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ASReview: An Opensource Machine Learning Tool for Automated Systematic Reviews

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Abstract:

This study explores the overview of an opensource machine learning tool for automated systematic reviews named ASReview (active learning for systematic reviews). ASReview's objective is to assist researchers and practitioners in quickly and transparently obtaining a summary of the most pertinent publications for their work. Systematic reviews are thorough summaries of the body of research on a particular subject. It takes a lot of time and resources to conduct. Recent years have seen the development of technologies and techniques that can reduce the amount of manual labor required to produce systematic reviews more quickly. The majority of the phases in the systematic review process have been accelerated by automation. Machine learning and AI are the hot cakes in the data- driven age. They play a crucial role in the automation to handle large amounts of dataset in research. As it is known, automating systematic review is the new practiced field to conduct. ASReview, to some extent, aims to alleviate the burdens by streamlining various stages of the systematic review process.

Keywords: *Systematic literature review, Machine learning, Automating review, ASReview, active learning.*

1. Introduction:

Automating literature reviews has emerged as a critical solution to manage the overwhelming volume of scientific publications. Recent advancements in artificial intelligence, particularly through the use of large language models (LLMs) and natural language processing (NLP), have facilitated the development of tools that streamline various stages of the review process. This automation not only enhances efficiency but also maintains the rigor required for systematic reviews. Automation has been applied across multiple systematic review stages, including search, screening, and data extraction, with varying degrees of success (Tóth et al., 2024). ASReview is an innovative tool that leverages artificial intelligence to enhance the efficiency of systematic reviews by streamlining the screening process. As we are aware, active learning (AL) is a strategic approach in both educational and machine learning contexts that emphasizes the active participation of learners or models in the learning process. In education, it fosters engagement and critical thinking, while in machine learning, it optimizes data labeling to enhance model performance. ASReview employs active learning techniques to optimize the selection of relevant studies, thereby reducing the time and effort required for researchers. ASReview facilitates the systematic review process by automating the screening of primary



studies, which traditionally is resource-intensive and error-prone (Quan et al., 2024). It utilizes machine learning models to classify studies as relevant or irrelevant, allowing researchers to focus on pertinent literature more effectively (Quan et al., 2024).

2. Literature Review:

Cacciarelli & Kulahci, (2023) defined in their paper that in order to reduce labeling expenses and enhance model performance, active learning is a machine learning technique that chooses the most instructive data points for labeling from a data stream. (Tóth et al., 2024) described by stating that although their practical use and efficacy are still restricted and vary throughout research, automated systematic reviews (ASR) use automation technologies for several stages of the review process, such as search, record screening, full-text selection, and data extraction. (Yao et al., 2023) examines and contrasts the accuracy and effectiveness of AI systems for automated systematic reviews in cancer research. Even if Abstrackr and other similar tools shown notable time savings, AI should be used in conjunction with human reviewers rather than in place of them until additional assessments are carried out.

Van Dinter et al., (2021) discusses the automation of systematic literature reviews (SLRs), highlighting that while various automation techniques exist, the primary focus has been on the selection of primary studies, with no automation applied in the planning and reporting phases. Quan et al., (2024) defines ASReview is an artificial intelligence tool designed to facilitate the screening process in meta-research. It helps researchers label studies as relevant or irrelevant, streamlining the selection of primary studies for meta-analyses and systematic methodological reviews. Van Dijk et al., (2023) states that ASReview is an open-source AI tool designed to facilitate title and abstract screening in systematic reviews. It employs a researcher-in-the-loop algorithm to rank articles based on relevance, significantly improving efficiency and transparency in the review process. Wolcherink et al., (2023) told the same as Quan et al., (2024) states that ASReview is an artificial intelligence-powered tool designed to assist in the screening of titles and abstracts in systematic reviews. It demonstrated potential for significant time savings and improved accuracy in identifying relevant articles in health economic contexts.

3. Research Gap:

The existing body of literature emphasizes the application of active learning and AI-driven tools to streamline the systematic review process, including the automation of tasks like record screening, study selection, and data extraction. Tools like ASReview, Abstrackr, and others have demonstrated potential for improving efficiency and reducing time costs. However, several limitations persist. Most studies focus on automation during the screening and study selection phases, with limited attention given to other critical stages of the systematic review process, such as planning and reporting (Van Dinter et al., 2021). Additionally, while tools like ASReview



have been shown to improve efficiency and transparency, their reliance on a researcher-in-the-loop approach highlights the need for further evaluation of their efficacy when compared to traditional methods (Van Dijk et al., 2023; Quan et al., 2024). Furthermore, although these tools have shown promise in specific domains such as cancer research and health economics, their generalization across diverse fields remains under explored. This creates a gap in understanding the broader applicability, long-term effectiveness, and potential integration of these technologies across all stages of systematic reviews.

4. Objectives:

A study relies on some objectives. The primary objectives of this study as follows

- (i) To aware about the automating systematic review in research
- (ii) To know the machine learning tool for automated systematic review, ARSeview
- (iii) To understand the implementation of ASReview in local machine for systematic review

5. Methodology:

The present study aims to demonstrate the utility of automated systematic review the by ASReview tool. Firstly, a dataset is prepared with a few records in a .csv file. Then the dataset is incorporated in the mentioned tool which is installed locally in the Ubuntu 22.04 system. The workflows, basically the installation part and its application, are told (see point 6) shortly.

6. Workflows in ASR:

The workflows lie from installation to systematic review for conducting the study.

6.1 Software Installation:

ASReview LAB can be installed locally. For installation the tool in local machine one needs to install python version 3.8 or higher than 3.8. After checking it (python --version) the tool (ASReview LAB) can be incorporated through command prompt by writing the following commands – (i) pip install asreview; (ii) asreview lab (to run)

```
anjanpal@anjanpal-HP-Pavilion-Laptop-14-dv2xxx: $ asreview lab
Serving ASReview LAB at http://localhost:5000/

If your browser doesn't open. Navigate to http://localhost:5000/
```

Figure1: Installation of ASReview LAB in local machine

To update the software regularly the needful command is pip install —upgrade asreview



6.2 Data preparation:

Before creating the project for review the ASR needs a dataset that includes a textual records such as titles and abstracts (mandatory) of scientific papers, newspaper articles, policy reports etc. The data file can be any format like .csv, .tsv, .tab, or .xlsx. Each record in the dataset should have a label. It is strongly advised to include a dataset with complete records and no duplicates in order to get the most out of the active learning model's performance.

6.3 Project creation & review:

To set up the project information, the mode should be selected. There are three kinds of modes given, such as Oracle (Which is the default), Validation (validate labels provided by another screener or derived from an LLM or AI) and Simulation (simulate a review on an entirely labeled dataset to observe ASReview LAB's performance). After incorporating the dataset, it is needed to label at least 1 relevant and 1 irrelevant record based on project to warm up the AI. Prior knowledge is used to start the active learning model. Depending on the project mode, there are different options for adding a dataset: file, URL or DOI, and extension.

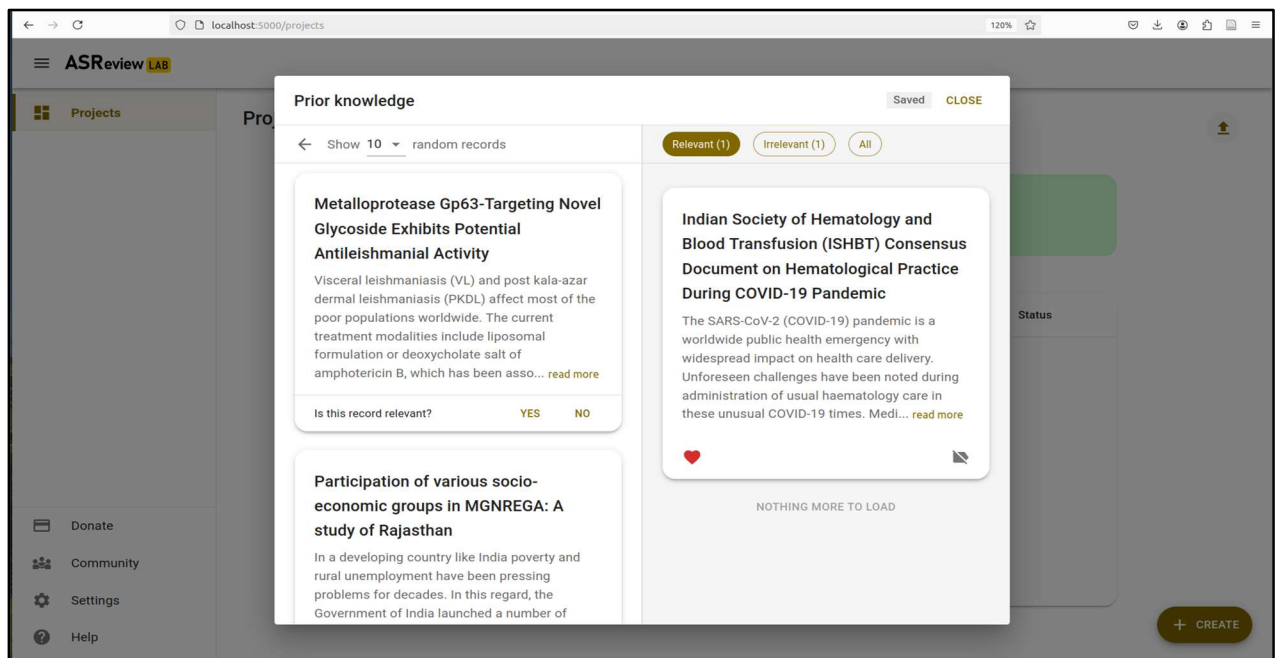


Figure2: Prior knowledge page in project creation

TF-IDF (term frequency-inverse document frequency), sentence BERT, etc are the included backends in the machine learning framework. The machine learning model that calculates the relevance scores is called a classifier. Naive Bayes is the default. The software comes with a number of additional classifiers, including logistic regression, random forest, SVM, LSTM, and neural net (required Tensorflow). Extensions or the API can be used to select additional



classifiers. After all the workflows, one can find the review. The tool offers some insightful statistics for keeping track of the screening process. The results can be exported in RIS, CSV, TSV, or Excel file.

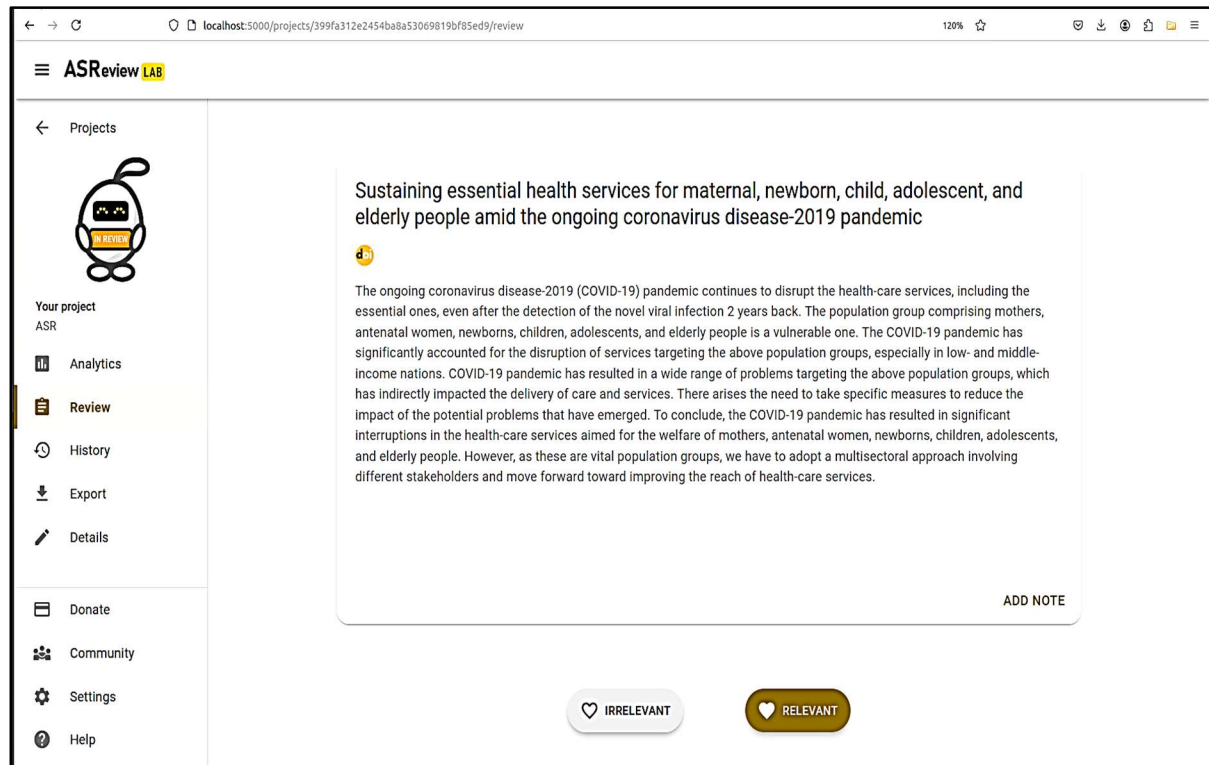


Figure3: Review Page in ASReview

7. Conclusion:

Although ASReview is a tool designed to assist researchers in conducting systematic reviews more efficiently by using machine learning and active learning, it has some limitations. Like The effectiveness of ASReview relies on the quality and quantity of the data. If the initial dataset is biased or incomplete, the active learning process may not perform optimally. Moreover, regular manual validation is needed throughout the review process to ensure the tool is learning correctly. ASReview depends on textual data (e.g., titles, abstracts) to identify relevant studies. It may not effectively utilize non-textual data or metadata (e.g., images, graphs, or non-standard file formats). Keeping these things in mind, ASReview's developers and community are actively improving the tool. But in the current scenario, the tool is absolutely effective for the research community.



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