# Introduction

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A more descriptive title for this book would have been "The application, design, infrastructure, and analysis of heterogeneous multi-agent distributed information processing systems and their political, societal, and ethical implications", but as brevity is the soul of wit, I decided to go with simply "Handbook of Human Computation".

Human computation means different things to different people. To some, it means using a computer to combine answers from many people into a single best answer. To others it means taking a problem that is too big for any one person and splitting it into smaller, more manageable pieces that can be delegated to many people. Human computation can be the analysis of human behavior in a social network to better understand the spread of ideas or to predict outcomes on the world stage. And possibly it even represents an opportunity to recognize or engineer a new life form with superhuman intelligence. Regardless of which of these things human computation might be, they all involve interconnected humans and machines that process information as a system, and they all serve a purpose.

## What this book is not

Though you will find much discussion of crowdsourcing herein, this is not the Handbook of Crowdsourcing. Crowdsourcing does not require computation; the term derives simply from "outsourcing to crowds". The individual contribution of each crowd member need not be computational nor give rise to computational analysis or output. Crowdsourcing is, however, a common method for engaging many participants in human computation, so they often coincide.

Nor is this the Handbook of Social Computing. Social computing is defined as the intersection of social behavior and computational systems (Wikipedia, 2013). However, social behavior is not a prerequisite for human computation. In fact, a workflow process may elicit human input, transform that input, and then pass the result to another human, in a pipeline that involves no social behavior or interaction whatsoever, yet is very much a manifestation of human computation. Thus, human computation subsumes social computing.

### Then what *do* we mean by human computation?

To answer that question, we must first consider what we mean by "computation". Computation in this context refers not just to numerical calculations or the implementation of an algorithm. Computation refers more generally to *information processing*. This definition intentionally embraces the broader spectrum of "computational" contributions that can be made by humans, including creativity, intuition, symbolic and logical reasoning (though we humans suffer so poorly in that regard), abstraction, pattern recognition, and other forms of cognitive processing. As computers themselves have become more capable over the years due to advances in AI and machine learning techniques, we have broadened the definition of computation to accommodate those capabilities. Now, as we extend the notion of computing systems to include human agents, we similarly extend the notion of computation to include a broader and more complex set of capabilities.

With this understanding of computation, we can further generalize our notion of human computation to encompass not only computation by an individual human, but also machine-mediated computation by groups of individuals (e.g., pipelined problem solving systems), aggregate analytic results by groups that result from individual information processing (e.g., prediction markets), distributed networks of human sensors (e.g., mash-ups), and many other varieties of information processing that derive from the computational involvement of humans in simple or complex systems.

While this is what is meant by human computation for the purpose of establishing conceptual guideposts for this handbook, it is itself among the directives of the handbook to not only formally define this space of research and practice, but to explore the past, present, and future scope of this frontier.

### Why is human computation important?

Each of this book's many contributors may have a distinct answer to this question. My short answer is the following. As a species, we face multifarious challenges stemming directly and indirectly from our use of technology, and many of these challenges pose an existential threat to humanity. I believe that one promising avenue of recourse is to use technology to help us cooperate more effectively to solve the problems we have created. Thus, I believe our very survival depends upon the rapid advancement of human computation as a theoretical and applied science, to help us mitigate the effects of climate change, cure disease, end world hunger, protect human rights, and resolve conflicts.

## Synopsis of Sections

Though the high-level structure of book is ordinal by design, the following section synopsis will help point the reader who has specific areas of interest to the section of most immediate relevance. For the armchair reader, you may embark on a guided tour of human computation by beginning at page one. But if you happen to have a mercurial spirit, just open the book to a random chapter and see where that might lead you.

### *Foundations*

The foundations section, edited by Matthew Blumberg, seeks to cast new light on old subject matters by asking basic questions, like "what is thinking?", "what is information?", and even "what is mental disease?". Answers come in novel forms that recast the interrelationship of foundational disciplines toward a deeper understanding of human computation.

### *Applications*

The applications section, edited by Haym Hirsh, seeks to convey the value proposition of human computation by examining recent examples of how people have been brought together in new ways to achieve desired outcomes. This section surveys a broad range of human computation applications, in domains such as disaster relief, archaeology, medicine, science, education, literature, finance, innovation, business management, and others.

### *Techniques and Modalities*

This section, edited by Kshanti Greene, catalogs an expansive and growing list of human computation techniques - that is, repeatable methods defined jointly by their applications, interaction paradigms, and/or computational methods. It is essentially a set of "design patterns" for human computation that facilitates modeling a new HC system on prior work.

### *Infrastructure and Architecture*

The infrastructure and architecture section, edited by Michael Witbrock, seeks to balance the logistics of humans as computational resources with goals of actualization and empowerment. Thus, it covers the broad space of computational structures such as state space, communication protocols, human device drivers, reward structure programmability, as well as HC-specific interaction modeling techniques that are sensitive to the quality of human experience.

### *Algorithms*

This section, co-edited by Remco Chang and Caroline Ziemkiewicz describes a variety of "systematic and general ways to treat humans as computational units" as well as new methods for formalizing the properties of human computation algorithms. Thus, this section may be useful for assessing, identifying, and constructing algorithms to fit specific use cases.

### *Participation*

This section, edited by Winter Mason, explores a range of factors and associated techniques that influence the decision to participate in human computation activities. Importantly, it also considers dynamics that affect the quality of participation.

### *Analysis*

This section, edited by Kristina Lerman, considers several analytic methods that can be used to predict emergent collective behavior and to inform the design of future human computation systems. These analytic methods are also considered in the context of quality control and performance assessment.

### *Policy and Security*

This section, edited by Dan Thomsen examines near-term ethical, regulatory, and economic considerations relevant to the emergence and growing prevalence of human computation and associated labor markets. It also delves into security and

privacy issues germane to HC systems, along with relevant technical and policy-based solutions.

### *Impact*

The impact section, which I had the privilege of editing, is a collection of forward-thinking essays on the near and long term implications of human computation on individuals, society, and the human condition. It asks hard questions and considers carefully the potential risks and rewards associated with the advancement of this new technology. It attempts to characterize a future with pervasive human computation and consider how we might prepare for it.

## Bon voyage!

Whatever your interest in human computation might be, by reading from this book you will hear from a coalescent community of communities and perhaps begin to understand our place in the world in a new way.

## References

Wikipedia (2013). Social Computing. In *Wikipedia, the free encyclopedia*. Retrieved from http://en.wikipedia.org/w/index.php?title=Social_computing&oldid=553413728