Multilingual Probabilistic Topic Modeling and its Applications in Web Mining and Search

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ABSTRACT

Multilingual topic models are a fairly novel group of unsupervised, language-independent and generative machine learning models. This tutorial covers all key aspects of their probabilistic framework and demonstrates how to easily integrate these models into frameworks for cross-lingual and multilingual Web mining and search.

1. TUTORIAL GOALS AND MOTIVATION

In the current international data-driven society, it becomes increasingly important to quickly and correctly find answers to a user's information need, so as not to lose the desired data in a vast ocean of information. Companies are increasingly interested in mining multilingual and multi-jargon Web data, and in linking Web data. In such a multilingual, multi-idiomatic and multi-domain (or simply *multi**) setting there is a need to access and mine information across multiple different languages and jargons, that is, we desire effective and cheap tools for cross-lingual information retrieval and search, semantic similarity, and for cross-language clustering, classification and linking of content.

Multilingual topic models can be effectively trained on large-volume of non-parallel, comparable *multi** data and capture the properties of *multi** data directly (e.g., multilingual Wikipedia, news, user-generated content, e-commerce data). They offer an elegant way to represent content across different languages, domains and jargons. State-of-the-art multilingual topic models follow the modeling paradigm established for monolingual settings by probabilistic Latent Semantic Analysis (pLSA) and Latent Dirichlet Allocation (LDA) [1]. A multilingual topic model learns topic distributions over documents (the so-called *per-document topic distributions*) and word distributions over topics (the so-called *per-topic word distributions*). The set of language-independent topics serves as a bridge between languages, jargons and other *multi** content. Each document, regardless of its actual language, can be presented as a mixture of the language-independent cross-lingual concepts, that is cross-lingual topics (modeled by per-document word distributions), while each topic has its own language-specific representation in each language involved in training (modeled by per-topic word distributions). Due to its generic language-independent nature and the power of inference on unseen documents, these mod-

els have been used in a variety of cross-lingual (or -domain and -jargon, or simply *cross-**) tasks that are of large interest for both academia and industry.

2. TUTORIAL OVERVIEW

The tutorial covers recent advances in multilingual topic modeling, with an emphasis on its applications in Web mining and search, and e-commerce. It includes: (1) A high-level overview of the key intuitions and assumptions behind topic modeling in general (starting from monolingual settings) and *multi** topic modeling in specific; (2) The methodology and mathematical foundations including training and inference (e.g., variational Dirichlet, Gibbs sampling); and (3) The application of these models in various cross-lingual and even cross-modal tasks, with a special focus on cross-lingual information retrieval, cross-lingual and cross-jargon Web mining and search, and the evaluation of these tasks.

The tutorial is illustrated with practical cases (e.g., [2, 3]) of using multilingual probabilistic topic models among which are cross-lingual event clustering, cross-lingual document classification, cross-lingual semantic word similarity, and translation and transliteration mining. The tutorial explains cross-lingual information retrieval starting from simpler query likelihood models [3] and leading to more elaborate retrieval models which combine cross-lingual topical knowledge with the relevance modeling retrieval framework [4] and use the topical knowledge for query expansion [3]. It goes deeper into linking user interests to the Web e-commerce data such as linking pins to webshops, processing user generated content such as summarizing tweets, and utilizing the topical knowledge in recommendation systems [5]. In a broader framework the tutorial is relevant for searching social media content, user profiling, computational advertising and multimodal data mining.

3. PARTIAL BIBLIOGRAPHY

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