CS486C – Senior Capstone Design in Computer Science

Project Description

Project Title: Continuous Community Review Compendium	
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Project Overview:

There exists long-standing and progressive decay in the methods that the scientific community reviews, accesses and explores published scientific literature. Up until a few years ago, each researcher needed to compensate for these systemic failings by applying a little more effort every year. But the maturation of large language models brought along with it AI-written papers filled with fake findings and AI-written peer review which undercut community trust in published literature. There are three separate but inter-related problems that can be solved with a change in the scientific community contract and made possible by a software tool that I hope you'll construct. First, you must understand the problems.

A tale of three problems:

Peer Review: It has only been 75 years that the process of peer review has been the standard for publication of scientific literature. It was adopted at a time, post-WWII, that there was a relatively small number of academics as well as academic fields. It's true that the publication of scientific results was expected from perhaps the mid-16th century, but the number of publications per year was not used as the metric by which academics were evaluated at a university until the second half of the 20th century. (One study says the standard researcher in 1950 produced on average 1.55 papers per decade, as opposed to 4 per year today.) Peer review is the process in which two or three experts in a field are asked by a journal to judge whether a submitted manuscript represents a scientifically accurate and valuable enough contribution to the field to merit publication. This is a time-intensive service that academics perform that is unpaid and mostly anonymous. However, the quality of the peer review depends upon the knowledge, capabilities, and ethics of the reviewer. To participate in peer review is an expectation for every academically active PhD, and yet, almost without exception, the graduate curriculum in Western universities provides no training to graduate students in the process, norms, or styles of peer review. If they're lucky, graduate students may get an example or two of peer review from their advisors, but again, this only provides the student a single sample from a single source, with no perspectives on the quality of that review sample. *Young researchers need access to a wide selection of real peer reviews from which they can learn review and analysis techniques and sub-community norms.*

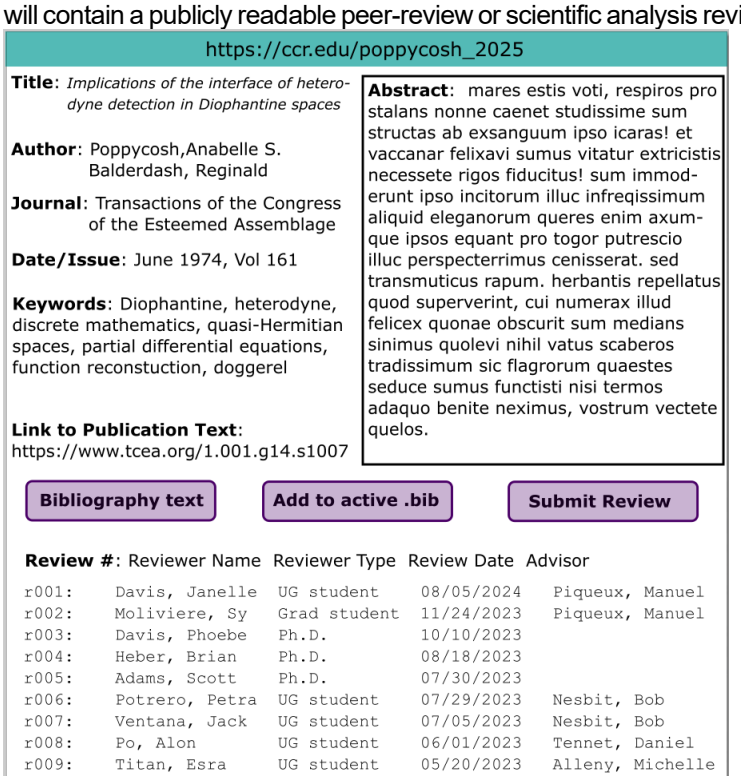
Literature Review: One of the necessary components of academic investigation is to perform a literature search to become expertly knowledgeable of what research has been performed to date. With the increasing cost of subscriptions draining library and university budgets, comprehensive literature reviews have become prohibitively expensive in time and money. In 1950, it is estimated that there were approximately 50,000 new publications a year, by 2024, this number was 3.5 million. Furthermore, there is no single trustworthy web of connective links and analyses that a researcher can rely upon. In short, every researcher must construct a personalized analysis of each paper, connect the material to other papers that they find, and annotate each paper to identify flaws or vagueness, and provide a subsequent digestion of the paper that also fills in what has occurred since that paper was published. In many cases, the findings of one researcher would be invaluable to many others, but *there is no community expectation or mechanism to share reviews of the state of the art or even a single paper.*

The Use of AI: Over the last few years, large language models (LLMs) have become ubiquitous and provide a very tempting crutch to researchers who are pressured to frequently publish as many papers as possible and review many

more. Two meta-analyses of published works estimated that nearly 70% of published papers today have been at least partially written or edited by LLMs, and nearly 50% of accessible peer reviews were completely written by AI. It is now common knowledge that it is difficult to guarantee that "facts" used by AI aren't hallucinated or incorrect due to the quality of their sources. Obviously, having AI both write and peer-review papers, even without questionable source material, is detrimental to the scientific body of knowledge. However, *having an expert-created, human-analyzed compendium of digested scientific analysis would be a valuable resource for future AI synthesis*.

Solution Overview:

There is a proposal in the physics department and three other departments at NAU to require graduate students to produce three peer reviews per semester as part of their curriculum. These peer reviews will be publicly attached to a searchable record of a scientific paper as well as to the academic record of the student. Papers will need to be viewable from a web browser, with the nominal conceptual format below. Each of the review entries at the bottom will contain a publicly readable peer-review or scientific analysis review record. Publication records will need to contain Title, Author, Journal name, Date/Issue, Keywords from author, the entire abstract of the paper, and a link to the publication text.



- A button that generates bibliography text using a selected format will allow the researcher to print it to the screen for their use.
- Another button can add a paper to an existing latex bibliography file.
- A third allows a reader to submit a new review, which will be added to the review list of that paper.

The content in each student-created review will start with addressing the following topics:

- Keywords you think should apply to the paper
- Thorough overview of the paper
- Strengths of the paper
- Weaknesses/flaws of the paper
- Relevant findings in bulleted form
- Is this paper repeatable?
- Does it require a repeat study?
- Is this derivative of other work?
- Suggestions to make it more understandable

The digital review records will need to be flexible enough to be adaptable to future fields. It is to be expected that researchers will want to provide more detailed connections with papers published later.

Impact of a successful product:

This product provides NAU with the extensible tool needed to
1. Train new researchers
2. Adapt the tool to the needs of the community
3. Be publicly owned and searchable
4. Provide a standalone, reliable, academically-verified source of scientific knowledge synthesis.

Commercial products such as Zotero, Endnote, Anara, Obsidian, and Research Rabbit each contain portions of this proposed product, but they don't put it all in one place and connect it to a curricular requirement and academic record. This tool would enable NAU to begin to change the relationship that the academic community has with scientific literature and provide a tool that solves growing problems in the peer-review process.

Knowledge, skills, and expertise required for this project:

Database server: Suggested is MySQL server and client setup to host all of the fields and allow for table extension. User accounts will need to be established for each researcher as a permanent record tied initially to some unique identifier, but with the expectation that it will be eventually converted to be attached to some university id.

Website design: For accessing, searching and appending to the database. There are a few website templates that will need to be generated to display the database information.

AI data porting: It is important to realize that eventually this material will be used to generate web-diagrams, reference trees and AI-assisted topical synthesis. It remains an open question as to how this data can be best formatted for AI digestion and is left to the team to determine an architecture.

Equipment Requirements:
All development platforms are freely available. An account on Amazon Web Services for hosting the database can be obtained with the expectation that the university may need to port the database over to university owned assets sometime in the future with sufficient funding.

Software and Other Deliverables:

- Freeware database on a server (AWS as an initial suggestion) containing the fields needed, with user accounts preferably set up through an automated process.
- Website (on NAU's server) with sufficient templates to display records from the database searchable via the various fields (e.g. all records from the same author, or all records that a single student reviewed, etc.)
- A user guide
- A preliminary report on suggestions of how database data can be digested into AI models.