CSC 510 Software Engineering: Project 1

Group-P

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ABSTRACT

Choosing a textbook for a class is something that many professors do several times a year, but the vast number of available textbooks for any given subject makes choosing one that both meets the needs of the class and meets the budget constraints of today's students is a challenge. In this paper, we propose two methods for automatically learning topics from books, a set of evaluations for those methods, and a system that will use those methods in a web app that attempts to suggest textbooks to a professor that balance hitting all topics the course requires while still being economical for students.

1. INTRODUCTION

One of the most basic tasks that a professor must do is identify what textbook to use for a given class. While some fields have textbooks that have become popular and are clearly the best in their subject matter, many fields (especially emerging ones) have no such exemplar. It would be a complex enough problem if there were not already a massive number of textbooks on sources such as Amazon, but self aware professors have attempted to use textbooks that are less expensive with hopes of allowing lower income students to attend more easily. This admirable intention serves to increase the time needed to research the given books, and there is no obvious heuristic to apply to searches to limit the field.

In the interests of making students lives less expensive, we propose exploring a system which can identify topics in books automatically, and which, given a set of requirements from a user (usually a professor), can suggest options of varying expense and completeness for a given set of topics. To do this, we propose exploring word clusters generated by Doc2Vec, a family of common natural language processing (NLP) algorithms that attempt to cluster similar words, and topics generated by latent dirichlet allocation (LDP), another common NLP algorithm that directly attempts to identify topics in text, to automatically infer the content of a set of textbooks. We then intend to build a web app that will allow a user to specify a set of topics and which will use the mentioned algorithms to make suggestions while minimizing the cost of said textbooks.

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2. LITERATURE REVIEW

We propose two methods for analyzing and storing topics from books automatically: LDA and Doc2vec.

2.1 LDA

2.2 Doc2Vec

Doc2Vec is a model that extends an existing model, Word2Vec. Doc2vec mirrors Word2Vec in most ways except that it adds context information. [1]

2.3 Related Work

3. PROPOSED SOLUTION

To tackle this problem, we propose a three-part system that will go about recommending books via a web app. The first component of this system is a recommendation engine, which will implement the above algorithms in some way and store their results (the topics) in an indexed database which we can summarily search (see section 3.1). The next component will be a recommendation engine which will implement our recommendation algorithm (see section 3.2). The third component will be a web app that will allow the end-user to search the database of topics and organize them into a useful search of books. It will then present a list of suggested books using the infrastructure mentioned earlier.

To host our project, we have begun work on an Ansible automation script that will communicate with NCSU's VCL environment. It is our intention to use this script to provision our needed hosting resources and to tear those resources down when they are not needed.

3.1 Book parser

The first major component of the system is the book parser. We intend to implement this taking advantage of the pre-built libraries available in Python such as SKLearn, Pandas, and others. The goal of the book parser is to implement one of the two algorithms discussed in section 2 and to store the parsed topics in a database for searching later. This will be implemented using the command pattern, which provides a simple interface to implementing different algorithms in code and allows us to easily swap between implementations.

The books being parsed will come from a freely available online database of textbooks. We have found a number of websites such as openstax.org and onlinebooks.library.upenn.edu that offer free libraries of textbooks that we are evaluating for use for this project. It is our intention to use a REST API or something similar to poll for books to analyze.

We are also exploring how much of the books we need to parse. Parsing entire books for topics is infeasible as the number of books grows (and as our introduction pointed out, there are plenty of books to parse) but we need to ensure that we have enough text to encapsulate all of the important topics the books cover, and that we have enough text to reliably train our algorithms on. To test this, the team intends to do testing before we test the actual application to see how much training is required when parsing the table of contents only, the index only, and any available summaries. We also intend to test some combinations such as the table of contents and the index together, to try to isolate what section might be most useful for training.

Because analyzing entire libraries of books is not something that we can do in real time, we plan to cache the topics parsed from these algorithms in a database to be referenced in the future. We are evaluating MySQL, Postgress, and an object-oriented DB such as Mongo for this task. This will allow us to train the algorithms on the books ahead of time and will make searching for books based on topics much more efficient. It also allows us to do routine similarity analysis on the topics of books to identify potential synonyms between topics. In other words, we could store the topics from two different books in the same database tables we are exploring algorithms that might then allow us to identify similarities in topics mined and then link the books to the same topics for future analysis. That said, this is a very lofty goal in an already complex project, and similarity analysis may need to be cut for time constraints.

3.2 Recommendation Engine

The next step in our problem is to use the topic analysis data outlined in the previous section (3.1) to suggest books based on the topics covered and the cost. This algorithm will be written in Python as well.

Conceptually, this algorithm will need to take in a set of required topics and weighting for topics vs price. This value will be used to favor inexpensive books over complete topic coverage in our algorithm. It will then search its algorithms for books that meet the required topics. The algorithm should then rank the books using the weighting mentioned earlier, then it will sort some number of the top results and give them back to the UI.

3.3 Web App

The web app is the final component of this architecture and it serves to tie the previous two components together. The app provides the UI to the algorithms, allowing professors to log in and select a set of subjects they wish to teach on, then it should present them with a UI for searching for topics in our database. It should then allow them to create a list of topics to suggest books for. Once the list has been generated, the tool should search against the book databases it has access to using the algorithms outlined in the previous sections.

We will develop this app in either the MEAN stack or some variant thereof. (Does it make more sense to just use Django since we are writing learning algorithms in Python?) The front-end will be developed using Bootstrap to save time in developing a useful, mobile friendly UI. In the end, the app itself will be a single-page web app that includes minimal authentication features. The real complexity of this app is in the learning algorithms and the suggestion engine, so the front end of the app itself needs only to be a client to reach out to those algorithms.

4. EVALUATION PLAN

This is a test of our evaluation plan section

4.1 Evaluating Topic Modeling

4.2 Evaluating textbook suggestions

5. CONCLUSION

5.1 Anticipated challenges

There are a few potential major pitfalls that we are trying to plan our way around in this project. The first and most glaring problem is that the team's staff has very little experience with NLP in general, so we will be relying on third party libraries that implement algorithms (Pandas, SKLearn, and Gensim specifically) as much as possible. The other major potential problem is extracting useful clusters out of Doc2Vec. Doc2Vec is not actually designed for this kind of topic modeling, and our application of it here is experimental in nature. It is our goal to see if Doc2Vec can match or outperform the more conventional LDA, and it may not.

5.2 Future enhancement

One major enhancement would be the introduction of a rating system to the suggestion engine. Another major enhancement would be including links in the UI to buy the books. A third major enhancement would be evaluating other topic modeling algorithms to see how they stack up. Another enhancement would be to test an even more rudimentary topic modeling method, such as simply representing topics as lines in a table of contents. Essentially asking the question of whether or not fancy algorithms are even more useful that simple text search for this domain.

6. ADDITIONAL AUTHORS

7. REFERENCES

[1] T. Mikolov, I. Sutskever, K. Chen, G. Corrado, and J. Dean. Distributed representations of words and phrases and their compositionality. Oct 16, 2013. Skip-gram model, Negative Sampling.