Monitoring Ecosystem Characteristics on Negotiation Environments

Nicolás Hormazábal, Josep Lluis de la Rosa, and Gabriel Lopardo

Agents Research Lab, Universitat de Girona, Girona, Spain
{nicolash,peplluis,glopardo}@eia.udg.edu
http://arlab.udg.edu

Abstract. In this paper we suggest monitoring ecosystems' characteristics in negotiation environments, such as the diversity of the organizations' working areas, which can be used for recommendation for the whole ecosystem to promote the entrance of new organizations or the recommendation of adapting the organizations for improving their performance.

We will see the connection of performance and diversity and an illustrative experiment of how inviting diverse companies after an alarming descendent diversity of companies in a open negotiation environment impact in improved fitness of companies.

1 Introduction

In Digital Business Ecosystems (DBE), where networked organizations cooperate, compete and share knowledge, most of the agreements happen through negotiation processes [8]. In real ecosystems, species grow their population or disappear depending on the available resources they have, as well on their ability to adapt themselves to environmental changes. The organizations, the living species in the DBEs, must adapt themselves, evolve or disappear depending on the environment's and organizations' characteristics. For example, agreements not always can be made if organizations cannot find potential partners in a field.

The ONE project aims to develop a business oriented application for small and medium enterprises, through the creation of a distributed and peer to peer negotiation platform, flexible enough for allowing its adaptation to different industry sectors. It will support automated negotiation execution based on knowledge sharing and self-learning

Being analogous to real life ecosystems, their features such as heterogeneity, openness, stability, security and fitness of their population (Small and Medium Enterprises, SMEs), that impact on the distributed learning process can be characterised in the DBEs. Monitoring of ecosystem characteristics will guarantee equal opportunity, efficiency, effectiveness, trust and worth, and privacy.

The ONE (Open Negotiation Environment) project[1] aims to develop a business oriented application for small and medium enterprises, through the creation

[1] http://one-project.eu

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of a distributed and peer to peer negotiation platform, flexible enough for allowing its adaptation to different industry sectors. It will support automated negotiation execution based on knowledge sharing and self-learning. Monitoring ecosystem characteristics in a negotiation environment such as ONE, will serve to have hints on the policies to take related to the whole environment such as improving its openness for increasing the heterogeneity.

This paper is organized as follows: Section 2 will mention some ecosystem characteristics and why they should be monitored. Section 3 will explain how the measure of the diversity can be used in a business environment. Section 4 will present a simple example on how the monitoring of the ecosystem characteristics can affect on the overall performance. Finally Section 5 will present conclusions and future work.

2 Ecosystem Characteristics

An ecosystem is a self-sustaining association of plants, animals, and the physical environment in which they live. It is composed by two main components: Community, which refers to the organisms (plants and animals) in an ecosystem, and Habitat, which refers to the type of environment that the organisms have adapted to and live in. In a DBE the community is composed by the SMEs, and the habitat is the negotiation environment.

The DBE concept is concerned with the development of an ecosystem inspired approach to the design of agent systems [4]. In this context an ecosystem can be viewed as an entity composed of one or more communities of living organisms, in which organisms conduct frequent, flexible local interactions with each other and with the environment that they inhabit[5]. Although the capability of each organism itself may be very simple, the collective behaviours and the overall functionality arising from their interactions exceed the capacities of any individual organism, as it happens from the resulting negotiations and subsequent coalitions between SMEs.

The introduction of new elements into an ecosystem can have a disruptive effect. In some cases, it can lead to ecological collapse or "trophic cascading" and the death of many species belonging to the ecosystem in question. Under this deterministic vision, the abstract notion of ecological health attempts to measure the robustness and recovery capacity of an ecosystem; that is, how far the ecosystem is can go away from its steady state ([1], [2]). Ecosystems can achieve and be maintained in states far from its equilibrium or steady state, through its openness (or non-isolation) property, which has as a consequence in the ecosystem's diversity [3].

Diversity has a significant role in Business environments as it can help providing equal opportunities for each different activity performed in the environment. The measure of heterogeneity or diversity is key to stabilize an ecosystem of companies with dynamic deals. The main causes of instability that nowadays are foreseen are: imperfect data (lack of data, bad data, wrong data, delayed data, distorted data, etc), dynamic market (chaotic changing demand, and increasing competition), and finally the lack of an appropriate supporting environment and knowledge.

The most common diversity measure, the Shannon-Wiener index, is entropy, giving the uncertainty in the outcome of a sampling process [6]. When it is calculated using logarithms to the base two, it is the minimum number of yes/no questions required, on the average, to determine the identity of a sampled species; it is the mean depth of a maximally efficient dichotomous key.

3 SME Activity Diversity Measure

Here we pretend to explain the significance of the diversity measure and how it can be used for the overall performance of the DBE.

In the DBE, SMEs can offer complex services and create new market opportunities, combining and sharing knowledge, products, services and infrastructures by joining together. Based on the Business Process Simulation (BPS) model for using it as example for this section, a business process has among other elements, resources and activities [7]. In this example, SMEs can run business processes where each related activity is developed by the different SMEs (being the resource element in the model) whose working field is related to it.

Each negotiation is focused on one or more items, often related to the partners specific business activity. In the case of the ONE platform, there will be different items being negotiated, and the diversity will depend on how many negotiations are being made containing each one of them. The diversity is important because a high level of diversity here, represents an even competition for each partner's interests or activities, what should result on good agreements as there should be enough options to choose from.

Let us take for example a football (or soccer) team. In a football team, there is the need of some kind of diversity level, not everybody has to be a defender, or a goalkeeper. The team needs every position covered, what gives as a result a high diversity level, but also not every position needs to have an equal number of elements, the optimal level of diversity depends on the environment's scope. In the case of the ONE platform, many offers will be available for different activities, then every activity should have enough partners to attend these offers, and compete between them. Let's take for example that there are 8 different activities represented in the ONE platform by different partners over a population of 1000 partners (table 1).

Table 1. Activities distribution with high diversity

Service	Population
Cleaning	125
Security	125
Catering	125
Transport	125
Logistics	125
Porterage	125
Reception	125
Green Management	125

Using the Shannon-Wiener diversity index:

$$H' = -\sum_{i=1}^{S} p_i \ln(p_i) \tag{1}$$

$$p_i = \frac{n_i}{N} \tag{2}$$

Where:

- H' Is the Shannon-Wiener Index.
- p_i Is the relative abundance of each species. Calculated by the number of elements for each species (n_i) divided by the total number of elements (N).
- S Is the number of species.

It has a diversity index of $H' = 2,0794$, which is the maximum possible value. Normalizing the value, we have $H' = 1$. In this case, with high entropy, we can

Table 2. Activities distribution with high diversity

Service	Population
Cleaning	438
Security	88
Catering	124
Transport	36
Logistics	5
Porterage	48
Reception	163
Green Management	98

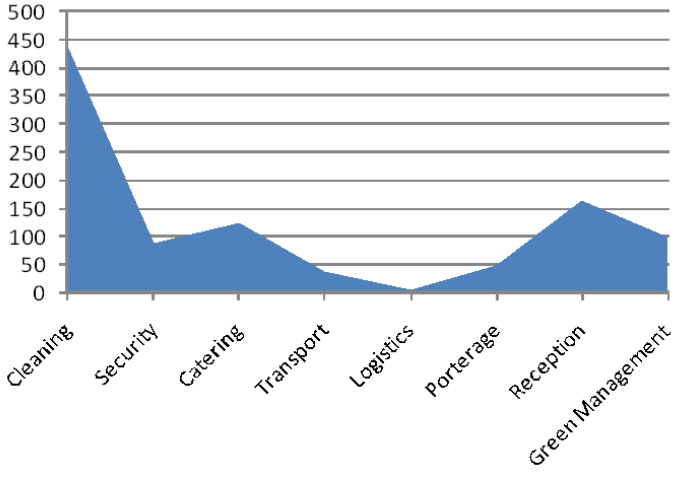

Fig. 1. Example of a low diverse distribution of the activities

see that there are a lot of competition on every activity, and also, every activity has enough people when an offer related to it arrives.

If the population is not so diverse as in the previous case (table 2).

The distribution is as shown in the figure 1. The diversity normalized (using the maximum index value, $H_{max} = \ln(S)$) in this case is $H' = 0,7933$. We have too many in the Cleaning, and a lack in Logistics, this is because the diversity index has been affected, and probably will affect on the result on the negotiations.

4 Diversity Measure Example

SMEs can look for other enterprises which perform complimentary activities, and together perform complex business processes by the aggregation of their services. We developed a simple simulation in Repast[2]. Repast is a free and open source agent-based modelling toolkit developed in Java. The simulation represents an environment where a population of different resources (the species), where each one of them can perform only one activity, have to look for another resource which can perform another different activity, if they do not find it it means that they fail to create a business process. For keeping the simulation as simple as possible, at each timestep the SMEs look for another with a random activity different from the activity they can perform.

We will track the activities' diversity at each timestep, and try to find a relationship between diversity and business processes creation failure. It is supposed that at a higher diversity value, there will be a lower number of failed business processes creation. This is because at higher diversity values, the resources will have more options to choose from for each activity. The equation used for calculating the diversity will be the Shannon-Wiener Index explained in the previous section.

For this case, the species will be recognized by the resources activities. So each species will be represented by an activity. We will run the experiment starting with a low diversity inserting the 75% of the elements belonging to the same species (this means, 75% of SMEs that perform the same activity) and the 25% remaining will belong to a random species (there will be a total of 100 elements and 8 different species). At each timestep, the half of the population will try to create a business deal, if they do not succeed because they did not achieve to find another resource capable to perform a different activity, it will be recorded a *business deal creation failure*.

From the timestep 5000 onward depending on the diversity value, the environment will allow the entrance of new resources which will replace the current ones, keeping the population's number. The system will try to keep the diversity as high as possible (above 0.98 for this experiment), the system will remove a random resource and add a new one that performs a random activity. This should make the diversity raise from timestep 5000, and reduce the number of *business deal creation failure* at each timestep (figure 2).

[2] http://repast.sourceforge.net

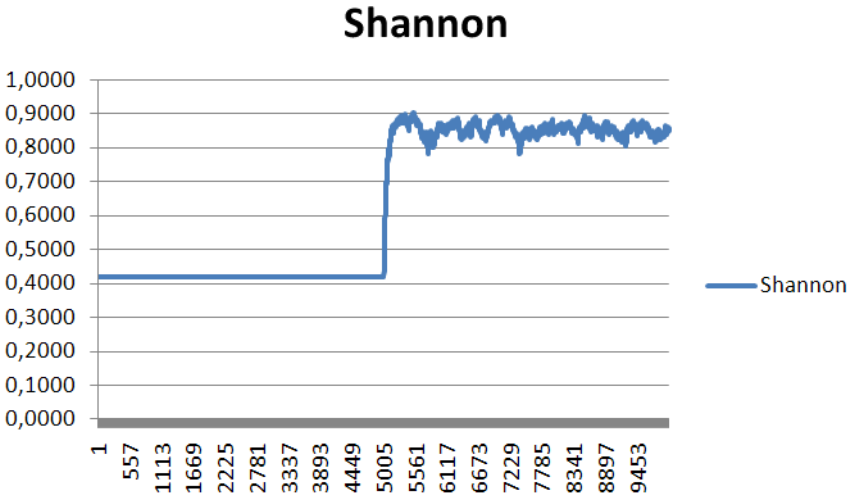

Fig. 2. Average Business Deal Creation Failure and Diversity

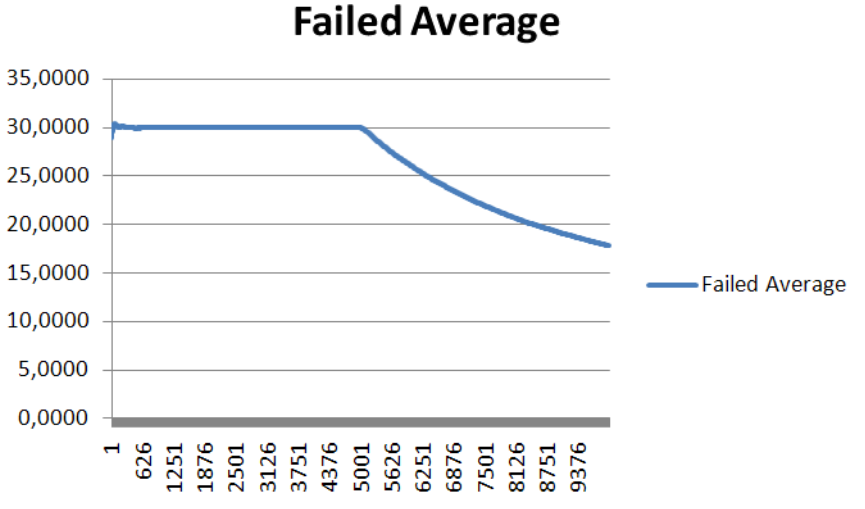

Fig. 3. Average Business Deal Creation Failure and Diversity

As expected, the average business deal creation failure per time-step falls once the environment "opens" itself allowing the entrance and departure of the resources. This can be seen on the figure 3, where after the time step 5000 the average business deal creation failure drops significantly. This could seem obvious, but the real application here is the use of the diversity monitor to encourage the DBE members to enter or exit for the environment.

From an administration point of view, an ecosystem characteristics monitor can give significant information to promote actions on the whole system which could improve the overall performance.

5 Conclusions and Future Work

An essential element of ecosystems is the negotiation of alliances, which enable companies to join competencies as well as services and products into a complex offering. Given this, DBEs should be empowered with a tool to support tactical negotiation and agreement processes among participants. This environment should support the creation of Virtual Organizations with a common business goal, offering complex services by the aggregation of its member's services, and should facilitate the building, stabilization, and improvement of the ecosystem performance on a shorter time frame.

The measure of ecology's properties in business environments can have different applications. In the field of recommender systems for example, it can be used for recommending on the negotiation style for each user in a negotiation environment [9]. In the current paper we present another application on the ecosystem monitoring on a business environment, but the application is not for the individual user; is for the environment as a whole. The data extracted from a ecosystem monitoring application can be used for improving the whole system, helping to take decisions like promoting the entrance of new members in the system (which can be translated on improving the ecosystem's openness).

In this paper we presented an example, in a simplified environment on how the diversity measure could affect on it, and how could be improved. Normally, real DBEs are more complex and not always the highest diversity index is better. Each environment has to be studied and evaluated, for example in business environments not every service has the same demand and then, not every service should have the same offer, this means that not necessarily the services' diversity index should be at the highest value.

Currently we have developed a monitoring tool for the ONE platform, and in the future it is expected to use its output to make recommendations for improving the system, but first a relation between the retrieved data and the system's results must be defined, in the meantime it is being used for monitoring the overall activity of the system within different metrics. As said before, it is necessary to find which are the best values on the indexes for the best overall performance, and not always look for maximizing them (like the case of the diversity index), and that can be done only observing the activity on the running platform.

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