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Social Media and Collective Intelligence: Ongoing and Future Research Streams

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The tremendous growth in the use of Social Media has led to radical paradigm shifts in the ways we communicate, collaborate, consume, and create information. Our focus in this special issue is on the reciprocal interplay of Social Media and Collective Intelligence. We therefore discuss constituting attributes of Social Media and Collective Intelligence, and we structure the rapidly growing body of literature including adjacent research streams such as Social Network Analysis, Web Science, and Computational Social Science. We conclude by making propositions for future research where in particular the disciplines of artificial intelligence, computer science, and information systems can substantially contribute to the interdisciplinary academic discourse.

Introduction

Over the last few years, the use of Social Media has increased tremendously all over the world. For example, Facebook has increased the number of its subscribers worldwide from approx. 660 million in March 2011 to approx. 840 million in March 2012 (http://www.internetworldstats.com/facebook.htm). At the time of this writing, according to Twitter announcements, the number of 'tweets' people send is more than one billion every 3 days or more than 4,000 tweets/sec each consisting of a text message of 140 characters or less, and the number of Wikipedia articles has increased from 3.5 million in January 2011 to 3.8 million in January 2012 (http://en.wikipedia.org/wiki/Wikipedia:Size_of_Wikipedia). The Chinese microblogging service Sina Weibo, claims to have registered more than 300 million users in just 3 years. Statistics published by YouTube claim that over 800 million unique users visit YouTube each month, the equivalent of 500 years of YouTube video are watched every day on Facebook, over 700 YouTube videos are shared on Twitter each minute, 100 million people take a social action on YouTube (likes, shares, comments, etc.) every week, and more than 50% of videos on YouTube have been rated or include comments from the community (http://www.youtube.com/t/press_statistics). Also, LinkedIn, a social networking site connecting people who include their professional profiles, grew its number of

members from 4,500 (after the first month of operation in May 2003) to approximately 175 million members in August 2012 (http://press.linkedin.com/about). Going beyond these sheer numbers, people communicate and get organized for important goals. For example, social movements such as the so-called "Arab spring" and grass roots movements related to major elections, including the USA congressional and presidential elections may have its roots in Social Media and may serve as examples of the growing societal impact of Social Media [1-2,75]. The number of special issues of reputable journals devoted to Social Media [e.g. 3,4-5,e.g. 6,7] is a further indicator for the increasing importance of this topic. With this special issue about social media and collective intelligence we aim to contribute to this fast growing and very important body of work.

In essence, Social Media has led to radical paradigm shifts in the ways we communicate, collaborate, consume, and create information. Technology allows virtually anyone to disseminate information to a global audience, almost instantaneously. Information published by peers in the form of tweets, blog posts, or Web documents through online social networking services has proliferated on an unprecedented scale, contributing to an exponentially growing data deluge. A new level of connectedness among peers adds new ways for the consumption of (traditional) media. We are witnessing new forms of collaboration, including the phenomenon of an emergent 'collective intelligence'.

In the next sections, our conceptual understanding of Social Media and Collective Intelligence and their reciprocal interplay will be illustrated. We point to related research streams that are active today, and highlight directions for further research that can substantially contribute to the interdisciplinary academic discourse, especially in the disciplines of artificial intelligence, computer science, and information systems. We conclude with a brief summary of the contributions of this special issue.

Defining Social Media

A recent search for "Social Media" in Thompson's Web of Science resulted in 1620 hits (Sep 28 2012). Many of the articles found demonstrate different interpretations of the term "Social Media" ([8] and [9]). As a minimal consensus, "Social Media" is taken as a generic term for social interactions built on a

multitude of digital media and technologies, which allow users to create and share content and to act collaboratively.

Prominent examples of companies offering related services include online social networking platforms such as Facebook, Linkedin and Google+, micro-blogging sites such as Twitter and Sina Weibo, Tumblr, and platforms for exchanging visual media such as YouTube and Flickr.

Even though studies on social interactions have been conducted in fields like sociology, economics, psychology and anthropology for decades, recent developments in Web and related real-time collaboration tools provide a rich and unprecedented opportunity to re-examine some assumptions and findings concerning the structure, behavior, and content of social interactions in terms of Social Media [10]. In addition to observing people's behavior on Social Media, we now have efficient and (relatively) inexpensive ways to conduct experiments [76]. AI and information systems scholars alike can complement each other and contribute based on "their" approaches, methodologies, and perspectives. As a consequence Social Media has become a rapidly growing research area among those scholars.

Digital traces that people leave while interacting with Web applications, static infrastructure, and mobile and wearable devices create new data sources, which in turn constitute a lucrative data base for analysts. An important quality of these new databases is their coverage of real "effective" behavior (in contrast to stated or postulated behavior). As already Jim Cray noted, this may open up new frontiers if not a new ("the 4th") paradigm of 'data-intensive science' [see, 11, for applications and examples]. Social networking sites - as an example - convey new means to reveal social interactions more transparently and traceably, allowing to raise and eventually answer new research questions. However, obtaining analytical insight requires deep research. Challenges emerge in coping with huge data collections requiring a paradigm shift in hardware and software, i.e. creating a so-called "Big Data" challenge. For instance, data needs to be analyzed on the semantic level, e.g. detecting sentiment, dialect coloring, rhetoric forms including irony, satire, sarcasm (where the action or expression *and* the context in which it occurs is decisive), or distilling and excerpting relevant concepts. Further research questions comprise the integration of weakly structured datastreams on a data scheme level or, alternatively, means of finding patterns and associations in

loosely integrated data sources – just to name a few of the problems. An additional challenge consists of gaining insight within short time frames where we witness continuous flows of data (in contrast to well structured, static (more or less) tables and relations of data records) [12].

For AI researchers the whole arsenal of statistical methods, computational intelligence and traditional symbolic AI is a promising starting point and some of its gems may find its renaissance aimed at gaining insight in to the data, substantiate reasoning and eventually building intelligent machines that exhibit intelligent decisions.

Based on the exponentially growing and technologically enabled online connectivity of individuals, and the development of APIs allowing more directed data collection at a granularity unimaginable just a few years ago, new avenues for research are opening. In particular, the more recent research stream, which is also reflected in this Special Issue, focuses on the related questions, whether and how Social Media contributes to the emergence of collective intelligence and how to harness it.

Defining Collective Intelligence

Collective Intelligence (CI) is traditionally understood as the intelligence emerging from the interaction between interconnected, communicating individuals. The overarching research question of Collective Intelligence has been formulated by a research group led by Tom Malone at the Massachusetts Institute of Technology as follows: "*Despite the diverse definitions of CI, the emerging predominant research question is: how can people and computers be connected so that collectively they act more intelligently than any individuals, groups, or computers have ever done before*" [13]. Noteworthy is the fact that this notion of CI encompasses both people *and* computers.

As we describe in this section, the diverse research approaches to collective intelligence are based on different definitions of the term. Since many of these definitions are conflicting, we will not adopt a definition of collective intelligence in this article. Rather, we will point out some defining elements of collective intelligence.

In all definitions researchers agree that collective intelligence is greater than the sum of individual contributions [e.g. 14,15-22]. As Nguyen (2008) puts it: *"It is a*

very exciting phenomenon that the knowledge of a collective is not the same as the usual 'sum' of knowledge states of the collective members" [14]. Nevertheless, in these definitions researchers disagree on whether Collective Intelligence emerges only from collaborating individuals, whether it can also emerge from competing individuals, and whether it can be harnessed from independent individuals. One group of researchers ([17,15,23-24] [25]) acknowledge explicitly that Collective Intelligence emerges also in competitive situations. Another group, however ([26-29]) do not explicitly mention competitive situations.

Many researchers who emphasize the collaborative aspects of Collective Intelligence state that Collective Intelligence is goal oriented and focuses on solving specific problems [e.g. 20,14,30-32,16,33,19,34]. As Gregg (2010) puts it: *"Collective intelligence is not a new concept. As long ago as 1968, computer visionaries foresaw the ability of computers to be applied to cooperation in creative endeavors by allowing people capable of solving specific problems to share their ideas […] collective intelligence applications can be custom applications designed for small highly specialized domains"* [20]

A prominent perspective of CI definitions is to regard collective intelligence as a form of collected/aggregated knowledge [35,e.g. 36]. For example Bothos et al. (2009) refer to *"[…] a typical example of collective intelligence, Internet-based information aggregation markets (IAMs) […] When referring to collective intelligence, an underlying information aggregation mechanism is implied. The mechanism elicits the collective intelligence by drawing out the pertinent information of each individual and by combining it in such a way as to make it useful"* [36].

For researchers who regard *Collective Intelligence* as a form of collected/aggregated knowledge, the aggregation of data and the observations of patterns in data are the main goals of CI research [e.g. 20,e.g. 25]. As Gregg (2010) puts it *"A collective intelligence application is one that harnesses the knowledge and work of its users to provide the data for the application and to improve its usefulness."* He goes on to list as one of the principle Collective Intelligence application requirements: *"Data is the key: Collective intelligence applications are data centric and should be designed to collect and share data among users […]"* [20].

Often, collective intelligence draws on user-generated content and the sharing of information, knowledge and ideas. Blogs and fora are examples of user-generated content frequently mentioned in the literature [e.g., 37,24,20,35,34]. In this context, several authors emphasize explicitly the "sharing aspect" of user-generated content as a main defining element of *Collective Intelligence* research [e.g. 24,38,e.g. Lévy cited in 32,e.g. 31,20,35,25].

After defining social media and identifying the defining elements of collective intelligence, the next section highlights three related research streams on social media and collective intelligence: (1) social network analysis, (2) web science and (3) computational social science. But before highlighting these three research streams, we point out works at the intersection of social media and collective intelligence research.

Related Research Streams on Social Media and Collective Intelligence

The first group of research at the intersection of social media and collective intelligence are works that examine how to harness Collective Intelligence from Wikis. For example, researchers propose an alternative search interface for Wikipedia [39], or examine the influence of the plethora of editors on the collective knowledge created in Wikipedia [40]. Other authors use methods from machine learning to improve the quality of an organization's corporate wiki and, in doing so, match experts to wiki articles for further review and contribution [41]. Further wiki-like systems analyzed by researchers are, for example, a Collective Intelligence system for crime reports [42] and a system for real-time traffic information [43]. Finally, Passant & Laublet [44] present a wiki-farm system to produce ontology-based data understandable by humans and computers, which leads to the next area of research at the intersection of Social Media and collective intelligence: Collective Intelligence and Data Categorization.

According to Lévy [45], a prominent researcher in the domain of Collective Intelligence, useful data categorization is a core problem of Collective Intelligence management in commercial enterprises. Hence, several researchers regard *social tagging* and the resulting *folksonomies* as a prominent Collective Intelligence research question [e.g., 46,47-48]. *Social tagging* refers to the process by which users bookmark objects (often on the World Wide Web, identified by their

Unified Resource Locators, or URLs) and annotate these objects with metadata, or so-called *tags*. The set of tags that results from all users' annotations is denoted *folksonomy*, a neologism derived from *folk* and *taxonomy* [see 46, for a discussion of the ontology of folksonomy]. In the literature, there is some dispute over the contexts for which *folksonomies* are more appropriate for content classification and categorization than taxonomies created by experts [see, for example, 47, for a comparison of taxonomies and folksonomies]. Therefore, design science approaches suggest artifacts that employ *social tagging for harnessing the Collective Intelligence* in enterprises. For example, Vanderhaegen et al. [48] illustrate how *social tagging* can be applied in process management, proposing an architecture, model and prototype.

The next three subsections highlight related research streams on social media and collective intelligence research.

Social Network Analysis

Social network analysis is an interdisciplinary research paradigm [e.g. 49]. In this editorial, we point out five areas of SNA research that have attracted a lot of attention. The first area concerns stochastic actor-based models that allow for inferential statistics and testing of hypotheses about underlying mechanisms that in turn lead to Collective Intelligence [e.g. 50]. These models are based on sociological literature that examines the evolution of networks [for an introduction to these models see, for example, 51,52-53]. The second area of research comprises work dealing with scale free networks and complex systems [e.g. 54,55,e.g. 56,57]. The third area of research, mostly undertaken by IS researchers, uses network analysis as a method to analyze electronic communication networks [e.g. 58,59-62,77]. The fourth area of research includes algorithms for the visualization of networks [e.g. 63,64-66]. The fifth area comprises research in management science and sociology that focuses on the association between network structure and the performance of the actors embedded in the networks [see, 67,68, for a literature review about these works in organizational research].

Web Science

Web Science refers to the emerging interdisciplinary field of research that takes the Web as its primary object of study [69]. However, Web Science is still in its

infancy and “we do not fully know what Web Science is” [70]. Web Science combines two quite different research approaches [compare 71]. Whereas sciences such as physics or biology analyze the natural world and aim to find (causal) laws that explain some observed phenomena, computer science is a design-oriented discipline concerned with the construction of artifacts to produce novel desired computer behaviors. Like Collective Intelligence, Web Science is a discipline that tries to follow both research approaches.

Computational Social Science

Computational Social Science has been defined as the “Interdisciplinary field at the intersection of the social sciences, computational science, and complexity science” [72]. Indeed, Computational Social Science is similar to Collective Intelligence research as some of the researchers who authored the most prevalent publications about Computational Social Science [e.g. 73] are the same researchers that have sought to foster the paradigm of Collective Intelligence [e.g. 74].

Directions for Future Research

Based on an extensive literature review, the observed state of the art in various academic disciplines, and technological as well as societal trends as pointed out in the introduction, we observe the following - not necessarily new - directions for future research. The interplay among the different relevant disciplines, artificial intelligence, computer science, and information systems, substantially contributes to the interdisciplinary academic discourse, leading to the following research questions:

- Which Social Media technologies can foster Collective Intelligence in organizations?
- How can we leverage Collective Intelligence for collaboration?
- How can we measure Collective Intelligence so that we can gain a better understanding of causal relationships of CI, thereby providing a model/theory-based foundation, which may help to better design CI?
- What is the role of model-driven, theory-driven, and data-driven approaches in Social Media research?

- How can we cope with Social Media induced big data in terms of quantity, flow characteristics, and weak structuring of data?
- How can we build on classical AI themes such as natural language processing (NLP), semantic technologies as well as fuzzy and soft computing in order to foster insight into raw data?
- How do we effectively analyze very rich databases, which allow for measuring (real) behavior rather than just (stated) attitudes and beliefs?
- How do people acquire knowledge from Collective Intelligence applications?
- How do people recognize misinformation or spam from Collective Intelligence applications?
- How do adoption and diffusion of innovations spread through a network?
- How does network structure influence creativity?
- How can we reveal individual and group behavior, social interactions, and community dynamics by mining their digital traces?
- How can we integrate data from diverse sources, which are large-scale, non-structured, and not necessarily semantically closely linked?
- What models can describe any predictive power that Collective Intelligence has when applied on Social Media data?

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