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Identification of interdisciplinary ideas

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ABSTRACT

Literature shows interdisciplinary research as an essential driver for innovation. Ideas that are used as a starting point for this research are of an interdisciplinary nature because they combine aspects from different disciplines. The identification of interdisciplinary ideas at an early stage enables the start of interdisciplinary research and thus, it enables advances to be made in the innovation process. We propose a new methodology that combines semantic clustering and classification to estimate the interdisciplinary nature of ideas from a set of given ideas. The set is created automatically by use of an existing idea mining approach. Ideas from this set are semantically clustered to obtain concepts that are latent in the data. The relationship between each concept and each discipline pair from a set of given disciplines is calculated. Based on the degree of relationship, concepts are used to represent the interdisciplinary field spanned by the two disciplines. The ideas standing behind these concepts are identified as interdisciplinary ideas. As a result, the proposed methodology enables an estimation of the interdisciplinary nature of given ideas. The results might be helpful for researchers as well as for decision makers in the field of innovation management.

1. Introduction

Literature defines interdisciplinary research as a research that covers several different disciplines and it shows that interdisciplinary research is an essential driver for innovation (Easton, 1991). This research often transcends the existing scope of a specific discipline, it often founds and pushes new technological fields, and it often accelerate scientific discovery (Millar, 2013). It fits the definition of the word innovation that refers to the Latin term innovation (something that is newly created).

An innovation process drives a new idea (Guiltinan & Paul, 1991), to its realization to obtain an innovative product that can be successfully introduced in the market and that increases producer or customer value (Mckeown, 2008). The process of creating an innovation starts with research activities based on a new idea (Moewslein & Matthaei, 2008). After developing and producing, a product is created and introduced in the market. After a while, it can be seen that the product possibly is successful in the market because it increases producer or customer value. In this case, the product can be considered as an innovation and the research idea standing behind the product can be considered as an innovative idea. Unfortunately, the innovative potential of a new idea can only be estimated afterwards: after the corresponding product is successful introduced in the market. Today, a high percentage of innovations fail because non-innovative ideas are selected as a starting point. This makes the innovation process time- and cost-consuming (Disselkamp, 2005), and thus, decision makers in the field of innovation management need estimations about the innovative potential of an idea beforehand.

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As described above, interdisciplinary research is an essential driver for innovation. This means, the probability of processing a successful innovation is normally larger by applying interdisciplinary research than by applying research that is focused on a single discipline. Ideas standing behind interdisciplinary research are characterized by an interdisciplinary nature to fulfill the requirement that the subsequent research has to cover several disciplines. Estimations about the interdisciplinary nature of an idea can be done beforehand: before starting the innovation process. Providing these interdisciplinary ideas as a substitute for innovative ideas might be helpful for decision makers in the field of innovation management.

The interdisciplinary nature of an idea can be estimated by the idea's creator subsequent to the generation of manual ideas. In recent years, literature introduces idea mining approaches that aim at generating ideas automatically where existing ideas are identified and extracted from text documents or from the internet (Ghanem, Minai, & Uber, 2010; Thorleuchter, Van den Poel, & Prinzie, 2010a). These automated processes generate a large number of ideas e.g. to advance a given topic or to solve a given problem. Relevant ideas are often described by texts on several webpages in the internet. Thus, these automated approaches extract many idea duplications or similar ideas that should be grouped for further processing. Semantic clustering can be used to identify the latent semantic textual patterns standing behind a group of ideas (Zhong & Li, 2010). Furthermore, these patterns are named concepts. They can be used to represent the corresponding idea groups. Estimations about the interdisciplinary nature of these concepts might be used to determine the interdisciplinary nature of all corresponding ideas within a group.

Interdisciplinary means that research is related to several disciplines and it is also important to know that disciplines change over time e.g. as an area of research that suddenly appears, that grows, that shrinks, that melts, and that transforms (National Academy of Sciences, National Academy of Engineering, & Institute Medicine, 2004). An idea that is considered as interdisciplinary today possibly can be considered as disciplinary tomorrow. Thus, the interdisciplinary nature of an idea depends from current disciplines and their current definitions. For the estimation about the interdisciplinary nature of an idea, it is important to provide a set of current disciplines including content descriptions. Then, concepts as represented by textual patterns (see above) can be assigned to classes as represented by descriptions of current disciplines from the provided set. Text classification can be applied to enable this assignment.

We propose a new methodology that estimates the interdisciplinary nature of ideas. It enables an automated process where estimation can be done for the large number of ideas provided by an existing idea mining approach. Latent semantic indexing (LSI) (Deerwester, Dumais, Furnas, Landauer, & Harshman, 1990), is used for semantic clustering. This groups similar ideas and identifies the concepts standing behind the groups. In a classification step, concepts are assigned to disciplines to identify their interdisciplinary nature. As a result, ideas standing behind the interdisciplinary concepts are presented as ideas with interdisciplinary nature and they might be used for innovation purposes.

The paper is structures as follows: In Section 2, a literature background is provided. The proposed methodology is depicted in Section 3. A case study (Section 4) applies the proposed methodology in the field of regenerative energy. The methodology is evaluated and example results (interdisciplinary ideas) are presented.

Overall, results from the case study show that the methodology is successful compared to related approaches and thus, it might help decision makers to improve the performance of the innovation process.

2. Background

2.1. Idea mining

Today, a huge amount of data is provided in the internet and many interesting ideas can be found within these data. A manual identification of ideas by human experts is not suitable because of the large size of data. Thus, (semi-) automatic approaches are provided to extract ideas from data especially textual data (Finzen, Kintz, & Kaufmann, 2012; Ghanem, Minai, & Uber, 2010; Lippmann, 2013; Trevisan, Neunerdt, & Jakobs, 2012).

Idea mining (Thorleuchter, Van den Poel, & Prinzie, 2010a), enables an automatic process for extracting ideas specifically from the technological domain. It is based on an idea definition from technique philosophy where ideas are divided in two parts: means and ends. The ideas are used to solve technological problems that also consist of means and ends. In a first step, idea mining identifies means and ends from the provided textual information that describes a problem. In a second step, idea mining searches in new information sources for textual patterns that contain either a means or an end from the problem description and that also contain a corresponding new means or new end. This identifies textual patterns where a new means corresponds to a given end or where a new end corresponds to a given means. These patterns represent a new idea and they can be used to solve the given problem. An example is a transistor (a means) used for switching electronic signals (a corresponding end). How could this process be improved? This question represents the technological problem. Searching e.g. in the internet shows that the term nanomagnet often occurs within a specific term distance together with the terms from the corresponding end. Thus, nanomagnet is a new means that also can be used for switching electronic signals perhaps with better performance than a transistor. This new idea might solve the given technological problem.

Based on a given problem description, idea mining normally identifies a large number of possible solution ideas automatically. To present the ideas in a comprehensible way to human experts, a text phrase is built for each idea. The text phrase is taken over one-to-one from the document where the idea is described. Human experts evaluate the ideas to show whether they can be put successfully into practice.

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