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# A Rule-Based Method for Determining the Degree of Student Satisfaction of a Web-Based Learning Environment

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# A Rule-Based Method for Determining the Degree of Student Satisfaction of a Web-Based Learning Environment

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## Abstract

Student essays representing their individual reflections on a collaborative web-based course in International Business are computationally analyzed according to a classification scheme based on a set of *a priori* fuzzy categories. This classification method enables the identification of themes and trends in the student responses that can be used to illustrate an overall evaluation of the personal learning experiences for this course. By processing the classification results using a computational neural network, we can depict the clustering intensity of thematic elements and illustrate the strength of dependencies between classification attribute values topologically using a self-organizing map (SOM), which provides a pattern recognition visualization. The resulting SOM can then be used to compare successive depictions for future iterations of new thematic data from student self-evaluations.

## Internet Discussion Groups

The use of computer mediated communication (CMC) for individual participation in discussion groups is now ubiquitous for internet-enabled collaborative learning environments. The methods used are both synchronous and asynchronous in operation and range in cardinality from one-to-one, one-to-many, and many-to-many situations such as email correspondence, threaded discussions and synchronous chat sessions that may involve two or more participants. The success of these discussion environments as positive contributors to learning is well documented across a wide range of academic disciplines. It is generally held that these learning environments are more suited to studies in business, science and technology, but increasingly, as reported by Talarico(1999) in the teaching of topics in the *Middle Ages and Renaissance*, topics in the arts and humanities are reporting internet-enablement success. In that report, email is regarded significantly less well than discussion boards; students prefer both the responsiveness and interactivity of ‘chat’ and also appreciate the diversity of opinions and information provided by a wider group than only the course instructor or simply one-to-one correspondence between participating students.

This was not the experience of students recently enrolled in an internet-enabled course in *Advanced International Business* developed by researchers at The Auckland University of Technology in New Zealand (AUT). The student’s concerns, as expressed in end-of-course evaluative essays, were that the commercial discussion board used was fraught with technical problems and had them resort to email correspondence. This course has been modified in that it now incorporates discussion group software. The course can be found on the World Wide Web at (http://csrs2.Aut.ac.nz/AIB/default.asp).

In their end-of-course evaluation essay, students were asked to submit their impressions of the course. They were asked to reflect and make comments on their personal learning experience. These evaluations have now been analyzed to report the distribution of student’s experience as a feedback to the course designers and presenters. It is envisaged that in a similar manner, the log of the chat material can be analyzed as a continual feedback evaluation device in the future, to enrich and modify the course as appropriate.

## Computer Mediated Communication

There is a large body of knowledge and experience pertaining to CMC in a number of contexts. Recent work with the readability of email reported by Sallis and Kassabova (2000) is one such example. This research examined not only what the readability of individual email messages was in the dataset being analyzed but also in how topics can be clustered and depicted as intensities of semantic nuance.

Ferris(1997) provides an overview of scholarly definitions for CMC and attempts to build taxonomy of domain-dependencies for each one. In essence, the mode of communication is domain-dependent and interactivity functions vary according to the application context. A mix of synchronous and asynchronous functionality seems appropriate for collaborative web-based learning.

Rudy(1996) has produced a critical review of research on electronic mail, which provides a broad appreciation of ongoing developments in this field. Wilkins(1991) gives a view of long-distance conversations by computer nearly a decade ago, which is a useful reflection on how far technology has moved since some of the earliest studies in CMC.

Berthold et al.(1997) described the use of autoassociative neural networks for exploring typicality in computer mediated discussions. The use of self-organising maps (SOMs) generated by a computational neural network as described by Kohonen(1990), was also demonstrated by Kassabova and Sallis(1998) with the application of connectionist methods to stylometric analysis for context-dependent email traffic moving through Usenet groups and Hoorn et al.(1999) has provided a neural network based solution to style identification for three contemporary poets. In all cases, neural networks were shown to be useful alternative methods for classifying and grouping attributes, then topologically depicting their relationship intensity change over time.

## Depicting Evaluation Results

Some previous work done by Sallis, Masi, et al.(1999) with the Alexandria Digital Library (ADL) at the University of California at Santa Barbara, Frew et al.(1996) and (www.alexandria.ucsb.edu) have demonstrated how a set of fuzzy labels can be attributed to a range of variables that illustrate system use. When processed by a computational neural network, relationship dependencies between the variables can be depicted over time to indicate their relative importance within performance evaluation criteria. Some of the elements of the methodology used to classify inexact textual data arising from session logs in the ADL study, can be used here to analyze the contents of the student evaluation essays in the AUT project. This approach has been established by related work in computational linguistics, some of which is referred to above. Essentially, this is a thematic analysis of full text documents using a classification scheme based on a set of *a priori* criteria for expected phrases of student self-evaluation of learning experience satisfaction.

## Method

The principal phases of analyzing the reflective essays and processing the data were:

1. construct an *a priori* classification scheme that relates to depth of learning, interest/involvement in the course and problems encountered
2. software development (programs written in the *Perl* language), comparison of programmatically produced results with the text of the essays, modification of the programs and summary of results
3. computationally identify target phrases (text strings) according to the classification scheme
4. summarise the results of the classification and produce standard statistical illustrations of the thematic distribution for all text evaluations
5. construct binary vectors of the results for input to a neural network simulation based on a *low*, *medium*, or *high* intensity of semantic inference
6. generate the results of the neural network processing by depicting the results as a SOM.

A set of descriptors for inclusion in a classification scheme suitable for this analysis was developed. This set was refined after a sample reading of the student essays and a greater definition of evaluative comment was identified. Eventually, the three experiential expression classification labels used were:

1. level of interest
2. level of frustration
3. depth of learning

The algorithm used here for linguistic analysis was developed using the Perl programming language. The entire analytical process is a hybrid of both human interaction and computational pattern matching with text in electronic form.

Parts of keywords that relate semantically to the three experiential classification labels are searched for and matched as patterns against a set of *a priori* 'go words'. For instance, the words searched for in relation to the **LEVEL OF INTEREST** classification label are matched against {interest.+}, {involv.+}, {contribut.+}, {introduc.+}, {incorporat.+}, {complet.+} and their trailing characters. The algorithm then associates these words with their adjacent pairs and phrasal context for semantic dissonance. Irregularities in grammar, vocabulary, usage and spelling confound the analytical process during this pattern-matching procedure. For example, the pattern {contribut.+} was found in the phrase, "…I would *contribute* this mainly…". It is clearly apparent when reading the sentence and indeed the paragraph that contains this phrase that the student meant to use the word '*attribute*', not '*contribute*'. An additional confounding factor here is word usage. For example, misuse of the word '*of*' rather than '*have'* in the verb form '*would have'*. One student used the word '*interesting*' when in context it was clearly a term of frustration, not real interest.

The words searched for in relation to the **LEVEL OF FRUSTRATION** classification label include those tightly coupled with the semantics of negativity. That is, {not.+help.+}, {difficult.*}, {unfortunat.+}, {no*.repl.+}, {frustrat.+}, {would.+have}, {could.+have}, {might.+have}, {no.+work}, {fail.*}, {not.+produc.*}, {urgen.+}.

The words searched for in relation to the **DEPTH OF LEARNING** were, {experience.+}, {example.*}, {aware.*}, {knowledge.*}, {learn.*}, {w+gain.*}, {increase.+}, {understand.*}.

It should be emphasised that this set of analytical terms and the algorithm itself is in a primary stage of development but the number of successful 'hits' on its first parse of the text is noteworthy. The algorithm is iterative. The text was reexamined successively to extract phrases that had been overlooked in preceding parses. Histograms, which show the number of phrases for each student in the sample, were generated and an example of one (in this case the **LEVEL OF FRUSTRATION**) is given in Figure 1. These histograms are considered useful in this methodology as a guide to the extent of feedback and effectiveness of the analytical process. This is a conventional statistical representation that can be compared with the connectionist method of result depiction using a SOM (op cit).

The SOM generated by the neural network for the **LEVEL OF FRUSTRATION** classification label is given in Figure 2. The depiction illustrates the clustering of feedback comments extracted from the student's essays as intensities of attribute relationship and dependencies between the individual category values. The visualization is best thought of as synonymous with a jigsaw puzzle, but where the adjacent pieces have a loose fit because the dependency relationship values are of variable intensity and hence, not binary. The darker colours indicate greater intensity and the lighter ones show less intensity. A cluster can be regarded as a topological depiction (map area) containing vector values for each attribute. The clusters divide the input vector data into disjoint classes. These are the clusters of results. This output is only one possible form that is generated by a commercially available software package under the name *Viscovery* by Eudaptics(1998). There are many such software packages available with a variety of depiction forms.

## Conclusions

By using some text processing algorithms from computational linguistics research and applying connectionist methods (especially fuzzy labelling and neural network simulation) to the text as a classification and analytical process, it can be seen how the self-evaluation of students presented in their written reflections on the web-based course can be depicted. As illustrated, the results are now usable as a comparison for future iterations of the course and its evaluation by students. The student body for each successive course will produce a new set of essays. These will then be analyzed. This in turn enables the developers and presenters to refine the course content and its delivery.

Clearly, the algorithm for identifying nearness of fit for the classification labels and their application to word phrases can be further refined. The precision of definition is, of course, an indefinite exercise as language is constantly changing over time. Nonetheless, further work on this refinement process and the analysis of further text will assist the robustness of the methodology described here.

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**Figure 1** – a sample histogram showing the number of relevant phrases extracted for each student for the fuzzy classification label **FRUSTRATION**.

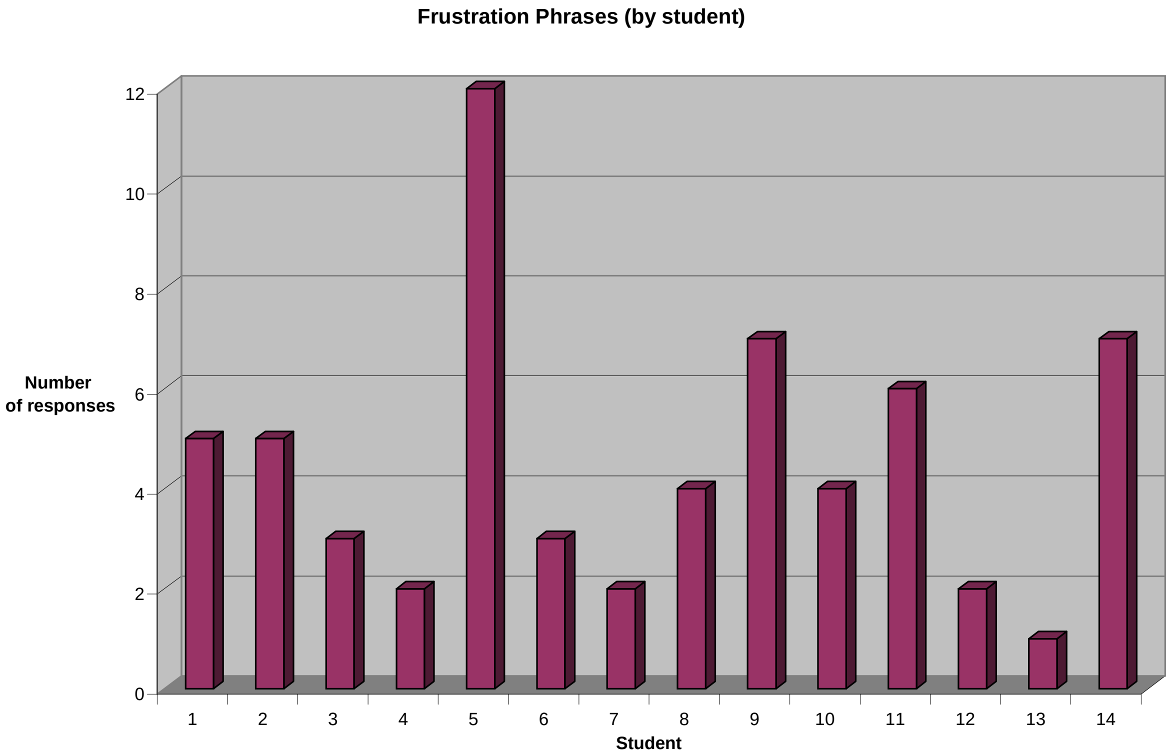


**Figure 2** – a sample SOM for the fuzzy label **LEVEL OF FRUSTRATION**.