustainability challenges.

"These problems are as complex as they are important; we need to engage deeply across disciplines to have any hope of meeting global sustainability challenges," said Deborah Estrin, professor of computer science at the University of California, Los Angeles, and chair of the committee that wrote the report. "The urgency of these problems means that we must begin to deploy our 'best-of-breed' approaches immediately to put our critical societal infrastructures on a digital plane. This will give us a chance to start creating opportunities for transformative efficiency gains, deep scientific understanding, and informed evolution of the associated political and economic systems."

The report uses smart energy grids, sustainable agriculture, and resilient

infrastructure as examples to illustrate the potential impact of advances in computing. In each example, the report shows how information, data management, and computational approaches can be used to weigh costs and benefits of alternative approaches, minimize the risks of failures and disaster, and cut waste and unnecessary redundancy. For instance, in the case of a smarter energy grid, better data management will enhance understanding of the energy supply and demand chain in ways that could foster substantial reductions in overall demand and more use of renewable energy sources.

The report recommends working toward these complex and challenging sustainability goals from the bottom up. By solving particular pressing problems, researchers can identify and improve approaches that can then be applied broadly. Past efforts in computer science research, such as Internet protocols, machine learning, and databases are successful examples of this problem-focused, iterative approach that can stimulate dramatic change.

An ultimate goal of applying computer science to sustainability is to inform, support, facilitate, and even automate decision making, the report says. Four broad research areas in computer science are crucial to attaining this goal: measurement and instrumentation; information-intensive systems; modeling, simulation, and optimization; and human-centered systems. Efforts in each will be needed, often in tandem. Since these areas correspond to established research areas in computer science, the research community is well-positioned to make progress.

The report stresses that computer science research in sustainability must be an interdisciplinary effort, with experts in the various fields of sustainability being equal partners in research. To further that end, undergraduate and graduate education in computer sciences should provide experience across disciplinary boundaries. Programs should include tracks that offer course work in areas such as life-cycle analysis,

agriculture, ecology, natural resource management, economics, and urban planning.

The committee was encouraged by the establishment of Science, Engineering, and Education for Sustainability (SEES) as a National Science Foundation area of investment. With an emphasis on interdisciplinary efforts, the program provides an opportunity to put the recommended principles of this report into practice at NSF and can be used as a model for computer scientists who wish to further their research in a sustainability-oriented problem space.

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