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Detecting Micro-Creativity in CSCL Chats

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Abstract: The paper presents an approach for detecting micro-creativity moments in CSCL chats, starting from the polyphonic model, which considers important concepts in the conversation as voices, which enter into inter-animations generated by divergent and convergent utterances. The main idea is that micro-creativity moments take place when several divergences among the voices are followed by a convergence. Four experimental implementations of the detection of the divergent and convergent utterances using artificial intelligence are introduced.

Introduction

Micro-creativity moments in CSCL chats occur when the utterances of the group members converge to an expressed idea that is new relative to their experiences (Chiu, 2008). Such moments are indicators of successful knowledge construction in chat sessions where small groups of learners solve a problem (Stahl, 2009) or design an artefact (Trausan-Matu, 2020). However, their detection in chat logs is a difficult and time-consuming task, therefore automated computer tools are needed, one approach being based on the polyphonic model (Trausan-Matu, 2020), which consider voices' inter-animation through divergences and convergences.

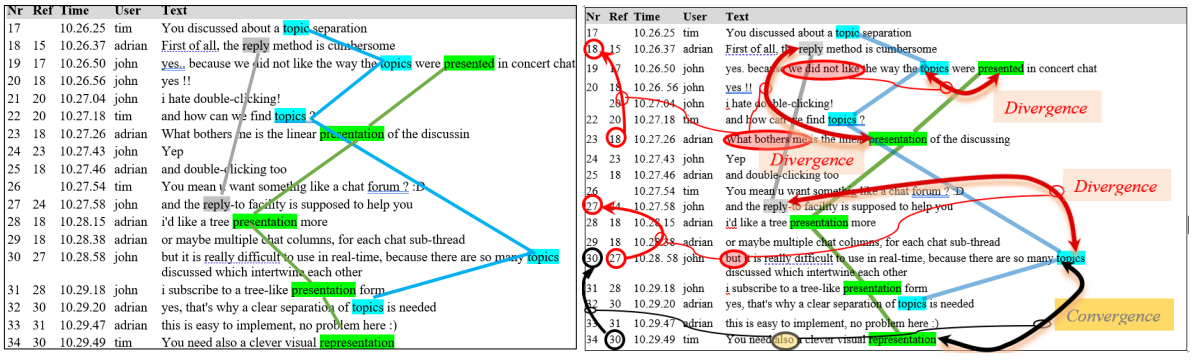
Dialogism, polyphony, and creativity

A main feature of a creative process is the combination of divergent and convergent thinking (Csikszentmihalyi, 1996). In the case of CSCL chats, divergent thinking is externalized through utterances that, when solving collaboratively a design problem, identify incongruities, incompatibilities, which eventually drive to a solution proposed in a convergent utterance. In an analogy to music, divergences may be seen as dissonances that require and are eventually solved with a consonance, a common practice used for making a musical piece appealing. Moreover, the musical analogy is enforced by Mikhail Bakhtin's dialogism and the polyphonic metaphor (Bakhtin, 1984), that were considered as a model of collaboration (Trausan-Matu, 2020). Furthermore, in Bakhtin's vision "dialogism could be seen as a type of creativity" (Lähteenmäki & Dufva,1998).

The main subjects of discussion in a CSCL chat (for example, elements, feature, and aspects of a design) may be regarded as *voices* in a polyphonic weaving (Trausan-Matu, 2020). Each voice in a polyphony has its individuality and *inter-animate* due to dissonances/divergences followed, when micro-creativity might take place, by consonances/convergences. Therefore, detecting in CSCL chats threads of concepts (voices) inter-animating through sequences of divergences followed by a convergence might be a sign that micro-creativity is present, showing a successful process of knowledge construction.

Figure 1

A chat excerpt containing three voices (on left), linked by three divergences and one convergence (on right)



An example of the divergence-convergence polyphonic weaving driving to micro-creativity is illustrated in Figure 1 on an excerpt of a conversation from a corpus of chats performed by students attending the Human-Computer Interaction course from the Computer Science Department of the University Politehnica of Bucharest. Students received a homework in which they had to form groups of 3-6 members and discuss for around two hours about how to design an interface for a collaborative system. They used a chat environment that allows to explicitly indicate the reference to a previous utterance, by clicking on it (Holmer et al., 2006), facility that permits

to have multiple threads of discussions in parallel, behaving like voices in a musical polyphonic framework. For example, in Figure 1 the first column is the number of the current utterance while the second is the number of the explicitly referenced utterance (for example, utterances 23-18, 30-27, and 34-30, linked in Figure 1-right). In Figure 1-left three threads of main concepts (the *voices*) discussed in the chat are represented by straight lines with different colors: 'reply', 'topic', and 'presented/presentation/representation'. Among these *voices*, on the right of Figure 1, three divergences and one convergence are indicated with red and respectively black curly arrows. The first divergence is generated by the phrase "we did not like" at utterance number 19, between *voices* 'presented/presentation/representation' and 'topics'. The phrase "What bother me" (utterance 23) expresses the second divergence, between *voices* 'presentation' and 'reply', the reference to the latter being indicated by the explicit reference to utterance 18 from 23. Eventually, the third divergence, between utterances 30 and 27 ("there are so many topics" vs. "the reply-to facility"), is generating a micro-creativity moment, the solution "a clever visual representation" at utterance 34, which is signaled by a convergence between *voices* 'representation' and 'topics' indicated by the explicit reference between utterances 34 and 30.

Automatic detection of divergences and convergences

A way for finding micro-creativity moments in CSCL chats is the identification of sequences of divergences followed by a convergence. For automatically detecting candidates of micro-creativity moments, natural language processing (NLP) and machine learning (ML) techniques were used in a series of experiments. The first experiment was based on an approach that started from a collection of patterns, and key words and phrases to detect the divergent and convergent utterances with NLP (Rasid & Trausan-Matu, 2017). A second approach used NLP and ML techniques trained with a corpus of 63 of the chats mentioned in the previous section, which were manually annotated by students from a Master level NLP course. The second experiment used a Naïve Bayes ML algorithm, followed by two other experiments, which used Deep Neural Networks (DNN): a 3-channel neural model consisting of Embedding and Convolutional layers, and a Siamese neural network model that uses Long Short-Term Memory (LSTM) cells (Nita et al., 2020). The dataset was randomly split, 85% for training data and 15% as test data. The training consisted of over 100 epochs. The obtained accuracy was slightly over 0.60, the Naïve Bayes obtaining a little better result (Nita et al., 2020).

Conclusions

The paper presented an approach for the identification of micro-creativity in CSCL chats based on the detection of sequences of divergent and convergent utterances. An annotated corpus of chats was built and experiments with it were performed using a pattern-based approach, a Naïve Bayes, and two Deep Neural Networks. Some more work should be done, by extending the number of annotated chats and by combining DNNs with the symbolic approach based on patterns. Future work will annotate the chats with the utterances where appeared the micro-creativity moments and will analyze the correlations with the sequences of divergences and convergences.

References

Nita, L.A., Rebedea, T., & Trausan-Matu, S. (2020) Analysis of convergence and divergence in chat conversations, in J. Vanderdonckt, A. Butean (Eds.), *Proceedings of RoCHI 2020*, 108-114

Bakhtin, M. (1984). *Problems of Dostoevsky's poetics* (C. Emerson, Trans.). University of Minnesota Press.

Chiu, M.M. (2008). Effects of argumentation on group micro-creativity: Statistical discourse analyses of algebra students' collaborative problem solving, *Contemporary Educational Psychology*, 33(3), 382-402

Csikszentmihalyi, M. (1996). *Creativity: flow and the psychology of discovery and invention.* HarperCollins.

Holmer, T., Kienle, A., & Wessner, M. (2006). Explicit referencing in learning chats: Needs and acceptance. In W. Nejdl & K. Tochtermann (Eds.), *Proceedings of EC-TEL 2006,* 170–184 Springer.

Lähteenmäki, M. & H. Dufva (1998). Dialogues on Bakhtin: Interdisciplinary Readings. University of Jyväskylä, Centre for Applied Language Studies. Jyväskylä, 28–35.

Rasid, C., Trausan-Matu, S. (2017) Identification of Agreement and Disagreement in Chat Conversations, in M. Mihaescu (Ed.), *Proceedings of RoCHI 2017*, 95-100

Stahl, G. (Ed.). (2009) *Studying Virtual Math Teams*, Springer.

Trausan-Matu, S. (2020) The Polyphonic Model of Collaborative Learning, in Mercer, N., Wegerif, R., Major, L. (Eds.), *The Routledge international handbook of research on dialogic education*, Routledge, 454-468.

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