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論 文 題 目	Patent Claim Segmentation Through Neural-Based Semantic Analysis		
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論文の内容の要旨

The transition from the last century brought a considerable number of changes to international relations and trade, with a sharp acceleration of the Globalization process. The previous focus of industrial development is being changed from the production of physical assets to the concept of Intellectual Property, which is regulated in most countries by the patent system. With an increasing number of patents being applied and granted, management of innovation related information became an arduous task, leading to the development of a variety of approaches for its automation. While the use of Natural Language Processing techniques is well established among such approaches, the characteristics of this type of document still provides challenges to be addressed.

In this dissertation, I present a method for identifying and classifying textual segments from patent documents into relevant information types. It aims to facilitate the categorization and comparison of inventions by means of semantic analysis and is centered on claim sentences. The claims are the main information source in patent reviewing and litigation, so they are an important target for automation. The central aspects of the presented method, and major contributions of this work, are the annotation methodology for identifying elements of ideas in patent claims, that emulates the workflow of a patent professional, and the gathering and exploitation of multiple linguistic features from different sources. Those features enable the use of powerful Machine Learning techniques known as Deep Learning (i.e., Deep Artificial Neural Networks) even in cases where available training data is scarce.

This research comprises the study of several aspects of patent information processing and describes the development of novel approaches to deal with them. In particular, the structuring of patent documents and claims from digitalized paper forms; the computational representation of lexical and semantic aspects of natural language; and the development and optimization of Deep Learning architectures for claim annotation. The analysis of claims is grounded on linguistic concepts and segmentation is done in a principled way, following patent expert advice. A manually annotated dataset for patent claims complete the set of

contributions. Some basic premises explored in this work regard the syntactic constraints found in patent claims, which allow simplifications in appropriate methods or the use of techniques that would otherwise not be effective, while avoiding the otherwise effective solutions that fail when applied to claims. Experimental evaluation is performed for each one of the solutions presented, and the benefits and drawbacks of the developed methods discussed in detail. Results indicate that the automated segmentation of claims using the proposed method is viable and produces the desired results. The annotation principles guarantee the usefulness of the results to the patent expert community.

Keywords: Claim segmentation, Patent Information Processing, Semantic analysis, Deep Learning, Natural Language Processing

論文審査の結果の要旨

This thesis presents a novel method using neural-based approach for the problem of Patent Claim segmentation. The major contribution of the thesis is as follows. The first one the candidate shows an efficient method for claim segmentation using a neural method. This is the first time a neural-based approach is applied for patent claim segmentation. For the second contribution, the candidate gives a novel method for word vector representation with named Term Definition Vector (TDV), which are human interpretable. This component is the contribution to the performance of claim segmentation. It can be also applicable for many natural language processing applications. As result, this work is published in the top conference on natural language processing domain (EACL 2017). The third contribution is that the thesis shows an efficient approach to patent document segmentation using the combination distributed semantic representation into sentence representation. In addition, a morphological decomposition system using softmax function is successfully applied to patent claim segmentation.

In overall, this thesis shows an efficient approach for patent claim segmentation. The candidate shows his ability in research. The presentation in the final defense is successful. All the committee members agree that he can graduate.

In conclusion, this is an excellent dissertation and we approve awarding a doctoral degree to Mr. Danilo S. Carvahol.