Classification of business activities by machine learning: The case of France

International Statistical Classifications Sprint, 2024

Insee

Measuring, understanding

1 STATE OF PLAY: HOW WE ASSIGN AN ACTIVITY CODE

2 FASTTEXT: AN EFFICIENT MODEL FOR CLASSIFICATION

3 INSEE’S PLANS FOR NACE REVISION

01 STATE OF PLAY: HOW WE ASSIGN AN ACTIVITY CODE

HOW DO WE CLASSIFY THE ACTIVITY ?

DIFFERENT PROCESSES

- Thanks to a literal description of the activity of the enterprise during an administrative procedure
  - The most important one : when an enterprise is set up, a form is filled in and a large amount of information is sent to Insee. This includes a literal description of the activity by the firm
  - New forms can be transmitted if the enterprise changes its activity
- Claims : if the enterprises disagree with the activity code given by Insee
- Surveys : structural statistical surveys (the so-called ESA, EAP) in which enterprises are asked about the breakdown of their activity

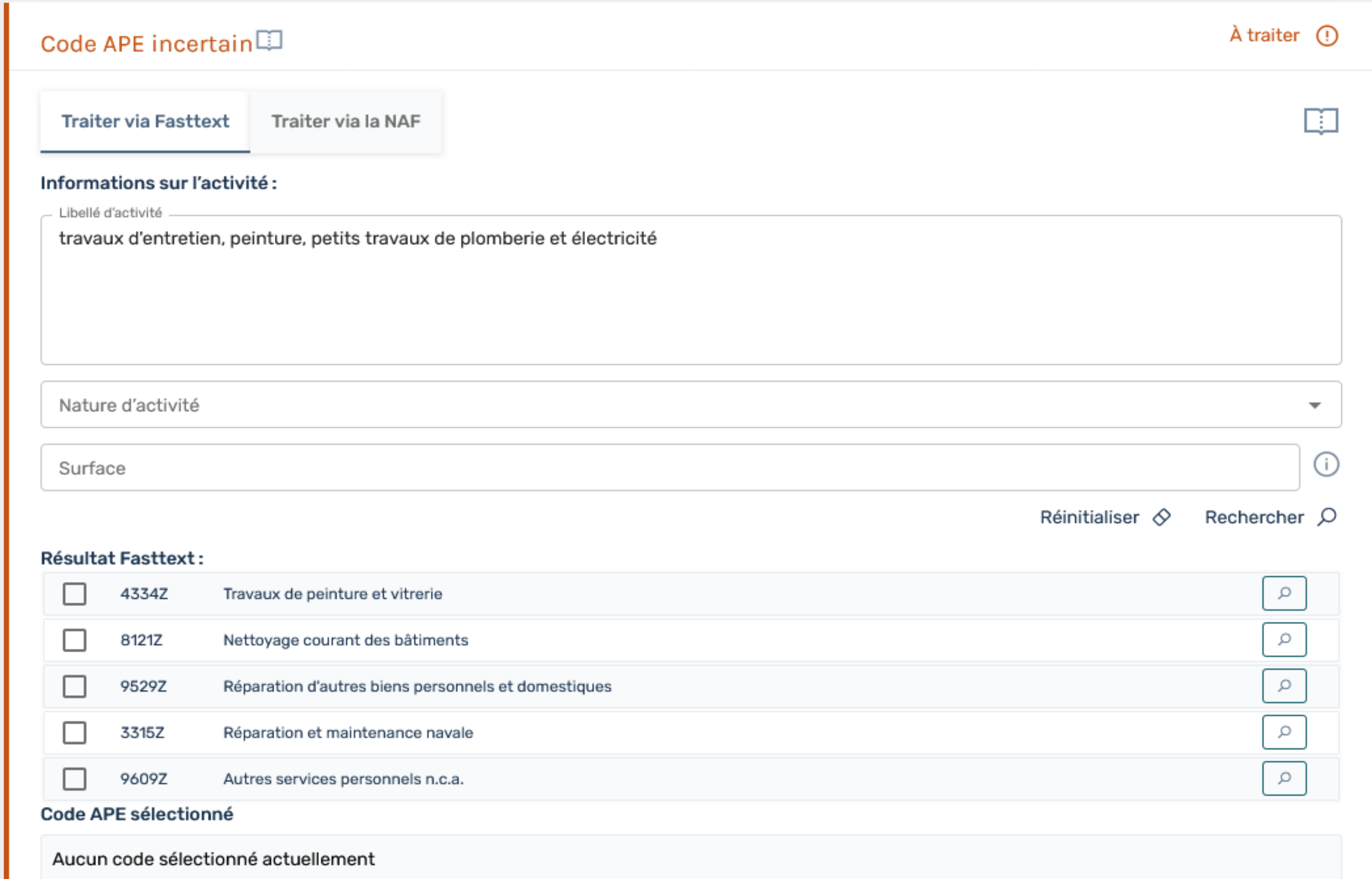
HOW DO WE CLASSIFY THE ACTIVITY ?

FROM A LITERAL DESCRIPTION TO A CODE

- Up until November 2022, we used an automatic label coding system, called Sicore
  - Based on a training file of encoding examples
  - Drawbacks : if the label did not match an encryption example, no code suggestion was returned. It was then coded manually by a human being
- Since November 2022, we have implemented a new model based on machine learning : FastText
  - The training sample : 10 million observations coded by Sicore or manually
    - ➔ **Use of the literal description+auxiliary variables**
    - ➔ **Need for preprocessing : lower case conversion, removal of punctuation, removal of numbers, removal of one-letter words, removal of stop words, stemming …**
  - Very accurate even with literal descriptions that have never been coded before
  - A 100 % result even with a low accuracy rate
  - However we have decided to maintain a manual check if the accuracy is not good

HOW DO WE CLASSIFY THE ACTIVITY ?

TWO POSSIBILITIES FOR HUMAN REVIEW: FASTTEXT OR MANUAL CHECK



Code APE incertain

À traiter

Traiter via Fasttext | Traiter via la NAF

Informations sur l'activité :

Libellé d'activité
travaux d'entretien, peinture, petits travaux de plomberie et électricité

Nature d'activité

Surface

Réinitialiser Rechercher

Résultat Fasttext :

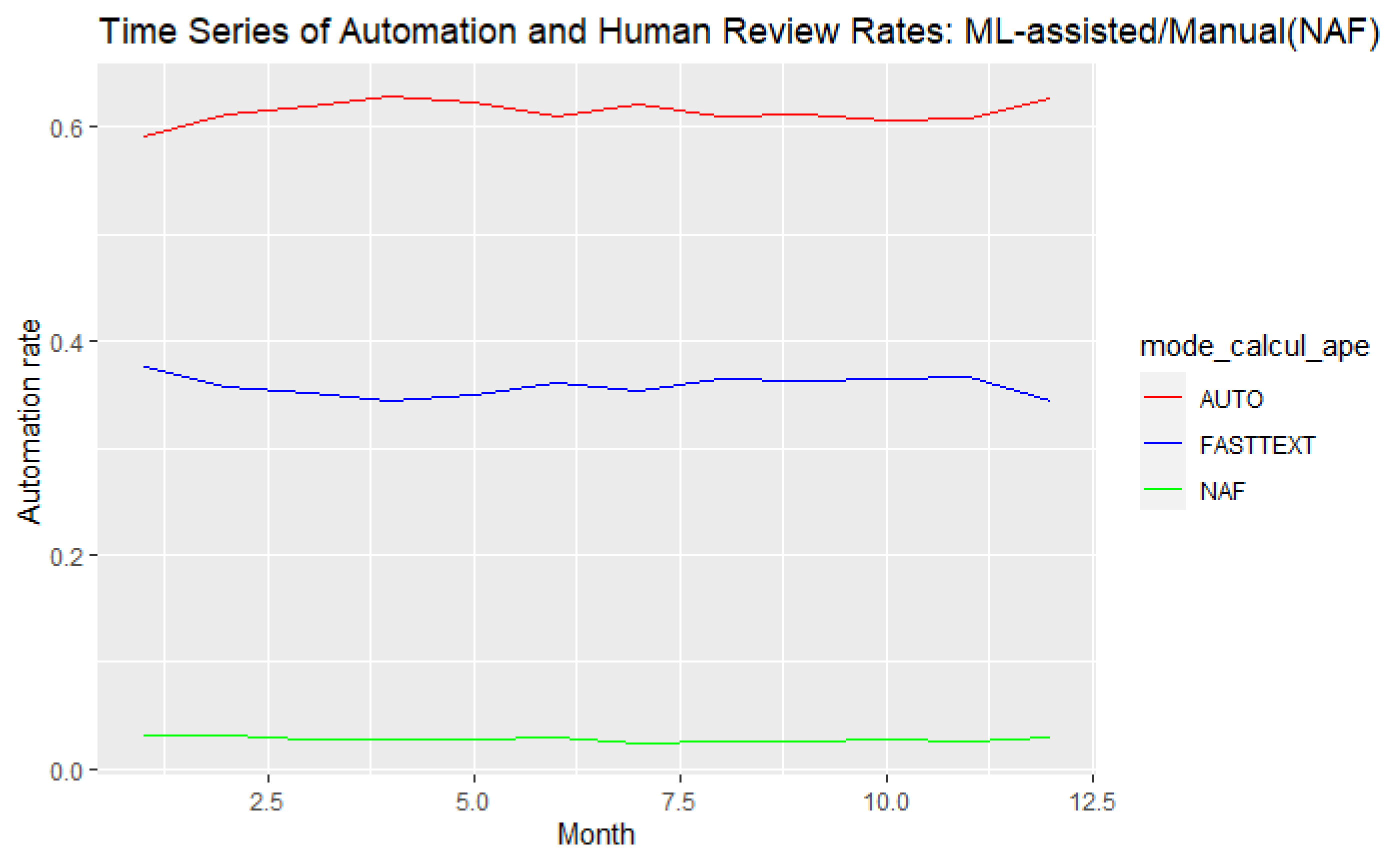
□	4334Z	Travaux de peinture et vitrerie
□	8121Z	Nettoyage courant des bâtiments
□	9529Z	Réparation d'autres biens personnels et domestiques
□	3315Z	Réparation et maintenance navale
□	9609Z	Autres services personnels n.c.a.

Code APE sélectionné

Aucun code sélectionné actuellement

SOME RESULTS OF THE MACHINE LEARNING APPROACH

AUTOMATION RATE DURING 2023



02 FASTTEXT : AN EFFICIENT MODEL FOR CLASSIFICATION

WHAT IS FASTTEXT ?

fastText

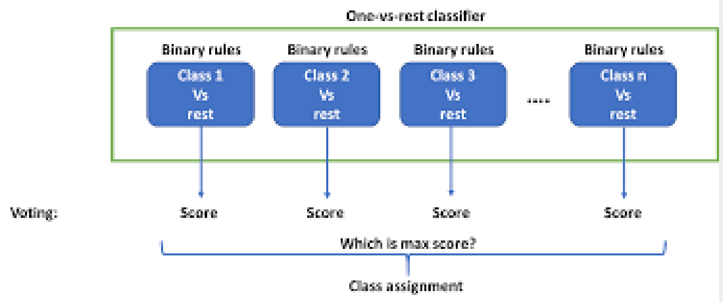
FOR A RAPID AND LIGHTWEIGHT MODEL

- A versatile and efficient tool
  - for learning word representations
  - for sentence classification
- Developed by Facebook's AI Research (FAIR) lab, this open-source library is acclaimed for its swift processing of large datasets
  - Notably, it excels in rapidly classifying millions of data points
    - **a task commonly challenging and costly for many machine learning models when handling complex tasks.**
  - Particularly well-suited for company classification
    - **seamlessly integrates into IT infrastructure without imposing excessive demands.**

MULTI-CLASS CLASSIFICATION

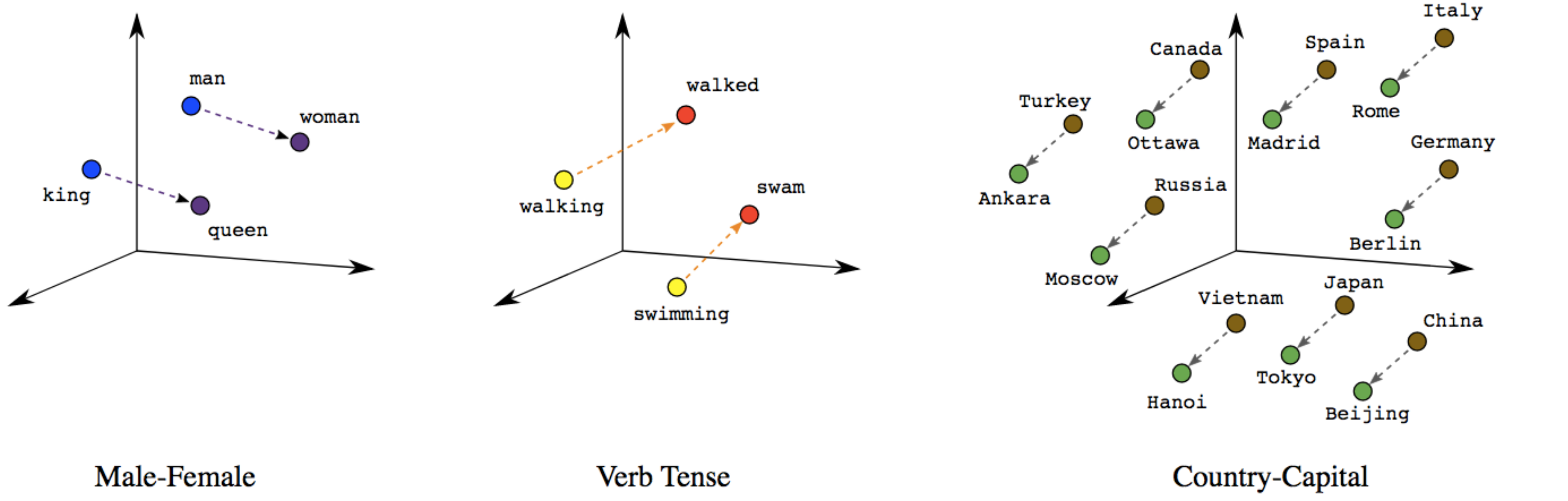
ONE-VS-ALL OR ONE-VS-REST CLASSIFIER

- **Approach:**
  - Train a binary classifier per class
  - Treat each class as positive, others as negative
- **Prediction:**
  - Obtain probabilities for each class
  - Choose class with highest probability
- **Advantages:**
  - Simple implementation
  - Probabilistic interpretation.



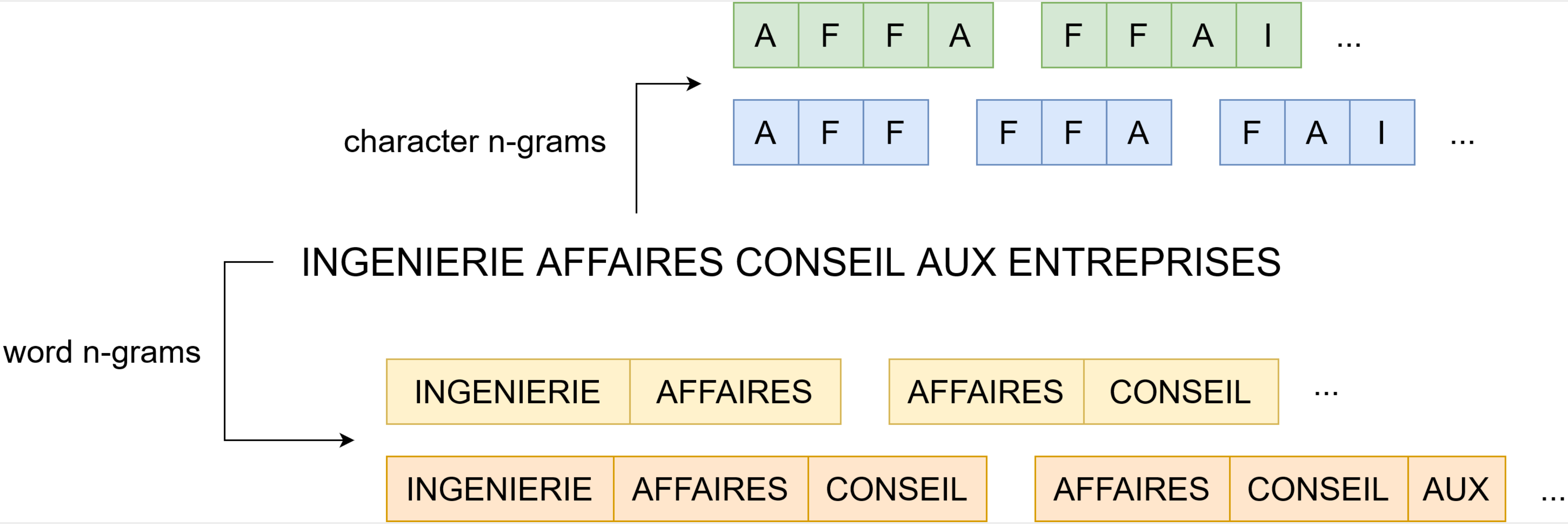
THE PRINCIPLE OF WORD EMBEDDING

- Dense abstract mathematical representations of individual words in a text, capturing context and surrounding word relationships



FEATURE EXTRACTION : THE USE OF N-GRAMS

- Instead of applying ML model directly to the raw data for better results



character n-grams

A F F A | F F A I | ...

A F F | F F A | F A I | ...

INGENIERIE AFFAIRES CONSEIL AUX ENTREPRISES

word n-grams

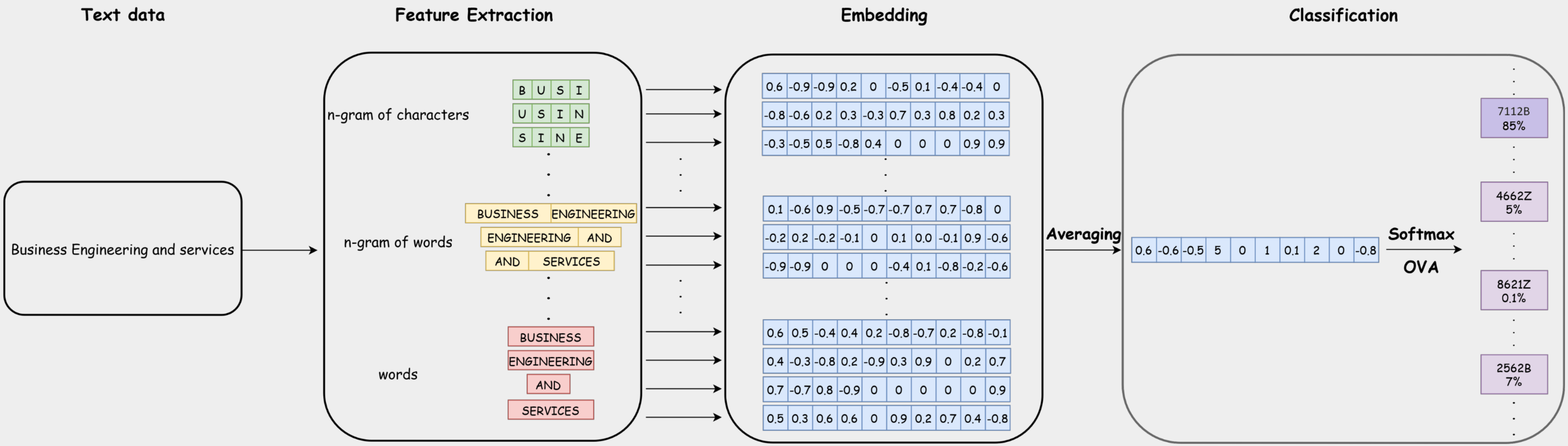
INGENIERIE AFFAIRES | AFFAIRES CONSEIL | ...

INGENIERIE AFFAIRES CONSEIL | AFFAIRES CONSEIL AUX | ...

MECHANISM OF FASTTEXT CLASSIFIER

A PRETTY LIGHT MODEL

- Simple neural network with only one layer



Text data

Business Engineering and services

Feature Extraction

n-gram of characters

B	U	S	I
U	S	I	N
S	I	N	E

n-gram of words

BUSINESS ENGINEERING

ENGINEERING AND

AND SERVICES

words

BUSINESS

ENGINEERING

AND

SERVICES

Embedding

0.6	-0.9	-0.9	0.2	0	-0.5	0.1	-0.4	-0.4	0
-0.8	-0.6	0.2	0.3	-0.3	0.7	0.3	0.8	0.2	0.3
-0.3	-0.5	0.5	-0.8	0.4	0	0	0	0.9	0.9

0.1	-0.6	0.9	-0.5	-0.7	-0.7	0.7	0.7	-0.8	0
-0.2	0.2	-0.2	-0.1	0	0.1	0.0	-0.1	0.9	-0.6
-0.9	-0.9	0	0	0	-0.4	0.1	-0.8	-0.2	-0.6

0.6	0.5	-0.4	0.4	0.2	-0.8	-0.7	0.2	-0.8	-0.1
0.4	-0.3	-0.8	0.2	-0.9	0.3	0.9	0	0.2	0.7
0.7	-0.7	0.8	-0.9	0	0	0	0	0	0.9
0.5	0.3	0.6	0.6	0	0.9	0.2	0.7	0.4	-0.8

Averaging

Classification

0.6	-0.6	-0.5	5	0	1	0.1	2	0	-0.8

Softmax

OVA

7112B
85%

4662Z
5%

8621Z
0.1%

2562B
7%

SOME RESULTS OF THE MACHINE LEARNING MODEL

A GOOD OVERALL PERFORMANCE

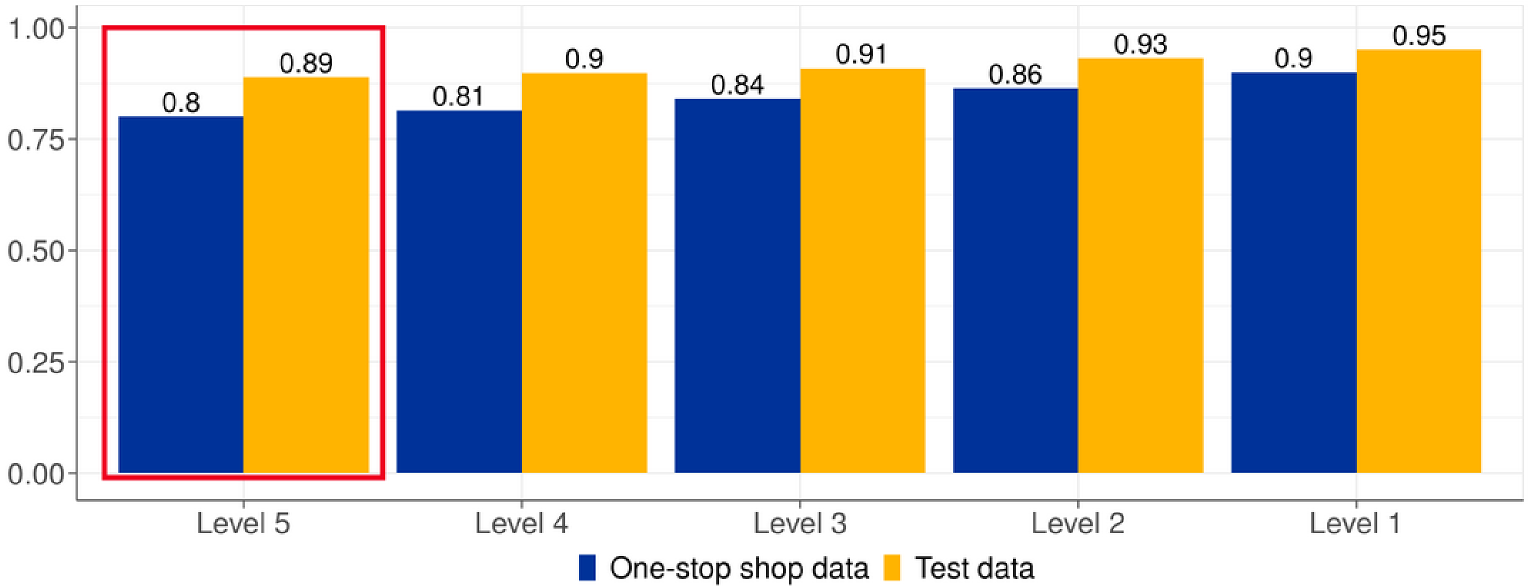


Figure 1: Accuracy for various level of the NACE nomenclature.

SOME RESULTS OF THE MACHINE LEARNING MODEL

- Knowledge of probabilities for each class.
- The correct classification is among the top 5 most probable predictions in 94% of cases.

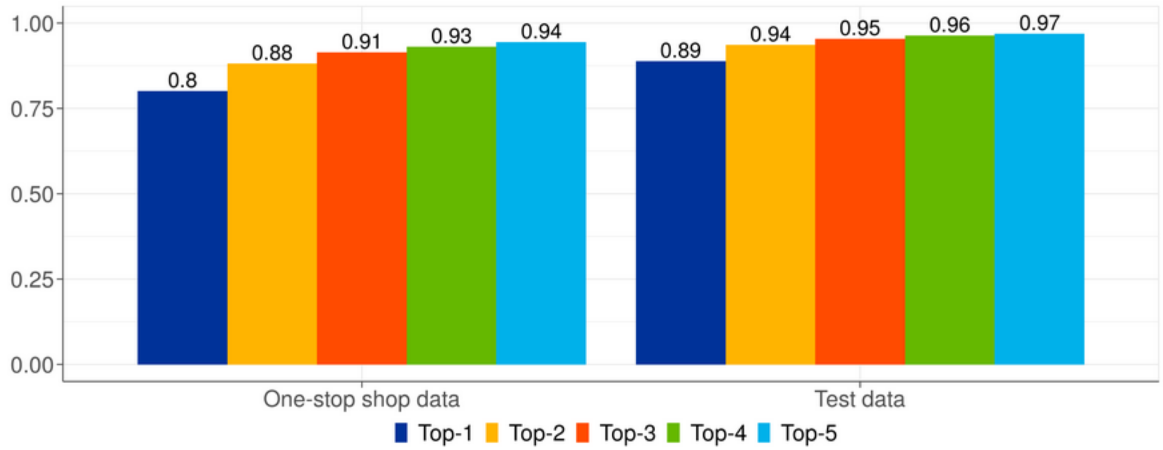


Figure 2: Top-k accuracy per sample.

DEPLOYMENT OF THE MODEL: MLOPS APPROACH IN PROGRESS

- **MODELS HAVE BEEN DEPLOYED AND RE-TRAINED MULTIPLE TIMES IN A PRODUCTION ENVIRONMENT SINCE NOVEMBER 2022**
  - **Emerging new challenges include:**
    - **Organisational issues**
    - **Real-time monitoring**
    - **Regular re-training**
    - **Data annotation tool**

MLOPS APPROACH IS REQUIRED:

03 INSEE’S PLANS FOR NACE REVISION

TWO MAIN ISSUES

- The flow : How to classify the activity of new enterprises according to the new NACE/NAF
  - Current classification: NAF 2008 (a more detailed version of the NACE Rev .2)
  - New classification: NAF 2025 (a more detailed version of the NACE Rev .1)
  - Consistent alignment required with both NACE and current NAF
- The stock : How to recode the activity of more than 10 million active legal units of our administrative business register (Sirene)
  - Not all textual declarations are retained in the historical database of firms for privacy reasons (deletion of too old data)
  - Not always direct correspondence between the old and new NAF

THE FLOW

- We plan to adapt our machine learning model
  - Using data annotated manually by human experts
  - Using some of the past data recoded to the new activity classification
  - Retraining the model with updated output labels to ensure the method’s longevity
- "Coding new enterprises: a two-stage process in both classifications"
  - 2025: Major coding with NAF 2008, manually reviewed by human for complex cases. Minor coding with NAF 2025 with fully automated processing, followed by data quality operations for further improvement.
  - 2026: Major coding with NAF 2025, manually reviewed by human for complex cases. Minor coding in NAF 2008 with fully automated processing, as the administrative business register officially adopts NAF 2025."

THE STOCK

DIRECT CORRESPONDENCE BETWEEN BOTH CLASSIFICATION

- The correspondence table for the subclasses that are unambiguous
  - A one-to-one mapping between codes in the two classifications
  - Automatic recoding for over 40% of active legal units in the business register
  - 4.5 million of legal unit with an ambiguous code
  - (plus 3 million of renters of furnished accommodation, mainly households)

THE STOCK

A NON-BIJECTIVE MAPPING BETWEEN CODES IN TWO DISTINCT CLASSIFICATIONS

1) Structural business survey (ESA/EAP) for the sampled enterprises (mainly the largest):
   - Activity codes for companies surveyed in 2023-2024 recoded based on questionnaire responses
   - We plan to add new product codes and some new questions
2) FastText applied to retained textual declarations (for around 70% of legal units with ambiguous activity codes)
3) Information from partner files for coding based on external data
4) Default code assignment for specific units registered as non-visible in the business register at the request of URSSAF or DGFIP.
5) Implementing default recoding methods in collaboration with sectoral managers in business statistics, including simplifications (automatically assigning the most frequent category for small businesses) or assessing the impact of potential changes in collective bargaining agreements to minimize disputes
6) Specialized survey to enhance the business register for complex and sensitive cases (has not yet commenced)

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Nathan RANDRIAMANANA

Data Scientist in the Department of Registers, Infrastructures and Structural Statistics

Insee, Business Statistics Directorate

nathan.randriamanana@insee.fr