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Innovation and cognitive distance within a community of practice: an agent-based model

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Abstract

The development of New Information and Communication Technologies (NICT) in particular brought considerable changes in the management of codified knowledge. Nevertheless, the management of such a capital quickly appears problematic. In fact, a great quantity of knowledge is not transmitted this way; it is rather diffused by means of social interactions. We focus here on communities of practice and wish to know what impact does the cognitive distance that may exist between different members of a community have on the process of knowledge creation. We use agent-based modelling and preliminary results show that the cognitive distance that may, or may not, exist between the different members of a community does not seem to have an impact on the process of knowledge creation.

Key words: innovation, knowledge, cognitive distance, agent-based simulations

1. introduction

The analysis of knowledge creation and transfer knew a renewal of attention in the academic world as well as in the professional one. Indeed, knowledge became a central concept considered as an asset to which organizations must pay great attention [Foray, 2000]. The development of New Information and Communication Technologies (NICT) in particular brought considerable changes in the management of codified knowledge. In fact, an important productivity gains can be carried out thanks to NICT, which facilitate the diffusion, the exchange and the treatment of this knowledge [Foray and Lundvall, 1996]. Nevertheless, the management of such a capital quickly appears problematic. Indeed, to manage knowledge amounts transforming "a *new idea, individual and tacit, into a collective knowledge, which is shared and memorized*" [Foray, 2002, p. 246]. In fact, the complexity of this process consists in particular in the complexity that one finds to measure it or articulate it with other assets, or because of the difficulty of capitalizing it within an organization, for example.

Although some knowledge, such as patents of intellectual properties, can be treated like "traditional" goods on a market, insofar as they can be bought and sold, that does not seem to be the case for all knowledge. In fact, a great quantity of knowledge is not transmitted this way; it is rather diffused by means of partnerships or of networks of relations, without going through the market [Lazaric and Lorenz, 1998]. In this context, there is a type of communities

that represents an environment that is particularly favorable to the exchange of this type of knowledge. These communities are called "communities of practice" [Lave and Wenger, 1991]. Our research focuses on the process of knowledge creation in the particular context of a community of practice.

The question that we raise here is: what impact does the cognitive distance that may exist between different members of a community have on the process of knowledge creation?

In order to answer this question, we will use an agent-based model that we will build an agent-based model and try to identify, through several sets of simulations, the eventual impact that individuals' cognitive distances may have on this process within a community of practice. But first, we will start by presenting the literature background around the concepts of communities of practice and knowledge creation. Then, we will briefly present the agent-based model that we built. And finally, we will describe some preliminary results and end this contribution with some concluding remarks and future research steps.

2. Innovation within a community of practice

As we suggested previously, a great number of knowledge are diffused by means of social relations. These often take place within social networks, and more particularly within social structures like communities for example [Dupouët, 2003]. In this context, we decided to study the process of knowledge creation in the context of one of these communities: communities of practice.

The concept of communities of practice appeared at the beginning of 1990s, following the work of Lave and Wenger [1991] and Brown and Duguid [1991]. Ever since, a great quantity of work on the subject emerged [Lesser and Storck, 2001; Créplet *et al*, 2003; Dupouët *et al*, 2003; Cohendet *et al*, 2006], where this concept is considered as a key element in the fields of innovation and knowledge capitalization.

A community of practice is defined as a group of individuals working *voluntarily* together around common issues [Lesser and Storck, 2001]. These individual share their knowledge, their experiments and their ideas, to develop their competences in a particular common field [Créplet *et al*, 2003].

Thus, we choose to study knowledge creation within communities of practice for the following reasons:

- They are considered as an environment that is particularly favorable to the diffusion of knowledge, and its creation;
- Their members aim to become experts in the practice of the community: the process of learning is emphasized in this perspective. This process may occur through exploration (knowledge creation) or exploitation (knowledge transfer)

Besides, this type of communities has the following properties:

a. A voluntary engagement of their members "in the construction, the exchange and the sharing of a repertoire of **common cognitive resources**".

b. The construction of a social identity through repeated interactions.

c. Social norms that constitute "the cement of knowledge community".

These characteristics suggest that knowledge creation and transfer hold an important place in the activities of a knowledge community. According to these literature elements, these processes represent the principal aim of the individuals who join this type of communities. Their voluntary commitment to take part in the exchanges taking place inside the community shows their motivation *to learn*. Thus, they engage in a process of repeated interactions, where social norms play a great part.

In this paper, we wish to focus on the process of knowledge creation within a community of practice. This type of communities is very relevant in terms of innovation. However, if all the members of the community share a common repertoire of cognitive resources, how will that influence knowledge creation in this context?

In order to provide an answer to this question, we introduce to the concept of cognitive distance [Nooteboom, 1999]. This concept refers to the distance which can exist between the knowledge held by two individuals, and to the way in which this distance may influence their capacities of learning. In fact, according to this concept, an individual will have more difficulties in assimilating knowledge if it is too far away from the knowledge he already has [Cohendet *et al*, 2006].

In the context of a community of practice, cognitive distance and governance distance are relatively weak [Nooteboom, 2007]. The former is due to the expertise and the repertoire of common resources that the members of such a community share. The latter is due to the community governance and the social norms which govern the interactions and are respected by all the members of the community. These elements enable the individuals to easily interact, to be understood. However, a small cognitive distance may lead to some difficulties in terms of knowledge creation. Since there is no great variety in the knowledge that a CoP's members hold, how will they be able to innovate, if most of them hold the same knowledge.

By using agent-based simulations, we wish to model the impact that cognitive distance may have on the processes of innovation within a CoP.

3. The model and preliminary results:

A population of 50 individuals is created, that has the structure of a community of practice. All of these agents have a common goal: to learn and create new knowledge and thus, increasing their individual competencies; we will name them "knowledge-seekers". They interact in a social environment "consisting of a network of interactions with other agents" [Gilbert and Terna, 2000]. These other agents represent "sources of knowledge"; we will name them "knowledge-providers". In order to model knowledge diffusion in a context with issues of availability and motivation for the agents, we decided to adopt Cowan and Jonard's [1999] modelling of an agent's knowledge as a vector.

Agents interact on a face-to-face basis in order to innovate. We run several sets of simulations. We will define these simulations and then present the results for each set briefly.

- Simulations where interactions are based on the concept of cognitive distance: here agents choose the agents that they will interact with in two different ways:
    - They choose the knowledge-providers with whom they have the smallest cognitive distance (simulations with increasing cognitive distances);
    - They choose the knowledge-providers with whom they have the largest cognitive distance (simulations with decreasing cognitive distances).

- Simulations where interactions are based on agents' competences: here knowledge-seekers always ask the most competent knowledge-providers first.

3.1. Preliminary results

Preliminary results are presented in what follows:

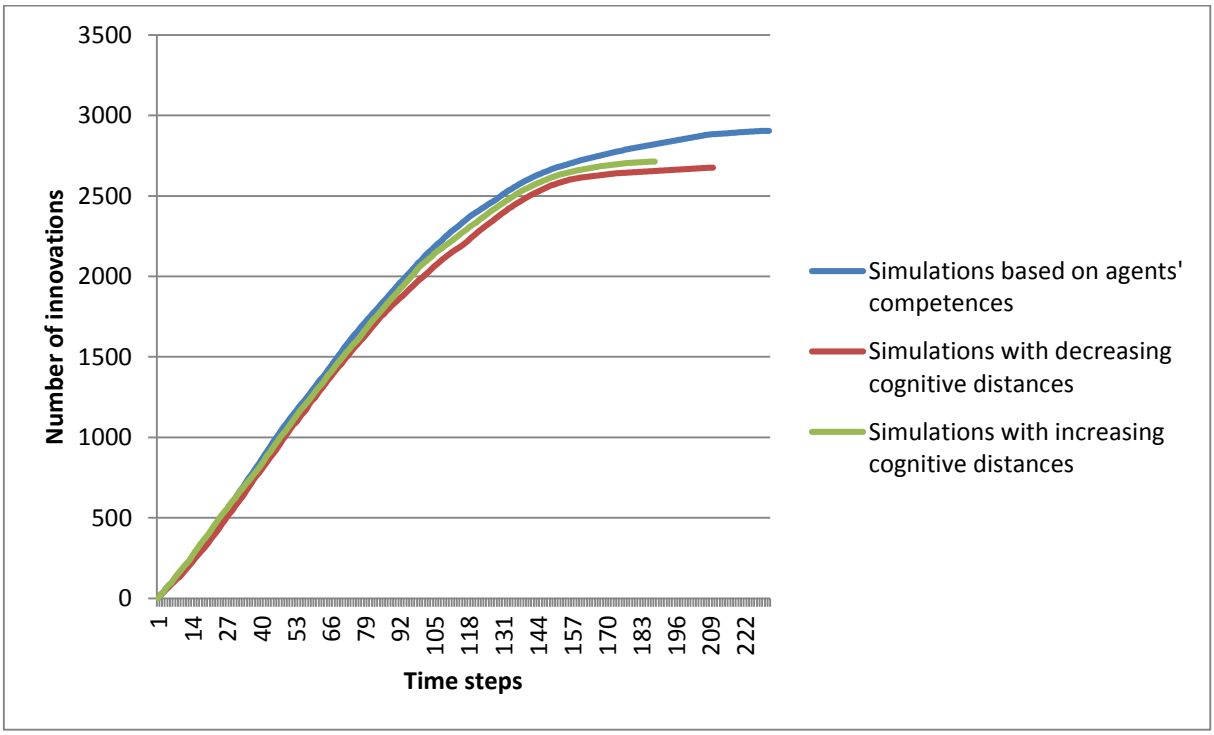


Figure 1 Number of innovations according to cognitive distance

Figure 1 shows that the cognitive distance that may, or may not, exist between the different members of a community does not seem to have an impact on the process of knowledge creation. However, the number of time steps for all knowledge seekers to become experts differs, as shown in the figure below.

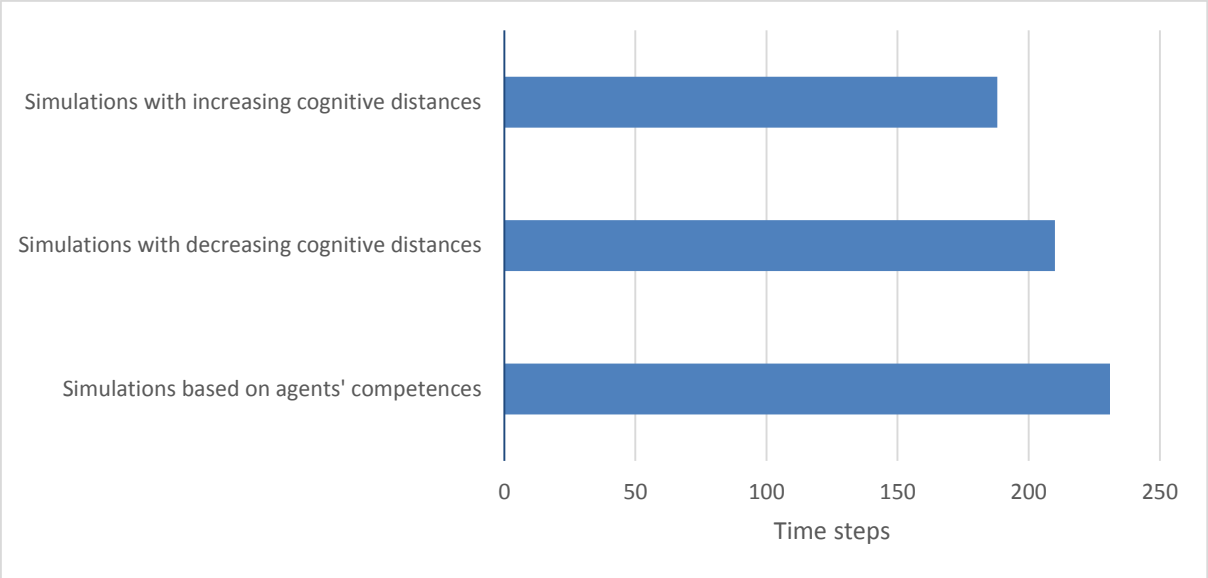


Figure 2 Duration of simulations

These preliminary results suggest that the initial cognitive endowments of the members of a community of practice do not really matter when these individuals are engaged in a process of innovation. This may lead to provide some answers if a community of practice is not very successful in creating new knowledge. In fact, if confronted with such issue, our result shows that the problems that this community may have are not related to the initial endowments of their members.

Other results also show that the cognitive distance between the members of the community does not have an influence on agents' coordination neither. Indeed, the same number of knowledge providers is reached at the end of all the types of simulations. That is, all knowledge-seekers become experts in all types of simulations. This suggests that the learning process, as implemented here, is not affected by the initial knowledge endowments of agents, at the beginning of the simulations.

We suggest to extend our model to both process of knowledge creation and *transfer*, and lead simulations where individuals can either learn by acquiring new knowledge, or by creating new knowledge. Also, Nooteboom [2007] suggests that, when a community of practice is at an early stage of its life cycle, learning happens mainly through exploitation of existing knowledge. On the other hand, when it is a more mature community of practice, learning happens through exploration, i.e. creation of new knowledge. This would be a relevant element to study in our future research.

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