A Taxonomy of Visualization Research Cases of Sentiment Analysis Data based on Visual Metaphors

Hyoji Ha*
Lifemedia Interdisciplinary Program
Ajou University

Kyungwon Lee†
Department of Digital Media
Ajou University

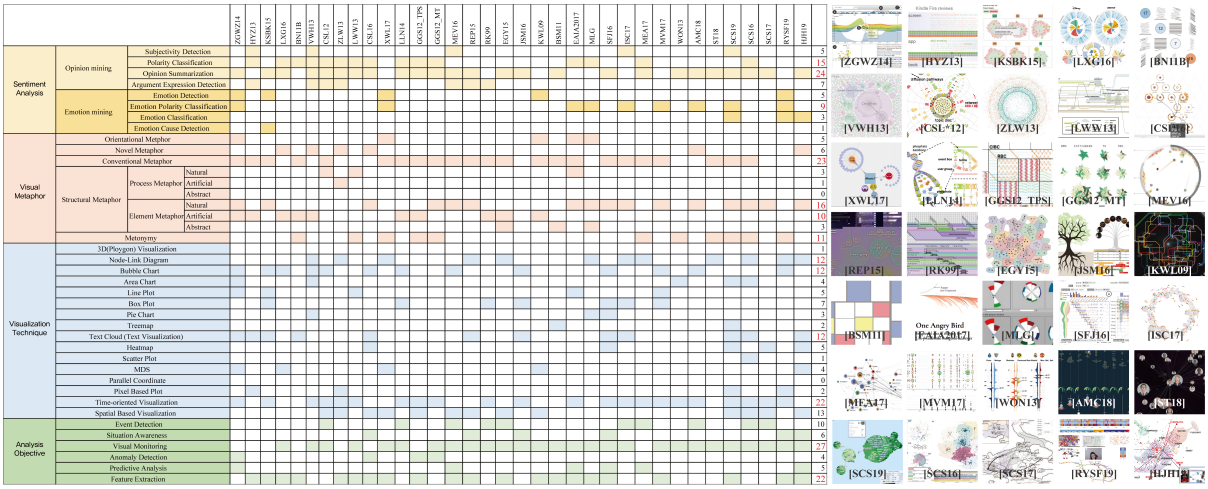


Figure 1: A classified table of the visualization of sentiment analysis data based on visual metaphors (35 cases). The red numbers at the last column of the table are criteria that are relatively more frequently collected than others.(Polarity Classification, Opinion Summarization, Emotion Polarity Classification, Conventional Metaphor,Element Metaphor: Natural / Artificial, Metonymy, Node-Link Diagram, Bubble Chart, Text Cloud, Time-oriented Visualization, Visual Monitoring and Feature Extraction)

Abstract

This study proposes a taxonomy to analyse visualization cases of sentiment data based on visual metaphors. In order to create a taxonomy, we established a group of classification criteria including sentiment analysis, metaphor analysis, visualization technique as well as analysis objective and classified the papers according to the criteria. This study identifies the effects of conducting sentiment visualization in a way that is accessible to the general public, and is expected to provide guidelines for understanding sentiment information using visual metaphors.

Keywords: Sentiment analysis, data visualization, visual metaphor, taxonomy

Index Terms: H.5.2 [Information Systems Applications]: Communications Applications—Information Browsers;

1 Introduction

Sentiment Visualization is an information visualization and visual analytics method for analyzing sentiment found in text data. The first step in conducting sentiment visualization is performing sentiment analysis, which is the text-based analysis of emotions, impressions, opinions, and evaluations that people present about a specific object, content, or information.

Due to the development of data mining and natural language processing technologies, the scale of sentiment analysis data collection is increasing, and each piece of information has a tendency to show more diversity beyond a positive or negative nature. This leads to cases of using high-level visualization techniques or combining various kinds of visualizations.

From the perspective of data scientists, performing various analyses can be interesting, but for the layman, it can be difficult to determine how the visualization should be analyzed.

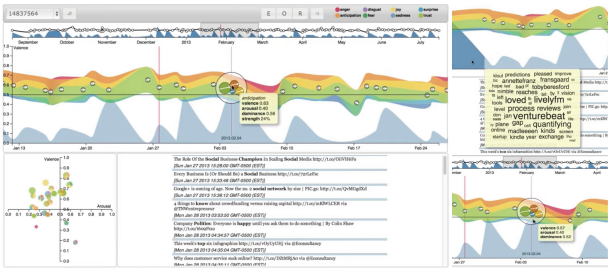
In addition, evaluations or feelings can vary widely from person to person because the concept of sentiment is based on subjective perceptions, even when viewing the same information visualization. As a result, judgments made by users are likely differ from the intention of the visualization's creator, causing the generalized facts conveyed by the information design output to not reflect the sentiment of the users. This has led to attempts by some researchers to suggest cases of using a "visual metaphor" to help people understand sentiment visualization more intuitively. Metaphors are used to assist in understanding new objects by relating them to known objects or experiences [3], which helps people to correctly interpret objects with varied meanings. This study aims to examine the trends of recent studies in the field and to investigate the ideal sentiment visualization patterns by creating taxonomy for cases of sentiment analysis data visualization using visual metaphors.

2 Establishment of a Taxonomy

Looking at existing research, there has been an attempt to organize sentiment visualization into categories, but no attempts have been made to examine, classify, and theorize sentiment visualization using visual metaphors.

Research by Kucher et al. presented sentiment visualization cases over the last 15 years, and the characteristics of the collected cases were organized into categories [2]. This categorization sought to

*e-mail: hjha0508@ajou.ac.kr
†e-mail: kwlee@ajou.ac.kr



Sentiment Analysis	Opinion Mining - Summarization, Emotion Detection, Emotion Polarity Classification.
Visual Metaphor	Conventional Metaphor, Structural Metaphor-Element Metaphor-Natural, Artificial, Orientational Metaphor.
Visualization Technique	Line Plot, MDS, Area Chart, Bubble Chart, Text Cloud, Time-oriented Visualization.
Analysis Objective	Anomaly Detection, Predictive Analysis.

Figure 2: Classification results of Zao et al. [5] according to the taxonomy.

explore the correlation between categories and to recommend appropriate techniques for conducting future sentiment visualization. In the study, analysis patterns were found through classifying each case by organizing taxonomy according to sentiment visualization, visualization task, and the intention of the visualization.

On the other hand, our study establishes a novel taxonomy of sentiment visualizations using visual metaphors and to improve systematic criteria for visual metaphor classification. Research about the metaphor was conducted by Lakeoff et al [3], this study classified the types of metaphor as conceptual metaphor, structural metaphor, and orientational metaphor. However, it is necessary to enhancement in order to analyze the metaphorical means that appeared in sentiment visualization because Lakeoff's work focused on linguistic aspects or daily language habits.

Therefore, our study adds further sub-elements of "*Natural*", "*Artificial*", and "*Abstract*" in the "*Structural Metaphor*" to suit the classification of sentiment visualization. And we adds "*Metonymy*", which refers to certain information being replaced by objects that are closely related to it for intuitive understanding. Additionally, our study establishes classification criteria for sentiment analysis by referring to the research by Yadollahi et al. [4]. Then, based on the research by Chen et al. [1], the criteria for classifying analysis objectives are generated. Also, the classification of visualization techniques is subdivided into a total of 16 visualization techniques. In this poster, we attached the appendix to provide details of classification criteria.

3 Classification Work and Results

This section explains, with a sample paper, how the visualization cases of sentiment analysis based on visual metaphors would be classified according to the classification criteria set in the study.

The study by Zao et al. [5] uses a sentiment analysis system called "PEARL" to show what emotional changes users have exhibited in posts that they wrote on Twitter over time (see Figure 2). This includes the *Summarization* process, which summarizes Twitter users' opinions, and *Emotion Detection* and *Emotion Polarity Classification* were found to apply because it shows the intensity of emotion and positive or negative information (polarity) about eight emotions (Joy, Anger, Disgust, Surprise, Anticipation, Sadness, Fear, and Trust).

Next, eight emotion intensities were set to the values on the Y-axis and show the changes over time in the form of a ribbon (Emotion Band), which can be classified under *Artificial* (artificial object: ribbon) as an Element Metaphor. In addition, a *Text Cloud* can be identified as being used to show the frequency of words in the Twitter posts, which can be classified under *Natural* (natural object: cloud) within the Element Metaphor as it uses a metaphor for the structure of the sentence in the form of clouds. It can also be categorized as a *Conventional Metaphor* in that the visual metaphors used commonly known targets. In addition to the visualization of the Emotion band, keywords containing emotion information in Twitter are displayed on the *MDS Map*, which has an X-axis and a Y-axis, giving direction for the emotion information. Also, an arrow display indicating the direction into which each band of emotional keyword will exhibit over time. Given this, Zhao's work uses an *Orientational Metaphor* to express the direction.

This study used a variety of visualization techniques to understand sentiment information. First, the Emotion band belongs to a *line plot*, which changes with the intensity of emotions over time. The *area chart* shows the amount of tweets sent and received by a person over time. Therefore, such visualization can be classified as *Time-oriented visualization*. In addition, the keywords shown in the *MDS Map* were found to present a *bubble chart* mixed with a pie chart to show 8 kinds of emotion information. As described above, a *Text Cloud* was used to effectively show the frequency of keywords mentioned in Twitter.

Lastly, this study can be classified as using *Anomaly Detection* because it has the purpose of searching tweet information with sentiment corresponding to outliers. In addition, it can be classified as *Predictive Analysis* in that it claims to be able to predict the emotion information to be collected later based on the emotion pattern that develops over time.

Like the example of classification covered in previous section, this study classified a total of 35 papers published between 1999-2019. The results are in Figure 1, which shows that there are relatively more cases of "*Opinion mining*" in sentiment analysis methods than those of "*Emotion mining*". This suggests that information about opinions and evaluations can be more difficult to be interpreted intuitively than information about emotions and thus requires more visual metaphor techniques. Next, the commonly understood "*Natural*" or "*Artificial*", metaphor methods were often used, and for visual techniques, "*Bubble chart*", "*Node-link Diagram*", and "*Text Cloud*" were often used. Finally, for analysis objectives, many cases of "*Visual Monitoring*" and "*Feature Extraction*" were found.

4 Conclusion

This study establishes a taxonomy of visualization cases of sentiment analysis data containing visual metaphors and presented its outcomes. The proposed taxonomy is expected to offer some guidelines for researchers doing research on the visualization of sentiment analysis data and visual metaphors. There are follow-up study plans to supplement the taxonomy by adding more case studies. And we also plan to develop a browser system to search case studies for their characteristics based on the taxonomy.

References

[1] S. Chen, L. Lin, and X. Yuan. Social media visual analytics. In *Computer Graphics Forum*, vol. 36, pp. 563–587. Wiley Online Library, 2017.

[2] K. Kucher, C. Paradis, and A. Kerren. The state of the art in sentiment visualization. In *Computer Graphics Forum*, vol. 37, pp. 71–96. Wiley Online Library, 2018.

[3] G. Lakoff and M. Johnson. *Metaphors we live by*. University of Chicago press, 2008.

[4] A. Yadollahi, A. G. Shahraki, and O. R. Zaiane. Current state of text sentiment analysis from opinion to emotion mining. *ACM Computing Surveys (CSUR)*, 50(2):25, 2017.

[5] J. Zhao, L. Gou, F. Wang, and M. Zhou. Pearl: An interactive visual analytic tool for understanding personal emotion style derived from social media. In *2014 IEEE Conference on Visual Analytics Science and Technology (VAST)*, pp. 203–212. IEEE, 2014.