Text mining for exploration of COVID-19 severity factors

Khang Duy LAI - Mariia KLIMINA

University Paris Cité

UFR des Sciences Fondamentales et Biomédicales

May 12, 2022

Text mining for exploration of COVID-19 severity factors

1. Introduction
2. State of the art
3. Data exploration
4. Data preprocessing
5. Data processing
6. Result

Introduction
State of the art
Data exploration
Data preprocessing
Data processing
Result

Introduction

COVID-19 is the disease caused by the Sar-COV-2 virus that originated in China at the end of the year 2019. Over the time, studies have shown that there is some form of background diseases and risk factors that can hugely affect the severity cases rate of COVID-19. This project will apply NLP and text mining methods in order to explore the CORD-19 dataset and extract background diseases and risk factors.

Introduction

COVID-19 is the disease caused by the Sar-COV-2 virus that originated in China at the end of the year 2019. Over the time, studies have shown that there is some form of background diseases and risk factors that can hugely affect the severity cases rate of COVID-19. This project will apply NLP and text mining methods in order to explore the CORD-19 dataset and extract background diseases and risk factors.

State of the art

In this project we used multiple state of the art NLP and Data Science libraries.

- Numpy,Pandas: Formatting the data and the calculations.
- Matplotlib: Library for drawing the charts and figures.
- Scikit-learn: LDA and T-SNE models.
- Spacy,Gensim, and NLTK: Important NLP libraries.
- Scispacy: NER,Spacy models for science papers.
- Bokeh: A library for visualising interacted charts.

State of the art

In this project we used multiple state of the art NLP and Data Science libraries.

- Numpy,Pandas: Formatting the data and the calculations.
- Matplotlib: Library for drawing the charts and figures.
- Scikit-learn: LDA and T-SNE models.
- Spacy,Gensim, and NLTK: Important NLP libraries.
- Scispacy: NER,Spacy models for science papers.
- Bokeh: A library for visualising interacted charts.

Data exploration

CORD-19 dataset

Figure 1: CORD-19 Structure

Data exploration

Figure 1: CORD-19 Structure

General Information

The metadata consist of more than one millions articles.

	cord_uid	sha	source_x	title	doi	pmcid	pubmed_id	license	abstract	publish_time	author
0	ug7v899j	d1aafb70c066a2068b02786f8929fd9c900897fb	PMC	Clinical features of culture-proven Mycoplasma...	10.1186/1471-2334-1-6	PMC35282	11472636	no-cc	OBJECTIVE: This retrospective chart review des...	2001-07-04	Madani, Tari A; Al-Ghamdi Aisha
1	02tnwd4m	6b0567729c2143a66d737eb0a2f63f2dce2e5a7d	PMC	Nitric oxide: a pro-inflammatory mediator in l...	10.1186/rr14	PMC59543	11667967	no-cc	Inflammatory diseases of the respiratory tract...	2000-08-15	Vliet, Alber van de Eiserich, Jaso P; Cros.
2	ejv2xln0	06ced00a5fc04215949aa72528f2eeaae1d58927	PMC	Surfactant protein-D and pulmonary host defense	10.1186/rr19	PMC59549	11667972	no-cc	Surfactant protein-D (SP-D) participates in th...	2000-08-25	Crouch, Erik (
3	2b73a28n	348055649b6b8cf2b9a376498df9bf41f7123605	PMC	Role of endothelin-1 in lung disease	10.1186/rr44	PMC59574	11686871	no-cc	Endothelin-1 (ET-1) is a 21 amino acid peptide...	2001-02-22	Fagan, Kare A; McMurtry Ivan F Rodman, Davi M
4	9785vg6d	5f48792a5fa08bed9f56016f4981ae2ca6031b32	PMC	Gene expression in epithelial cells in respons...	10.1186/rr61	PMC59580	11686888	no-cc	Respiratory syncytial virus (RSV) and pneumoni...	2001-05-11	Domachowske Joseph E Bonville Cynthia A Ro.

Figure 2: Overlook of the meta data of the dataset

General Information
The metadata consist of more than one millions articles.
Figure 2: Overlook of the meta data of the dataset

General Information

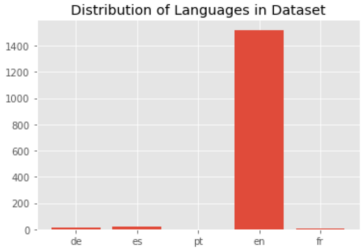
Columns in the metadata

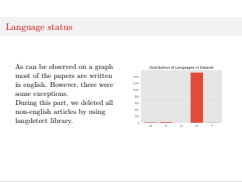
```
['cord_uid', 'sha', 'source_x', 'title', 'doi',
 'pmcid', 'pubmed_id', 'license', 'abstract',
 'publish_time', 'authors', 'journal',
 'mag_id', 'who_covidence_id', 'arxiv_id',
 'pdf_json_files', 'pmc_json_files', 'url', 's2_id']
```


General Information
Columns in the metadata
['cord_uid', 'sha', 'source_x', 'title', 'doi', 'pmcid', 'pubmed_id', 'license', 'abstract', 'publish_time', 'authors', 'journal', 'mag_id', 'who_covidence_id', 'arxiv_id', 'pdf_json_files', 'pmc_json_files', 'url', 's2_id']

Language status

As can be observed on a graph most of the papers are written in english. However, there were some exceptions.
During this part, we deleted all non-english articles by using langdetect library.





Data preprocessing

- Converting JSON format into DataFrame format.
- Removing all non-english paper.
- Removing special characters
- Removing numbers
- Tokenizing.
- Removing stopwords.
- Stemming.
- Lemmatisation.

Data preprocessing
- Converting JSON format into DataFrame format.
- Removing all non-english paper.
- Removing special characters
- Removing numbers
- Tokenizing.
- Removing stopwords.
- Stemming.
- Lemmatisation.

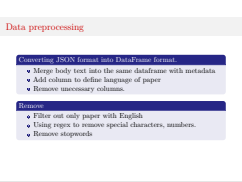
Data preprocessing

Converting JSON format into DataFrame format.

- Merge body text into the same dataframe with metadata
- Add column to define language of paper
- Remove unecessary columns.

Remove

- Filter out only paper with English
- Using regex to remove special characters, numbers.
- Remove stopwords



Data preprocessing

Stemming and Lemmatisation

- Lowers inflection in words to their root forms
- (connections, connected, connects, is connect)
- Using NLTK library

Data preprocessing
Stemming and Lemmatisation
- Lowers inflection in words to their root forms
- (connections, connected, connects, is connect)
- Using NLTK library

Data preprocessing

[35]: 'quarantine isolation main containment strategy intended help protect public preventing spread contagious disease strategy primarily refer r estriction movement limitation personal contact quarantine definition person exposed disease isolation contagious person require separation person infected finding previous research pointed increased risk negative psychological outcome depression anxiety isolation quarantined per son equally heightened risk adverse mental health outcome rapid review brook reported increased negative psychological outcome including pos ttraumatic stress symptom confusion anger person quarantine author concluded important stressor longer quarantine electronic supplementary m aterial online version article doiorgs x contains supplementary material available authorized user duration infection fear frustration bored om inadequate supply inadequate information financial loss stigma finding suggest containment strategy quarantine isolation negative impact psychological outcome related broad spectrum psychosocial stressor need investigation mental health problem associated containment strategy highlighted rising implementation quarantine isolation worldwide currently ongoing covid pandemic unprecedented number people worldwide affe cted quarantine isolation identification individual elevated risk adverse mental health effect mandatory suggested vulnerable population ris k negative psychological outcome implementation containment strategy eg person mental illness low income lack social network particular grea ter risk quarantine isolation world health organization included covid list disease pathogen prioritized research development rd public heal th emergency context pose greatest public health risk epidemic potential insufficient countermeasure established containment strategy main c ountermeasure context systematic investigation evidence concerning psychological effect urgently need single study review suggest increased risk negative psychological outcome person quarantine isolation presented partially contradicting result furthermore prevalence estimate poi nt elevated level adverse outcome quarantined isolated population validity finding limited underlying uncontrolled study design conducted sy stematic literature review metaanalysis mental health effect quarantine isolation based controlled primary study data best knowledge metaana lysis including quarantine isolation exists date systematic literature review metaanalysis protocol project published prospero prospero regi strationno crd method followed guideline cochrane collaboration conduction systematic review searched pubmed psycinfo embase database study restriction beginning searched time period april assessing rate psychological effect quarantinedisolated person compared nonquarantinednonis olated person search entry described online supplement supplement database search entry broad specific search term combined increase likelih ood detecting eligible study research aim specific search term included list disease pathogen prioritized research development rd public hea lth emergency context world health organization covid additional record identified manual search reference included study included language restriction translation native speaker acquired test eligibility criterion article language english study author contacted case missing data search carried endnote x clarivate analytics philadelphia usa trial considered appropriate test hypothesis included met following criterion observation person quarantine isolation described second quantitative assessment psychological outcome parameter performed comparators perso n quarantine isolation fourth data calculation effect size corresponding measure dispersion provided study observing psychological outcome p arameter qualitative assessment excluded study excluded focused specific subpopulation primary infection controlassociation isolated person prison study assessing correlation mental health outcome varying duration quarantine isolation excluded quantitative synthesis reported qual itative synthesis determinant entire literature search study screening carried independently reviewer f jvb consensus unclear case reached d iscussion additional member reviewing team lb jh testing eligibility criterion study selection classification coding data predefined excel s preadsheet microsoft excel mac version microsoft corporation usa followed recommendation cochrane collaboration handbook performed independe ntly reviewer lb jh reviewer jh lb independently extracted data characteristic study study sample quantitative data severity mean score freq uency incidence prevalence mental healthoutcome group comparison group eg relative risk odds ratio result determinant testing reported reac h statistical significance original study multiple measure outcome reported extracted data following hierarchy continuous measure mean score categorical measure highest cutoff defined author original study ie severe manifestation disorder risk bias study classified independently r eviewer lb jh according newcastleottawa scale no recommended cochrane handbook table summary assessment study classified holding low unknown high risk bias taking account bias main domain selection comparability exposureoutcome disagreement resolved consensus additional review aut hor calculated standardized mean difference smd confidence interval ci outcome measure primary study respective measure dispersion available calculated ci p value recommended cochrane handbook stratified predefined mental health outcome effect size comparison quarantinedisolated n onquarantinedisolated group summarized forest plot table quantitative synthesis result possible heterogeneity included study methodology pop ulation outcome restricted quantitative synthesis predefined outcome primary study provided data categorical outcome based validated diagnos

Data processing

- Data selection
  - Selecting articles with risk factors and severity key-words.
  - Clustering using Latent Dirichlet Allocation.
- NER (Named-entity recognition).

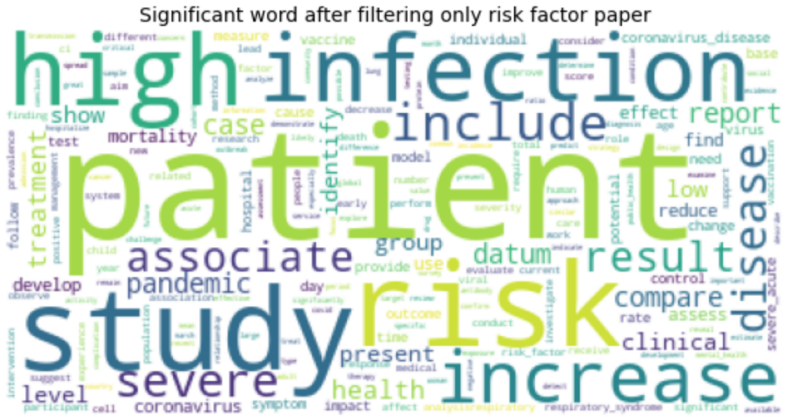
Data processing
- Data selection
  - Selecting articles with risk factors and severity key-words.
  - Clustering using Latent Dirichlet Allocation.
- NER (Named-entity recognition).

Risk factors and severity paper filtering

- Create a dictionary of key words related to risk factors and severity.
- Filter out only the paper that contain words in the dictionary.

Risk factors and severity paper filtering
- Create a dictionary of key words related to risk factors and severity.
- Filter out only the paper that contain words in the dictionary.

Risk factors and severity paper filtering



LDA

In natural language processing, the latent Dirichlet allocation (LDA) is a generative statistical model that allows sets of observations to be explained by unobserved groups that explain why some parts of the data are similar.

The LDA algorithm structure:

- Providing to an algorithm a certain number of topics.
- The algorithm is assigning every word to a temporary topic.
- The algorithm is checking and updating topic assignments.

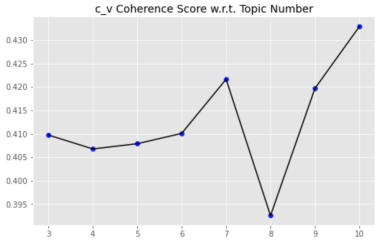
LDA

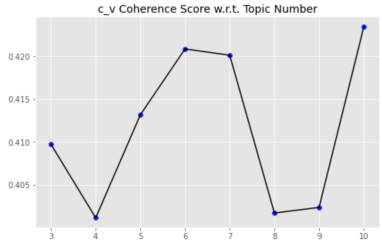
In natural language processing, the latent Dirichlet allocation (LDA) is a generative statistical model that allows sets of observations to be explained by unobserved groups that explain why some parts of the data are similar.

The LDA algorithm structure:

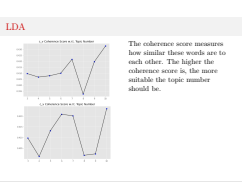
- Providing to an algorithm a certain number of topics.
- The algorithm is assigning every word to a temporary topic.
- The algorithm is checking and updating topic assignments.

LDA

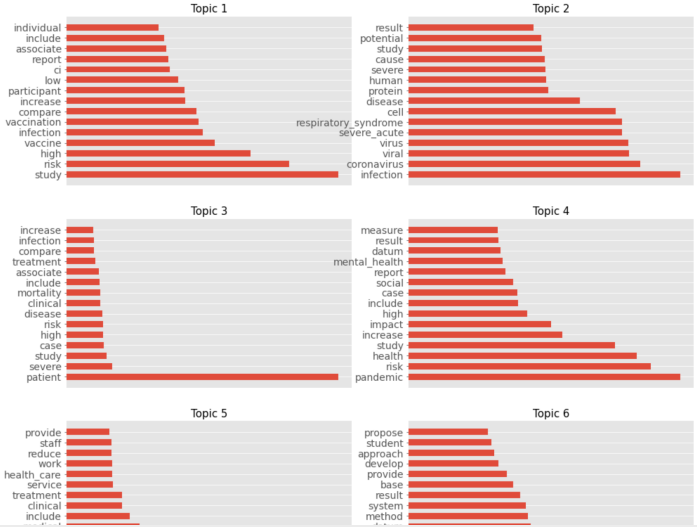




The coherence score measures how similar these words are to each other. The higher the coherence score is, the more suitable the topic number should be.



LDA


Topic 1
individual
include
associate
report
ci
low
participant
increase
compare
vaccination
infection
vaccine
high
risk
study
Topic 2
result
potential
study
cause
severe
human
protein
disease
cell
respiratory_syndrome
severe_acute
virus
viral
coronavirus
infection
Topic 3
increase
infection
compare
treatment
associate
include
mortality
clinical
disease
risk
high
case
study
severe
patient
Topic 4
measure
result
datum
mental_health
report
social
case
include
high
impact
increase
study
health
risk
pandemic
Topic 5
provide
staff
reduce
work
health_care
service
treatment
clinical
include
Topic 6
propose
student
approach
develop
provide
base
result
system
method


LDA

NER

Named entity recognition (NER) is probably the extraction-method that seeks to locate and classify named entities in text into pre-defined categories such as the names of persons, organizations, locations, expressions of times, quantities, monetary values, percentages. In our case it's biomedical entities: diseases,chemicals etc.

We used Scispacy library with different SpaCy models for biomedical text processing.

NER
Named entity recognition (NER) is probably the extraction-method that seeks to locate and classify named entities in text into pre-defined categories such as the names of persons, organizations, locations, expressions of times, quantities, monetary values, percentages. In our case it's biomedical entities: diseases,chemicals etc.
We used Scispacy library with different SpaCy models for biomedical text processing.

NER

Scispacy

- Science pretrain model
- en_ner_bc5cdr_md for biology, mark diseases and chemicals.

Result

Example of table of result

0	chronic obstructive pulmonary disease copd	DISEASE
1	death	DISEASE
3	copd	DISEASE
9	dyspnea	DISEASE
10	cough	DISEASE
11	copd pulmonary function	DISEASE
13	respiratory tract infection	DISEASE
14	chronic unstable disease system malignancy	DISEASE
19	obstructive pulmonary disease	DISEASE
21	copd airflow	DISEASE
25	hypertension	DISEASE
26	atherosclerotic heart disease	DISEASE

Result
Example of table of result
0 chronic obstructive pulmonary disease copd DISEASE
1 death DISEASE
3 copd DISEASE
9 dyspnea DISEASE
10 cough DISEASE
11 copd pulmonary function DISEASE
13 respiratory tract infection DISEASE
14 chronic unstable disease system malignancy DISEASE
19 obstructive pulmonary disease DISEASE
21 copd airflow DISEASE
25 hypertension DISEASE
26 atherosclerotic heart disease DISEASE
27 bronchiectasis DISEASE

Conclusion

To conclude, the deep text-analysis was made. The data was filtered out by using several techniques such as LDA topic modeling and NER. As a result we generated the dataframe table with all covid-related diseases being sorted by a tag «Disease».

Conclusion
To conclude, the deep text-analysis was made. The data was filtered out by using several techniques such as LDA topic modeling and NER. As a result we generated the dataframe table with all covid-related diseases being sorted by a tag «Disease».

Future improvement

Creating a knowledge graph. Calculating the severity rate.

Future improvement
Creating a knowledge graph. Calculating the severity rate.

Thank you

Thank you for your attention.

Thank you
Thank you for your attention.