INSTITUT NATIONAL DES SCIENCES APPLIQUÉES TOULOUSE

Text Cleaning & Vectorisation

IA Frameworks

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Google Cloud Platform

ML Python Libraries

scikit learn
Keras
gensim
surprise
Gym
TensorFlow
NLTK

Python Environment

PC
jupyter
ANACONDA

Viz' Python Libraries

matplotlib
Version 3.1.1
seaborn
plotly

Framework & Tool

docker
Google Cloud Platform
git

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Introduction

Text use case in Artificial intelligence

There are multiple applications of artificial intelligence on text data:

- **Information retrieval**: on text or content-based *(Google, Yahoo etc.)*
- **Pattern recognition**: Information/Named extraction.
- **Sentiment analysis**: Marketing. Website comments.
- **Text generation**: Chatbot. Newspaper article.
- **Text translation**: Google Translate. DeepL.
- **Disambiguation**: Security.
- And many others…

Text processing does not always mean Natural Language Processing (NLP)

Example: Text classification

Objective: Automate the categorisation of text product within discount website.
Data come from datascience contest **website**.

Difficulties:

- Text data require processing to used machine learning model on it.
- Big amount of data (15M of text description).
- Highly unbalanced classes.
- High number of classes (more than 5000).
- Real dataset that requires a lot of cleaning.

Data

Train file contains 15.786.885 products. Answer of test file not furnished.

Three levels classification:

- 47 categories of level 1.
- 536 categories of level 2.
- 5789 categories of level 3.

Field	Type	Description
product id	String	Unique identifiant du produit
Catégorie 1	String	Catégorie de niveau 1
Catégorie 2	String	Catégorie de niveau 2
Catégorie 3	String	Catégorie de niveau 3
Description	String	Description produit
Libelle	String	Description courte
Marque	String	Marque du produit

Data example

Categorie1	
ANIMALERIE - NEW	Lit Mijou, 48 × 37 Pouces, Crème - -imitation ...
ARME DE COMBAT - ARME DE SPORT	Réplique chargeur STI DUTY ONE (CPG1945) - Rép...
ART DE LA TABLE - ARTICLES CULINAIRES	Mugs Alchemy (king 13) (Taille unique) - Mugs...
ARTICLES POUR FUMEUR	E-PACK FRUITÉ 'EXPERT' (Titanium bleu - Mixte ...
AUTO - MOTO (NEW)	Tube de fourche Tarozzi KYMCO X-CITING 500 - 0...
BAGAGERIE	portefeuille porte cartes billets compagnon fe...
BATEAU MOTEUR - VOILIER	Echelle pour plateforme70086 - Fabrication i...
BIJOUX - LUNETTES - MONTRES	Seiko SFP599 Hommes Montre - Acheter Authentiq...
BRICOLAGE - OUTILLAGE - QUINCAILLERIE	Clé polygonale double contre-coudée - 20x22 - ...
CHAUSSURES - ACCESSOIRES	Bottes bi-matière à talons bleu - Zaza Pata -...
CONDITIONNEMENT	EMBALLAGE Ruban adhésif d'emballage PVC colle ...
CULTURE / JEUX	De Keenen Ivory Wayans avec Shannon Elizabeth,...
DECO - LINGE - LUMINAIRE	Cars Poster Reproduction Sur Toile, Tendue Sur...
DROGUERIE (NEW)	PERCHE TELESCOPIQUE SECURITY LOCK 3X2M - PERCH...
ELECTROMENAGER	Filtre metal antigraisse (x1) AD546BE11 AD546W...
ELECTRONIQUE	Bloc de jonction à fusible Contenu: 20 pc(s) p...
EPICERIE	Sel de Guérande aux épices, Verrine 150 gr - S...
HYGIENE - BEAUTE - PARFUM	Uriage AquaPRÉCIS Crème Confort 40 ml - Les mi...
INFORMATIQUE	Batterie Acer Aspire One 751H-52Yr - Li-Ion 11...

Difficulties

- Noise linked to spelling, grammar, conjugaison mistake.
- Non significant terms.
- Mining of terms depends of context. *(Clothes / Dolls' clothes)*
- Different from one language to another.
- Transcription to machine learning.

Implies a lot of cleaning.

Text Cleaning

Stemming

Problem: Term can be written in different way (accentuation, genre, conjugaison, plurals, etc.) but still have the same meaning.

Solution: replace word with their stems.

Example:

- Épée, épee, épées, épée = epe
- vert, verts, vertes, vertes = vert
- mange, manger, mangez, mangent, = mang

Algorithm that generate steming from words are rules-based and depends of the language.

The one used on nltk for French language is the Snowball algorithm.

Stopwords

Problem: Terms that are very common does not help to classify data and can even disturb the training.

Solution: Most common words are removed. This words are called stopword.

Example:

- **French:** ‘au’, 'aux', 'avec', 'ce', 'ces', 'dans', 'de', 'des', 'du', 'elle', 'en', 'et', 'eux', 'il', 'ils', 'je', 'la', 'le', 'les', 'leur', ‘lui', 'ma', 'mais', 'me', 'même', 'mes', 'moi', ‘mon’, etc.

- **English:** ['i', 'me', 'my', 'myself', 'we', 'our', 'ours', 'ourselves', 'you', "you're", "you've", "you'll", "you'd", 'your', 'yours', 'yourself', 'yourselves', 'he', ‘him’, etc.

Other clean steps

- Remove punctuation, number or other non-letter symbol.
- Increment stopwords list with domain words.
- Removed technical noise (HTML code).
- Lower case.

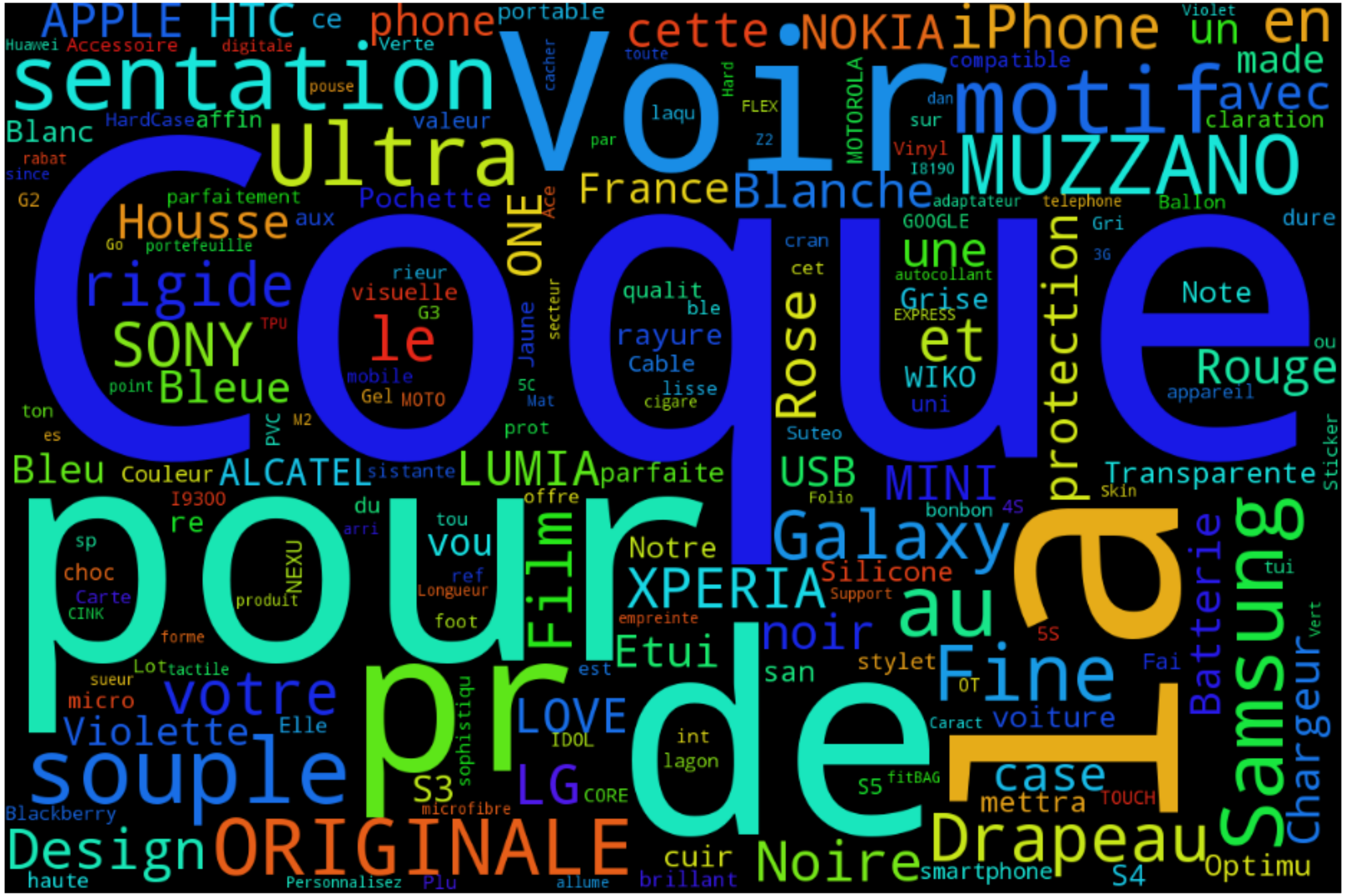
Most of these steps depend of the objectives you want to achieve.

Example:

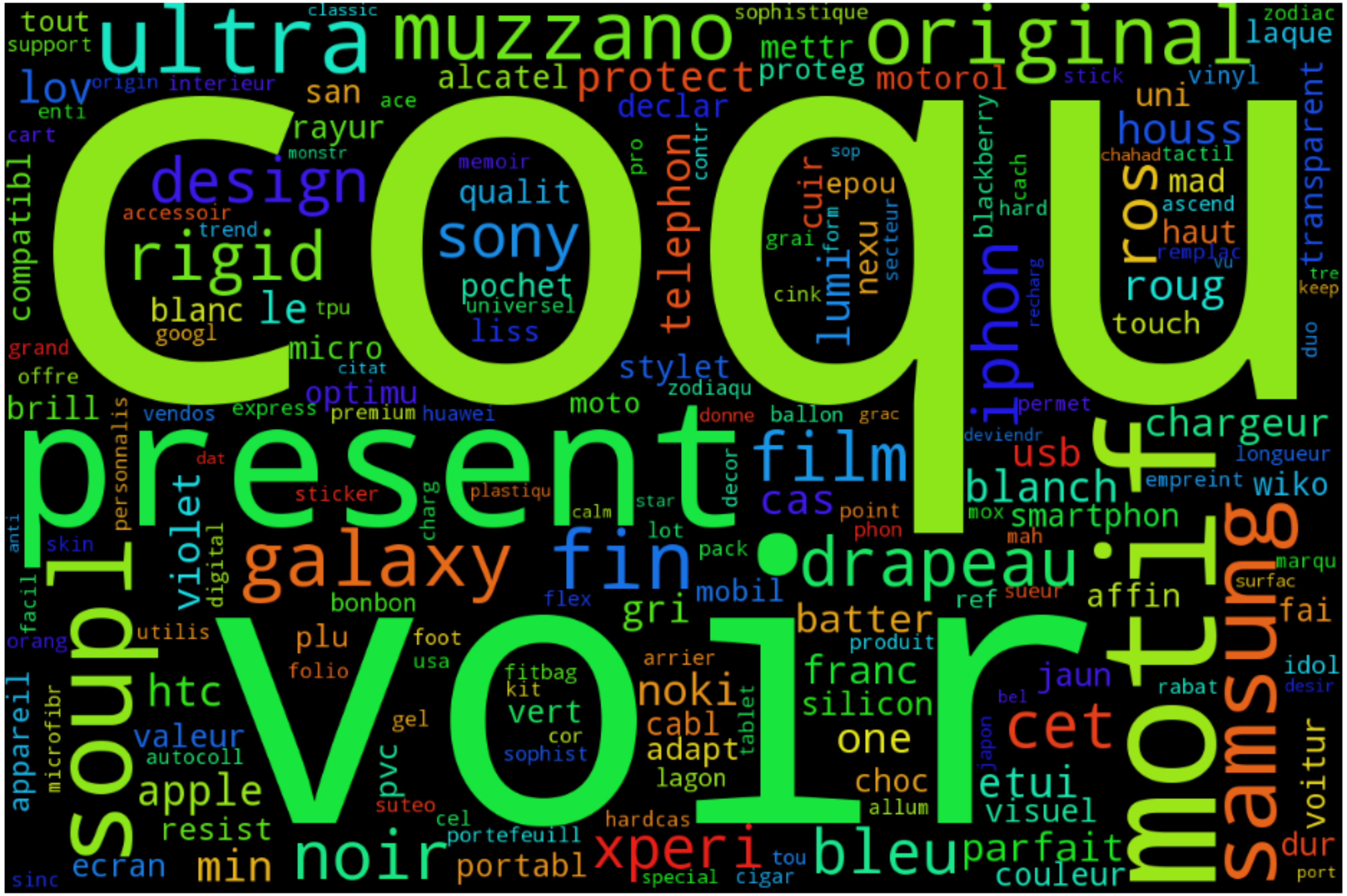
- Upper case can be kept for sentiment analysis.
- Cdiscount: Number can be removed for categorie 1’s level and not categories 2 (xbox 360).
- etc.

Regular expression

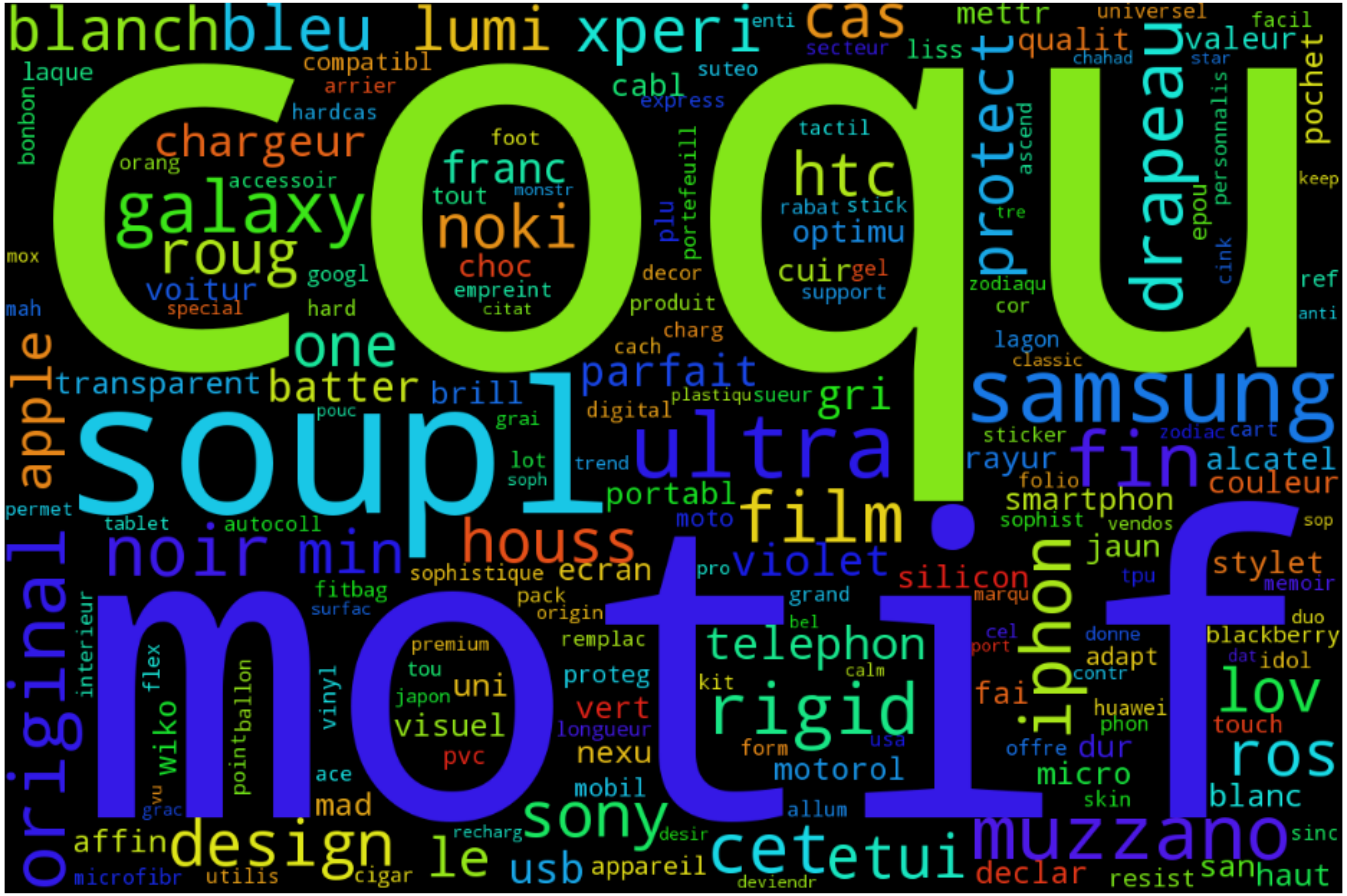
Stopword - Category - “Téléphonie - GPS”



Stopword - Category - “Téléphonie - GPS”



Stopword - Category - “Téléphonie - GPS”



Libraries for text processing

- **NLTK** *(python)*: language processing (steming, stop words)
- **Lucene** *(java)*: text indexation and information retrieval
- **BeautifulSoup**: clean html text.

Vectorisation

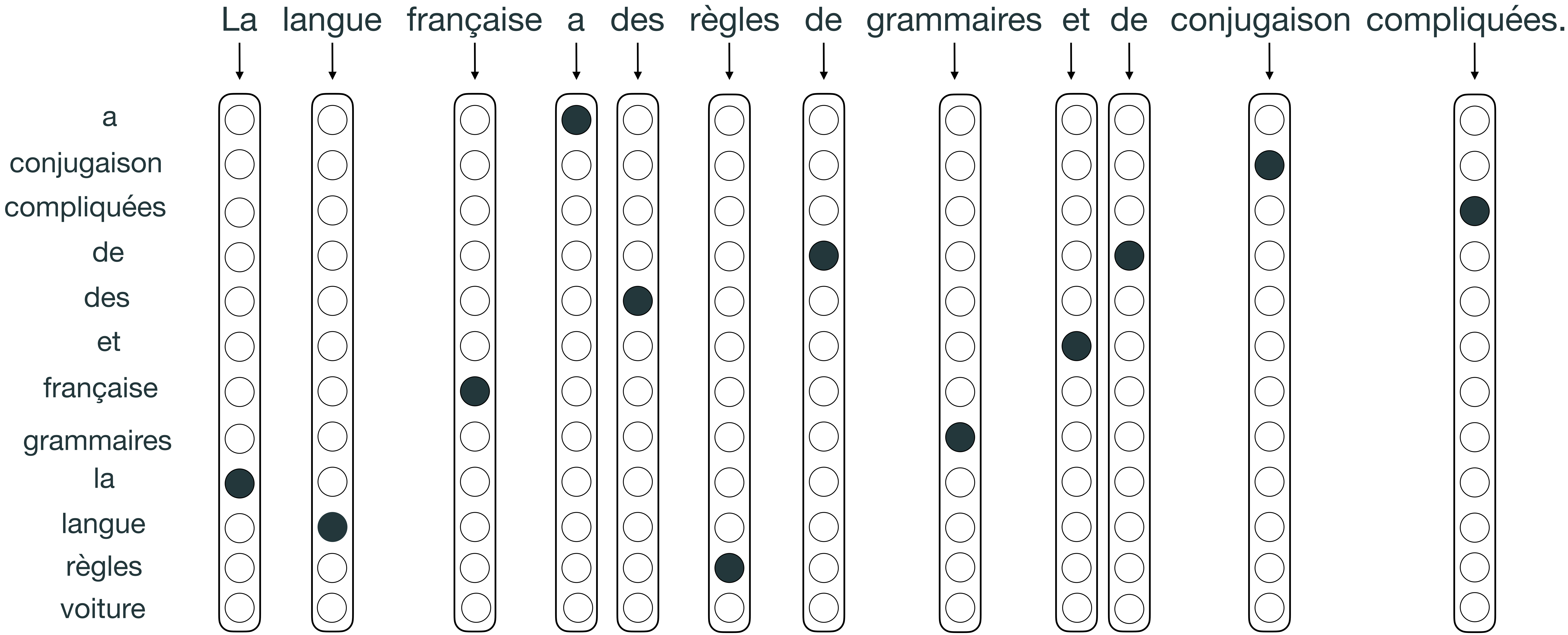
Objectives and difficulties

- Transform text to numerical data to be used in AI algorithms.
- Manage high number of features. Example:
  - 21.543 lines on category “TELEPHONIE - GPS”
  - 24.486 unique words -> 8384 after cleaning.
- Choose significatif words

Two types of solutions:

- Frequency based : Vectorizer
- Learning based : Word Embedding (See corresponding course).

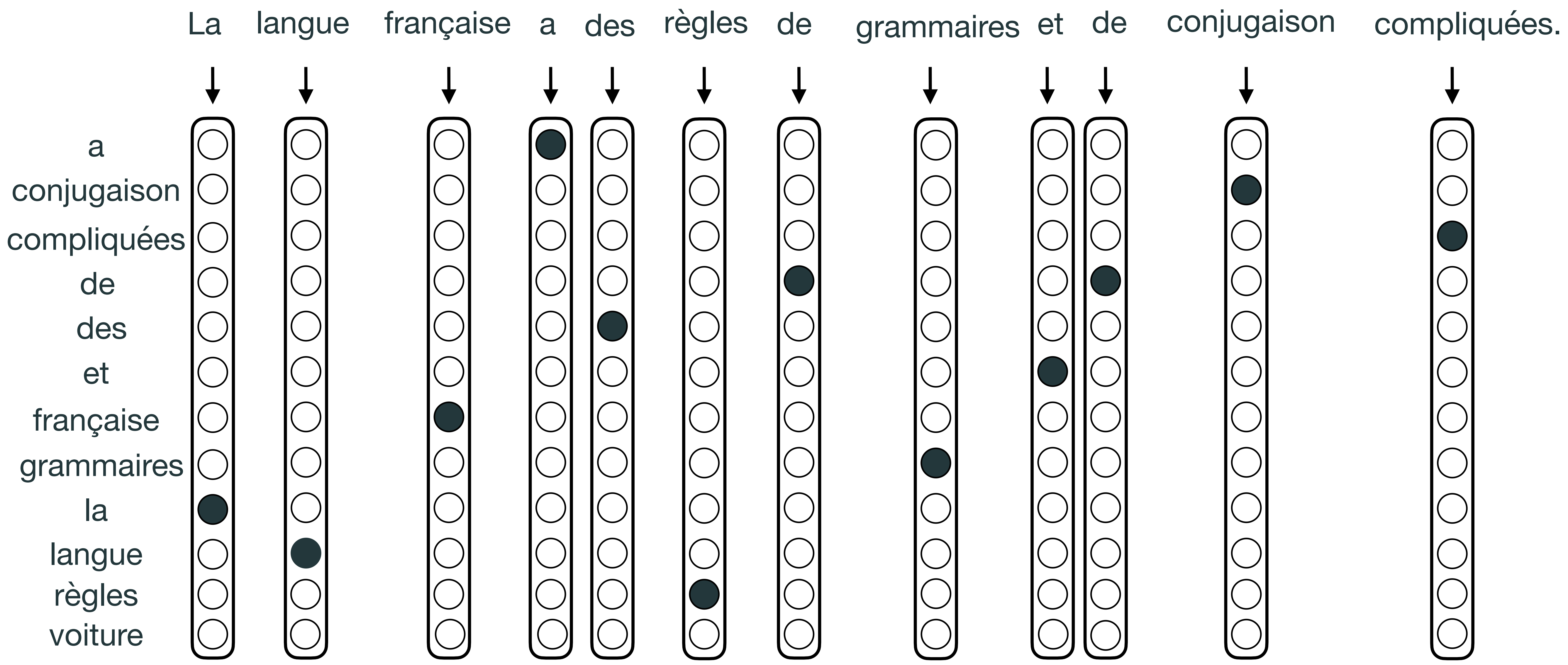
One-Hot-Encoder



Dictionary size: V = 12

Count & Binary Vectoriser

How to convert OHE encoding to ‘sentences’ encoding ?



Count Vectoriser

a	1
conjugaison	1
compliquées	1
de	2
des	1
et	1
française	1
grammaires	1
la	1
langue	1
règles	1
voiture	0

Binary Vectoriser

a	1
conjugaison	1
compliquées	1
de	1
des	1
et	1
française	1
grammaires	1
la	1
langue	1
règles	1
voiture	0

Limitation: all words have the same weights

TF-IDF

Assign a weight to word, a token or an association of words in a document regarding to a corpus of document.

- *t* : a word or and association of words.
- *d* : a document.
- *D* : a corpus of document.

DEFINITION: TF-IDF general formula.

$$\text{tfidf}(t, d) = \text{tf}(t, d) \times \text{idf}(t, D)$$

- *tf(t, d)* : *Term-Frequency*. Number of occurence of token *t* in document *d.*
- idf*(t, D)* : *Inverse-Document-Frequency*. Importance of token *t* in the corpus *D.*

TF Formula

The *tf(t, d)* general formula is defined as the number of occurence *t* in document *d*.

$$tf(t,d) = f_{t,d}$$

This definition is used in **scikit-learn** python library and **MlLib** spark library.

However there exist some variations:

Binary	0,1
Logarithmique normalisation	$1 + log(f_{t,d})$
max normalisation	$K + K \times \frac{f_{t,d}}{max_{t' \in d} f_{t',d}}$
max normalisation (0.5)	$0.5 + 0.5 \times \frac{f_{t,d}}{max_{t' \in d} f_{t',d}}$

IDF Formula

The *idf(t, D)* change from an implementation to another.

$log(\frac{N_D}{DF(t,D)})$	
$log(\frac{N_D + 1}{DF(t,D) + 1})$	MlLib (Spark)
$log(\frac{N_D + 1}{DF(t,D) + 1}) + 1$	Scikit-learn (Python)

- N_D: Number of documents.
- $DF(t, D)$: Number of documents in which terms t appears.

Dimension issue

Binary Vectoriser

a	1
conjugaison	1
compliquées	1
de	1
des	1
et	1
française	1
grammaires	1
la	1
langue	1
règles	1
voiture	

V=11

Binary Vectoriser

a	1
	⋮
conjugaison	1
	⋮
compliquées	1
	⋮
de	1
	⋮
des	1
	⋮
et	1
	⋮
française	1
	⋮
grammaires	1
	⋮
la	1
	⋮
langue	1
	⋮
règles	1
	⋮
voiture	0

V=10.000

- Vectors are very big
- Dimensions gros quickly

Hashing [Weinberger and al, 2009]

Vectorise descriptions while reduce features space

X $\Longrightarrow$ ϕ

Vector of size V, unknown until computing all vocabulary.

Vector of size n_{hash} fixed.

- Determinist function.
- Only one pass on data to build the vector.
- Unbiased cross product: $\mathbb{E}[\langle \phi(x), \phi(x') \rangle] = \langle x, x' \rangle$

Hashing [Weinberger and al, 2009]

Hashed Feature Map

$$\phi_j^{\xi,h}(x) = \sum_{i \ s.t \ h(i)=j} \xi(i) x_i$$

Where

$$h : \mathbb{N} \to \{1,\ldots,nhash\}$$
$$i \mapsto j = h(i)$$

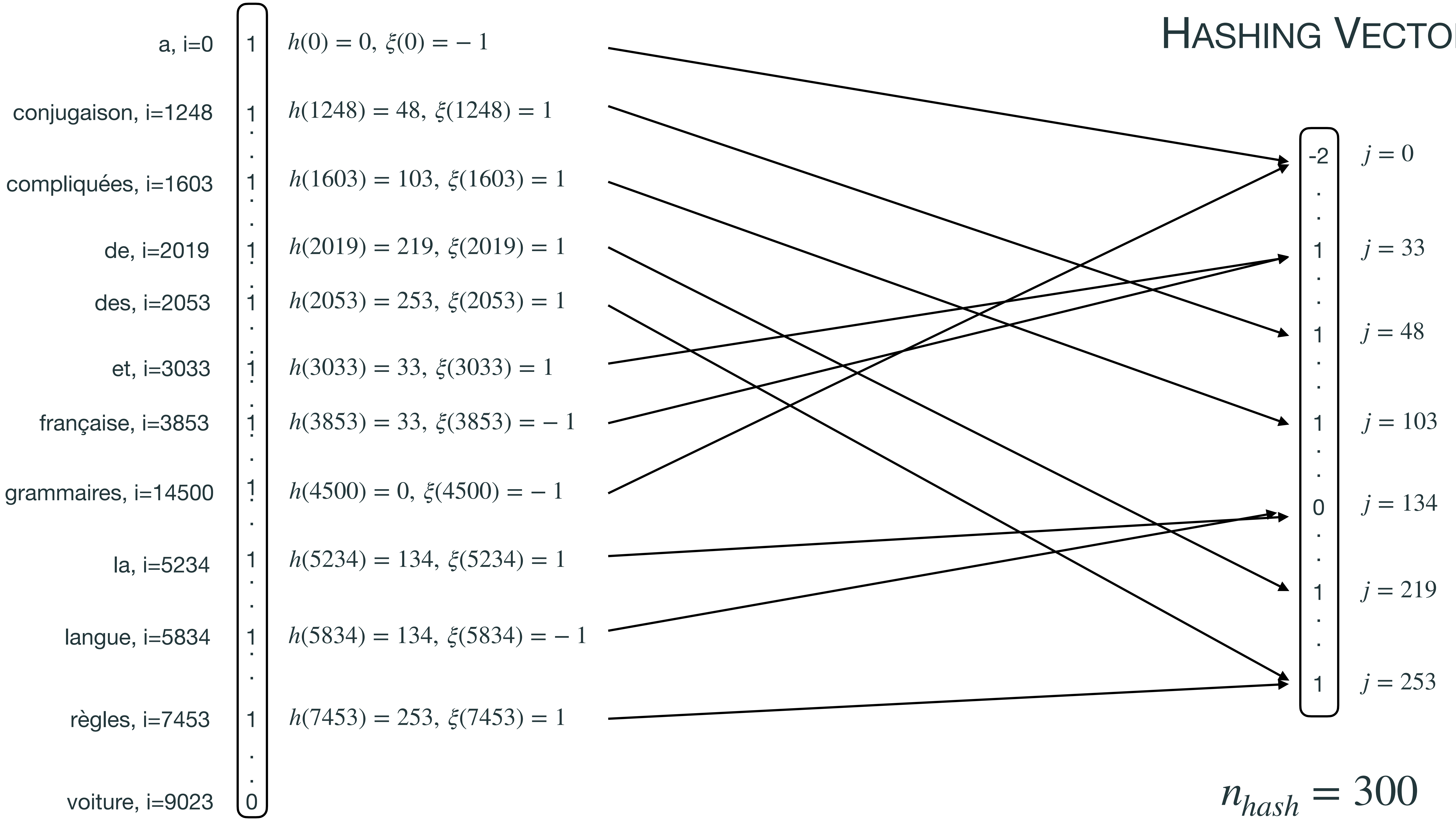
And

$$\xi : \mathbb{N} \to \{1,\ldots, -1\}$$
$$i \mapsto j = \xi(i)$$

Hashing [Weinberger and al, 2009]

Binary Vectoriser

Hashing Vector



$n_{hash} = 300$

$V = 10.000$

Application of vectorisation for learning

- Hashing and then TF-IDF are applied on training dataset.
- Same hashing function are used on test dataset.
- TF value between a word *t* and a document *d* are recomputed for the test dataset.
- IDF terms computed during training are re-used.

N-Grams

Problems

Some words does not have the same sense according to the context where it used.

- *Short de bain* $\neq$ *short* $\neq$ *bain*

Solution

We consider not only the word (*unigram*) but also succession of two (*bigram*) or more words (*n-gram*).

- Solve language ambiguity.
- Explosion of vectors size. Example:
  - For 21.543 lines of categorise “TELEPHONIE - GPS"
  - 8.384 unigrams, 50.012 bigram, 90.854 trigram..

TP

- Clean Cdiscount text’s dataset.
- Vectorize and hash text dataset using scikit-learn library.
- Apply product classification on vectorised data.