Lessons Learned From Research on Multimedia Summarization

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1 Introduction

Map generalization is often is often considered as a cognitive task similar to text summary. Like text summary, generalization seeks to reduce the level of detail of initial data, highlighting the important features regarding a given need, and preserving the main characteristics of the initial data (Ruas 2002). The automation of text summarization is key research topic for language processing scientists, and it should be interesting to verify if the similarities in the human cognitive process lead to similarities in the automation techniques. Moreover, text summarization is a part of the multimedia summarization problem that also includes video and music summarization, and this complete literature is interesting to review. The aim of the paper is also to identify some guidelines for further map generalization research that can be derived from the multimedia summarization research community.

This paper first identifies similarities and differences in both automation problems. Then, section 3 proposes ideas from multimedia summarization that could be beneficial for the map generalization community. Finally, the paper is concluded with some ideas for further research opportunities.

2 Similarities and Differences between Both Problems

Exhaustive reviews of techniques have been published for text summarization (Mani 1999, Das & Martins 2007), video summarization (Truong & Venkatesh 2007), or music summarization (Peeters 2004, Jun & Hwang 2013), to go into more details. Some of these techniques are presented here only to illustrate the similarities and differences between summarization and generalization.

First, map generalization and text summarization are complex cognitive tasks that do not have any exact perfect solution. Different human cartographers may create different generalized maps from the same geographic data that can be considered as good. Similarly, human summarizers do not agree with each other with a same document and same rules to guide them. In both cases, it has been noted that the lack of metrics to globally evaluate a solution illustrates the difficulty of the task (Das & Martins 2007, Stöter *et al* 2014).

Most summarization techniques are based on the selection of the most important sentences in the document, which are extracted to create the summary. For instance, the seminal proposition from Luhn (1958) analysed the frequency of words and the position of sentences to extract the key sentences (Figure 1). The same mechanisms clearly drive the selection

operation in map generalization (McMaster & Shea 1992). So we should be able to use in selection processes some methods defined for text extraction.

SCIENCE IN REVIEW

Chemistry Is Employed in a Search for New Methods to Conquer Mental Illness

By ROBERT K. PLUMB

By coincidence this week-end in New York City marks the end of the annual meeting of the American Psychological Association and the begining of the annual meeting of the American Chemical Society.

Psychologists and chemists have never had so much in common as they now have in new studies of the chemical basis for human behavior. Exciting new finds in this field were also discussed last week in Iowa City, Iowa, at the annual meeting of the American Physiological Society and at Zurich, Switzerland, at the Second International Congress for Psychiatry.

Two major recent developments have called the attention of chemists, physiologists, physicists and other scientists to mental diseases: It has been found that extremely minute quantities of chemicals can induce hallucinations and bizarre psychic disturbances in normal people, and mood-altering drugs (tranquilizers, for instance) have made long-institutionalized people amenable to therapy.

Money to finance research on the physical factors in mental illness is being made available. Progress has been achieved toward the understanding of the chemistry of the brain. New goals are in sight.

At the psychiatrists meeting in Zurich last week, four New York City physicians urged their colleagues to broaden their concept of "mental disease," and to probe more deeply into the chemistry and metabolism of the human body for answers to mental disorders and their prevention.

Blood May Tell

Dr. Felix Marti-Ibanez and three brothers, Dr. Mortimer D. Sackler, Dr. Raymond R. Sackler and Dr. Arthur M. Sackler cited evidence that the blood chemistry of victims of schizophrenia is different from that of normal people. Perhaps multiple biological factors are responsible for this chemical change, they suggested.

Mental disease is a "developmental process" and long duration of a disorder may result in "permanent alteration of anatomy and physiology," they said. They urged that trials of new drugs which affect the brain should be concentrated on complex studies of the mechanism of action of the drugs. The variety of substances capable of producing profound mental effects is a new armory of weapons for use in investigating biological mechanisms underlying mental disease, they said.

The sources of behavioral disturbance are many and they may come from external as well as internal forces, the four reported. This concept has already proven practical, for instances, when it enabled psychiatrists to predict that the administration of ACTH and cortisone could produce psychosis.

"It led some years ago to the development of a blood test which was 80 per cent accurate in the identification of schizophrenic patients," they said. "It permitted us on physiologic grounds to deny that the psychoneuroses and the psychoses were lesser and greater degrees of the same disease process, and, in fact, to affirm that they represented opposite and even mutually exclusive directions of physiologic disturbances," they said.

Chemicals now available should be used not only to bring relief to the mentally sick but also to uncover the biological mechanisms of the disease processes themselves. "Only then will the metabolic era mature and bring to fruition man's long hoped for salvation from the ravages of mental disease," they reported.

Chemistry of the Brain

At the psychologist's meeting here, a technique for tracing electrical activity in specific portions of the animal brain was described by researchers from the University of California at Los Angeles. They reported that deep brain implants in cat brains were used to record electrical discharges created as the animals respond to stimulations to which they had been conditioned. In this way the California group reported, it is possible to track the sequence in which the brain brings its various parts into play in learning. Specific areas of memory in the brain may be located. Furthermore, the electrical pathways so traced out can be blocked temporarily by the use of chemicals. This poses new possibilities for studying brain chemistry changes in health and sickness and their alleviation, the California researchers emphasized.

The new studies of brain chemistry have provided practical therapeutic results and tremendous encouragement to those who must care for mental patients. One evidence that knowledge in the interdisciplinary field is accumulating fast came last week in an announcement from Washington.

This was the establishment by the National Institute of Mental Health of a clearing house of information on psychopharmacology. Literature in the field will be classified and coded so that staff members can answer a wide variety of technical and scientific questions. People working in the field are invited to send three copies of papers or other material—even informal letters describing work they may have in progress—to the Technical Information Unit of the center in Silver Spring, Md.

Figure 1. Example of sentence extraction to derive an abstract from a newspaper article (Luhn 1958).

Furthermore, context is fundamental in both map generalization and summarization, as it helps brain to build the comprehension of the map or the text. An isolated building and a building in a dense city are not considered similarly in generalization, and in the sentence below, only the context of the preceding sentence helps to understand what "the hat" is (MCKeown & Radev 1995).

Bob got a new Stetson. He loves the hat.

Enriching the initial cartographic data with implicit structures and patterns is essential in generalization in order to preserve or abstract the structures in the generalization process (Mackaness & Edwards 2002). Text summarization has the same requirements, has grammatical structure is a key to text meaning. Thus, some text summarization methods first analyse the grammatical structures of sentences (Figure 2) before abstracting the document into a summary (McKeown *et al* 1999).

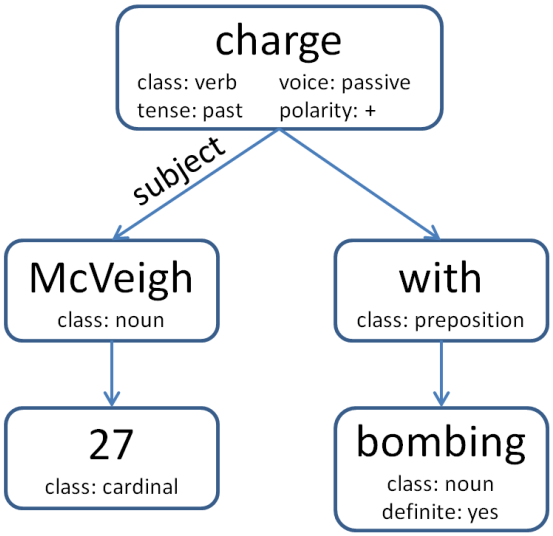

Figure 2. Dependency tree structuring the sentence "McVeigh, 27, was charged with the bombing", example from (McKeown *et al* 1999).

Other methods first classify the document to summarize into well-known sequences, such as verses and choruses in songs (Figure 3), prior to the summarization. Then, for instance, only one verse and one chorus are kept (Peeters 2004). For instance, this can be seen as analogous to the classification of urban blocks in (Trévisan & Gaffuri 2004) in order to use different AGENT parameters for each type of block.

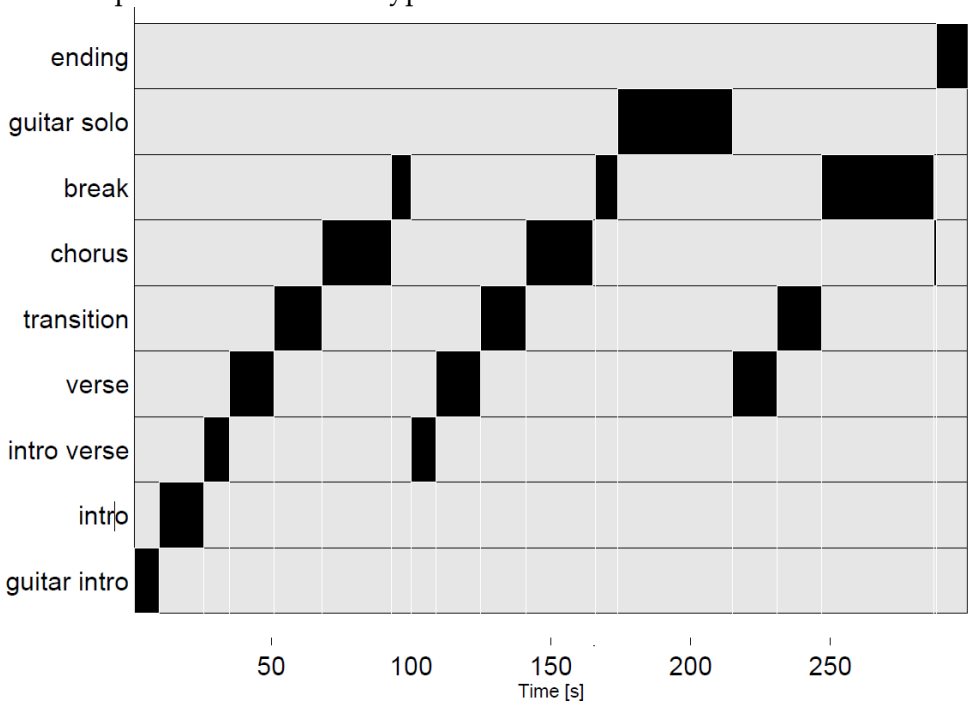

Figure 3. Characteristic sequences in the song "Smell Like Teen Spirit" from Nirvana, detected by the Peeters algorithm (2004).

Added to that, many summarization methods use multiple document as input, for instance to summarize news using all the existing news channels, and their different point of view on an event. This process can be seen as similar to the conflation process required to make mashup maps out of several sources of geographical data.

Despite these similarities, the automatic processes of map generalization and multimedia summarization are very different. The main difference lies in the nature of the input data. Vector geographical data requires computational geometry techniques to deal with two or three dimensions data, while text (one dimension) requires natural language processes and videos require image processing techniques.
The need for generalization mainly derives from the legibility, or eye perception problems caused by scale reduction, so the generalization processes mainly seek to derive legible maps, where eyes are able to distinguish all details; keeping the main features of the map is only one of the objectives. Text summary has no such constraint, and only aims at the optimal number of words to grasp the meaning of a text. So, the multimedia summarization processes can only be compared to the selection processes in map generalization.
Finally, generalization seeks to convey more the geography behind the data, and its implicit spatial relations and structures, than to convey the precise positioning of objects. As a consequence, exaggeration operations (McMaster & Shea 1992) such as typification, dilatation, or parallelism enhancement are quite common in generalization (Figure 4), while summaries remain faithful to the original source data. Nevertheless, this difference is slightly modified when text summary is less literal, and seeks to highlight the important aspects of a text like map caricature (McKeown *et al* 1999).

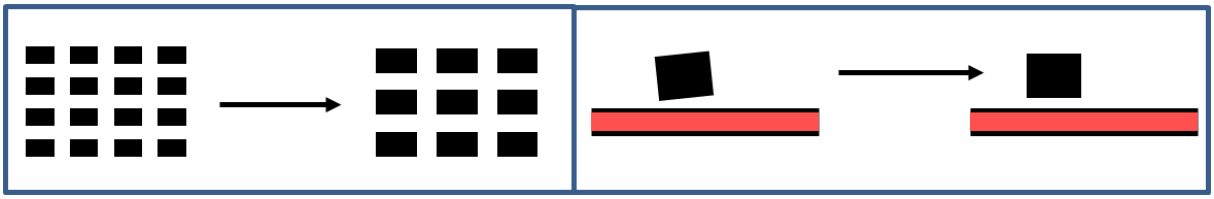

Figure 4. Examples of caricature and exaggeration operations in generalization that cannot be related to summarization operations.

3 What Can Be Learned for Map Generalization Research

This short review and the differences highlighted in section 2 show that multimedia summarization techniques cannot directly be applied to map generalization. However, some lessons can be learned from this research domain, and some are presented in this section.

3.1 A Massive Use of Machine Learning

Although the machine learning techniques have been tested to automate generalization (*e.g.* Weibel *et al* 1995, Mustière *et al* 2000, Kilpelainen 2000, Burghardt & Neun 2006), it appears that this technique has been under-used when compared to the diversity of learning techniques used in text summarization (Das & Martins 2007).
For instance, the orchestration and the parametrization of generalization processes is one of the main difficulties remaining in generalization research, but is it possible to learn in already generalized maps how to guide the orchestration, or the parametrization of algorithms? Taillandier et al (2011) used learning similarly to optimize the parametrization of

the AGENT generalization model, but this could be made in a broader way. I believe that the community needs to look once again at the machine learning research, to see if their recent outcomes could help us (*e.g.* LeCun *et al* 2015).

3.2 The Notions of Importance and Redundancy

The parallel between text extraction and the selection operation highlighted in section 2 make the criteria used in text extraction interesting to study. Importance and redundancy are two key notions in the text extraction methods. Several proposals exist to infer importance and redundancy of words or expressions, and could be transferred through analogies to map generalization. Mackaness and Gould (2014) pleaded for a better consideration of geographic saliency in map generalization, and such analogies could help us to do so.
Road selection processes are an interesting case study for highlighting the usefulness of the notion of redundancy. Most main contributions in the domain tried to identify the main roads with graph theory based methods, and/or Gestalt based methods, and provide quite satisfying results. But thinking the other way round, i.e. removing the roads identified as redundant, would maybe improve the existing methods (Figure 5).

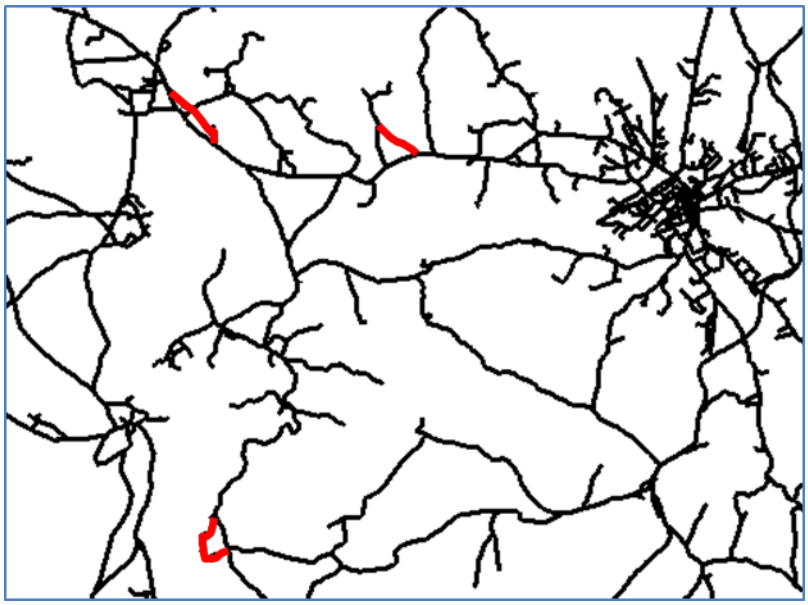

Figure 5. Three redundant roads in a network as they provide neither shortcut nor additional connectivity.

3.3 A Major Focus on Evaluation

The generalization research community has clearly neglected the evaluation step compared to the number of papers regarding algorithms for instance, and recent papers highlighted this lack of major contribution (Stöter *et al* 2014, Mackaness & Gould 2014). On the contrary, multimedia summarization research significantly focused on evaluation protocols, with standards for manual and automatic evaluation, and many metrics to evaluate a summary and compare alternative methods (Lin 2004). The agreement on standards to evaluate a text summary in comparison to one or several references greatly helped the development of automatic summarization techniques. I believe that the research presented in Stöter et al (2014) should pushed further and that the community should make similar agreements for standardizing the evaluation of automatic generalization, with for instance a standard set of constraints to satisfy to maximize legibility and a set of metrics to assess global readability.

3.4 Benchmarks to Allow Reproducible Science

Reproducible science is a key factor of scientific thinking (Peng 2011), as it allows scientists to compare each other methods with reproducible experiments. In map generalization, sharing algorithms in a web platform, such as the web services framework proposed in (Foerster *et al* 2008), would help comparing algorithms to each other.

In order to promote reproducible science, to compare the large number of proposed methods, and also to provide datasets to academic researchers, the text summarization community soon organized workshops to develop evaluation competitions (Das & Martins 2007). TREC[1], DUC[2] and MUC[3] promoted evaluation baselines on chosen training datasets. For instance, guidelines for manual evaluation of summaries have been defined with such initiatives (Lin & Hovy 2002), and the same could be made for generalization benefiting from the knowledge of the cartographers working in the national mapping agencies. The need for such standard has been recently acknowledged by Stöter *et al* (2014).

As mentioned earlier, such as generalization, there is not a unique good solution to multimedia summarization problems, but several. Text summarization benchmarks evolved to propose now several acceptable summaries for training texts, and this diversity of solutions is used by evaluation systems (Lin 2004).

The EuroSDR project on the state-of-the-art of commercial software in generalization was a first step to the creation of benchmark datasets with sets of constraints related to each of the four datasets (Stöter *et al* 2010). We should now go further by providing open datasets with sets of constraints to satisfy, good results, and existing processes to compare to. The recent research on sharing the generalization knowledge in ontologies (Gould *et al* 2014) is also a step forward.

4 Conclusion

Although texts and maps are different kinds of information, the cognitive processes of summarization and generalization are similar. So it is interesting for the generalization research community to learn from the research on text/multimedia summarization. The main feedbacks are the under-use of machine learning in generalization, the lack for importance, saliency and redundancy definitions, the lack of focus on generalization evaluation, and finally the importance of benchmarks to allow reproducible research. Although the techniques used in multimedia summarization cannot be directly used in map generalization, I believe that generalization researchers should regularly review the summarization community outcomes in order to integrate major trends.

More generally, the effort presented in this paper of reviewing a new field of science and relating it to map generalization could be done for other interesting domains. For instance, the research on visual search, tries to understand the mechanics the brain uses to optimize visual search (see Eckstein 2011 for a review). It would be useful to understand how the brain searches information in a map to better generalize it.

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[1] http://trec.nist.gov

[2] http://duc.nist.gov

[3] http://www-nlpir.nist.gov/related_projects/muc/proceedings/muc_7_toc.html

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