Modelling the Consistency between Customer Opinion and Online Rating with VADER Sentiment and Bayesian Networks

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Presenter's Resume

Alexandros Bousdekis

- Current position
  - Post-doctoral Researcher (Athens University of Economics and Business)
    - Title of postdoctoral research: "Advanced data analytics and knowledge discovery for e-service customization"

- Education
  - PhD in Information Systems (National Technical University of Athens)
  - MSc in Manufacturing Systems Engineering (University of Warwick, UK)
  - BSc in Production and Management Engineering (Technical University of Crete)

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Motivation

- With the increased popularity of online bookings, **53% of travellers** state that they would be **unwilling to book a hotel that had no reviews**, while a **10% increase in travel review ratings would increase bookings by more than 5%**.

- These online reviews in the e-tourism era, in the format of both textual reviews (comments) and ratings, generate an **electronic Word Of Mouth (eWOM) effect**.

- In contrast to a pre-designed questionnaire survey, online textual reviews have an **open-structured form** and can:
  - show **customer consumption experiences**
  - highlight the product and service **attributes customers care about**
  - provide customers' **perceptions in a detailed way**.

Research Objective

- **Hotel quality evaluation from online reviews** is an **emerging research field**. However:
    - the exploitation of online textual reviews is still largely **under-explored**
    - there is a **lack of advanced data analytics** approaches for modelling complex dynamics of **online hotel review data**.

- The **increasing amount of online reviews** pose significant challenges for the development of advanced data analytics models providing a **higher level of intelligence** and thus, **increased business value**.

- In this paper, we propose an approach for **modelling the consistency between the customer opinions expressed in review comments and the rating** that they provide.
    - The proposed approach incorporates the Valence Aware Dictionary for Sentiment Reasoning (VADER) algorithm for extracting the polarity of the review comments and Bayesian Networks for revealing the relationships between the aforementioned sentiment scores and the online rating.

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The Proposed Methodology

- The research methodology consists of 5 main steps:

  - Data Acquisition
  - Extraction of Sentiment Scores with the VADER Algorithm
  - Assignment of Sentiment Scores to a Discrete Scale
  - Modelling the Relationships between Sentiment and Review Rating with Bayesian Networks
  - Evaluating the Consistency between Customer Opinion and Online Rating

Data Acquisition

- In this step, the data are acquired from the database storing the review comments and the online rating about the product or service, provided by the customer.

- Then, they are pre-processed by being subject to cleaning in order to remove records that do not include either the review comment or the review rating.

- Finally, the acquired data are structured so that they feed into the next steps for further processing.

Extraction of Sentiment Scores with the VADER Algorithm

- In this step, the online review comments are processed in order to extract their sentiment scores with the use of the VADER algorithm for sentiment analysis, an algorithm that has been proved to outperform several other sentiment analysis lexicons.

- VADER sentiment is a lexical sentiment classifier and it is used to do initial sentiment labelling of each review comment.

- VADER sentiment can also aggregate sentiment scores from individual words into sentence scores.

Assignment of Sentiment Scores to a Discrete Scale

- In this step, the sentiment scores are assigned to a discrete scale.

  - For example, if the review rating takes values between 1 and 5, the sentiment scores are classified to a respective discrete scale:
    - [-1, -0.6] is assigned to "DISASTER"
    - (-0.6, -0.2] is assigned to "MANY THINGS NEED TO BE IMPROVED"
    - (-0.2, +0.2] is assigned to "FAIR ENOUGH"
    - (+0.2, +0.6] is assigned to "PERFECT"
    - (+0.6, +1] is assigned to "ABSOLUTELY PERFECT"

Modelling the Relationships between Sentiment and Review Rating with Bayesian Networks

- In this step, the relationships between the sentiment discrete scale created in the previous step and the review rating of the customer are modelled in a probabilistic model with the use of Bayesian Networks.

- A Bayesian Network (BN) is a powerful tool for knowledge representation and reasoning under conditions of uncertainty and visually presents the probabilistic relationships among a set of variables.

- A BN has many advantages such as combination of different sources of knowledge, explicit treatment of uncertainty and support for decision analysis, and fast responses.

Evaluating the Consistency between Customer Opinion and Online Rating

- In the last step of the proposed approach, the consistency between the customer opinion and the provided rating is evaluated in order to identify the customer behaviour.

- Moreover, these results may reveal the level of satisfaction of the customer when this is not explicitly evident from the review comments.

  - For example, a customer may not mention some aspects, although they affect their opinion and thus, the online rating.
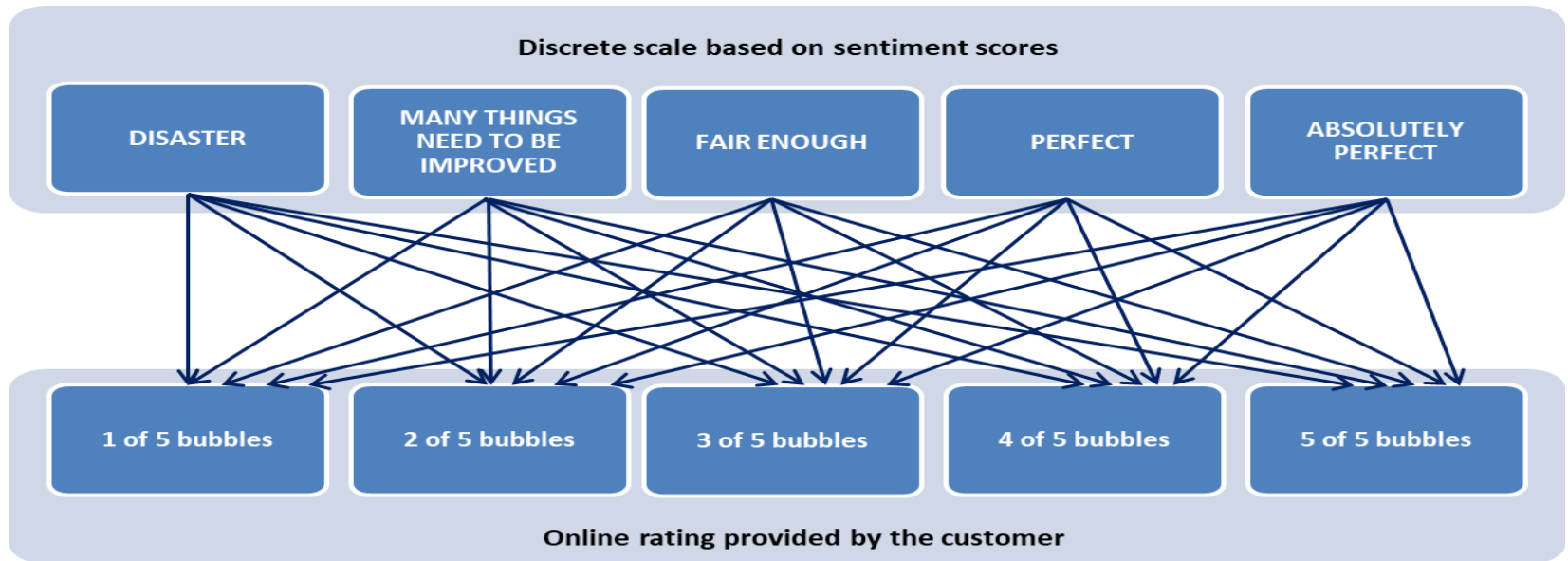
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The structure of the Bayesian Network

Discrete scale based on sentiment scores

| DISASTER | MANY THINGS NEED TO BE IMPROVED | FAIR ENOUGH | PERFECT | ABSOLUTELY PERFECT |

| 1 of 5 bubbles | 2 of 5 bubbles | 3 of 5 bubbles | 4 of 5 bubbles | 5 of 5 bubbles |

Online rating provided by the customer

Conditional probabilities of rating given the discrete scale

P(R|DS)	Discrete Scale (DS)				
	DISASTER	MANY THINGS NEED TO BE IMPROVED	FAIR ENOUGH	PERFECT	ABSOLUTELY PERFECT
Review Rating (R) 1 of 5 bubbles	45.27%	22.69%	17.99%	9.56%	1.14%
2 of 5 bubbles	27.90%	21.85%	19.05%	14.67%	2.17%
3 of 5 bubbles	19.97%	34.87%	33.33%	32.89%	9.04%
4 of 5 bubbles	5.34%	11.76%	19.05%	25.56%	28.07%
5 of 5 bubbles	1.52%	8.82%	10.58%	17.33%	59.57%

Discussion

- These results validate the statement that there are usually inconsistencies between the review comments and the review ratings.
  - This fact occurs for two main reasons.
    - First, different people use different ways of expressing themselves.
    - Second, the customers select some main points to be mentioned in the review comments. However, there are various aspects that affect their level of satisfaction and their preferences that are not mentioned at all and remain at their own mind.
- From the business perspective, the proposed approach can support product and service managers to look beyond the ratings into the sentiments of the customers.
- On the other hand, customers can choose from services that brings them desired satisfaction.
- The proposed approach enables customers to look beyond online customer ratings while selecting products and services.
- The proposed approach summarizes the underlying sentiments of the comments for customers to easily comprehend and decide.

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Conclusions & Future Work

- Despite the large amount of research works dealing with sentiment analysis, the consistency between the customer opinions expressed in review comments and the rating that they provide has not been explored.

- In this paper, we propose an approach incorporating the VADER algorithm for extracting the polarity of the review comments and Bayesian Networks for revealing the relationships between the aforementioned sentiment scores and the online rating.

- The proposed approach was validated in the tourism domain using a dataset with hotel reviews, extracted from the TripAdvisor.

- The proposed approach is able to model effectively the aforementioned relationships in order to derive the consistency between the review comments and the online rating.

- In our future work, we will apply probabilistic and fuzzy approaches in order to relax the discrete scale derived from the sentiment scores and tackle with sentiments that are close to the borders between two discrete values. We will also examine how different aspects of the review comments affect the overall sentiment and rating.

Thank you!