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ANALYSIS OF EMOTIONS IN IT PROJECTS IMPLEMENTED IN THE OPEN SOURCE FORMULA USING MACHINE LEARNING METHODS

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Purpose: The aim of this paper is to analyze possibilities of using automatic emotion analysis in project management.
Design/methodology/approach: The approach adopted involves literature review, analysis of data availability and availability of IT tools. Then, an attempt was made to adapt these elements for use in project management.
Findings: The paper discusses three fundamental research questions that arise in the context of using machine learning methods to analyze emotions in projects. The first of them concerned what data can be used for analysis. It was established that electronic communication in projects implemented in the open source formula is publicly available and susceptible to text analysis. The second question concerned the methods that can be used in the analysis of emotions. Here it was established that machine learning methods may be useful due to the problems described in the literature with the use of dictionary methods. The third question concerned the purposes for which the analysis of emotions can be useful. In response to this question, it was established that recognizing particularly destructive emotions, such as anger, can be useful in effective project management.
Research limitations/implications: The presented work is limited only to conceptual digressions on the possibility and usefulness of using methods of automatic emotion detection in project management. In future studies, these concepts should be verified on real data.
Originality/value: The novelty of paper is an attempt to define a framework for the use of known methods of automatic emotion detection in project management.

Keywords: project management; emotion recognition; natural language processing.

Category of the paper: Conceptual paper.

1. Introduction

Projects in the current economy face a unique set of challenges and opportunities. Some of the key issues related to project management in the context of the problem considered in this work are listed in the following paragraphs.

First one is Economic Uncertainty. The global economy is constantly evolving, and factors such as inflation rates, interest rates, and market volatility can impact project planning and execution. It's crucial to regularly monitor economic indicators and adjust project plans accordingly.

Next one is Remote Work and Virtual Collaboration. The COVID-19 pandemic has accelerated the adoption of remote work and virtual collaboration. Project teams may be distributed across different locations, requiring the use of digital tools and platforms for communication, project tracking, and collaboration.

Related with previous one is Technology and Digital Transformation. The rapid pace of technological advancements offers opportunities for innovation and efficiency improvements. Project managers should stay updated on emerging technologies relevant to their projects and explore how they can leverage them to enhance project outcomes.

Most important key parameter is Stakeholder Engagement. Engaging stakeholders, including customers, employees, investors, and regulators, is crucial for project success. Clear communication, managing expectations, and addressing stakeholder concerns are essential to maintain support and alignment throughout the project life cycle.

Taking these factors into account, we may try to use new elements in project management, such as, for example, sentiment or emotion analysis in electronic communication and to propose new tools for their use.

Electronic communication, based on emails, are especially susceptible to automatic analysis based on Natural Language Processing. Many computer methods of natural language processing (NLP) are currently being developed. They are methods of text and speech processing (Speech recognition, Word segmentation), Morphological analysis (Lemmatization, Stemming), Syntactic analysis (Parsing), Lexical semantics (Sentiment analysis with Emotion recognition, Terminology extraction) and many others like Automatic summarization and Machine translation. Sentiment analysis seems to be a particularly useful tool for analyzing communication in a project. Having such tools at our disposal, we can analyze the impact of external phenomena on IT projects implemented in the open-source format.

The aim of the study is to analyze possibilities of using automatic emotion analysis in project management. On the one hand, it is an exploration of the models used in psychological literature to describe human emotions as a complex phenomenon. On the other hand, it is an examination of the availability of data for later research. On the third hand, it is also an analysis of available IT tools that can be used in the automatic detection of emotions.

The work is divided into the following parts. The first section presents literature survey on topics of interest, namely open source projects, emotions models, automated emotion recognition and IT tools for emotions analysis. Next section formulating research questions that appear in the context of the problem under consideration. The third section contains discussions of the questions raised and presents some findings. The whole paper ends with a summary.

2. Literature survey

2.1. Open source projects

Nowadays, software development is a very complicated undertaking in which many specialist are involved. One of the most effective ways to develop software is the open-source formula. Open-source software (OSS) is computer software that is released under a license in which the copyright holder grants users the rights to use, study, change, and distribute the software and its source code to anyone and for any purpose (Laurent, Andrew, 2008).

Some organizations which are follows open-source formula are the Linux Foundation, the Eclipse Foundation, home of the Eclipse software development platform, the Debian Project, creators of Debian GNU/Linux distribution; the Mozilla Foundation, home of the Firefox web browser and finally the Apache Software Foundation.

Mailing lists are the core means of project communication in open source projects, where they are used during software development and maintenance to discuss technical issues, propose changes, report bugs, or ask how-to questions about configuration or any other parts of the product (Obaidi, Klünder, 2021). The idea of using open source project mailing list communication to analysis comes from Tourani et al., (2014).

2.2. Emotions models

Starting with the work of von Neumann and Morgenstern (1944), decision theory was based on rationality. Later work by Simon (1955) and Bertalanffy (1968) merely modified the basic assumption of rational decision-making. In the real world, the decision maker's emotional states strongly influence the decisions made. Stressful situations they evoke strong emotions that lead to wrong decisions.

Clarke (2010) was probably the first who notice that projects are emotional. Despite previous work on the significance of conflict in projects (Chen, 2006), and recognizing that conflict is a source of strong emotions (Barki, Hartwick, 2004), the topic of recognizing emotions in the project has not been considered in the literature on the subject. In mentioned paper Clark (2010) analyze how emotions can influence project manager behaviors and decisions in order to better understand why projects can often take very different directions to

those expected within the predominant rationalist paradigm. He interviewed PMs who took part in Emotional Intelligence training, so they were aware of the important role of emotions in decision making.

Virine et al. (2015) analyzed emotions in the context proposed by D. Goleman (Goleman, 2006) and adopted for project management by A. Mercino (Mercino, 2007) model of emotional intelligence. Proposed model analyse five domains: Self-awareness, Self-management, Social awareness, Relationship management and Team leadership. Virine et al. notice that not only negative emotions may cause wrong decisions but also positive ones may lead to mistakes. They propose some methods to deal with emotions but they first step is emotion recognition.

Human emotions are very complex phenomenon. For this reason, models of this phenomenon are considered in psychology. A fairly wide overview of the models can be found in (Nandwani, Verma, 2021). Most widely are used Ekman model (Ekman, 1992) and Plutchik Wheel of Emotions (Plutchik, 1980). Ekman model is categorical one, with six defined emotions: anger, disgust, fear, joy, sadness, surprise. Plutchik considered two types of emotions. Basic ones which include Ekman six emotions supplemented by trust and anticipation and mixed emotions which are made from the combination of basic emotions. Plutchik represent his emotions on a colored wheel. Plutchik model is also categorical one. Opposite type of models are Dimensional Emotion models (Nandwani, Verma, 2021). They are based on three parameters: Valence (positive, neutral, negative), Activation or Arousal (excited, neutral, calm) and Dominance or Power (weak, neutral, strong).

2.3. Automated emotion recognition

Recent years have seen a strong development of computer natural language processing methods. After the first periods of Symbolic NLP (1950s - early 1990s), and Statistical NLP (1990s-2010s), present NLP methods have huge potential for implementation. Natural Language Processing (NLP) refer to automated machine-driven algorithms for understanding of human language and extracting information (Dinov, 2018). Common tasks for these methods include text and speech processing, morphological analysis, syntactic analysis, lexical semantics, relational semantics, and discourse (Natural language processing, 2021). Some new applications includes: automatic summarization, machine translation, natural language generation. Very interesting directions of NLP development in the context of project management are the Sentiment Analysis (SA) and Emotion Analysis (EA) which leads to emotion recognition.

Sentiment Analysis (SA) and Emotion Analysis (EA) are sometimes equated, but there are important differences between them (Nandwani, Verma, 2021). Sentiment analysis is a means of assessing emotions are positive, negative, or neutral. In contrast, Emotion detection is a means of identifying complex human emotion like fear, love etc. As mention Yamini (2023), Emotion Analysis has also outperformed Sentiment Analysis in some ways. First it reveals

complex emotions. Then it provides deeply meaningful and relevant insights and at last it helps to turn insight into action.

Automated emotion recognition use various methods like electroencephalogram (EEG), facial, and speech signals, text analysis. Current overview of trends and future perspectives can be found in paper (Maithri et al., 2022).

By the nature of things, emotion detection from text will be used to analyze emotions in open source projects where almost all communication takes place via mailing lists. We are talking about emotion detection here, narrowing down the area of emotion analysis.

Many papers have been written in recent years devoted to this topic. Worth mentioning are (Shivhareand, Khethawat, 2012) where Word Ontology was used and (Minu, Ezhilarasi, 2012) which describes an English emotion ontology based on WordNet. Batbaatar have used novel neural network architecture, called SENN (Semantic-Emotion Neural Network) which can utilize both semantic/syntactic and emotional information by adopting pre-trained word representations (Batbaatar et al., 2019). Ho et al. (2020) have used to analyse other than English language namely Vietnamese. Most recent surveys on emotion detection from text can be found in paper (Nandwani, Verma, 2021) and also in two papers which present utilization of deep learning models (Uymaz, Metin, 2022; Chen, 2022).

2.4. Tools for emotion recognition

There are two general ways for dealing with automatic emotion detection: knowledge-based techniques and statistical methods (Emotion recognition, 2023). Knowledge-based techniques are referred to as lexicon-based techniques but also contain rule-based systems. Statistical methods are based on the use of different supervised machine learning algorithms.

Emotion lexicons are dictionaries that associate words or phrases with specific emotions. Tools that can be used for emotion recognition are:

- NRC Word-Emotion Association Lexicon (Mohammad and Turney, 2010; Mohammad and Turney, 2013).
- WordNet (Princeton University, 2010).
- EmotiNet (Balahur et al., 2012).

Example of rule based system is ANEW (Affective Norms for English Words) (Bradley, Lang, 1999).

Statistical methods based on supervised machine learning algorithms use such architecture as:

- Convolutional neural network (CNN) (Wang et al., 2016).
- Bidirectional Encoder Representations from Transformers (BERT) and Bi-directional Long Short-Term Memory (BiLSTM) (Chen, 2022).

There are also effective hybrid methods, an overview of which can be found in (Alswaidan, Menai, 2020).

3. Research questions

When starting research in the selected area, one should be aware that the proposed models will have to be verified based on data from the real world. The question arises about the availability of such data, hence the first research question was formulated:

RQ1: What data from real projects can research be based?

Another problem that needs to be faced is the availability of methods and tools for detecting emotions. Their spectrum is quite extensive as discussed in the previous section. However, another research question arises in the form of:

RQ2: What methods can be used to analyze emotions in project management?

The last question that arises in the context of the conducted considerations is what this knowledge can be used for in project management. If data for research are available, methods and tools will be selected, whether the ability to automatically detect emotions can be used in project management. Hence the next research question arise:

RQ3: For what purposes can emotion recognition be used in a project management?

A discussion of the presented research questions is presented in the next section.

4. Discussion and findings

4.1. Data selection

Due to the specificity of projects in which teams are focused on achieving goals, it is difficult to expect that during their implementation someone will have time to answer surveys or undergo EEG tests. In this case, there is also a question about the relevance of the results of the research conducted in this way. This is especially important in the context of the use of surveys that need to be developed. We also resign from the use of facial analysis methods. It seems that at the initial stage of research it will be beneficial to focus on the analysis of texts and communication carried out in this form.

Communication in the project takes place in defined communication channels and is usually confidential. Fortunately, in IT projects implemented in the open source formula, the projects communication is based on mailing lists and by nature are publicly available.

The mailing list of the Apache OpenOffice project, implemented in the open-line formula, was selected in this work. For this, project communication is publicly available at "https://openoffice.apache.org/mailing-lists.html". Mailing list is maintained since 2011 till today. Every month, several hundred messages appear on all sub lists together.

OpenOffice is an open-source office suite. It was an open-sourced version of the earlier StarOffice, which Sun Microsystems acquired in 1999 for internal use. Sun open-sourced the OpenOffice suite in July 2000 as a competitor to Microsoft Office. In 2011, Oracle Corporation, then the owner of Sun, announced that it would no longer offer a commercial version of the suite and donated the project to the Apache Foundation. Apache renamed the software to Apache OpenOffice. Today the most actively developed successor projects is LibreOffice (OpenOffice.org, 2022).

Apache OpenOffice is an office productivity suite providing six productivity applications (Writer, Calc, Impress, Draw, Math, Base) based around the OpenDocument Format (ODF). OpenOffice is released on Windows, OS X, Linux. It is available in 41 languages.

4.2. Methods selection

It seems that methods based on dictionaries and deep neural networks are particularly interesting. While the use of dictionary methods can be problematic, due to the problem mentioned by Tourani (Tourani et al., 2017), involving the use of specific IT slang in open source projects, the use of deep neural networks may be interesting. Another research problem arises as to whether these tools will be able to capture emotions from e-mail communication. It is also a question about the selectivity of these methods in detecting emotions.

4.3. The use of emotion recognition in project management

In the context of the latest views on the success of a project, according to which success is considered to be meeting the expectations of and stakeholders, their emotions may be important in the correct assessment of the project. We know that some negative emotions (such as anger) as well as positive ones (such as love) can affect the way we view the situation and the decisions we make. Hence, the ability to catch particularly bad emotions can be helpful in effectively managing stakeholder engagement. As a consequence, it can also have an impact on achieving project success more effectively.

For the above reasons, it seems justified to focus primarily on the detection of bad emotions, such as anger.

5. Summary

The presented work deals with the topic of using automatic emotion recognition in projects. On the one hand, there are effective tools for emotional analysis. On the other hand, there is a need to manage stakeholder engagement.

The available data for the analysis of emotions in projects was reviewed. It turned out that it would be beneficial to use publicly available communication in open source projects. It also implied the use of methods of emotional analysis in texts. In the course of the conducted analyses, effective methods of analyzing emotions from the text were also reviewed. Finally, an analysis of the possibility of using emotion recognition in project management was made. The most beneficial seems to be the use of the proposed methods to detect bad emotions that disturb the delay in project goals.

The presented work presents the concept of using emotion recognition in project management. The initial considerations carried out led to many further questions that need to be verified in empirical research. This will be the subject of further research.

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