Crime and Punishment — final project for CAPP 30255

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Abstract

We made a first version of a question-answering program that retrieves a set of potential answers to questions like: What is the penalty for committing murder?. We use the 300 current Mexican federal laws, specifically attempting to retrieve criminal and administrative sentences (e.g. jail years, fines, political disablement). We implement this machine in Python, using the framework described by Jurafsky and Martin [1]. We show our results, challenges, and potential next steps to improve our machine.

Keywords: question-answering machine, natural language processing, Mexican federal laws, text analysis.

1 Introduction

We thought a question answering machine was a good idea for a final project because:

- This could empower people to look if certain sentences or penalties are real. In a corrupt country like Mexico, sometimes people don't know if the punishment they're receiving is even legally sound. A lot of people would not dare to contradict a judge or a lawyer, just because they don't have any education to understand laws.
- It's hard to read lots of laws at once. Hector worked in the past with regulations in energy and had to quickly understand 14 new laws when they came out. This took him a very long time to read, especially since laws sometimes use a particular language and understanding them correctly takes a lot of time.
- Since we're Mexican, we wanted to do a text analysis project in Spanish. We were very happy to be able to apply many of the concepts we learned in class: dynamic programming, word2vec, n-gram models with Hidden Markov Models, and information retrieval (IR).

2 Framework

2.1 Overview

We followed the three stages of an IR-based factoid question answering machine (figure 1). We scraped 300 Mexican federal laws from the Mexican congress website[1]. We then used these documents to create passages (a smaller unit of documents) that would be retrieved by an IR algorithm.

[1] http://www.diputados.gob.mx/LeyesBiblio/index.htm

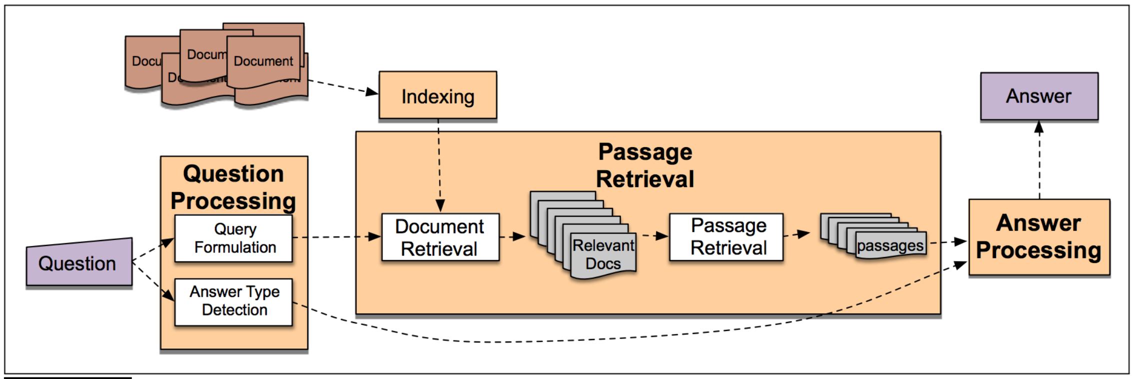


Figure 1: IR-based factoid question answering has three stages: question processing, passage retrieval, and answer processing. This is Figure 28.2 from [1], Chapter 28.1.1.

Finally, we prioritize these passages, using a combination of BM25 and the probability of the passage containing an answer. Because of time constraints (we had less than 1/3 of a 10-week quarter to work on this project), we could not do any work on the answer processing part of the pipeline.

2.2 Document creation

Scraping was done using `scrape.py`. Laws were available both in `pdf` and `doc` files. Two methods were tested to convert the files to `txt` files that could be processed in Python.

First we tried converting `pdf` files to `txt` using out-of-the-box packages (e.g. using `pdftotext` utility in the command line). Unfortunately, Mexican laws have a ton of useless text as headers and footnotes 2, which are repeated over all documents. This introduced a lot of noise in our models, so we tried next using `doc` files.

We attempted unsuccessfully to just open `doc` files in Python. There were a lot of binary characters that made reading and text processing difficult. Maybe it was our lack of experience opening files, but we could not find a way to retrieve only the text we needed, especially since many characters have accents in Spanish. We also tried using `antiword` and `python-docx`, but we kept having installation errors, even using a virtual environment[2].

After spending several hours, we opted to manually convert `doc` files to `txt` manually. These can all be found in the folder called `/leyes/*`.

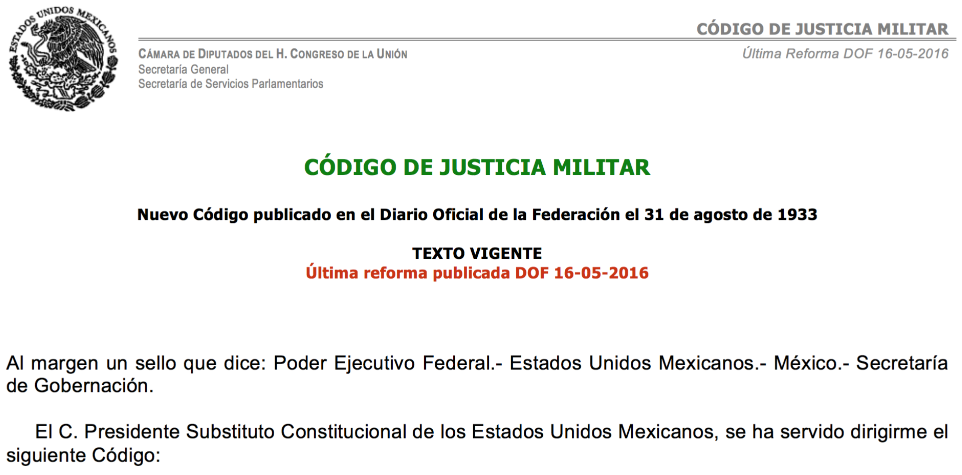
2.3 Question processing

Bla bla bla, Carlos did magic here!

2.4 Document retrieval

The document retrieval part had two steps: first create indices and store them on disk, then do the actual querying. For the first step, we built an inverted index where keys were words and values

[2]Using a macOS Sierra 10.12.3 and python 3.5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Nuevo Código publicado en el Diario Oficial de la Federación el 31 de agosto de 1933

TEXTO VIGENTE
Última reforma publicada DOF 16-05-2016

Al margen un sello que dice: Poder Ejecutivo Federal.- Estados Unidos Mexicanos.- México.- Secretaría de Gobernación.

El C. Presidente Substituto Constitucional de los Estados Unidos Mexicanos, se ha servido dirigirme el siguiente Código:

Figure 2: Example of the top part of a Mexican Law saved as a doc file. Notice the headers, the titles, subtitles, and additional text that is non-informative.

were names of laws containing an occurrence of such word. We also made such an index for every law, where we could find the article number containing a specific word. These indices can be built using the python file called `index.py`.

For the querying step, we also took two steps: first look for documents where it was possible to find an answer, then scoring retrieved passages to determine which ones seemed to have an answer. The first search just employed inverted indices, identifying documents where at least one of the terms of our search appeared. Finally, to score our passages we employed a mix of the BM25 algorithm and a 3-gram model with Naive Bayes; this 3-gram model attempted to predict which passages were the most likely to be actually passages containing penalties or sanctions.

It is important to note that words were stemmed for this exercise using the Spanish stemmer from the `nltk` library. We also avoided stop words, which were manually filtered after getting the most frequently occurring words in the corpus. To separate laws into their corresponding articles, we used regular expressions. Encoding text files previously was really useful, as diacritics in Spanish were very easy to match using UTF-8 encoding and regex.

For the scoring we tried different methods, including:

- Jaro-Winkler distance of the original query with the passage.
- Count of terms in the query appearing in the passage.
- TF-IDF

Unfortunately, none of them seemed to provide useful results by itself. But when we added the extra filter with the n-gram model, results started to make more sense. This 3-gram model was trained using a manually constructed database of articles that contained information on penalties, sanctions, and fines from a variety of laws. We also used a database containing counterexamples of texts that did not have any type of penalties on them. We would finally take the probabilities of being a sentence passage (label 1) or not (label 0), and get a ratio as a score.

3 Results

We did not have metrics for this exercise, as we didn't have a labeled dataset to test questions. We manually checked for the coherence of top results, using three main questions:

- Cual es el castigo por homicidio? (*What is the punishment for murder?*)
- Cual es el castigo por el robo de hidrocarburos? (*What is the punishment for stealing hydrocarbons?*)
- Cual es el castigo por no pagar impuestos? (*What is the punishment for not paying taxes?*)

We got mixed results for these questions. Overall, we are still far from retrieving the exact articles that contain answers for our questions. We analyze some of the reasons we believe this is happening.

For the query corresponding to the first question, *What is the punishment for murder?*, we obtained the following articles:

- In cases of wrongful misdemeanor, up to one quarter of the penalties and security measures assigned by law to basic type of criminal offenses, with exception of those for which the law specifies a specific penalty, will be imposed. Additionally, if corresponding, it will be imposed the suspension of up to three years of license to work on their corresponding profession. [...]
- The judge will void the substitution and will order the execution of prison penalty previously imposed when the sentenced doesn't comply with the conditions ordered for such effect, except when the judge esteems convenient to warn the sentenced that if a new fault is observed or is condemned by a new criminal offense, the sanction will be made effective. [...]
- Technical or artistic professionals and their auxiliaries will be responsible for the crimes they might commit in the exercise of their profession [...]:
  Additional to the fixed sanction for the felonies consummated, depending on whether offenses are wrongful misdemeanor or criminal offenses, a suspension of one month up to two years will be applied or up to definitive suspension in the case of recidivism. [...]
- Prison of three day up to two years or 30 to 90 days of fine will be imposed to:
  I. Whomever hides, destroys, or buries a corpse or human fetus without the order of the authority who corresponds, or without the requisites stipulated by the Civil Code and Health Code or special laws.
  II. [...]

We can identify that it is only in the last result where we have explicit penalties for crimes. Nevertheless, these do not correspond directly to murder or homicide, but rather to burying dead corpses. Although related, not the same concept. The other results talk about criminal offenses and wrongful misdemeanors, these are categorizations, and murder fall into one of these, depending on the intention of the murderer.

For the following two questions, we got unusual results. Sometimes these would refer to ...

3.1 Further Work

There are possibilities of improvement in all the sections of our work. The first and most important would be to create a test dataset with some example questions for which we know exactly which articles are relevant. Since neither of use are lawyers, we could only use our best judgement to determine which seemed to be sensible results. But after having a useful test set, we could do the following improvements.

Document processing: improve the pipeline to convert `doc` to `txt` files.

Question processing:

Document retrieval: test other methods for passage retrieval (e.g. proximity), and other parameters for the tested ones (e.g. use a 4-gram or higher-gram model). It could also be useful to make a more specific document retrieval, based on the whole query, and not individual words.

Answer processing: actually develop a script that takes a long passage and returns only the amount of information related to the sanction, penalty, or fine

4 How to run the code

4.1 Dependencies

- requests, bs4, for the scraping
- synonyms
- gensim
- nltk, for stem.snowball.SpanishStemmer, tokenize.RegexpTokenizer
- textblob, for easy word manipulation
- jellyfish, for Jaro-Winkler sitance
- sklearn, for general processing, including TF, IDF, and Multinomial Naive Bayes models
- numpy, pandas

4.2 Instructions

Before running the code, make sure that the `txt` files are in folder called leyes and that the file called `docnames.csv` is in the folder called `doc`. Make sure that the `stanford-postagger-full-2016-10-31` folder is in the root directory. Also make sure that the word2vec vectorx `SBW-vectors-300-min5.txt` are in the `Data` folder.

1. Open a Python shell, preferably ipython.
2. If you want to download the `doc` files, run
   ```
   $ run scrape.py
   $ go()
   ```
   This will download the `doc` files in the folder called `/doc`.
3. Create the indices by running
   ```
   $ run index.py
   $ go()
   ```
4. You can then open the `jupyter notebook` titled `QA_machine`, available in the root directory of the repository. Instructions for the notebook are written in the file.

References

[1] Jurafsky, Dan, and James H. Martin. *Speech and language processing: an introduction to natural language processing, computational linguistics, and speech recognition.* India: Dorling Kindersley Pvt, Ltd., 2014.

A Repository structure

The repository has the following folders:

- `Data`
- `doc`
- `indices`
- `leyes`
- `stanford-postagger-full-2016-10-31`

It also has a bunch of Python scripts and miscellaneous files:

- `scrape.py`
- `index.py`
- `ngrams.py`
- `query.py`
- `question_processing.py`
- `retrieval.py`
- `spanish_tagger.py`
- `synonyms.py`
- `Word2VecModel.py`

Miscellaneous:

- `get_l.sh`: count average document length to use in BM25 algorithm.