Journal of Intelligence Studies in Business

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Publication details, including instructions for authors and subscription information: https://ojs.hh.se/index.php/JISIB/index

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Vincent Grèzes[a]*, Riccardo Bonazzi[a] and Francesco Maria Cimmino[a]

[a]Entrepreneuriat & Management Institute, University of Applied Sciences Western Switzerland, HES-SO Valais Wallis, Switzerland; *Vincent.Grezes@hevs.ch

To cite this article: Grèzes, V., Bonazzi, R., & Cimmino, F.M: (2020) Atman: Intelligent information gap detection for learning organizations: First steps toward computational collective intelligence for decision making. *Journal of Intelligence Studies in Business*. 10 (2) 26-31.

Article URL: https://ojs.hh.se/index.php/JISIB/article/view/568

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Journal of Intelligence Studies in Business
Vol. 10, No. 2 (2020) pp. 26-31
Open Access: Freely available at: https://ojs.hh.se/

Atman: Intelligent information gap detection for learning organizations: First steps toward computational collective intelligence for decision making

Vincent Grèzes[a]*, Riccardo Bonazzi[a] and Francesco Maria Cimmino[a]

[a]*Entrepreneuriat & Management Institute, University of Applied Sciences Western Switzerland, HES-SO Valais Wallis, Switzerland*

**Corresponding author: Vincent.Grezes@hevs.ch*

Received 20 January 2020 Accepted 15 May 2020

ABSTRACT Companies' environments change constantly and very quickly, so each company must be aligned with its environment and understand what is happening to maintain and improve its performance. To constantly adapt to its environment, the company must integrate a learning process in relation to what is happening and become a "learning company." This posture will ensure organizational effectiveness in relation to changes in the environment and allow companies to achieve goals under the best conditions. Our project aims at delivering a competitive and collective intelligence service allowing to support decision making processes through the diagnostic of alignment between internal knowledge of the organization and available external information.

KEYWORDS Contingency theory, environmental scanning, knowledge-based view, learning organization, machine learning

1. INTRODUCTION

Each company's environment changes constantly and very quickly, so the company must be aligned with its environment and understand what is happening to maintain and improve its performance. To constantly adapt to its environment, the company must integrate a learning process in relation to what is happening and become a "learning company". This posture will ensure organizational effectiveness in relation to changes in the environment and allow them to achieve goals under the best conditions.

Contingency theories suggest that there is no single best way to behave, coordinate or lead, and that in different situations, a style of management and leadership may not be effective (Fiedler 1964). Therefore, the optimal organization or management style is dependent on different external and internal variables: the is no universal way to lead. Moreover, those theories argue that effective organizations must be aligned within their subsystems and environment.

According to this approach, the effectiveness of decision-making depends on aspects of the situation, such as the amount of relevant information held by the leader and his or her subordinates, and the acceptance of the decision by the subordinates (Vroom and Yetton 1973).

Organizational learning theory (Cangelosi and Dill 1965) supports that to be competitive in a changing environment, the company must adapt its actions to achieve its goals and optimize the degree of alignment between expected and achieved results. For learning to occur, the company must (1) make a conscious decision to change in response to the

circumstances, (2) consciously link the action to the result and (3) remember the result.

Initial learning takes place at the individual level. However, it becomes organizational learning once the information is shared, formalized, and stored in the organization to be transmitted and used for decision-making. These personal, organizational and environmental approaches to learning inspired us to name our project : “Atman” which refers, in the Hindu philosophy, to the concept of “vital breath” coming from inside (self) or outside the body (cosmic) to a transpersonal relationship (organizational).

The first part of the learning process involves the acquisition of data in the form of a "memory" of valid action-result links, the environmental conditions under which they are valid, the probabilities of the results and the uncertainty surrounding this probability. Links are constantly updated, either by additions or rejections based on new evidence. There are many ways to acquire these links, including experience, experiments, benchmarking, and transplantation, but they must consist of a conscious effort to discover, confirm or use a cause and effect, or simply be blind actions based on chance. Successful companies then analyze their environment for signs of change, real or anticipated, to determine whether change is necessary: this implies that they (a) have learned which indicators are important to analyze and (b) have learned what degree of change in the environmental indicator requires a change in actions.

The second part of the process is interpretation. Organizations continuously compare actual results with expected results to update or add to their "memory". Unexpected outcomes should be assessed to determine the causal link, appropriate actions or new action-result links specified if necessary, and enhanced learning.

The third step is adaptation or action. It is at this point that the company takes the interpreted knowledge and uses it to select new action-result links appropriate to the new environmental conditions. The main point here is that it is a continuous process of adaptation to environmental conditions. Once the adaptation is completed, the company's knowledge base is updated to include the new action-result link, probabilities, uncertainty, and applicable conditions. The process is ongoing. This feedback is an ongoing and iterative process.

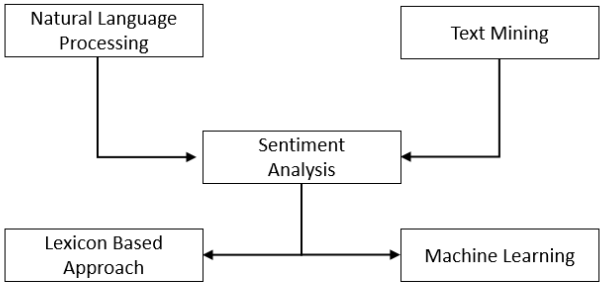

Figure 1 Data mining technics involved in text analysis.

2. STATE OF THE ART

Competitive and business intelligence solution providers are now able to offer services based on the use of artificial intelligence interfaced with the user in the form of a chatbot that processes the company's marketing, sales, customer relations, operations and Internet of things data, for example those found at crystal.ai.

In addition, many conceptual proposals for environmental monitoring are proposed in the literature (Camponovo G., Pigneur, Y. 2004a, 2004b; Camponovo G. 2009; Grèzes et al. 2012; de Almeida, F. C., Lesca, H. 2019). The link between environmental monitoring and corporate learning is also considered by Choo (2001).

However, these approaches do not take into consideration the computational diagnosis of the alignment of the company’s internal (tacit and explicit) and external data, nor the added value of an additional organizational recommendation service.

Nevertheless, several data mining techniques can be considered to deal with the computer diagnosis of the alignment of internal and external company data (see Figure 1). Natural language processing (NLP) is a field of computer science concerned with the interactions between computers and human (natural) languages. With the diffusion of techniques of data mining (the set of processes developed to acquire huge amounts of information) we made developments in the field of text-mining based on the same principle, but the data is extracted from texts.

With the diffusion of commercial websites that have a huge amount of feedback via user comment and social platforms such as Twitter and Facebook, researchers have the possibility to access a new field of data: opinion/sentimental driven data. This research area is called sentiment analysis (SA) or opinion mining (OM). Before reviewing the two principals’ families of methodologies to make a

sentiment analysis, it can be useful to give definitions of sentiment analysis (SA) or opinion mining (OM), to clarify.

Vindoline, G., & Chandrasekaran, R. M. (2012) define it as "the computational study of people's opinions, attitudes and emotions toward an entity", while Nasukawa, T., & Yi, J (2003) explain that "the essential issue in sentiment analysis is to identify how sentiments are expressed in texts and whether the expressions indicate positive (favorable) or negative (unfavorable) opinions toward the subject".

Figure 1 shows there are two main methodologies: the "lexicon-based approach" and "machine learning" that are involved in computing natural language data to extract meaning.

The lexicon-based approach is the conversion of a character string (a text) into a list of tokens. To make this operation we had two different approach: dictionary based, or corpus based. The dictionary is the simplest to use, is based on an established map of sentiment where words are pre-categorized. Corpus based is where you have access other the pre-categorized sentiment labels, also to a context.

The core of machine learning is creating an algorithm based on data for solving a specific task. For the analysis of sentiment, we can use different algorithms, some examples are discussed here.

The decision tree algorithm is compared to a tree structure. Each internal node represents a test on an attribute (value above or below a certain number) and each branch represents the result of the test. Bilal (2016) and Wan & Gao (2015) have used this method.

The support vector machine is a binary linear classificatory, which is capable of classifying a value between two classes by a predetermined training set. Here, a text document is not suitable for learning because the input is a vector space and the output is 0 or 1. For this reason, he needs to be formatted properly, as in Patil (2014).

Neural networks are based on a universal approximation theorem that allows us to find patterns between the input and output. This "learning" process is generally based on an "example," more formally called prior information. Boiy (2009) and Neethu (2013) use this technique.

3. RESEARCH QUESTION

In order to facilitate and accelerate the acquisition and processing of relevant information related to the alignment between the organization, its subsystems and its environment, our research question is: How can one promote organizational learning by prescribing useful information based on the continuous evaluation of its current knowledge?

4. OBJECTIVES

Our solution aims at comparing internal company data (business intelligence) with external company data (environmental scanning) to provide a diagnosis of the company's alignment with its environment (technical innovation). This diagnosis will allow the realization of organizational and strategic recommendations for the company (service innovation). The consideration of the recommendations and the implementation of actions by the company will make it possible to modify the company's internal data. This learning will allow the company to realign itself with its environment.

5. METHODOLOGY

To develop this system, we first tested the interest of the alignment diagnostic of two groups of actors using the lexicon approach. The tests were focused on the alignment between the knowledge of the group of actors and the firm's formal knowledge. The test's methods were interviews of actors and quantitative analysis of qualitative data with

War therefore is an act of violence intended to compel our opponent to fulfil our will. (Clausewitz)

Sun Tzu said: The art of war is of vital importance to the State. (Sun Tzu)

	war	act	violenc	intend	compel	oppon	fulfil	sun	tzu	art	vital	import	state
Clausewitz	2	1	1	1	1	1	1	0	0	0	0	0	0
Sun Tzu	1	0	0	0	0	0	0	1	1	1	1	1	1

Figure 2 Example of translation and comparison of phrases.

R. This approach allowed us to realize a lean prototype of the expected process.

To illustrate our approach of NLP with R Studio, we illustrate a simple example by using two public sources available on gutenberg.org. Let us assume that the internal knowledge of the organization is contained in the strategy book "The Art of War" by Sun Tzu. The external knowledge is described by the first chapter of "On War" by Clausewitz.

We assess these two pieces of information in three steps. The first step is internal and external data collection. We convert the two texts into a data frame (in Figure 2 we show how we translate one of the first phrases in each book).

The second step is data interpretation. The document frequency matrix allows one to create polarized word clouds that show the words in common and the words specific to each text. In our example, both sources describe how to deal with the enemy, but the first chapter of Clausewitz seems to focus on war whereas the book by Sun Tzu appears to describe how take advantage of different types of ground.

The third step is identifying learning and prescription to action. The frequency correlation matrix looks at correlations between words to identify clusters. In our example, the book by Sun Tzu (Figure 4, top left) seems to focus on how to beat an enemy. However, the first chapter by Clausewitz extends this notion (Figure 4, top right) and describes how to conduct war. From this, we can suggest to integrate the external source with the internal sources (Figure 4, bottom).

6. TECHNOLOGY DESCRIPTION

Our technology development aims at delivering three improved services. These are internal and external data collection, data interpretation and learning and prescription to action.

6.1 Data collection

Internal data collection is a management information system that centralizes and unifies the collective intelligence through knowledge management. Our proposal aims at facilitating and accelerating acquisition and processing of pertinent information useful to the organization's alignment with its subsystems and environment through external data collection.

Figure 3 Example of word cloud of data.

6.2 Interpretation

The accompaniment and analysis of results aims to lead the organization to understand and interpret the indicators to consider the actions to be taken in order to adapt and align itself as closely as possible with its environment. Human intervention is necessary here to identify the important indicators to be analyzed, and to teach the software the relevant variables and thresholds involving change or learning on the part of the organization (machine learning process).

6.3 Action and Learning

The company's internal documents automatically update, which allows validation of the alignment process (Figure 4).

7. DEVELOPMENT AND FIRST RESULTS

Initial tests were carried out in two situations. The first was a diagnosis of the alignment between the knowledge of a group leading a tourist destination (Association Council of Municipalities) and the content of all the steering studies carried out for their destination (internal tacit and explicit knowledge). The test or our method made it

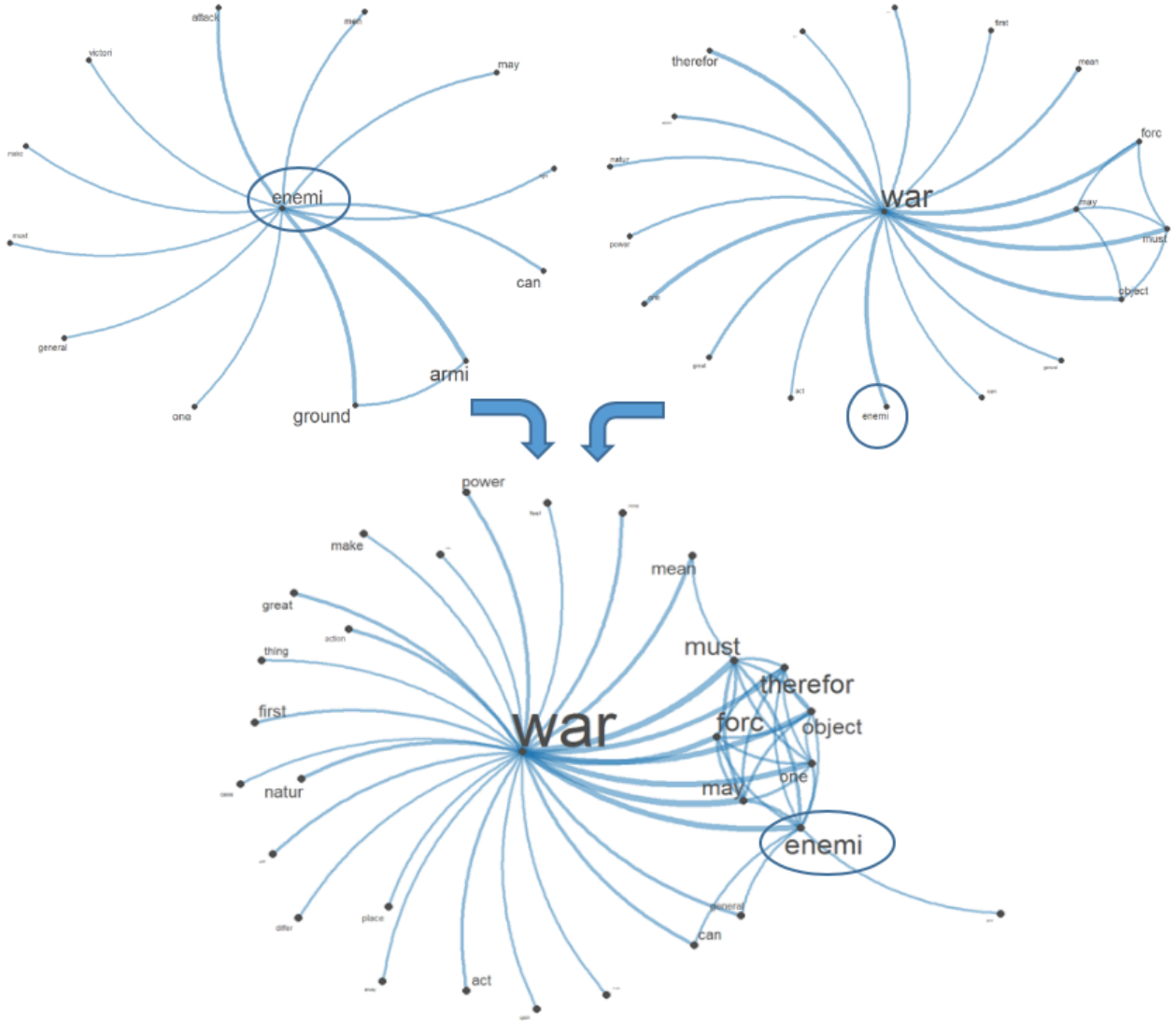

Figure 4 Example of correlation.

possible to highlight the shortcomings and bias of the studies, the distortion between knowledge and content, and to promote the adaptation of the organization to fill the identified gaps.

The second situation was a diagnosis of the alignment between the learning achieved after professional training by a group of collaborators and the formal program. This test revealed the contrast between what participants retained and what the presentation documents contained. This has made it possible to improve the organization of the transmission of the message and to identify the points to be reinforced.

8. BUSINESS BENEFITS AND DISCUSSION

The preliminary study produced a proof of concept that extends the company's current services and creates a clear competitive advantage in the strategic intelligence market, based on a unique positioning in terms of intelligence supported by artificial intelligence technologies. The commercial potential and the extension potential of the solution are linked to the adaptation of the algorithm to different languages. This makes it possible to consider the extension of geographical markets. The expected revenue model is based on licensing the use of the diagnostic application, customization of the modules, referral services for decision making and training services for the companies in the use of the application.

9. DISCUSSION AND CONCLUSION

Our initial results show an interest in continuing the research and integrating the formalization of the knowledge of all employees into the organization's knowledge base to align the data as closely as possible with the available external information.

Our research limits at this point are based on the capacity to develop and test the external data analysis module (technical innovation on Fast Data Retrieval, Machine Learning, NLP) and the recommendation process development (service innovation). In addition, the learning effects of the recommendations will have to be measured.

Further research will focus on the processing of alignments of several sources of internal data with the external data, such as the measurement of the effects of the recommendation on the decision-making process of the organization.

Moreover, an extension of the technique could be particularly useful in terms of competitive intelligence, particularly in the context of the use of the business model canvas as a benchmarking tool (Grèzes et al. 2012) and could be scalable to several type of organization according to the scanning of internal knowledge as a basis for the external monitoring process.

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