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Student ID: 02101882 CIS 580 Term Paper

Title: BERT-Based Approach for Greening Software Requirements Engineering Through Non-Functional Requirements.

Author: Ahmad F. Subahi **Publication date: 20 September 2023**

Review of the Research Paper

What problem(s) are the authors attempting to solve?

By offering a structured framework, improved dataset, and cutting-edge machine learning model for greening software requirements engineering, the author hopes to close the gap between software engineering methods and environmental sustainability objectives.

Linking NFRs to Green IT Procedures: By developing a framework, the author hopes to connect software engineering's Non-Functional Requirements (NFRs) to the variables affecting green IT practices. He hopes to improve knowledge of how software design choices affect socioeconomic and environmental sustainability by doing this.

Labelling and Expanding the Dataset: The author expands the dataset to include NFRs annotated with green IT factor types, such as socioeconomic and eco-technical factors, in order to assist the mapping technique. The goal of this extension is to offer an all-encompassing base for machine learning model evaluation and training for NFR classification.

BERT Model Development: In the framework of greening requirements engineering, the author uses the capabilities of the BERT (Bidirectional Encoder Representations from Transformers) model to create a refined model for binary categorization of NFRs according to their semantics. This tackles the difficulty of comprehending the complex connotations of NFR expressions and how they affect sustainability.

Which topics discussed in CIS 580 does this paper relate to?

The research paper by Ahmad F. Subahi is relevant to multiple significant concepts in the context of CIS 580, "Paradigmatic Software Development."

Software Development Lifecycle: By concentrating on requirements engineering, the research adds to a more comprehensive knowledge of the software development process. It investigates the ways in which sophisticated methods like as BERT may be utilized to improve this stage of software development, therefore enhancing our (students') understanding of the software development lifecycle as a whole.

Non-Functional Requirements (NFRs): With an emphasis on features including performance, security, usability, and sustainability, NFRs are an essential component of software requirements engineering. Focusing on non-functional requirements (NFRs) associated with environmental sustainability, this paper follows up on CIS 580's describes the significance of taking into account a range of non-functional requirements in addition to functional requirements.

Do you think this paper helped you improve your understanding of the related course topic?

The research provides insights into how cutting-edge technologies can affect the software development process by presenting a novel method that makes use of sophisticated natural language processing techniques, like BERT, to analyse and classify non-functional requirements linked to environmental sustainability. This works in closely with CIS 580's learning goals, which include comprehending paradigms' function in software development and how they affect the process and final result. By offering a modern illustration of how software development paradigms interact with more general social, technical, and environmental challenges, the research improves my comprehension of the relevant course topic. It helps me better understand the software development lifecycle and how paradigms fit into it by showing how sophisticated approaches may be applied in real-world situations.

Summary of Results

In order to connect software Non-Functional Requirements (NFRs) with variables impacting green information technology (IT) practices, the paper offers a thorough methodology. The process begins with adding new categories of NFRs related to sustainability, such energy efficiency, environmental effect, and socioeconomic variables, to an already-existing collection of NFRs called PROMISE_exp. The methodical process of looking through and evaluating papers pertaining to software/system development projects yields these NFRs, which are then manually classified and validated.

The Socioeconomic and Eco-technical factors labels are two new ones that are introduced to make it easier to classify NFRs according to how well they correspond with green IT characteristics. These terms stand for several facets of sustainability: Eco-technical highlights environmental concerns, while Socioeconomic focuses on the social and economic effects of software.

Developing a refined BERT (Bidirectional Encoder Representations from Transformers) model for binary text categorization is the fundamental component of the suggested framework. The latest model for natural language processing, BERT, is excellent at deciphering text's subtle contextual information. Using an enlarged dataset of NFRs tagged with socioeconomic and eco-technical parameters, the model is trained.

According to a number of criteria, including accuracy, precision, recall, and F1 score, the model assessment findings show promising performance. Improvements are seen when utilizing higher batch sizes, and various combinations of training epochs and batch sizes are investigated.

While it is still difficult to strike a balance between recall and precision, the confusion matrices produced throughout the assessment show a fair degree of accuracy in forecasting both socioeconomic and eco-technical occurrences.

By utilizing cutting-edge natural language processing techniques, the study presents a unique method for categorizing software NFRs according to how well they fit with green IT characteristics. Though the findings show promise, more model modification and fine-tuning is recommended to improve performance and produce a more fair categorization result.

To sum up, in order to include green software requirements engineering into the software development process, the article presents a BERT-based method. Author examines environmental sustainability-related non-functional requirements (NFRs) using BERT, an advanced natural language processing approach.

By experimenting with a dataset of software requirements papers, he shows that his method is able to correctly identify and classify green NFRs. The suggested BERT-based approach performs better than conventional methods, according to the results, and presents a viable way to integrate environmental sustainability concerns into software development.

What new contribution(s) does the paper make to the field of software engineering?

Large Datasets:

By adding new categories of Non-Functional Requirements (NFRs) related to sustainability, the research considerably improves an already-existing dataset, PROMISE_exp. The expansion process is a methodical one that includes human classification of NFRs into predetermined categories, confirmation by topic experts, and data extraction from several sources, including student dissertations. The work expands the range and depth of resources accessible for software engineering research, especially with regard to sustainability issues, by adding new examples of NFRs to the dataset.

BERT Model:

The research creates a complex categorization model for NFRs by utilizing cutting-edge natural language processing methods, especially BERT (Bidirectional Encoder Representations from Transformers). More precise and nuanced classification of NFRs according to their relationship to sustainability criteria is made possible by BERT's sophisticated abilities to extract contextual information and semantic details from text data.

The research shows how sophisticated machine learning models may improve software engineering methods by including sustainability criteria into the requirements analysis stage, as demonstrated by BERT's fine-tuning on the larger dataset.

Labelling:

The use of two new labels—socioeconomic and eco-technical factors—to classify software requirements according to how well they correspond with sustainability aspects is a significant innovation included in the paper.

This labelling scheme provides a more detailed understanding of NFRs, enabling socio-economic and technical analyses of their implications for green IT practices. The study facilitates a better understanding of the relationship between software engineering and environmental concerns by directly connecting software requirements to more general sustainability goals.

Evaluation:

The paper's comprehensive analysis of the performance of the BERT-based categorization model is one of its key features. The model's efficacy in categorizing NFRs into the established sustainability categories is evaluated by the authors using a variety of assessment criteria, including as accuracy, precision, recall, and F1 score.

The research gives helpful advice for academics and practitioners looking to use comparable machine learning techniques in software engineering contexts by giving in-depth insights into the model's advantages and disadvantages across various configurations and circumstances.

The incorporation of sustainability factors into software engineering processes has advanced significantly as a result of the paper's contributions. The report establishes the foundation for future research targeted at creating software systems and processes that are more sustainable by fusing data-driven methods with advanced machine learning techniques.

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What is the value of this paper?

Offering a fresh perspective on software development methodologies, the research introduces a ground-breaking method that unites software engineering with environmental issues. This research fills a significant void in the literature by extending the dataset with a wide variety of software needs and using a careful tagging procedure.

The research illustrates the viability of automated categorization of non-functional requirements (NFRs) based on their alignment with green IT elements through the use of cutting-edge machine learning techniques, namely the customization of BERT models.

This work is extremely valuable to the area of software engineering in many ways. First of all, it contributes to our understanding of how software non-functional requirements (NFRs) directly affect sustainability dimensions, which in turn helps developers create software systems that are ecologically dedicated.

Second, by giving practitioners the tools to methodically connect NFRs to sustainability aspects, the suggested approach supports the choice of relevant development paradigms and directs decision-making procedures.

Furthermore, the research creates opportunities for the automation of sustainability-driven processes, improving software development methods' efficiency and scalability, by utilizing cutting-edge natural language processing techniques like BERT.

What impact will it have on the practice of software engineering in the immediate future?

This research will likely have a significant influence on software engineering practice in the near future. Practitioners are probably going to include sustainability issues more heavily into their development processes, using the study's insights to create software that is more environmentally friendly.

Development methodologies that prioritize sustainability may give rise to software tools and frameworks that are environmentally friendly, enabling programmers to produce products with as little negative influence on the environment as possible.

What will be the long-term impact? Why?

In the long run, this study will have an influence that goes beyond specific development initiatives. The adoption of environmentally conscious software engineering approaches, as promoted in this paper, is set to become standard practice as sustainability continues to gain ground as a major concern across sectors.

The use of sustainability-driven development approaches has the potential to provide extensive consequences, encompassing everything from market competitiveness to regulatory compliance needs. The research builds the foundation for a future where environmental considerations are intrinsic to software development processes, contributing to a more robust and sustainable digital ecosystem. It does this by pioneering concepts of sustainable software engineering.