Crowd-Computer Interaction, a Topic in Need of a Model

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Abstract. Crowd-Computer Interaction - CCI - is a form of human-computer interaction - HCI - in which single actions from many individuals are aggregated to produce a different result that would not be achievable otherwise for one individual alone. As a research topic several questions remain open regarding CCI, for example, to what extent the principles and heuristics of interactions design under the paradigm of one-user-one-interface are applicable to crowds interacting with a network of interfaces? If a system is usable for individuals, will it be usable for crowds? Should designs be centered on the individual or on the crowd? A model of how crowds interact with computers is needed to start finding answers, that need is discussed in this paper along with some research proposals to develop that model.

Keywords: Crowd-Computer Interaction, Usability, Interaction Design, Models of Interaction.

1 Introduction

In his seminal book first published in 1895 "The Crowd: A Study of the Popular Mind" [3] the French social psychologist and sociologist Gustave Le Bon describes two concepts for crowds, the first from the ordinary sense of the word: "a gathering of individuals of whatever nationality, profession, or sex, and whatever be the chances that have brought them together." The second from a deeper analysis: "Under certain given circumstances, and only under those circumstances, an agglomeration of men presents new characteristics very different from those of the individuals composing it. The sentiments and ideas of all the persons in the gathering take one and the same direction, and their conscious personality vanishes. A collective mind is formed, doubtless transitory, but presenting very clearly defined characteristics." Le Bon recognized that what he called "psychological crowd" is different from the simple aggregation of individuals.

In this paper we will argue for the need of addressing the interactions between crowds, in the sense of Le Bon's psychological crowds, with networks of computers as a different problem from that of a single user interacting with one computer, or a fairly homogeneous group of users interacting with a system, that has traditionally been the subject of HCI.

Other authors have noticed the peculiar properties of masses. James Surowiecki is the author of the book "The Wisdom of Crowds" [15] in which he argues that under conditions of diversity, independence and decentralization, collectives are smarter than individuals and even smarter than the smartest member of the group.

The emerging field of crowdsourcing [5, 12, 13] has attracted the attention of several researchers that want to find innovative ways of capitalize on the power of crowds for solving tough problems. On the behavior of individuals and crowds in a crowdsourcing setting, a technical report by a team from Microsoft Research [17] concludes that "the scale matters: individual worker behavior differs qualitatively from collective behavior."

During the CHI 2009 conference in Boston, Barry Brown, Kenton O'Hara, Tim Kindberg and Amanda Williams conducted a workshop entitled "Crowd Computer Interaction" [11] in which participants explored the possibilities of interactions between crowds and technologies designed specifically for them. Although the name of the workshop may suggest a first examination of the topic of CCI as a specific sub field of HCI we believe that it left plenty yet to be defined in order to introduce CCI as a topic of research on its own right.

What is clear is that interactions at the crowd level are different from those at the individual level. Not just because they aggregate actions but because they produce different results [3, 15]. At the individual level users work with computers to get a task done driven by particular motivations in a cyclic action process [9]. They engage differently and are rewarded differently. How well designed the interaction is becomes crucial at this level. If it is poorly designed the engagement and reward the user will get from using it will most likely be poor deriving into avoidance or reluctance to use. On the other hand, if it is well suited for the task and is easy to learn and use, enthusiasm and enjoyment would be the feelings associated with it; furthermore, happy users will share their experiences and encourage others to join the interaction [16, 18, 19].

At the crowd level the aggregated interactions can be analyzed from a different point of view. If an important number of users use a particular information artifact then several tendencies can be studied and associated with positive or negative qualities of the designed interaction. User base growth rate, average amount of time spent using, average number of outcomes by type, regularity of use, messages transmitted among users, communities being formed, and others. None of these results is expected to remain stable for long. A new cycle of aggregated interactions will change or reset the tendencies and set new ones. In that sense CCI can be said to be cyclical just as single-user HCI is.

Although intuition suggests that positive individual user experiences lead to good numbers at the crowd level, once the crowd is set and becomes the center of attention for the owners of the system, changes in the design of the interaction may start focus-

ing on getting better tendencies at the crowd level rather than improving experiences at the individual level. Is it that under certain circumstances usability engineering switches attention from the individual to the crowd? Or should it do?

Several experiments have demonstrated that crowds are capable of performing useful tasks [1, 6, 14]. In fact there are companies whose business model consists of creating the proper environment to host a crowd and then allowing customers to hire the crowd for suitable tasks such as massively testing a particular feature in a web site, tagging pictures and discarding those that may seem offensive under a set of criteria, etc. Individuals in the crowd are rewarded with money or other incentives according to their participation in the task [2, 4, 5].

Under this business scenario the crowd is observed not only to acknowledge the trends produced in the use of the environment but also for assessing quality of results in order to make sure that customers obtain what they are paying for [2].

Several research questions remain open regarding CCI: what new aspects of human-computer interaction become apparent at the crowd level? Which ones are best studied at the crowd level than at the individual level? To what extent a successful crowd-computer interaction is related to a well designed interaction at the individual level? Is it enough to take good care of the design at the individual level to guarantee a good response at the crowd level? Are there other principles and heuristics to take into account when designing interactions for crowds? Does usability aggregates in the same form as individual interactions aggregate to produce results in CCI? What makes a user interface better for a crowd? Those questions and many others remain to be answered.

As mentioned earlier the crowdsourcing process has driven much research attention but it may be missing the perspective of seeing crowds as humans wanting to pursue their own goals when using computers and not always fulfilling them because the interaction has been poorly designed. The situation might be similar to that of early days of computers when programmers worked in a task-centered style instead of a user-centered approach.

To start finding answers to these questions a general model of crowd-computer interaction is needed. In this paper we propose such model and our plan to address the problem.

2 Characterizing Crowd-Computer Interaction

Crowd-computer interaction actually happens between a crowd and a network of computers, usually a social network. Individuals in the crowd are attracted to the network by specific stimulus they receive very much in the same way our sensory cells are stimulated by a special type of physical phenomena which they are specialized to interact with.

Individuals are like sensory cells for crowds and as with our sensory cells the result of their aggregated interactions is a completely different product. In crowds the aggregation of individual interactions produces trends and preferences some of them stable others changing at different pace in time.

The idea of individuals as cells was also proposed by Le Bon: "The psychological crowd is a provisional being formed of heterogeneous elements, which for a moment are combined, exactly as the cells which constitute a living body form by their reunion a new being which displays characteristics very different from those possessed by each of the cells singly." [3] In CCI the specification of sensory cells [20] would be better suited for the condition of cyclical information processor of each individual.

Individual interactions between a human and a computer are cyclical [9]. The individual approaches the computer with a task in mind, performs some action, obtains a result, and iterates until the result is the one desired to consider the task done. New tasks or subtasks may spark during the process triggering new rounds of interaction.

When aggregated at the crowd level, these interactions produce different types of trends over time: trends of use (intense, sparse, intermittent, etc.), trends of results, message exchanges and communications, preferences, and others. These trends could be observed from different perspectives and they can be detected at different time frames, even intertwining with each other. Each time a trend is set the crowd can be said to have completed a cycle of interaction.

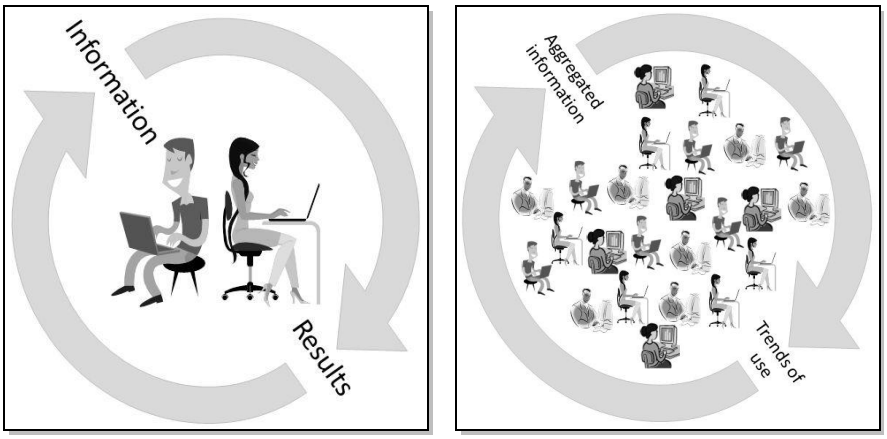

Fig. 1. The cyclic nature of the interaction with computers by single users (left) is resembled by crowds using networks of devices (right).

A crucial element of CCI is the number of individuals interacting with the system [7]. If this number is low it may be regarded as not enough to produce crowd results and not to be representative of an interaction between a crowd and a network. Nevertheless defining the right number of users required to reach the threshold level and start getting crowd results remains a tricky task [12, 13].

There are several types of incentives for individuals to form an interacting crowd. Some may be explicit, known in advance to any potential user. Others are subtle, less evident and only enjoyable after some rounds of interaction [6]. In any case, once the crowd is formed there is another important incentive to join: the sense of belonging to a community [8, 21]. This one is so important that it may outweigh any other benefit.

As the interaction evolves members will gain status, credibility, notoriety, and reputation, or at least they would expect to [10]. A serious handicap in the system would be to fail to acknowledge these properties and if there is no mechanism to circumvent the failure people may feel less compelled to use it.

Finally to completely fulfill the expectations of a social network, the interaction should provide some form of triadic closure, or the ability to make friends with the friends of a friend. The presence or absence of this property can compel users to join or leave. For an interesting study on social needs and motivations in the setting of online sport communities, see [22].

3 The Elements of a Model for CCI

From all these considerations, the elements for a model of Crowd-Computer Interaction can be derived as follows:

- The number of users must exceed a certain threshold above which the crowd-computer interaction starts
- Crowds interact with networks through a multitude of platforms and devices, with varying interfaces
- Crowds interact with networks in cycles the same as individuals do with computers
- Interaction cycles for individuals produce computational results. For crowds, the results are trends they set
- The trends set by a crowd as they interact with the network are the clues to characterize the interaction
- Individuals are like sensory cells for crowds
- Individuals have to be attracted to the network by some form of incentive
- Social recognition (community belonging and gain of reputation) is a normal expectation in the members of a crowd and can be provided through mechanisms in the network
- The possibility of triadic closure (making friends with the friends of a friend) is an appealing feature to include in the interaction design.

These elements are depicted in Fig. 2. What our model proposes is that to recognize a crowd-computer interaction these elements should be assessed and that the usability of a crowd-oriented application relies on their appropriate adjustment after observing the trends outputted in an iterative process much in the same way the usability of user interfaces designed for single users is tweaked observing reactions of users to prototype changes.

4 Validating and Using the Model

To validate the model it has to be tested, and possibly adjusted, against as many crowd-computer interactions as possible.

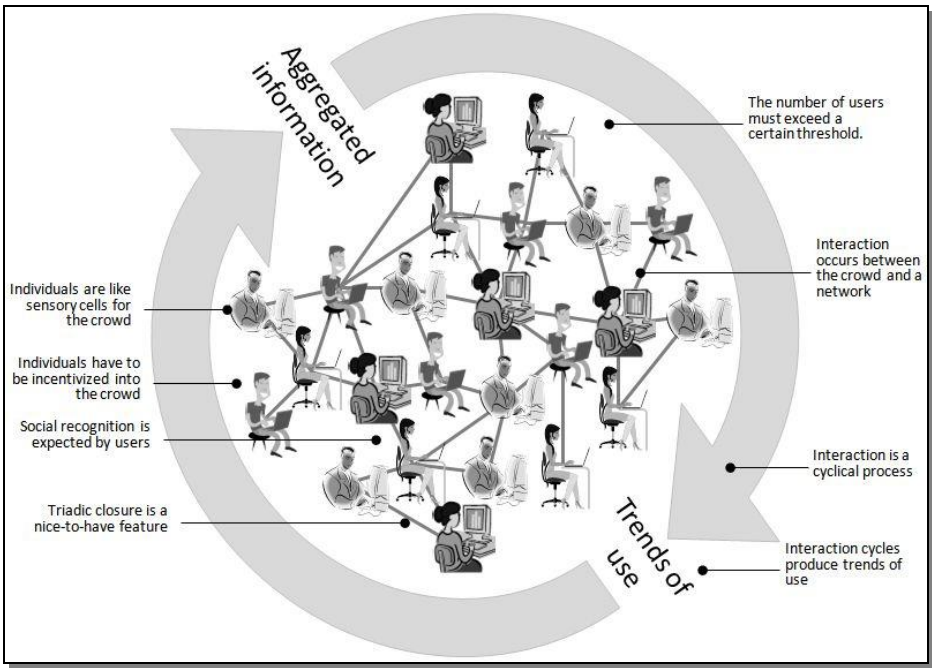

Fig. 2. The cycle of interaction between crowds and computers and the elements of the model.

Because there is no ready-made list of examples of crowd-computer interactions a set will be compiled based on the criteria we had at the beginning of the project: the subject of study is interactive systems where crowds of users produce results different from and beyond those of individual interactions.

Checking the model against examples is the first stage of validation.

For a second phase we plan a crowd-computer interaction experiment. An online form (a single user interface deployable to many) is to be shared with as many knowledgeable people in the field of HCI (the crowd) as possible to request examples of CCI congruent or not with the proposed model. The form can be filled as many times as needed (allowing iteration) and the results updated and shared back as often as possible with the names of contributors visible (to provide social recognition). Our team has already started this process, in a limited version, with good results and interest from the community.

Finally, after some iteration, the form will be closed and a list of contributors will be published along with the results of this project. This incentive will be announced in the invitation to participate so it serves as a perceived benefit (the stimulus to join).

The experiment is expected to yield examples that match the model as well as others that need explanation or point to adjustments in the model. Because this is only a work in progress we are not completely sure of how the proposed model could be used or with what aim. One of the expectations of the team is to provide the basis for usability engineering at the crowd-computer interaction level, including equivalents for prototype testing, heuristic evaluation, user testing, and other techniques.

Our first intuition is that the equivalent of user reaction at the crowd level can only be trends set in use. A usability evaluator at the single user level pays attention to facial, body and verbal expressions, struggles, indications, thinking aloud verbalizations, and other clues for determining adequacy between design and intended users for the tasks to be performed with the interface. At the crowd level the trends that emerge when considered from different points of view perform that function.

5 Conclusion

In this paper we have explained why the phenomena related to Crowd-Computer Interaction – CCI – deserves especial attention from the HCI research community and how this attention could be delivered.

In is important to note that although the topic of crowdsourcing is being studied abundantly as shown in the several references included here, there are important characteristics of crowds that need to be addressed according to their peculiar nature especially when crowds interact with computers through networks. Crowdsourcing should not be considered completely equivalent to CCI. When considering crowdsourcing and CCI a parallelism could be made with the duet of computers as productivity tools and HCI as the study of humans using computers. Computers and software are powerful tools to solve problems, and so is crowdsourcing, but if their use is designed without considering the insights provided by HCI and CCI the results can be much less than optimal.

Several research questions where proposed in the paper. To start searching for answers an incipient model of crowd-computer interaction was presented. It is the model of a cyclic process with properties that are considered desirable. Our plans to test and validate the model where also shared. The future work is implicit.

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