Subconscious Social Computational Intelligence

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Abstract The success of social network Web services mediating social interactions, as well as the increasing observation capabilities of human interactions in real life, has prompted the emergence of new computational paradigms, namely social computing, computational social science, and social intelligence. Subconscious social intelligence appears when the social network service is able to provide solutions, generated by a hidden intelligent layer, to problems posed by the social player. This paper discusses some features of subconscious social intelligence and ensuing challenges for machine learning systems implementing the hidden intelligent layer.

Keywords Social computing · Social intelligence · Subconscious reasoning · Learning systems

1 Introduction

This paper discusses the requirements for machine learning systems contributing to the development of a nascent computational field, which can be identified by the name of subconscious social computing. Reviewing the related fields of social computing and computational social science will help to clarify the subtle distinctive features of this new class of systems. We describe the general scheme of subconscious social computing highlighting its contrast with the previous ones, including the description of one instance, the EU-financed SandS project [1, 3, 4, 6]. Then, we identify requirements posed by this kind of systems on learning subsystems implementing the subconscious intelligent layer, discussing how computational intelligence approaches can cope with them.

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2 Social Computing Paradigms

Computational social science [2] aims to understand the dynamics of social systems form of data that can be extracted from all existing sources of human behavior observation, ranging from surveillance cameras, mobile identification tags to social Web services or electronic commercial transactions. From computational social science point of view, the social players are subjects of observation and experimentation, searching for answers to questions such as:

- which interaction pattern leads to economic success?
- how social interaction influences contagious sickness diffusion?
- what is the best way to promote a product?
- what social hints can be useful to predict the fate of a stock asset?

To this end, computational social science deals with intelligent and efficient hardware/software systems able to process huge amounts of data coming from all kinds of observational sources within some real-time constraints. Big networking data are subject to statistical and data mining analysis, providing answers to the institutional or corporate costumer.

Social computing [5, 8] concerns the development of software for the enhanced interaction between social players and to develop simulation scenarios to forecast the effects of policies and forces, such as technological innovation, on societies. Examples of these systems are entertainment/therapeutic social games involving autonomous intelligent agents, negotiation, recommender and reputation systems, security applications for the detection of criminal social activities, and artificial societies of agents designed to provide adaptation to changing environments (i.e., traffic) through competition, platforms for scientific collaboration offering information about the current state of the research community and research effort planning. Social computing is developing into a productive model where rewarding mechanisms are required to control the desired output of the system [7].

Social intelligence is the emergence of problem-solving behavior out of social interactions from the point of view of the social player. In other words, the social player expects to obtain solutions to his/her problems from the pool of intelligence available from a social network and the computational resources that may be at work behind the social service. We may further distinguish between conscious and subconscious intelligent computing. In the former, social players contribute information and the intelligence to create/discover solutions. In the latter, an underlying intelligent layer is able to provide innovative solutions to old and new problems, following an autonomous process that is not directly controlled by the social players. Figures 1 and 2 illustrate the differences between paradigms. The social interaction layer in both figures includes all means of sharing information between users, but does not contemplate any information transformation.

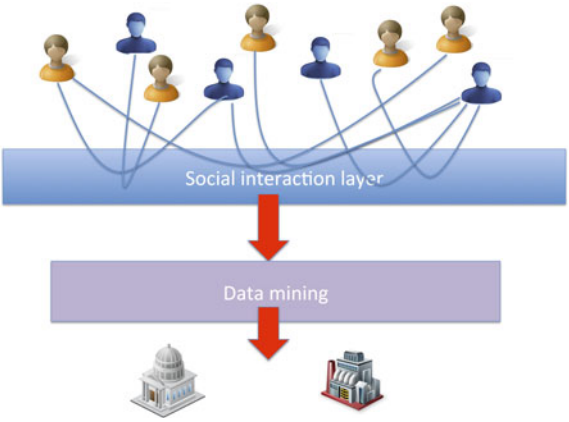

Fig. 1 Social computing and computational social science paradigm

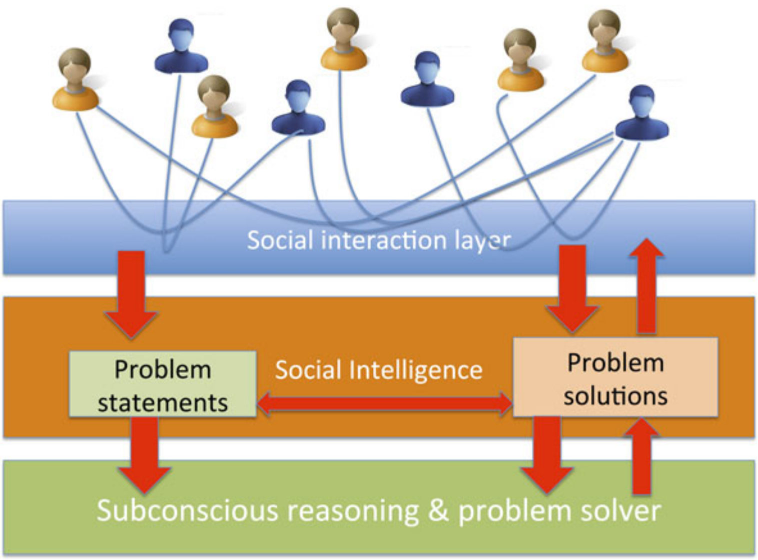

Fig. 2 Subconscious social intelligence paradigm

3 Subconscious Social Intelligence

In the social computing and computational social science paradigms illustrated in Fig. 1, there is an underlying computational layer that performs data mining over observations of the social interactions. The social player is unaware of it and does not directly benefit from it. This lack of benefit motivates research in rewarding mechanisms [7]. The results of these computations are delivered to a third party, either government institutions or industry. The productive model of social computing relies on the technological prowess of this data mining layer that provides the benefit from the investment in the social interaction layer.

On the other hand, in the subconscious social intelligence paradigm illustrated by Fig. 2, the social intelligence layer below the social interaction layer is dedicated to provide solutions to problem statements posed by the social players. To that end, repositories of problem statements and problem solutions are maintained, along with a mapping between them. The upward and downward red arrows model the flow of problem statements and solutions. Problem statements posed by social players flow downward to the social intelligence, matching problem solutions are searched in the repository (horizontal red double-headed arrow), if one is found, it flows upward to the social interaction layer to be retrieved by the interested social player. If there is no solution matching the statement, the statement is percolated further down to the subconscious reasoning and problem solver layer that works to produce a solution that will be pushed upward to the social intelligence layer solutions repository, and the user at the social interaction layer. The subconscious reasoning and problem solver is trained on problem solutions that percolate from the social intelligence layer. The product of the social intelligence goes directly back to the user, and there is no beneficiary institution, either company of government. The aim of the system is empowering the social player to solve his/her real-life problems, maybe against the pressures of some institution, or within its. As a corollary, social players do not need to be rewarded externally to use/contribute the system.

4 Requirements for Learning Systems

The requirements for learning systems meeting the SandS networked intelligence and the general subconscious reasoning and problem solver of Fig. 2 are as follows:

- Quick learning times that allow for quick adaptation to changing environments and supporting the effects of scale that potentially big social communities will introduce. Social network services can experience dramatic rises in user involvement and subsequent computational load. Moreover, changes in problem specification may involve addition/removal of variables with ensuing retraining processes.
- Flexibility to cope with diverse data representations and desired outputs. The desired responses may be categorical and continuous, involving both classification and regression, even in the same problem-solving process.
- Robust performance when dealing with multidimensional heterogenous output. Most machine learning approaches have serious degradation when the desired output is multivariable, and even worse when it is composed of diversely typed variables.

- Minimal uncertainty: In the development of subconscious social intelligence, we want to perform one-shot training with minimal uncertainty about the achieved performance. Machine learning papers often report average or peak results of extensive computational experiments. These results do not provide a performance guarantee for a specific instance of the learning process, nothing prevents it to be catastrophically stupid.
- Robust incremental learning to process incoming batches of user feedback driving the adaptation process. Incremental learning, on the fly adaptation, is not an optional feature in this setting. Social systems and the needs of the social players are continuously evolving. Training systems with a sample of data are meaningless after some period of time.
- Easy implementation/learning of forward and backward mappings, the former to provide solutions and the latter to translate the user feedback into error measures driving learning processes. Social players want to be able to understand why a solution works, which is the chain of reasoning that produces this improved solutions, and to have some control on the responses of the system to required adaptive changes.
- Hybridization of diverse computational paradigms to allow the composition of selection/classification/regression modules to cope with the complex landscape of user problem statement. It is not likely that a single learning paradigm will be able to cope with all kinds of social player requests and needs. Many kinds of intelligence may need to be called upon to provide answers at diverse levels.

5 The SandS Project

The EU-funded SandS project (http://www.sands-project.eu) aims to build an instance of the subconscious social intelligence in the domotic domain. SandS social players are users of household appliances that exchange information about them in the form of "recipes" of use. The software structure under development in the project follows the pattern of Fig. 2. The SandS social network has a repository of household tasks that have been posed by the users and a repository of appliance recipes, which are related by a map between (to and from) tasks and recipes. This map needs not to be one-to-one. User queries interrogate the database of known/ solved household tasks. If the queried task is already known, then the corresponding recipe can be send to the user appliance. After recipe execution, the user can express its satisfaction with the results. When the queried task is unknown and unsolved, it is forwarded to the underlying SandS networked intelligence to produce a new recipe by an intelligent system reasoning able to learn and predict new recipes maximizing user satisfaction. The source of recipes filling the repository is, therefore, twofold. On the one hand, engaged user and/or appliance manufacturing companies consciously provide new recipes. On the other hand, the underlying networked intelligence is the subconscious generator of new solutions.

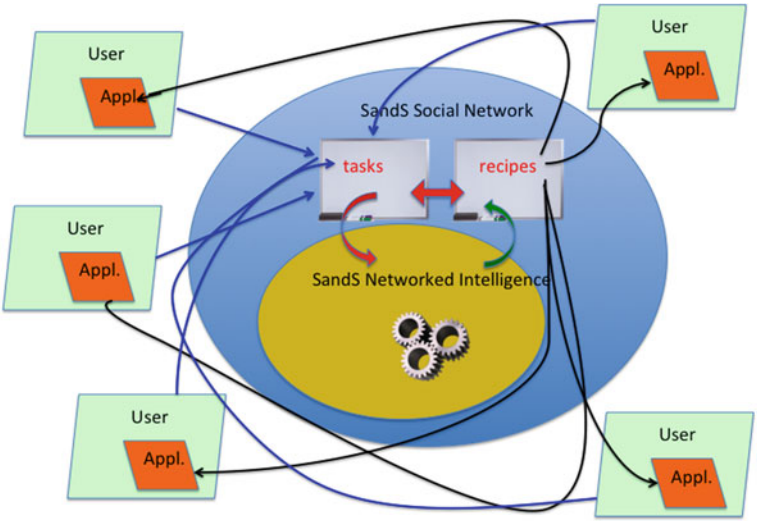

Fig. 3 Social and smart system prototypical architecture

More specifically, Fig. 3 shows an intuitive representation of the architecture and interactions between the system elements. The SandS social network mediates the interaction between populations of users, each owning a set of appliances. The SandS social network has a repository of tasks that have been posed by the eahoukers and a repository of recipes for the use of appliances. These two repositories are related by a map between (to and from) task and recipes. This map needs not to be one-to-one. Blue arrows correspond to the path followed by the eahouker queries, which are used to interrogate the database of known/solved tasks. If the task is already known, then the corresponding recipe can be returned to the eahouker appliance (black arrows). The eahouker can express its satisfaction with the results (blue arrows). When the queried task is unknown and unsolved, the social network will request a solution from the SandS networked intelligence that will consist in a new recipe deduced from the past knowledge stored in the recipe repository. This new solution will be generated by intelligent system reasoning. The eahouker would appreciate some explanation of the sources and how it has been reasoned to be generated; therefore, explicative systems may be of interest for this application.

In the SandS social network, input data should be in the form of household task codifications, while the output may correspond to recipe parameter settings, which may be continuous variables, i.e., water temperature in the washing machine, or categorical, i.e., steps in the washing process. The user feedback may be expressed in simple terms, such a Likert scale of satisfaction, which needs to be translated into an error measure that may drive the recipe learning. Household tasks performed by different appliances need to be solved by specific learned systems, which amounts to perform some partition in the task/recipe space by a selection mechanism driven by the task specification.

6 Conclusions

Subconscious social intelligence is a new way to pose the problem-solving power of social networks, combining conscious social computing built from explicit interactions from social players and subconscious problem solving trained from the experiences percolated from the social interaction down to a subconscious reasoning layer. The consideration of this kind of systems amounts to a radical shift on how social Web services are designed and deployed. It would no longer be the needs and requirements of the large corporations owning huge computational facilities that drive the system computational intelligence. Instead of the social players, the individual users of the system are the ones reaching the benefits of the social interaction for a better personal and social life.

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