

Hansard Historical Sentiment Analysis and Comparison

Final Report for CS39440 Major Project

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Declaration of originality

I confirm that:

- This submission is my own work, except where clearly indicated.
- I understand that there are severe penalties for Unacceptable Academic Practice, which can lead to loss of marks or even the withholding of a degree.
- I have read the regulations on Unacceptable Academic Practice from the University's Academic Quality and Records Office (AQRO) and the relevant sections of the current Student Handbook of the Department of Computer Science.
- In submitting this work I understand and agree to abide by the University's regulations governing these issues.

Name: Adam Neaves

Date: 04/05/2018

Consent to share this work

By including my name below, I hereby agree to this dissertation being made available to other students and academic staff of the Aberystwyth Computer Science Department.

Name: Adam Neaves

Date: 04/05/2018

Acknowledgements

I am grateful to...

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Abstract

Politics affects all aspects of a persons life. The results of debates in Parliament may have a profound influence on an individuals life, and knowing how your local MP speaks and the opinions they express during these debates could prove useful. Websites, such as They Work For You, show a user how their local MP votes, and how often they attend debates, ask questions, and other information that may allow the user to make informed decisions when voting during elections.

The aim of the Hansard Sentiment Analysis Tool is to provide a tool to automatically detect the sentiment of statements made during political debates, and to compare it with sentiment expressed about the topic previously, or compare it with sentiment expressed by the same MP. The sentiment analysis will use a machine learning approach, where a model will be trained on labelled datasets generated from the source data.

Being able to view how sentiment changed over time, expecially about certain topics, could prove useful for a user who wants to not only know how an MP votes, but also how they represent themselves and their constituency in parliament. If an MP is seen to change opinion on a topic as time passes, this information could be used to keep voters informed.

This report will document the process of designing and developing the Hansard Sentiment Analysis Tool, highlighting any challenges encountered during development, and also the results of the technical work.

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Chapter 1

Background & Objectives

1.1 Background

1.1.1 Hansard Dataset

The Hansard Dataset is a set of documents produced by the British Parliament, which began in the 18th and 19th century. These documents contain reports and details of debates in the House of Commons, going back to the year 1803. Eventually, in 1907, these reports were made official and started being produced by Parliament itself, becoming The Official Report, though still unofficially known as Hansard. Along with becoming official, a report was officially defined as being one:

which, though not strictly verbatim, is substantially the verbatim report, with repetitions and redundancies omitted and with obvious mistakes corrected, but which on the other hand leaves out nothing that adds to the meaning of the speech or illustrates the argument” [1]

Hansard is available in a variety of versions. The most commonly used and best known version is the Daily Hansard, which appears each morning and reports of the previous days proceedings. However, access to this is via an API that only provides the most recent 7 days. For this project, most training and processing will be done on the Historical Hansard dataset, which is a dataset containing all 6 series of Hansard, between 1803 to 2004, though it is expected that some of the older documents will be less useful for this project due to the likelihood of them using outdated speech that would no longer be relevant.

The Historical Hansard Dataset is available online in an XML format. Multiple documents per series are available, each document covering a few days debates at most. It is a large dataset, reaching around 10Gb in size in total. Most of the documents available are scanned from hard copies, rather than typed up directly, meaning there is a possibility of small errors from the scanning process that may have to be dealt with. Additionally, from preliminary looks, the data itself appears to be only loosely formatted, and each of the six series appear to be formatted in a slightly different way, so any system designed to read this data will have to be capable of dealing with any changes to formatting.

1.1.2 Natural language Processing

Natural Language Processing (NLP) is the process of getting a computer to read and understand written text. Computers are very good at dealing with numbers and performing complex calculations at high speed but are not as good at understanding spoken or written language. Because of this, a large part of NLP is the act of processing the data, or text, to make it easier for the computer to understand and work with. NLP covers multiple topics, such as Named Entity Recognition, part of Speech Tagging, and Sentence Boundary Disambiguation. However, the part this project is mainly interested in is the act of Sentiment Analysis.

Sentiment Analysis, also known as Opinion Mining, is the process of identifying and extracting the opinions expressed in a piece of text. It aims to determine the attitude of a speaker or writer towards a topic, or the overall polarity of a piece of text. This can be a judgement made by the writer or speaker, in the case of reviews, or the emotional state of the speaker or writer.

A basic version of Sentiment Analysis classifies the polarity of a piece of text, classifying it as either positive, negative or neutral. A more advanced version would be, for example, looking at emotions expressed in the text, classifying it as angry, happy, or sad, as some examples. A basic method used can be to compare a piece to two lists of words, one a list of words that usually denote a positive polarity, and one that usually denotes a negative polarity. A system can then simply count the number of positive and negative words in a piece of text, account for any negation (Saying not great would change the word great from a positive to a negative word, for instance) and whichever type of word was most common would denote the piece of text's sentiment. However, this method is likely only useful for those pieces of text where it's known that strong sentiment is likely to be expressed in a simple enough manner, in text such as a review.

Stance Detection is another aspect of Natural Language Processing, similar to Sentiment Analysis. However, the difference here is that Stance Detection sets out to classify the relative stance of two pieces of text, classifying whether the texts agree with, disagree with, discuss, or are unrelated to each other. An example would be detecting the stance of a news article compared to its headline. This may be more applicable to the Hansard Dataset than Sentiment Analysis as the members of parliament are likely to be expressing some form of stance on a topic that they are debating, but also somewhat more complicated to do, due to the additional classes involved.

1.1.3 Related Work

In researching the potential design of project, a few relevant pieces of work done by others were discovered, some of which had a useful impact on the design of this project.

Towards sentiment analysis on parliamentary debates in Hansard [2] is a paper which discussed the progress made by a group of PHD researchers towards applying classic sentiment analysis techniques to the Hansard dataset, such as word association. The paper details the proposed approach to sentiment analysis, by using heuristic classifiers based on the use of statistical and syntactic clues in the text and using a sentiment lexicon base known as the MPQA corpus to identify sentences containing known positive or negative words. They first classify a sentence using this lexicon, annotating sentences as positive or negative depending on the number of positive or negative words, before then applying syntactic clues to improve the classification, such as the presence of negations, such as not or never, and the inclusion of intensifying adverbs such as very. The paper reports an average of 43% correctly annotated sentences, claiming that the correctly annotated

sentences were those without compound opinions, sarcasm and comparative sentences, showing that the style of debate speech renders their syntactic and lexical based approach insufficient for the task.

They Work For You [3] is a website that allowed the user to search for their local MP via post code, and the site can then display the voting patterns for that MP, along with information about how often their votes align with their parties votes, and shows examples of appearances made by that MP and what they said. The source code is publicly available on Github and uses python for a large part of their code base. Whilst it does not appear that they use any form of sentiment analysis, its still a good example of the sort of thing that can be done using the parliamentary data, and would likely be well supplemented by my project, allowing them to also show how an MP might speak in debates, as well as how they vote.

The Fake News Challenge [4] is a challenge set up to explore how artificial intelligence technologies could be leveraged to combat fake news. and aims to eventually produce a tool that can help human fact checkers tell if a news story is a hoax, or intentionally misleading. The first part of the challenge involved the use of Stance Analysis on a series of news articles, comparing the contents of the article with the headline, to tell if the article contents agree with the headline or not. As the project is set up as a competition, multiple teams submitted solutions to the problem, showing a variety of techniques in solving this problem.

1.1.4 Technical Research

Before any form of planning could begin for the project, some research on the kinds of technologies available was required. Three topics had to be researched, namely the language to be used, what methods were available for sentiment analysis, and what was available to extract the data from its original form to something more useable

For sentiment analysis, and other required NLP tools, the Natural Language Toolkit (NLTK) [5] was found. This Python package provides methods and classes for a majority of NLP tasks, including everything required for this project. Additionally, its well documented, as it is commonly used by other projects that require some form of NLP. This means it would be easy to find solutions to any problem encountered during development, as it is highly likely someone else using the same package has encountered a similar issue and documented a solution online. Due to this, it was quickly decided that the NLTK package would be used for all NLP requirements, which also meant the language to be used would be Python.

Once a language was selected, some form of parsing tool had to be discovered. As the data is provided in XML, a commonly used semi-structured database format, the chosen parser solution had to be able to parse XML. An often used package for Python that could do this is lxml, a package which could read in XML data structures and translate them into its own set of classes to be used in Python. However, lxml expects well structured data, whereas the hansard dataset is not as well organised. For this reason, it was decided that BeautifulSoup4 [6] would be used, a module designed to parse less structured data, in HTML or XML. It makes use of the lxml module, but provides methods that allow the parsing of data whose structure is unknown.

1.2 Analysis

Following along from the background research, some decisions were made on how this project would proceed, and what challenges were expected. Additionally, the design of the overall system had to be developed, and the developmental process.

Due to the size and complexity of some of the source data, it was decided that the system would not be able to work directly with the original data without some form of intermediary parsing system. Thus, part of the project was to develop a parser that would get all relevant data from the original files, and reorganize them into a more useful format. It was therefore also necessary to decide on the structure of the data once parsed, and how this data would be stored and accessed by the rest of the system. It would also be necessary to decide what exactly from the original data was relevant to the project. Additionally, it was important that speech be attributed to the correct member of parliament. It often appeared that the way an MP was referenced in the data would change, going from a full title, honorific and name to just surname. It was important that these different forms of name be recognized as the same person, otherwise speech attributed to just one person would be seen as being said by different people, reducing the accuracy of any searching. This could be done using Named Entity Recognition, an aspect of NLP.

Any form of supervised machine learning method requires training and testing datasets. Due to the nature of the data being used, there are no preexisting sets of annotated data available, and thus the datasets used must be hand annotated. A tool designed to do this must therefore be produced that can assist in this lengthy process, allowing a user to generate a set of annotated data that can then be used to train an Artificial Intelligence.

1.3 Process

The process selected for this project was Feature Driven Development (FDD), an agile styled methodology designed to focus on delivering working blocks of software repeatedly. Though this methodology is not usually designed for a single developer, its overall design worked well enough for this project. It began with an overall design of the system (see the diagram above), and then this design was broken down into a list of features, by breaking down the overall design into functional sections, represented by the blocks in the diagram. Each of those is decomposed further into a list of features for each one, which can then be targeted as milestones during development. Because these features are relatively small, completing them is a small task, and keeping track of the progress on each feature can give a decent report on the progress of the project as a whole.

For version control, git, and Github.com was used to maintain versions of code. This can then also be used as a backup service, with the online version of the code hosted on Github being a form of backup, and allowing the code to be transferred between multiple machines with relative ease.

A to-do page was also maintained on Trello(CITE HERE), which is an online resource for producing Kanban style to-do lists. There were four columns in the Kanban Board:

- A to-do column for tasks that needed doing that were not yet complete,
- A Doing column for tasks currently in progress,

- A Blocked column for tasks that cannot be started until another task has been completed, or tasks that have been started but cannot continue until another task is done or some event is complete,
- A Done column for tasks that have been completed.

In utilizing this tool for organisation of the project, development was planned out. Each "Card" of the board represented one task, and could be moved between columns. More complicated tasks were broken down into separate tasks, or a checklist could be added to a card, should the task need to remain as a single task for whatever reason.

Chapter 2

Design

In FDD, large, detailed design documents are not necessary. A simple overview of desired features and a breakdown of the overall system are sufficient, and are what will be detailed in this chapter.

2.1 Overall Architecture

As the project was developed using Feature Driven Development (FDD), the initial design of the system focused on the desired features of the system. These features were:

- Download the dataset.
- Parse the original data into a more useful format.
- Allow a user to annotate the data with sentiment, to generate training and testing datasets.
- Train an AI algorithm on the datasets generated.
- Search the parsed data to find speech about a certain topic, or by a particular Member of Parliament.
- Use the trained AI algorithm to extract sentiment from the speech found.
- Display a comparison of the sentiment expressed about a topic or by an MP over time.

Using these features, the overall system can be designed, and an unofficial class diagram can be created that can help guide implementation.

As seen in fig.2.1, the system is broken down into functional blocks, each representing a distinct part of the system. They were split this way to maintain readability in the source code. Whilst it would have been possible to keep all functionality in a single file, it would have made maintaining the code very difficult. Each functional block is therefore a separate class in the Python source code, so any interaction between them is easy to manage.

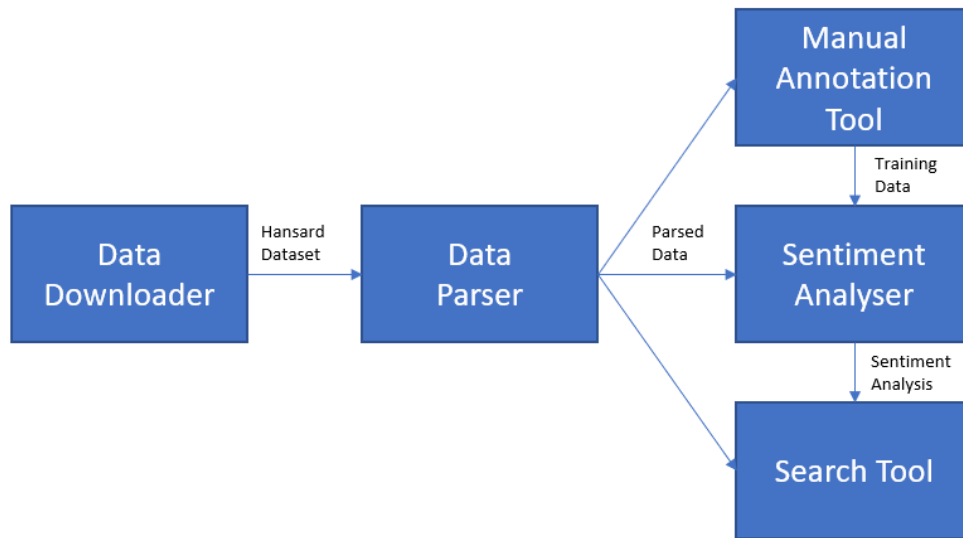


Figure 2.1: Functional block diagram of the overall system. Arrows represents data movement

2.1.1 Data Downloader

The Data Downloader is designed to download all of the Hansard Dataset from the site on-line, and store it locally for use by the rest of the system. It is likely that this first block will only need to be run a single time, but still proves useful in ensuring all the data is downloaded.

The files are to be downloaded from the Hansard Archive page. Each of the six series has a sub-directory under that root page, that contain all the data files. The data files have a distinct naming pattern that can be referenced using something like Regular Expressions in order to automate the downloading and searching of the files.

Originally, this was not going to be a part of the main system, as it is possible to download the data manually. However, only ten files are displayed on the web page each time, and some of the series have up to a thousand files to download. This can be seen in fig.2.2

2.1.2 Data Parser

The Parser is designed to read the original files downloaded by the Data Downloader, and save all relevant data in separate location, in a more consistent layout than that of the original dataset. This should allow any usage of the data from other parts of the system to be much simpler, and thus faster and less prone to error. It should ensure speech is always attributed to the correct person, even if their names are presented differently. This means the Data Parser will have to utilize a part of NLP known as Name Disambiguation, which is not a simple task.

Debates in zip format

Please click on the debate zip file link that you wish to download from the list below.

File Name	Size
S5CV0844P0.zip	1 MB
S5CV0845P0.zip	1 MB
S5CV0846P0.zip	1 MB
S5CV0847P0.zip	1 MB
S5CV0848P0.zip	1 MB
S5CV0849P0.zip	1 MB
S5CV0850P0.zip	1 MB
S5CV0851P0.zip	1 MB
S5CV0852P0.zip	1 MB
S5CV0853P0.zip	1 MB
... 71 72 73 74 75 76 77 78 79 80 ...	

Figure 2.2: Screen capture from the Hansard Archive website, showing the number of files available

2.1.3 Manual Annotation Tool

The Manual Annotation Tool (the MAT) is designed to allow a user to create a testing and training dataset from the parsed data. It should show a selection of speech to the user, and ask them to annotate it as either a positive sentiment, negative sentiment, or neutral sentiment. These choices will be recorded, and can then be used to train a machine learning algorithm to extract sentiment from the remaining data. It would also provide the option to edit the text, the MP's name, or the topic title, to allow the user to correct typos transferred from the original dataset.

Originally, the MAT would display an entire paragraph of speech, displaying everything a Member of Parliament said about a topic on a particular day. However, this would often display too much text, with parts showing positive sentiment and other parts of the same text showing negative sentiment. Additionally it was realized that attempting to train an AI algorithm on these large blocks of text would be far too complex. For those reasons, the MAT was modified so that it would only display a single sentence at a time, allowing a more accurate way of annotating sentiment.

2.1.4 Sentiment Analyzer

The Sentiment Analyzer will use the datasets generated by the MAT and produce a model based off the data. It should also provide the ability to load a previously trained model, rather than spend time retraining every time the system is run. Once trained or loaded, it should be able to accept blocks of text, which it can then extract sentiment from, and return it.

As AI algorithms are trained on "Features" rather than plain text, the Sentiment Analyzer must have some method of converting a sentence or paragraph into a set of features for the algorithm to use. Following on from a tutorial found on Youtube [7], it appears that a good way to turn the text into a set of features is to use a dictionary, where the keys are the most used words from the training set, and the value is a True or False, for if the word is contained in the sentence or paragraph given. The potential issue with this is the loss of context, as separating the words completely will lose any negation, such as in the sentence "This is not good".

2.1.5 Search Tool

The Search Tool will be used by the user to search through the data for a particular Member of parliament, to get their speech and its sentiment, or for a particular topic, to get the sentiment expressed about that topic.

2.2 Data Design

As parts of the system were designed to modify the layout of the original data at times, the formatting of said data had to be designed as well.

2.2.1 Parsed Data

For the parser, the format of the data files that it produces was originally designed as thus:

```
<date dateformat="1984/04/13">
  <speech>
    <member>memberName</member>
    <topic>topicTitle</topic>
    <stance>POS/NEG</stance>
    "Actual Text of Speech would go Here"
  </speech>
  ....
</date>
....
```

The ellipses represent repeats, so inside the *Date* tags, multiple *speech* tags, all formatted like the one shown, can exist. A file may also contain multiple *Date* tags.

This, however, was causing some issues during development based around the size of the produced files, as each entire series of data was being parsed into the same file. In order to combat the slow speeds of accessing such large files, and other issues caused by the layout, the data format was changed. Now, each unique date found within the source had a separate file, and within this file the data was formatted in its final form. Each date file is an XML file, the structure of which can be represented as a tree, shown in fig.2.3.

Each file can contain multiple member tags, which each have the member of parliaments name as an attribute. Each member tag can contain multiple tags for the topics they discuss, each of which have the topic title as an attribute. Each topic tag can have multiple speech tags, each speech tag containing the verbatim copy of what the member said about the particular topic.

2.2.2 Annotated Data

The formatting of the annotated data files was also designed at this stage. It was decided that the files would be saved as CSV files (comma separated values), which is a simplistic database style

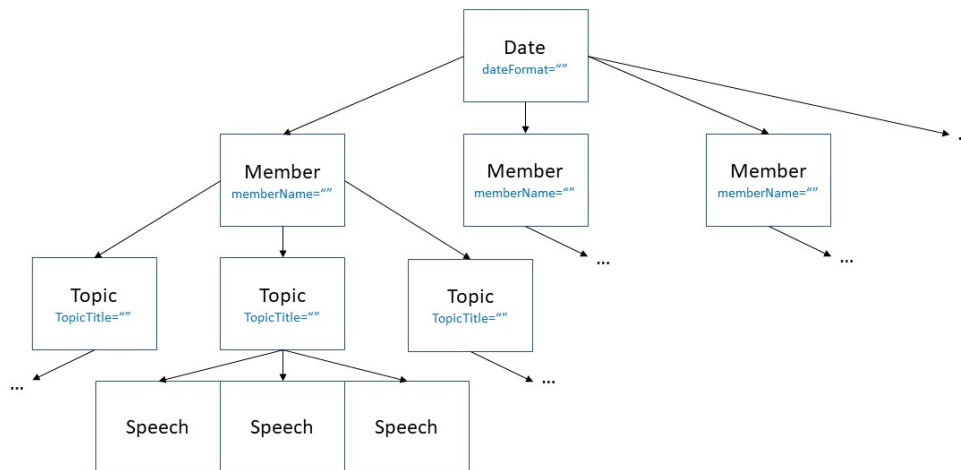


Figure 2.3: Diagram showing the structure of the parsed data, in XML. The *Date* tag is the root of the file

where a line in the file represents a single record, each value of the record being separated by a comma, hence the name. The layout was designed as the following:

Sentence; Sentiment; Member; Topic

As shown, it was decided that the best way of annotating full speech was to split it by sentence, so that each sentence would be annotated with its own sentiment. This would simplify the training process for the machine learning algorithms, as it was thought that trying to train it on too large a block of text would result in sub par results.

2.3 User Interface

Due to the complexity of the project, it was decided that the system would only be interacted with via the command line. This meant that, beyond basic menus, no GUI had to be designed for use. It was though that, should there be time during or after the project development, a GUI could be designed which worked by interacting with the command line interface in the background, but it was not considered system critical to have such a thing.

2.4 Algorithm Design

2.4.1 AI Algorithm Choice

There are many potential algorithms that may be chosen for this project. It may prove difficult to choose one, or more, without simply trying them. The design calls for the use of Naive Bayes at first, mainly as its one provided by the NLTK package. However, multiple other algorithms may be tested, and the results compared to decide on the final choice. Should multiple algorithms prove useful, a voting system could be implemented, which applies each algorithm, and they cast a vote to what sentiment they "think" applies. The votes would then be counted and the result shown.

Naive Bayes Naives Bayes is a supervised algorithm with uses the statistical analysis of Bayes Theorem as to classify data. It treats each feature as completely distinct, which isn't accurate for NLP, but will may suffice for development of the system.

2.4.2 Parsing

The Data Parser needs to find and extract useful speech from the original data. Though said data is somewhat disorganized, there are exploitable patterns that the Parser can use to find as much speech as possible. The overall method is documented in the following pseudo-code:

```

FOR EACH FILE
  FOR EACH DATE TAG
    IF (DATE_FILE FOR DATE EXISTS)
      LOAD DATE_FILE CONTENTS INTO DATE_XML
    ELSE
      CREATE FILE
      CREATE DATE_XML
  FOR EACH CONTRIBUTION IN DATE_TAG
    GET CONTRIBUTION PARENT_TAG
    GET MEMBER NAME AS CHILD OF PARENT_TAG
    GET TITLE AS SIBLING OF PARENT_TAG
    GET SPEECH FROM CONTRIBUTION
    IF MEMBER HAS BEEN SEEN BEFORE IN CURRENT DATE_FILE
      IF TOPIC HAS BEEN DISCUSSED BY MEMBER BEFORE
        ADD SPEECH TO TOPIC
      ELSE
        CREATE NEW TOPIC
        ADD SPEECH
    ELSE
      CREATE NEW MEMBER TAG
      ADD TOPIC TO MEMBER TAG
      ADD SPEECH TO TOPIC
  ADD SPEECH TO DATE_XML

  SAVE XML TO DATE_FILE (OVERWRITE)

```

This shows that, so long as the parser can find a tag in the source XML for the date, all other relevant information can be found in relation to the position of this date tag in the XML. It also shows the method of ensuring all speech by one Member of Parliament is correctly attributed to them, to avoid repeated mentions of the same MP in the same file.

Chapter 3

Implementation

The implementation should look at any issues you encountered as you tried to implement your design. During the work, you might have found that elements of your design were unnecessary or overly complex; perhaps third party libraries were available that simplified some of the functions that you intended to implement. If things were easier in some areas, then how did you adapt your project to take account of your findings?

It is more likely that things were more complex than you first thought. In particular, were there any problems or difficulties that you found during implementation that you had to address? Did such problems simply delay you or were they more significant?

You can conclude this section by reviewing the end of the implementation stage against the planned requirements.

Appendices

The appendices are for additional content that is useful to support the discussion in the report. It is material that is not necessarily needed in the body of the report, but its inclusion in the appendices makes it easy to access.

For example, if you have developed a Design Specification document as part of a plan-driven approach for the project, then it would be appropriate to include that document as an appendix. In the body of your report you would highlight the most interesting aspects of the design, referring your reader to the full specification for further detail.

If you have taken an agile approach to developing the project, then you may be less likely to have developed a full requirements specification. Perhaps you use stories to keep track of the functionality and the 'future conversations'. It might not be relevant to include all of those in the body of your report. Instead, you might include those in an appendix.

There is a balance to be struck between what is relevant to include in the body of your report and whether additional supporting evidence is appropriate in the appendices. Speak to your supervisor or the module coordinator if you have questions about this.

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A paper detailing the progress made on trying to apply standard sentiment analysis techniques to the hansard dataset. It discusses the fact that these normal approaches are inadequate for the style of speech used in parliamentary debates.

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A guide to the Natural Language Toolkit for Python, a specific package that may be used for the project.

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An online article that describes how the author trained a Naive Bayes classifier on movie reviews using the NLTK for Python. It should serve as a good reference when looking to do something similar.

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This book provides a decent overview on Natural Language Processing for computer systems. It does not, however, mention any specifics for Sentiment Analysis.