



# Computing at the Margins

## A New Research Agenda at Georgia Tech

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## What is *Computing at the Margins*?

Computing at the Margins is a research agenda at Georgia Tech aimed at understanding the unique technology needs of under-served communities, creating innovative technological solutions that serve and empower these communities, and advancing the field of computing to more ably address the digital divide.

## Introduction

Technology, it is argued, has the potential to improve everyone's life—enhancing one's experience in the workplace or at home, in the car or in the hospital, in school or at the ball park. To date, however, technology research and development has typically only focused on a limited range of settings, such as the workplace or the broadband-connected residence. But what of people whose lives do not fit these models, for whom even the existence of a job or a home cannot be assured? For the many segments in society, we have not yet begun to realize the potential of technology to make a positive difference in their lives.

Very often, what is needed by these communities is not merely *cheaper* versions of the same technology used in the mainstream. Often, what is needed is *fundamentally different* technology, designed with an understanding of the unique constraints and considerations of the communities for which it is intended. There are deep scientific and intellectual challenges in knowing what to create in the first place, and how to design technology so that it is adopted by and adapted to these communities rather than simply foisted upon them.

At Georgia Tech, we are focused on research on *Computing at the Margins*: understanding the fundamental barriers to adoption of technology in communities outside of the business and entertainment contexts targeted by “mainstream” computing research. By understanding the constraints and the opportunities of these communities we advance the science of computing, driving the creation of new technology and solutions, and ultimately impacting the lives of those at the margins.

## Goals of the Program

Georgia Tech is a trailblazer among academic institutions in the U.S. by placing this focus on Computing at the Margins at the forefront of its research enterprise. Our goal in launching this program is to have a four-fold impact:

1. **Impact on our communities.** For too long, computing technology has ignored those outside the contexts of business, entertainment, or the well-to-do homeowner. We seek to empower the many other communities that represent the breadth of the human condition, by creating technology more appropriate for their needs, and—ultimately—helping them to develop their own technology that works for them.
2. **Impact on education.** We seek to change what gets invented by changing those doing the inventing. Education in mainstream Computer Science departments all too often focuses purely on technology, removed from the

constraints of the real world. Our unique approach to broadening participation in computing education (embodied in programs such as our Human-Centered Computing Ph.D. program, our undergraduate degree in Computational Media, and even our work at the high school level) takes a deeply interdisciplinary focus, situating rigorous technical education within the constraints—and opportunities—posed by the real world.

3. **Impact on computing research.** We aim to reframe how computing research is done in the U.S. We fundamentally believe that by situating technical computing research within the unique economic, social, cultural, and technical constraints that exist at the margins, we improve the quality of that research. Perhaps most directly, by operating under such constraints we *uncover opportunities for new innovation* that may not be apparent if we consider only the same contexts of use that have been explored for decades by prior computing research. We must forge a computing research agenda for the diversity of the U.S. and the world.
4. **Impact on the business of computing.** We want to invent and identify new technologies and new processes that can allow computing innovation to reach broader segments of the worldwide population to computing. Very often, those at the so-called “margins” actually outnumber those in the “mainstream.” By understanding the needs of these individuals and communities, we can create new business opportunities, and open new markets to technical innovation.

## Why Focus Outside the Mainstream?

The “mainstream” that has been the focus of so much computing research is a misnomer.

Virtually all computing research has targeted a demographically narrow slice of the potential users of information technology, providing business tools and entertainment applications to the well-to-do in high-income areas—in other words, individuals and organizations with both technological sophistication and large disposable incomes. Globally—and even within the U.S. itself—these users represent only a tiny portion of the potential users of information technology. In the U.S., for example, over 30% of the population have virtually no access to the Internet. Globally, the gap is even more apparent, with over 80% of the world population having no access [Computer Economics, March 2007].

While many are excluded from the potential benefits of these technologies because of basic economic factors, such as cost of access, other considerations often play a huge role. For example, the applications and infrastructures created by the broader computing research and development community are not designed with the unique needs, opportunities, and challenges of these communities in mind: cultural norms and values, disability, educational disadvantage (including literacy problems), racial discrimination, and the lack of reliable infrastructure all conspire to prevent “mainstream” computing tools from benefiting a broader spectrum of the population. Yet very often it is these very segments of the population that have the most to gain from information technologies, as well as the most to lose when they are denied access.

The few examples of computing research focused on understanding and designing for the unique constraints of a local community point to the impact that can occur when computing research shifts its focus away from the mainstream. In Africa, for example, solutions designed for the unique local context have led to innovation and adoption of radical new technologies for banking and commerce (such as the M-Pesa payment system), and telephony and networking (such as new store-and-forward architectures for low-cost message passing). These same innovations are now being *brought back* to the mainstream, where they are influencing research on mobile computing and commerce.

For computing research, the message is clear: by changing the constraints under which we do research—by focusing on resource-poor rather than resource-rich environments, or by focusing on settings without fixed telecommunications infrastructure or populations without widespread literacy—we foster innovation that not only advances societal

responsibility with respect to the disadvantaged, but that also advances novel technology interactions for the mainstream, benefiting all of society.

Our mission is to expand the computing research agenda in the United States, to recognize that research “at the margins” is in fact a pathway to innovation that can improve all of our lives.

## Themes and Commonalities

While there are numerous population segments outside the mainstream, one can identify a smaller set of underlying dimensions along which the communities differ from the typical demographic segments well served by computing technology. These fundamental variations include:

- **Diversity:** Mainstream computing systems have traditionally targeted only a narrow slice of the diverse global population; in fact, only recently has the core technical infrastructure of computing evolved to the ability to represent multiple languages well. Bringing an understanding of the broader cultural, linguistic, and gender diversities on our planet is essential for widening the currently narrow focus of computing technology and informing what technologies could and should be built.
- **Scarcity:** Most computing technologies are designed with a world of plenty in mind: ready access to power, ubiquitous connectivity, and ample bandwidth. Designing for scarcity rather than abundance can lead to innovative new technologies that meet the needs of previously excluded populations while advancing the field toward more sustainable solutions that scale beyond marginal communities.
- **Human Capacity:** Human capacity—both physical and mental—forms a spectrum along which we all lie. Technologies designed for the “norm” may exclude those with disabilities, those who lack education or literacy skills, or even people whose capabilities may be diminished through age.
- **Nomadcity:** Globally, our population is increasingly mobile and transient: from job seekers who must move very few months or years to find work, to the urban homeless, to those displaced by conflict, to trans-nationals and broader national and international diasporas. Technology has a key role to play here, providing continuity of access and information mobility to populations on the move.

An advantage of organizing computing technology challenges according to these dimensions is that solutions designed to address a particular demographic population can be similarly applied to other communities if they are challenged by the same variation from the norm. For example, consider technologies that make it feasible for medical or educational records to follow homeless children as they are moved between temporary shelters or foster care situations. Solutions to record tracking challenges for such transient or nomadic populations would also empower organizations seeking to develop consistent health care delivery to migrant farm workers. An interface designed to assure HIPAA-compliant informed consent for illiterate patients has tremendous potential for assisting rural illiterate mothers in making intelligent decisions for their children’s health and nutrition. This notion of developing novel computing capabilities that enable the deployment of applications in support of under-served populations is the core mission of Computing at the Margins; it is what distinguishes this effort from individual projects designed solely to address a specific problem for a particular targeted population.

### A Case Study of a Computing at the Margins Research Project

Researchers at Georgia Tech are currently working with the local homeless population, as well as with the many caregiver and social support organizations that interface with this population, to create a *mobile information access* infrastructure to better connect and empower homeless people. Contrary to popular wisdom, most homeless people do not actually live in a state of what might be called “information poverty.” Rather, many homeless people—particularly the single female head of household that is the “statistically stereotypical” homeless person—face regular information overload. They must work with multiple caseworkers and agencies for services ranging from job placement to child care to food support and shelter; they must manage complex schedules, maintain medication regimens, and orchestrate transportation across the urban landscape. They must do this while facing economic, health, and—often—literacy challenges.

Mainstream applications do not meet the needs of users such as this: a PC with a shared calendar is insufficient and irrelevant to these users. In response to these challenges, Georgia Tech researchers have been working on the ground with homeless individuals and support agencies to **understand** the challenges and the opportunities for technological intervention; to **innovate** new infrastructure and applications that support the extant needs of the homeless; and to deploy and **evaluate** these technological tools in the real world. The key technological system that we are creating is a personalized, wireless information system, designed to be accessed from the mobile phones that play such a large role in the lives of homeless people today. This system will allow caseworkers to create personalized profiles of their clients to direct needed information to them; the system will also empower homeless clients themselves, allowing them to more easily share information with each other and with caseworkers. Built with the economic considerations of our user population in mind, the system will use a combination of public Wi-Fi networks and text messaging for data transmission, and is crafted around a technology that is relevant to the urban homeless.

While designed specifically for the needs of the Atlanta homeless community and their caregivers, the underlying technologies created as a part of this project—including flexible data transmission mechanisms, privacy frameworks, location aware services, and user interfaces designed for use by users without strong literacy skills—are applicable to a range of other uses.

## Creation of Enabling Technologies

How do we create technology that serves and empowers communities outside of the mainstream? There is far more involved than simply creating technology and throwing it over the wall; the process requires not only technological expertise to create innovative and sustainable systems, but also the deep domain expertise that comes only from on-the-ground collaboration and involvement with the local community, as well as the methodological rigor to evaluate the effects of a deployment to learn from not only its *successes* but also its *failures*.

These three processes—**understand**, **innovate**, and **reflect**—feed off of each other, and imply a style of participatory action research that is necessarily interdisciplinary, grounded in the real world, and collaborative with the communities we wish to work with. By pushing the boundaries of computing research along these three themes we produce new knowledge about the communities we seek to understand (their particular needs and values, and an understanding of why certain technologies may or may not be appropriate), new technology (necessary in order to create the unique systems and applications for these contexts), and new methodologies (needed to design, study, and evaluate the effectiveness of technologies once deployed).

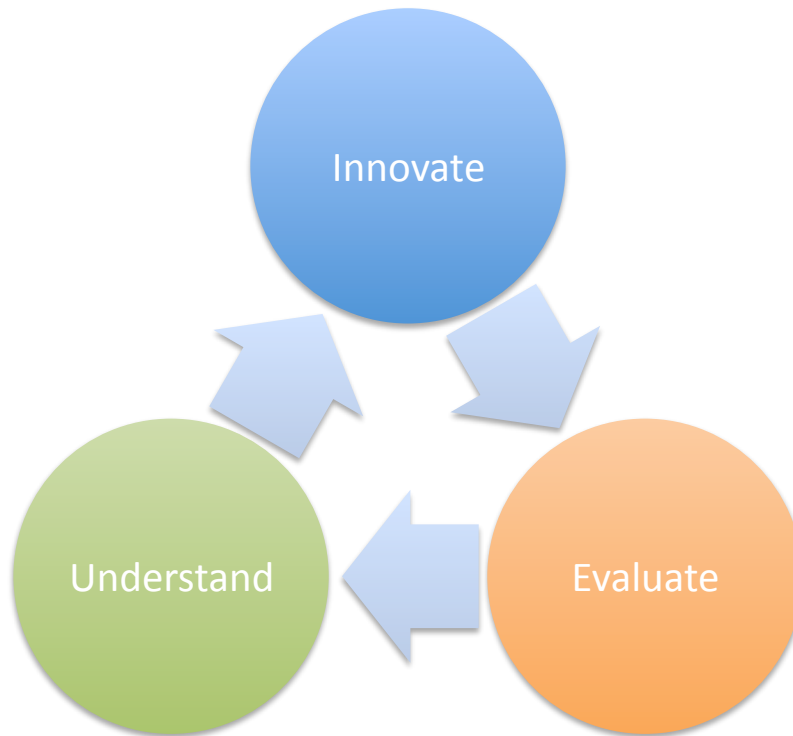


Figure 1: Creating technologies at the margins is a process of *understanding* unique challenges and opportunities, *innovating* technology that fits within the local context, and *evaluating* the deployment to learn from successes and failures

## Why Georgia Tech?

Georgia Tech's GUV Center and School of Interactive Computing bring unique strengths to Computing at the Margins.

The GUV Center conducts research in human-centered computing by enabling interdisciplinary, university-wide research and educational. GUV's mission is to *unlock human potential through technical innovation in computing technologies*. GUV faculty and students are drawn from each of Georgia Tech's six colleges: Computing, Engineering, Management, Sciences, Architecture, and Liberal Arts. Deep collaboration among these diverse disciplines enables the GUV Center to engage in research that would otherwise be difficult to tackle in traditional academic and industrial settings.

The School of Interactive Computing is unique among academic departments in the United States, with a mission to redefine the human experience of computing, and to invent computational capabilities that empower people to address society's needs. With over 35 faculty, the School brings together world-class researchers and students that combine deep technical expertise with strengths in design, education, policy, international affairs, and the social sciences. The School's key differentiator is that it combines the core technical strengths of a "traditional" Computer Science department with the wide breadth of domain and methodological expertise necessary to have impact "outside the box"—*using computing as a means to improve the human experience, rather than improving computing as an end in itself*.