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Guest editorial

Collective intelligence in information systems

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Abstract. In recent years, advances in information technologies have also facilitated the use of distributed knowledge from different autonomous sources for finding solutions to some common problems in the real world. This approach can be considered as an efficient approach to tap into collective intelligence, which is often considered as the intelligence emerging from the collaboration and competition of many individuals in a group. This paper aims to present the application of collective intelligence in information systems briefly. Apart from these, we also introduce papers in this issue.

Keywords: Collective intelligence, intelligent systems, collective knowledge

In the era of Industry 4.0, technologies play a key role in developing intelligent systems and finding crowd-based solutions to some common problems. Also, advances in Cyber-physical Systems have facilitated the connection of billions of people around the world [1]. Such a possibility can be considered as an efficient approach to exploiting the collective intelligence of crowds which is assumed as the intelligence that emerges from the collaboration and competition of many individuals in a group [2].

In [3], the authors have classified and modelled the collective intelligence (CI) systems into two broad categories: passive and active CI systems. With the former systems, specific characteristics of individuals may be presented via their behaviour and actions. These characteristics later can help guide each one of them to achieve their shared target easily. Meanwhile, with the later ones, individuals' behaviour does not pre-exist, but they are formed and coordinated through specific system requests. Depending on the properties of individuals in a group, this category is classified into three subcategories such as collaborative, competitive, and hybrid collective intelligence systems.

According to Levy definition [2], it can be seen that collective intelligence is mainly based on the notion of the knowledge of a collective as a whole is more than the sum of individual knowledge [4]. Research in this field is mainly dealing with methods for processing knowledge from distributed and autonomous sources like humans, animals or agent systems. To date, many research results have revealed that the aggregating of individual knowledge is an efficient approach to providing more proper solutions to cognition problems [5]. In [6, 7], the findings have revealed that Crowdsourcing a useful platform to leveraging distributed knowledge, ideas, etc. In addition, it can increase the collective intelligence of crowds by changing the way of producing collective knowledge and make them actionable. Similarly, prediction markets systems are also well-known as reliable sources to foster the collective intelligence

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of crowds and improve collective performance [8]. In particular, Crowdsourcing systems like Amazon Mechanical Turk (AMT) can be used for creating corpora in computational linguistics or for evaluating results in information retrieval [9].

It can be seen that collective intelligence has been significantly enhanced by the emergence of *social media* [10]. Collective intelligence does not merely aim at combining individual potentials; it also aims at maximizing the potential of a group [11]. Indeed, social media has been considered as a crowd-mediated for harnessing collective intelligence from a group of diverse individuals [12]. Referring to [13], wikis, social networks, and content-sharing platforms is considered as collective intelligence systems for collective knowledge creation and sharing processes. Question and Answer (Q&A) websites such as Quora and Yahoo!Answers can be considered as efficient approaches to using collective intelligence of crowds on the Internet to find proper solutions to some common problems in the real world [14].

Collective knowledge is often considered as the sum of shared individual knowledge contributed by community members [15]; the common state of knowledge of a collective as a whole [16], etc. In [17], the authors have developed a Collective Knowledge System by taking advantages of Social Web (creating values by aggregating much individual contributions of users around the world) and Semantic Web (creating values by integrating structured data from many autonomous sources).

To date, the knowledge gained by the process of knowledge integration from community members in virtual communities (i.e., social media) can be considered as collective knowledge [18]. In [19], the findings have shown that social networking has a positive impact on trust and shared language and can be considered as a mechanism serving for knowledge integration. According to [20], the duration of knowledge integration process is dependent on the characteristics of knowledge sources.

Recently, social web, information sharing platforms, and virtual communities have been considered as additional sources of information which are often referred as the wisdom of crowds to information systems like information retrieval and machine learning systems. *Intelligent systems* seem to have significantly benefited by exploiting big data to incorporate massive volumes of data to improve their solutions to problems in the real world [9]. *Big data* technologies have been designed to handle the challenges of the three Vs of big data including Volume (massive amount of data), Velocity (speed of data in and out), and Variety (range of data types and sources) [21]. However, the common problem is that *Big data* often are gathered without a well-specified purpose, and this often leads to such situation that a lot of data do not refer to the subject which is interested in the user. Thus the most important feature of data is neither volume nor the other Vs but their semantics. Owing to it one can filter the data.

Although, many research results have documented the effectiveness of informed individuals in solving some difficult problems, even problems that are based on insufficient or higher uncertain information or non-historical data [22]. There exist several questions for future research concerning methods for enhancing collective intelligence such as by changing in collective structure or collective norms, or proposing new kinds of collaboration and communication tools [23]. In addition, the need for how to properly aggregate the results of the diverse members, and how to increase the quality of collective prediction are also challenges.

Another issue concerning the use of collective intelligence in social media is how to form a wise group of problem solvers? For such a task, the criteria worked out by Surowiecki can be taken into consideration [24]. Referring to [25, 26], the experimental results have indicated that social influence has affected collective solution. In these works, however, only criteria of diversity and independence have been taken into consideration. No mathematical models have been worked out to build collectives satisfying criteria of *Diversity, Independence, Decentralization,* and *Aggregation* [24]. To the best of our knowledge, the model will consist of the structure of member profile, including knowledge, relationships with other members and a distance function for measuring the difference between member profiles. On this basis, it will be possible to define the notions of diversity, independence and decentralization for collective members.

Apart from these, the reliability of available information on social media is also an issue. In some sense, referring to information from these sources for finding solutions to some common problems can be inefficient and lead to unreliable solutions. Fake news, is an instance for such a phenomenon, which has negative effects on community users. Recently, research on fake news detection on social media has received much attention from researchers as in [27]. In general, the method of detecting fake news can be divided into 2 categories: based on content and social

context. However, traditional methods for detecting fake news are ineffective in the case of news collected from microblogs (like tweeting on Twitter). In this case, some characteristics of social networks can be applied to increase the efficiency of the proposed methods such as comments (comments) on news of network users, historical posts of a user, user profile as well as user's historical activities.

In this special issue of the *Journal of Intelligent and Fuzzy Systems* we have included 45 papers which are extended versions of selected papers from the proceedings of conferences ACIIDS 2018, 2019 and conferences ICCCI 2018, 2019. These all papers have been thoroughly peer reviewed. The authors presented very interesting aspects of both theoretical and practical approaches to the impact of collective intelligence in information systems.

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