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Semantic Identification of Possible Cross-Industry Cooperation

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Abstract: A key aspect of the Cross-Industry Innovation approach is the search for analogue problems and solutions in a variety of industries to find viable cooperation partners. Usually a media based search is conducted to find these partners. However, media based search approaches often suffer from unfiltered search results due to the lack of semantic understanding of the search queries. Thus the filtering of relevant search results takes an additional step within the search process which is time consuming. To improve the process of finding viable partners, the lack of semantic understanding can be remedied by using an ontology-based database. This paper presents a first approach of an ontology based search procedure as well as the embedded structure of the ontology. It specifies how an ontology-based database can be built and points out which stakeholder have to be involved to support the idea of a semantic identification process.

Keywords: Open Innovation, Cross-Industry Innovation, Semantic Search, Ontology

Introduction

With growing competition from increasingly globalised markets, companies are forced to differentiate themselves from competitors by creating new and innovative products (Chesbrough, 2006). To achieve this goal, companies have (amongst others) embraced the concept of Cross-Industry Innovation (CII) which describes a specific approach based on the principle of Open Innovation. Transfer proved technologies or knowledge domains from other industries to create innovative and often radical solutions to problems of the own industry is the idea behind that concept (Enkel and Dürmüller, 2008). Therefore, a methodology for identifying the relevant technologies and knowledge is immensely valuable. Against the background that every industry uses its own set of vocabulary to describe a problem, coping with industry-specific languages is one of the biggest obstacles in this regard (Pocsai, 2000).

The existing approaches in this field concentrate mostly on media-based search procedures (the searcher analyses databases, scientific publications, books, articles and other media manually) (Echterhoff et al., 2013) (Gassmann and Zeschky, 2008) (Brunswicker and Hutschek, 2010). The main challenge with a media-based search is that existing software in this field invariably check for the presence of a certain word. What lacks is an understanding for the contextual meaning (also described as "semantic understanding").

An example for this is the common word "point". Depending on the context, this word can have multiple meanings. For example, it can be used to describe a particular location, the action of directing at something and an argument in a discussion. However, the software is checking for its presence and not the implicit meaning of the word, which can therefore lead to a bulk of irrelevant results. The searcher then has to check these results and select manually the ones with the intended meaning. This can, however, be a huge assignment and is therefore very inefficient. This paper presents a first approach of a semantic methodology which includes an ontology-based search procedure.

Current Understanding

There are multiple approaches which focus on systematically finding analogue problems and solutions in other industries (Gassmann and Zeschky, 2008) (Echterhoff et al., 2013) (Schmitz, 2013) (Brunswicker and Hutschek, 2010). While these approaches differ in detail, they all propose an almost similar approach and can be described by the four steps:

- Problem Abstraction
- Search for Analogies
- Assessment
- Adaption

Within the first step, the problem at hand has to be abstracted in order to find similar problems with comparable underlying problems in other industries. The abstraction is an essential step, since it greatly influences the range of identified solutions (Holyoak and Thagard, 1995). The abstract formulation enables the search for solutions in different

knowledge domains. The main focus of this search is to look for analogue problems and related solutions in other industries by mostly conducting a media-based search. Thereby, the searcher analyses databases, scientific publications other media. This media-based search can be conducted manually or with the help of software (Kaiser et al., 2013). Once enough promising analogies have been found, the results are analysed in-depth and assessed regarding various criteria like degree of similarity, technological distance, cost etc. In the end, the best rated solution is chosen and adapted to the problem to be solved.

The four-step approach described above offers a guideline to engineers and therefore systematizes the searching process. However, there are some inherent problems with this approach especially in the second step of searching for analogous problems. If a person-based search method is conducted, the results are heavily depending on the individuals that are questioned. It is therefore hard to systematize the procedure or predict the outcome. Using media-based search, the process itself is more predictable and systematic, but analysing industry-spanning knowledge resources demands specific knowledge for every knowledge domain (Pocsai, 2000).

The lack of cross-divisional knowledge can lead to overlooking promising results. To exhaust the full extent of the Cross-Industry potential, the search for analogous problems and related solutions has to be based on a semantic understanding. This raises the research question of how to remedy such a lack of semantic understanding with reasonable effort?

Findings

The lack of semantic understanding can be remedied by creating a suitable database that uses ontology. Ontology is a formal definition of entities and their interrelationships. In simple terms, this means that unstructured pieces of information can be transferred into a dedicated structure which then in turn allows displaying the semantic meaning of those pieces of information. Figure 1 shows the ontological structure of the above mentioned example “point” and the allocation of the words to their respective entities (Gaag, 2010).

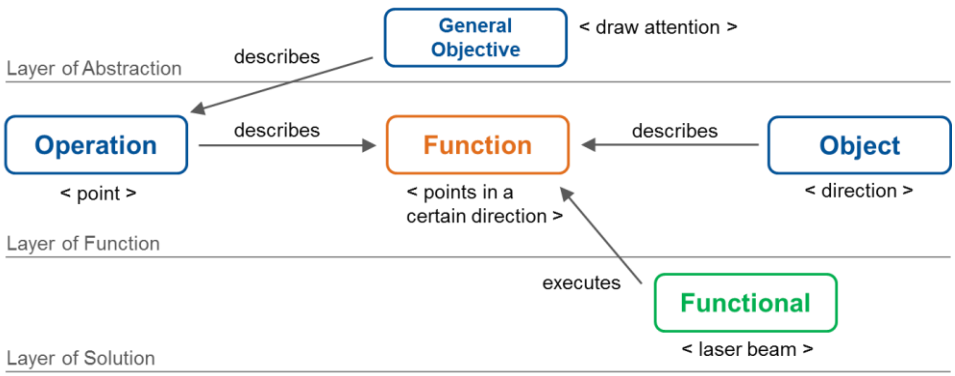

Figure 1 Illustration of the ontological structure using the example “point” (adapted from Gaag, 2010)

Using the example "point" - this means the sentence "a laser beam points in a certain direction" is not only saved as eight individual words. Rather the semantic meaning can also be embedded by classifying "laser beam" as subject (functional), "points" as verb (operation) and "direction" as object which is affected by the subject.

Therefore, the database now "understands" the interdependencies between those words. Thereby, it can now be searched for semantic meanings rather than just the presence of words which in the end promises far more relevant search results and therefore offers high potential to efficiently identify proper solutions for technical problems to be solved.

To apply the ontological structure within the search for Cross-Industry partners, established approaches (Echterhoff, 2013) (Kaiser et al., 2013) (Gaag, 2010) from the field of semantic searching procedures are transferred in the area of CII. Those approaches have been mainly developed for specific needs in the area of text mining. This means that two so far not related research areas are combined and thus significant potentials are accessed. Based on these methods a semantic search approach to leverage the search in knowledge domains of other industries for analogies is derived. As described above the leverage effect is emphasised by an ontology-based database to improve the semantic understanding of the search queries. Thus the more refined search approach decrease the amount of effort needed to manually filter the results. Figure 2 shows the idea of the database and how it must be filled with data.

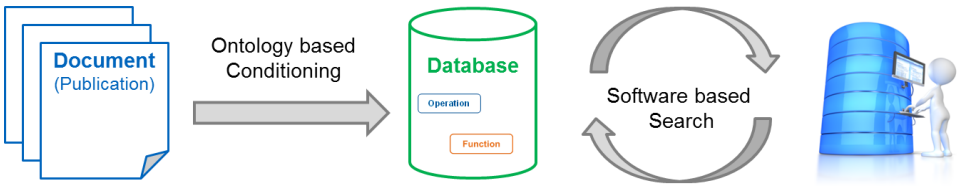

Figure 2 Idea of an ontology based database

To initially create a sufficient basis for a semantic search approach companies have to reveal their gained knowledge. Revealing means the companies provide their knowledge by filling the database with information. The information can either be derived from patents or other documents describing a solution to a given problem. Due to the nature of the ontology the information cannot transferred directly into the database and therefore must be adapted to fit the structure of the ontology. Thus a preparation is needed to match the data structure and allocate the information to their respective entities. Once the database is filled with information, it provides a fundamental knowledge cluster to search for analogue problems.

Beside the creation and filling of such an ontology based database there is the question of the overall environment the database is embedded in. The challenge is the definition of a stakeholder responsible for database. This means a stakeholder must permanently maintain the database and handle the search queries. However, by searching the database for viable cooperation partners a company reveals its recent research activities which has to be prohibited. The idea is to introduce a trustworthy third party acting as a mediator between stakeholder searching for analogue problems and stakeholder providing solutions to a given problem. For example, a handy third party could be an industry

association acting as a mediator. Figure 3 illustrates the applicable methodology and how the database can be embedded in an industrial environment.

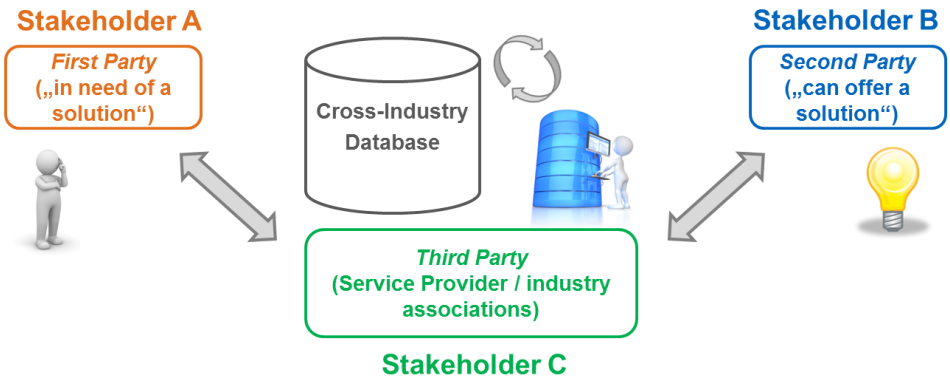

Figure 3 Ontology based database embedded in an industrial environment

There are three major parties involved in the industry applicable methodology. The first party represents stakeholders which are lacking proper solutions to given problems. Therefore they want to utilize the semantic search to find possible cross-industry partners to transfer solutions from a different industry. The second party represents stakeholder that already have a solution to a given problem and published these solutions in the database. The third party represents the mediator which is responsible for maintaining the database and handles the search requests.

To make use of the semantic search approach stakeholder A abstracts the problem and files a search request to a third party service provider. The third party service provider, acting as a mediator between a party searching for solutions and a party providing solutions to given problems, handles the request und analyses the database to find matching results. Every matching result, i.e. a possible solution to the given problem, is linked to a stakeholder which provided the solution. While the second party won’t be informed about the search request itself, it will be informed by the service provider about positive matchings to the search request. Thus the second party can decide whether it wants to participate in a cross industry cooperation or not.

There are some benefits associated with the introduction of service provider or industry associations as a third party mediator. Due to the fact that the service provider is fully responsible for providing and maintaining the database the companies themselves don’t have to deal with the effort needed to build up the technical environment. As a result, the outsourcing of the database lowers the initial threshold for the companies to participate in such a programme. Nevertheless, the database has to be filled with content by the companies. Thereby, the quality and size of the database, which directly influences the search results, still depends on the companies’ acceptance provide their knowledge.

Another advantage of a mediator is the prevention of accidental knowledge flow. The mediator represents an interface between the stakeholder searching for analogue problems and the one offering a proper solution. Thus an unintentional transfer of

knowledge between the involved stakeholders is avoided. However, the third party service provider has to be highly trustworthy and accepted by the company as a mediator. Furthermore, by utilizing a third party to search and maintain the ontology-based database, the search activities of the stakeholder won't be revealed to the public or competitors. Therefore a possible leakage of research activates by revealing the search queries can be prohibited.

There are challenges with the implementation of the industry applicable methodology. While the database is maintained by a third party service provider, the size of the database, i.e. the amount of information stored in it, depends on the acceptance of companies to provide their information. However, the usefulness of such a database greatly correlates with the amount of information stored in it. Therefore a lot of effort has to be put into the initial implementation phase as well as the maintenance of the database. Furthermore, the accessibility to the information has to be limited to a trustworthy third party.

Conclusion & Outlook

The ontology-based approach discussed in this paper explored the effect of using semantic identification of possible cooperation partner to facilitate the Cross-Industry Innovation by solving technical problems by identifying proved technologies from other industries. In particular the increasing efficiency of the searching procedure provides an enormous expansion of the solution space.

The described methodology represents the structure of a semantic search framework. It includes the idea to utilize Ontology to realize a semantic search. Furthermore the ontology based database is described within the paper and how it can be embedded in an industrial environment. In future work the approach of semantic identification of possible Cross-Industry Cooperation is investigated in more detail. For Example, an evaluation on the effort of building a database has to be conducted. Additionally, the interdependencies of the stakeholders and the type of cooperation must be further clarified. Regarding the ontology, the idea of the ontological structure has to be defined in detail and secured.

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Feedback

The author is interested in a critical reflection of the idea to use ontologies for identifying proper technologies in other industries. In particular a discussion of advantages and disadvantages would be enormously helpful.