Defining an Agenda for Computational Sustainability

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ABSTRACT

What significant role can computation have in the sustainability domain? A rather unsatisfying implied answer can be found based on what work is prominent in interactive computing up until recently. That work focuses on changing individual behavior so that people (read as individuals) do less damage to the environment. Examples of this approach are summarized in Froehlich's survey on eco-feedback technology [6] and the series of related papers that have studied how people conceptualize and act out sustainability (*e.g.*, Woodruff *et al.* [7], Pierce *et al.* [8]). This approach has been critiqued in articles such as Dourish [1] and Mankoff [2].

Using my own work as an illustrative example, which began in 2006 with social feedback, sensing and self-reporting around green actions, I will explore and critique the question of impact. The basis for these critiques is the assumption that change lies in the hands of individuals at all (especially the relatively affluent uni-cultural individuals usually the focus of existing work), and the question of whether the changes that we focus on are likely to be substantial enough to make a difference.

If we discard the focus on individual behavior change, what is left? I argue that we should focus on scale (and scalability) of impact across socio-economic groups, across cultures, and across organizational levels (moving the focus up from individuals to institutions, cities, and even national policy). This also leads to the idea that we develop a new set of metrics for judging IT for sustainability, and a new set of perspectives on what role IT may need to play going forward.

But what role does computation have to play in these settings? I will review the recent literature in computational sustainability. The answer to this question potentially includes many things:

- Machine learning can find optimal solutions to complex problems that are difficulty for humans alone to model. For example: Golovin et al. [3] used machine learning to select patches of land for species conservation that optimize species survival. There is a nice synergy here as the problem being solved led to advances in machine learning. There must be dozens of similar problems waiting to be tackled.
- Big data meets big visualization in a number of projects. Urbmet.org provides data about energy use, population, and so on *via* a map supporting exploration, comparison, and so on. Data is also made available via an API. In a similar vein, Paulos et al. [4] visualize air quality using data sense from the tops of taxi cabs and buses. SourceMap visualizes where things come from on a map, using crowdsourced data. While maps are very powerful, especially when it comes to community action, it would be nice to see this data used in other ways as well. For example, one could imagine that air quality sensors and data of this fidelity could have huge political and medical impacts for those asthma.
- Modeling and prediction aren't just useful for climate change. For example, UrbanSim, an interdisciplinary project led by Waddell, Borning, and others uses geometric and behavioral modeling in the "interactive design of urban spaces" [5].
- Cross-cultural studies looking at low income communities, developing countries, and so on can shed light on the diverse technology and information needs that exist, and highlight assumptions that may not generalize widely. Examples include Dillahunt *et al.*'s study of energy use in low income communities [9] and Shrinivasan *et al.*'s study of conservation in urban India [10].

Computational sustainability is clearly a diverse and important topic that can already be seen to include multiple types of computation (more examples of this can also be found in Mankoff et al.[11]. As a community we need to define the metrics for success and the breadth of topics that fit within the goal of reducing energy use and, more generally, increasing worldwide sustainability.

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