Modeling content and structure for abstractive review summarization

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Abstract

Reviews are valuable sources of information for many important decision making tasks. Summarizing the massive amount of reviews, which are available these days on many entities and services, is critical to help users better digest the sentiment about an entity or a service and its aspects (i.e. features of the entity or the service). This article presents a novel aspect-based summarization framework that generates an abstract from multiple reviews of an entity without the need for a handcrafted feature taxonomy or any training data. We generate summaries using Natural Language Generation (NLG) by taking into account the importance of aspects, as well as the association between them. We model these information in the form of a tree, called *Aspect Hierarchy Tree (AHT)*, in which nodes indicate the important aspects and edges indicate the relationship between them. We propose and investigate three alternative content selection and structuring models for the automatic construction of an AHT in our summarization framework: 1) *Rhetorical model*, which captures the aspects' importance and relationship by looking at the way people discuss and relate the aspects when expressing opinion in their reviews. 2) *Conceptual model*, which exploits a common-sense knowledge base (e.g. ConceptNet) to find the conceptual association between aspects. 3) *Hybrid model*, which exploits both the rhetorical and conceptual information. Our abstractive summarization framework has the potential to implement one of the proposed models depending on the application or apply all three models and let a user choose the output, depending on his/her desire to use the conceptual, rhetorical or both sources of information. Quantitative and qualitative analysis on the resulting AHTs of the three content selection and structuring models for seven entities in three domains shows that the three models generate AHTs that differ in interesting ways in terms of both content (i.e. selected aspects to be included in the summary) and structure (i.e. the relation between aspects).

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1. Introduction

Reviews are valuable sources of information for customers to make informed decisions and for companies or government to improve their entities or services based on customer feedback. However, it is time-consuming and sometimes impossible for users to go through the huge amount of available reviews to find and digest the important information

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hidden in them. Aspect-based sentiment summarization has been proposed in the past to address this problem. An aspect-based sentiment summarization system takes as input a set of reviews of an entity or a service (e.g., a camera or a vacation-package) and generates as an output a summary containing the opinion toward the entity and its aspects (e.g., the lens of a camera).

The existing aspect-based sentiment summarization systems are mostly *extractive* and produce a summary that contains a flat list of aspects along with the aggregated sentiment and the supporting textual evidence for each aspect (e.g. Titov and McDonald, 2008b). The generated summary, although useful, suffers from the lack of coherence. Also, it does not provide any ordering on the aspects and does not show clearly which aspects are more responsible for the overall opinion of users on the entity, and how the opinions on different aspects relate and affect each other.

Recent research on sentiment summarization has targeted the above mentioned limitations and aims at generating more coherent and informative summaries. To generate a more coherent summary, recent works (Carenini et al., 2013; Di Fabbrizio et al., 2014) follow the *abstractive* summarization approach that takes advantage of Natural Language Generation (NLG) techniques to generate new sentences from the information extracted from the corpus. To identify how opinions on the aspects are related to each other, previous works use a user defined feature taxonomy for each entity (Carenini et al., 2013) or require a large amount of training data to learn the aspect ordering for summary generation (Di Fabbrizio et al., 2014). However, relying on a user-defined feature taxonomy or requiring training data makes the current approaches non-scalable.

In this paper, we propose a novel summarization framework that generates an aspect-based abstract from multiple reviews of an entity without the need for a handcrafted feature taxonomy or any training data. The input to our summarization system is a set of reviews about an entity or a service (e.g. Canon G3) where each sentence of every review is marked with the aspects present in that sentence (e.g. picture, lens) and the polarity (e.g. positive, negative) and strength (e.g. weak, strong) of opinions over each aspect. The polarity and strength (P/S) values are presented jointly with an integer value in the $[-3, +3]$ interval, where $+3$ indicates the most positive and -3 indicates the most negative polarity value.

There are various methods for extracting the aspects and predicting the polarity of opinion (Hu and Liu, 2004c, 2006b; Kim et al., 2011). In this paper we do not focus on aspect extraction and sentiment prediction but rather consider the aspect and their polarity/strength (P/S) information given as input to the system. We also do not attempt to automatically resolve coreferences between aspects. For example, the aspect *"g3"*, *"canon g3"* and *"canon"* were manually collapsed into *"camera"* as a preprocessing step.

Fig. 1 shows two sample input reviews where the aspects and their P/S scores are identified. For example, in R1, aspects *camera*, *photo quality* and *auto mode* are mentioned. The P/S values for the three aspects are [+2], [+3] and [+2] respectively which indicate positive opinion on all aspects.

We generate summaries using NLG by taking into account the importance of aspects as well as the association between them. *Importance of aspects* is used to rank and select aspects to be included in the summary while *aspect association* is considered to better explain how the opinions on aspects affect each other. We model these information in the form of a tree, called *Aspect Hierarchy Tree (AHT)*, in which nodes indicate the important aspects and edges indicate the relationship between them. Such a tree structure helps to find the related aspects when explaining
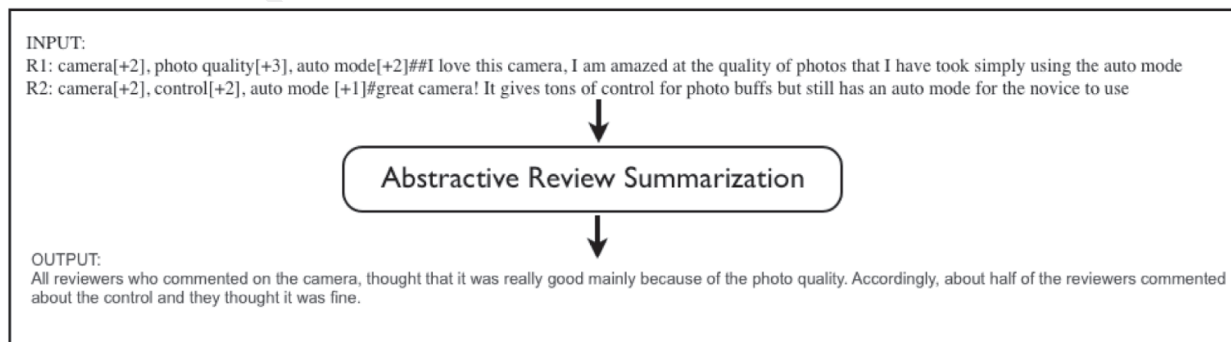

INPUT:
R1: camera[+2], photo quality[+3], auto mode[+2]##I love this camera, I am amazed at the quality of photos that I have took simply using the auto mode
R2: camera[+2], control[+2], auto mode [+1]#great camera! It gives tons of control for photo buffs but still has an auto mode for the novice to use

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OUTPUT:
All reviewers who commented on the camera, thought that it was really good mainly because of the photo quality. Accordingly, about half of the reviewers commented about the control and they thought it was fine.

Fig. 1. A toy example illustrating the input and output of the abstractive summarization system.