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Standardizing linguistic data: method and tools for annotating (pre-orthographic) French

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ABSTRACT

With the development of big corpora of various periods, it becomes crucial to standardise linguistic annotation (*e.g.* lemmas, POS tags, morphological annotation) to increase the interoperability of the data produced, despite diachronic variations. In the present paper, we describe both methodologically (by proposing annotation principles) and technically (by creating the required training data and the relevant models) the production of a linguistic tagger for (early) modern French (16-18th c.), taking as much as possible into account already existing standards for contemporary and, especially, medieval French.

CCS CONCEPTS

• **Applied computing** → **Arts and humanities**; • **Computing methodologies** → **Natural language processing**.

KEYWORDS

linguistic annotation, pre-orthographic language, lemmatisation, POS-tagging

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1 INTRODUCTION

If medievalists have been working for years on the creation of high quality corpora as well as the tools to build and analyse them (*e.g.* the *Base de français médiéval* (BFM) [Guillot et al. 2017] and TXM [Heiden et al. 2010]), the situation is different for more recent periods of French literature. As far as we know, for texts written between the 16th and the 18th c., *Presto* is the only project that has developed a corpus [Blumenthal et al. 2017] with some computational resources [Diwersy et al. 2017]. However, both are not maintained anymore, which leaves more than three centuries of French literature computationally understudied. It becomes therefore important

to overcome this difficulty, and to create the tools that we desperately need for (early) modern French (henceforth EMF).

Such a task cannot be done without taking into account longstanding annotation practices, in order to allow (minimal) interoperability with already existing datasets. Such a statement is sadly easier said than done, because EMF is an intermediary stage between medieval (12th-15th c.) and late modern and contemporary (from c. 1750) French, two states of language that tend to have different needs regarding annotation: EMF is then caught in between two (potentially incompatible) practices, one for each extreme of the continuum. Facing such a dilemma, we have decided first to look up, in diachrony, and align (when possible) our choices with those of medievalists, rather than to look immediately down at what synchronists do – which tends to be the norm. Our project is indeed to create a tagger for EMF producing data as much as possible compatible with existing medieval corpora, and therefore build the technical frame for the computational study of pre-orthographic French, understood as the forms of this tongue prior to their standardisation based on the recommendations of the *Académie française*.

Textual production before the implementation of this "academic" French (c. mid-18th c., rather than the publication of its *Dictionnaire* in 1694) share common features [Catach 2001]. Among many others, the most important one is to undergo a significant graphematic variation, *i.e.* a relative instability regarding the spelling (*estoit vs étoit*) and the segmentation (*à fin que vs afin que*). Thus, to bypass this problem, the linguistic annotation has to be thought as a pivot format [Aurox 2000, p. 393] that allows users to navigate across heterogeneous data.

Several options are available, such as the conflation by phonetic identity or by lemma [Jurish 2012] – proto-forms being currently investigated as a potential solution, without being yet fully operational [Fourrier and Sagot 2020]. Among all possibilities, we have decided to opt for lemmatisation+POS tagging as a joint solution for two main reasons: on the one hand many resources are already available (*cf. infra*), and on the other hand it is already used for other tasks such as collation [Camps et al. 2019b] or stylometric analysis [Camps and Cafiero 2019].

2 ANNOTATION PRINCIPLES

Since all choices have been carefully discussed in our annotation manual [Gabay et al. 2020] we will here present the main problems raised by annotating EMF: tokenisation, lemmatisation, POS and morphological tagging.

2.1 Tokenisation

As any language, French has undergone phenomena of agglutination at the graphematic (*ce pendant* → *cependant*) and at the lexical (e.g. *bien que*) level. Such a process is not easily datable, because it varies from one region or one phenomenon to the other: in long diachrony, it is therefore impossible to decide precisely when such occurrences have to be tagged as two, or one token. For this reason, we have decided to use the blank space as the main separator for the tokenisation, with hardly any exception to this rule: all locutions, may they be conjunctive (*tandis que*), adverbial (*à demi*) or prepositional (*quant à*), are segmented in two parts rather than one (*tandis* and *que*, *à* and *demi*, *quant* and *à*).

Following this maximalist approach, none of the compounds are analysed as one token: *peut être*, *long temps*, . . . are all considered as multiple tokens (*peut + être*, *long + temps*) – and this despite the presence of the hyphen, which is considered as a token itself (*peut-être* → *peut + - + être*, *long-temps* → *long + - + temps* . . .). For the same reason (absence of blank space), words that are already welded (*monsieur* < *mon sieur*) are treated as one token.

Such a choice to respect the actual segmentation of original witnesses introduces a bias, because it follows the *scripta* (i.e. the writing practice) of printers in (early) modern France [Pellat 1995] and not necessarily the preference of authors. This decision is however more in line with our philological approach, because it relies less on today's linguistic understanding of EMF and outsources complex decisions to historical speakers.

2.2 Lemmatisation

This tokenising strategy creates some lemmatisation problems. The most important one is the absence of coherent lemmas for agglutinated forms that have no autonomy outside a locution such as *parce* (in *parce que*, < *par ce*) or *afin* (in *afin que*, < *à fin*), but also with portmanteau words (*tresobeissant* < *tres+obeissant*). A simple solution is the creation of compounded lemmas, with an underscore separating the original lemmas (*tres_obeissant*), but such a method cannot be generalised: on the one hand, in diachrony, (too) many tokens could need one (*mon_sieur?* *autre_fois?*), and on the other hand we take the risk to end up with (too) many compounded lemmas for a single token (*audit* → *à_le_dit*). In order to limit our logic, tokens that have subsisted into contemporary French are therefore analysed as a simple lemma (*parce*, *afin*), but those that have not subsisted are analysed as a compounded lemma (*tres_obeissant*): this limits the creation of lemma, and maintains interoperability with other language states.

For other words, we have decided to use, when possible, the contemporary form of each token as a canonical form. It usually is the infinitive form (for verbs: *mangeons* → *manger*) or the masculine singular (for nouns or adjectives: *comtesses* → *comte*). Such a process is diachronically problematic, since some words have lost

(*dominus/domina* > *dame* but also old fr. *dom*), or almost lost (*damoiseau* vs *demoiselle*), their masculine counterpart over time: in such cases, we only choose the feminine version if the masculine one is not attested anymore at the end of the 18th c.

In order to control the consistency of the annotation, several authority lists have been created. The main one derives from the lexicon of medieval French inflected forms *LGeRM* [Souvay and Pierrel 2009] in its *mode* version (i.e. *moderne étendu*) produced for the *Presto* project [Diwersy et al. 2017]. The *LGeRM* lexicon is based on the *Freeling* version of the *Lefff* [Sagot 2010], augmented with *Morphalou* [Romary et al. 2004] for contemporary lemmas, and the *Dictionnaire du Moyen Français* (DMF) [ATILF-CNRS and Université de Lorraine 2015] for (early) modern ones. Such an approach should help us maintain minimal interoperability with the medieval version of *LGeRM*, but also the *Trésor de la Langue Française informatisé* (TLFi) [Pierrel et al. 2004]. Two other authority lists have been created: one for named entities (people, places. . .) and an other one with foreign words.

2.3 POS-tagging

Regarding POS-tagging, we have decided to use CATTEX [Prévost et al. 2013] for three reasons: first it is already used for the *BFM* and by several other corpora [Camps et al. 2019a], second it already benefits from a detailed annotation manual [Guillot et al. 2013a], third, it has been designed to cope with the complexity of old states of the French language.

Between the options exposed by Guillot et al. [2013b], we have opted for morpho-syntactical annotation: we take into account the context when categorising tokens and adjectives can be tagged as adverbs (*il parle fort*) or adverbs as substantives (*il fait le bien*). It allows us to follow the evolution of uses over time for a single word. However, following CATTEX as well as *Presto* recommendations, we never categorise present and past participles as adjectives, because if such distinctions are already difficult in synchrony, they are even harder to identify in diachrony. It would be too complicated to precisely differentiate the past participle of *perdre* (*perdu*) from the adjective *perdu* over the very centuries during which the verb has undergone a slow process of adjectivisation, especially without clear markers such as the determiner for the substantivization (*il fait bien* vs *il fait le bien*).

Our (maximalist) tokenisation principles incite (but do not force) us to tag words with their original part of speech: *bien* in *bien que* is an *ADVgen* and not a member of a potential *LOCconj* (that does not exist within CATTEX). This choice considerably simplifies the interoperability with Old and Middle French. It does create some problems though, and we are forced to use analogies to tag certain tokens: *pource* in *pource que* is therefore *ADVgen*, such as *bien* in *bien que*.

2.4 Morphology

We have decided to implement CATTEX-max [Prévost et al. 2013], that is to say to annotate each token with morphological information (gender, mood, tense. . .). Contrary to lemmas and POS, this linguistic information has been added for technical purposes (it has helped maximise the efficiency of the final model): if it has been proofread to avoid major mistakes, its perfection is not guaranteed.

3 TRAINING A MODEL

Based on the previously introduced annotation choices, we have decided to train a lemmatiser and a POS-tagger.

3.1 Data recycling

A substantial amount of heterogeneous data is already available (cf. tab. 1). Considering the cost of creating a gold corpus, we have decided that it would be more efficient to re-process existing data rather than create new ones from scratch.

Name	Gold	Norm.	Tokens	POS	Morph
<i>CornMol</i>	Yes	Yes	90,000	CATTEX	Yes
<i>FranText OA</i>	No	Yes	2 400,000	EAGLES	No
<i>Presto gold</i>	Yes	Yes	60,000	MULTEXT	No
<i>Presto core</i>	No	Yes	6,820,000	MULTEXT	No
<i>Presto controlled</i>	No	Yes	11,636,000	MULTEXT	No
<i>Presto extended</i>	No	Yes	28,309,000	MULTEXT	No

Table 1: Available training data

Two corpora come from a previous study [Camps et al. 2020] and are almost ready to use:

- The *CornMol* corpus has been created to carry stylistic studies [Camps and Cafiero 2019]. It is based on 41 comedies written in the 17th c., carefully sampled and proofread, which have been thoroughly described [Camps et al. 2020].
- The *Frantext open access data* [ATILF-CNRS and Université de Lorraine 2018] is composed of 32 texts, mainly written in the 18th (7 texts), 19th (24 texts) and 20th c. (4 texts). Because the corpus is already tagged and lemmatised (but not fully corrected) following other guidelines than ours, the lemmas have been aligned according to our standards, as much as we could.

Regarding *Presto*, because it is composed of four different subcorpora (for a detailed description of the different levels and variations, cf Vigier [2018]), it requires some selection, processing and correction:

- A gold corpus is made of 60 000 tokens, taken from 5 texts written in the 16th (1 text), 17th (2 texts) and 18th c. (2 texts). These texts have all been sampled, tokenised, tagged, lemmatised and proofread to create training data for a *TreeTagger* model.
- The final *Presto* corpus is a three-fold one: *noyau* (“core”), *contrôlé* (“controlled”) and *étendu* (“extended”). We have limited ourselves to a selection of its core version (cf. Appendix).

3.2 Preparation

Because the *CornMol* and *Frantext Open Access* corpora have already been prepared for our previous experiment on normalised-spelling French, it already follows closely our choices regarding tokenisation and POS-tagging (minor changes have been made in between), and the shift of authority list from *Morphalou* to *LGeRM* is of almost no impact since the latter derives from the former. All the effort have therefore been put on the correction and the alignment on our standards of the two *Presto* sub-corpora, which was problematic for three reasons. First, our choices differ strongly from *Presto*'s

regarding tokenisation and POS-tagging – but not lemmatisation, since they also use *LGeRM*. Second, because their training data has been mainly prepared for POS-tagging and not lemmatisation, and also because the annotation has been done with an older and less precise tool (*TreeTagger*), the result is far from being perfect. Third, it is impossible to recycle some texts of their final corpus into training data, because we need (fairly) clean texts – Jean de Léry's *Voyage en terre du Brésil* had therefore to be withdrawn because of the noise produced by hyphenation. Most of the correction work has been done with *Pyrrha* [Clérice et al. 2019].

In order to deal with more complex data than the one we use for training, we have artificially added a very limited number of glyphs typical of (early-)modern prints such as the long *s* (*f*), the *eszett* (*β*) or tilded letters traditionally used as abbreviations (*õ*, *ã*, *ũ*, *ĩ*).

Out of all these data, two different corpora have been produced:

- A primary corpus, fully annotated with lemma, POS and morphology, based on tokens with normalised and non-normalised spelling, has been created out of the two gold corpora (*CornMol* and the revised version of *Presto gold*).
- A secondary corpus, with lemmas only, has been produced out of *Frantext open access data*, the corrected versions of *Presto gold* and *Presto core*, and *CornMol*.

These two corpora are used to train two separate models: one for the POS and the morphology, and another for lemmatisation only. Therefore, two training datasets have been created using *Protogénie* [Clérice 2020b] (cf. tab. 2): they contain a train set, a development set (for evaluation during training) and a test set (for in-domain testing). The breakdown of tokens between the train, dev and test set is dependent on the total amount of data and has been done on an empirical basis, in order to keep as much tokens for training as possible, while still keeping a reliable test set. As such, it is dependent on the total size of the corpus (the bigger the corpus, the smaller the fraction of it which is necessary for reliable training).

Corpus	Train set	Dev set	Test set	Total
<i>POS</i>	132,905 84%	9,733 6%	15,303 10%	157,941
<i>Lemma</i>	6,666,473 94%	70,009 1%	352,482 5%	7,088,964

Table 2: Breakdown of the tokens per set (numbers are rounded)

Because of the size of the corpus, it is impossible to control each token. The general quality is therefore guaranteed by the use of already existing corpora, which have already been carefully prepared for previous tasks. The consistency of the annotation is controlled with authority lists, but also with intermediary models, which help inspect the consistency of the data sets. After each training, the creation of a confusion matrix allows to identify frequent confusions between predictions and ground truth data, that could be due to inconsistencies in the human annotation.

3.3 Set up

We use *Pie* [Manjavacas et al. 2019] as our main training and tagging software¹. For training, *Pie* is used for lemma- and POS-tagging. At inference time, we use *Pie-extended* [Cl ericie 2020a] which wraps the former with more user-friendly functionalities (model sharing, advanced post- and preprocessing options. . .). Several architectures have been tested for our previous study on normalised texts (for more detailed scores, cf. Camps et al. [2020])², the best one being:

- RNN with 300 dimensions for characters
- Sentence and word embeddings (150 dimensions) using 343 drama texts from [Fi evre 2007] and those of the *FranText Open Access* that we presented *supra*, for a total of c. 7M tokens.
- Hidden size of 150
- Forward and backward language models

However, additional tests have proven since the possibility of increasing even more the accuracy with a bigger number of dimensions for the RNN (300→400) and the hidden size (150→256), and NFKD unicode normalisation of the data, without word embeddings.

LEMMA					
<i>Lemma</i>	M2	M3	M3+NFKD	<i>support</i>	
<i>In-domain</i>	99.09	99.12	99.28		4,181
<i>Out-of-domain</i>	97.92	98.59	98.67		13,497
POS					
POS	M1	M1+aux	M2	M2+aux	<i>support</i>
<i>All</i>	96.72	96.51	96.84	97.01	4,181
<i>Ambiguous token</i>	91.86	91.43	92.40	92.29	934
<i>Unknown tokens</i>	86.24	86.24	78.44	81.65	218

Table 3: Scores (normalised spelling data only). *M1* is the basic *Pie* configuration, *M2* adds word embeddings to *M1* architecture, and *+aux* indicates the use of auxiliary tasks – these architectures being fully described in Camps et al. [2020] as *base (sent-lm)* and *wembs*. *M3* uses a bigger number of dimensions (400) for the RNN than for the *M1* configuration (150), and *+NFKD* indicates the additional use of unicode normalisation.

Based on these new results, we have decided to test this new successful *M3* configuration rather than the *M1* and *M2* previously presented as the most efficient. Two versions have been tested: the first with one linear layer, the second with two linear layers. For each configuration, due to the stochastic nature of the process, three models were trained, using early stopping with threshold 0.001 and patience 7. The best one was retained. For time and ecological purposes, NFKD normalisation has been tested on the most relevant architecture only.

¹Previous tests included a comparison with *Marmot* for POS-tagging, and results were equivalent to those obtained with *Pie* [Camps et al. 2020]

²“Unknown tokens” are tokens never seen during training, while “ambiguous tokens” are forms that can correspond to different lemmas. “Unknown targets” are lemmas never seen in training, but that the neural network can still sometimes accurately predict, thanks to its character level modelling.

3.4 Results

First, the existence of spelling variation seems to have a limited impact, or to be efficiently counter-balanced by our data augmentation: the accuracy remains similar to the one of models trained exclusively on normalised spelling data for lemmatisation (98.62% vs 99.28%) and even higher for POS-tagging (97.18% vs 97.01%). Such results are very promising. When looking into the details, we observe that two linear layers have an almost null (+0.001 pt of % for POS) or slightly negative impact (-0.0002 pt of % for lemmas). Considering the (much) larger training time and energy use, it does not seem to be a satisfactory solution.

	1 layer	+NFKD	2 layer	<i>support</i>
<i>all</i>	98.62	98.48	98.46	352,483
<i>unknown tokens</i>	68.96	68.07	68.31	3,843
<i>ambiguous tokens</i>	98.3	98.16	98.12	182,472
<i>unknown targets</i>	54.27	54.13	54.32	2,047

Table 4: Lemmas (normalised+original spelling)

Because NFKD lowers the amount of characters (235 → 164) we have decided to lower the amount of dimensions for the RNN character embeddings (400 → 300). The final results show a slightly negative impact on the accuracy, which proves that the efficiency of NFKD on the *CornMol* corpus is linked to the smaller size of the corpus and that unicode decomposition and normalisation is probably less relevant on big corpora – similar scores could be achieved with fine tuning, especially by lowering the number of dimensions.

	1 layer	2 layers	<i>support</i>
<i>all</i>	97.09	97.18	14,303
<i>unknown tokens</i>	87.57	88.4	724
<i>ambiguous tokens</i>	93.81	94.11	4,281

Table 5: POS (normalised+original spelling)

The significant increase of training data (90,000 to 150,000 tokens) have a significant effect on the efficiency of the POS-tagging model, and we improve the results of the previous model based on normalised-spelling data only.

3.5 Impact of spelling variation

The score for “ambiguous tokens” given by *Pie* evaluates its efficiency regarding homographs, *i.e.* its capacity to disentangle tokens like *entre* which can be both a form of the verb *entrer* (*il entre dans la pi ece*) or the preposition (*entre les murs*). However, lemmatising historical variation-rich languages is also about handling polymorphism, because a same word can frequently have different graphematic realisations (*e.g. besoin vs besoin*). We have therefore decided to evaluate the robustness of our best model regarding the graphematic volatility of (early-modern) texts, as Millour and Fort [2019] did for their study on dialectal variation.

214 pairs of two different tokens sharing the same lemma, POS-tag and morphology have been extracted from the whole *presto gold*

corpus, so that we have a *Form A* and a *Form B* in each pair: *afin* vs *affin*, *changements* vs *changemens*. . . . It is to be noted that, by including only pairs that are actually present in the final training data, we have limited the significance of our results for out-of-domain and/or rare graphematic realisations.

In order to evaluate the effect of spelling variation, we designed a simple algorithm: in the test set, for each pair, all sentences containing a token matching the lemma and one of the variant of the pairs are extracted. This group of sentences is then duplicated: the first set is left untouched, while, in the second set, all occurrences of variant *i* are replaced by the alternative variant *j*. Both groups are then lemmatised and the accuracy is compared to evaluate the robustness of the model despite spelling variation in strictly equivalent contexts.

By doing so, we are able to evaluate the recognition of the spelling variants while neutralising variations due to the left and right contexts (each form is artificially given the same number of occurrences and the same contexts). We then test our model on both set, and compare accuracy for *i* (Acc_i) and for *j* (Acc_j), with a simple difference:

$$\Delta_{Acc} = |Acc_i - Acc_j|$$

For all these pairs, the median Δ_{Acc} , the geometric mean Δ_{Acc} , and the weighted geometric mean, using the frequency of variant *j* in the training data as weight, are all equal to 0 (arithm. mean is 0.025; weight. arithm. mean is 0.011). We can therefore conclude that spelling variation has a very limited impact on the accuracy, as long as both forms are present in the training data. In the future, it would be necessary to extend this kind of analysis to pairs for which one variant is unseen by the model³.

3.6 Out-of-domain tests

We have tested our best lemma and our best POS models on the same out-of-domain testing data than the one used for our previous study. There are two test sets for each century: one made only of theatre, the other one of everything but theatre. Each test set is composed of 10 short samples (c. 100 tokens), as representative as possible of the linguistic production of the century (female and male authors, decade of publication, genre. . .).

Because the model built for the previous study was trained on normalised-spelling data, out-of-domain data had been normalised too. For this new study, the out-of-domain test set has been duplicated and now exists in both original and normalised transcriptions for the 16th, 17th and 18th c. texts only, and not for 19th and 20th c. texts, which do not require any spelling normalisation.

We observe that accuracies on normalised-spelling out-of-domain testing data are relatively similar for both the model trained on normalised data and the one trained on original data. The fact that the main difference are observed for theatrical plays could imply that the model trained on normalised data has been tailored for this genre. Without surprise, regarding non-normalised out-of-domain testing data, the accuracy of the model diminishes with centuries as we go back in time.

Results regarding POS annotation are relatively similar to the one of lemmatisation, and we observe again a significant impact of the theatrical genre on the accuracy.

³The scripts for this particular evaluation are available on: Thibault Cl rice and Jean-Baptiste Camps, [PontleNeptique/classique_variante](https://github.com/PontleNeptique/classique_variante), *GitHub*, 8 sept. 2020, https://github.com/PontleNeptique/classique_variante.

Corpus	16th	17th	18th	19th	20th	All cent.
Test 1						
<i>Drama</i>	97.6	98.10	98.88	98.34	98.00	98.19
<i>Not drama</i>	97.78	98.02	98.06	96.97	97.39	97.65
<i>Both</i>	97.69	98.06	98.46	97.66	97.70	97.92
Test 2						
<i>Drama</i>	96.65	97.42	97.69	98.2	97.5	97.51
<i>Not drama</i>	97.48	98.24	98.27	97.12	96.79	97.59
<i>Both</i>	97.08	97.83	97.99	97.66	97.15	97.55
Test 3						
<i>Drama</i>	93.93	96.36	96.95	98.2	97.5	96.64
<i>Not drama</i>	96.23	97.25	98.2	97.12	96.79	97.13
<i>Both</i>	95.12	96.8	97.59	97.66	97.15	96.89

Table 6: Lemmatisation accuracies of the best model on out-of-domain data. *Test 1* tests our best model trained on normalised-spelling data on normalised out-of-domain data. *Test 2* tests our best model trained on original-spelling data on normalised out-of-domain data. *Test 3* tests our best model trained on original data on original out-of-domain original data.

Corpus	16th	17th	18th	19th	20th	All cent.
Test 1						
<i>Drama</i>	95.05	96.59	95.98	94.81	93.57	95.18
<i>Not drama</i>	92.89	94.27	96.53	91.87	91.35	93.42
<i>Both</i>	93.93	95.44	96.27	93.36	92.48	94.30
Test 2						
<i>Drama</i>	93.53	95.68	95.01	93.37	93.42	94.19
<i>Not drama</i>	92.75	94.5	95.21	92.09	93.59	93.64
<i>Both</i>	93.12	95.09	95.12	92.74	93.5	93.92
Test 3						
<i>Drama</i>	89.3	92.72	94.49	93.37	93.49	92.72
<i>Not drama</i>	89.42	92.6	95.49	92.09	93.59	92.67
<i>Both</i>	89.36	92.66	95.01	92.74	93.5	92.69

Table 7: POS accuracies of the best model on out-of-domain data

4 INTERPRETATION

Interestingly, none of the most important errors are linked to graphematic polymorphism. Most of the problems are linked to homographs: *le* pronoun (*il le veut*) vs determiner (*le ch teau*), the verb *a* (*il a*) vs the preposition (*  Gen ve*) when it does not have the grave accent (*a Gen ve*), the determiner *des* (*il fait des ronds*) vs the enclise *de+le* (*le p re des enfants*). If such results confirm those obtained on normalised data, the presence of noise in the *Presto core* corpus could explain some errors.

5 FURTHER WORK

The next step, already in preparation, is the extension of the annotation to named entities to train a NER for EMF. With texts published on three centuries, and especially with a long excerpt of the *Encyclopédie* (c. 1,500,000 tokens), we do believe that our corpus is rich enough to carry preliminary tests. The presence of already corrected lemmas and POS tags for proper nouns (to which a special attention was given during the correction of the corpus) should dramatically ease the annotation process.

Regarding lemmatisation and POS-tagging, the most important task will be the extension of the training data for 16th c., and even 15th c. French, which is clearly underrepresented in our corpora: the complexity of middle French would certainly require more data, and new strategies to maintain the interoperability between medieval and (early) modern datasets.

6 CONTRIBUTIONS

This project is a follow-up to another one designed by Florian Cafiero, J.-B. C. and S.G. It has been led by S.G., who prepared the data and the final article, with the help of many: J.-B. T. for the conversion of *Presto gold* from MULTEX to CATTEX, Lucence Ing for the annotation of *Presto gold*, and Matthias Gille Levenson for the correction of *Presto core*. Trainings have been configured and executed by T.C. J.-B. C. has accompanied the entire process, providing technical guidance and philological feedback on the compatibility with medieval data. All authors discussed the results and contributed to the final manuscript.

7 DATA

The most up-to-date version of the models can be easily obtained and used thanks to the `pie-extended` Python package, available on `Pypi` (<https://pypi.org/project/pie-extended/>), with the command `pie-extended download freem`. All the data are available online at <https://github.com/e-ditiones/LEM17>.

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APPENDIX

The full breakdown of the *CornMol* and *FranText Open Access* corpora can be found in Camps et al. [2020]. We therefore describe only the *Presto* data we have used.

Presto Gold

Author	Title	1st ed.	used ed.	Tokens
SCEVE M.	Saulsaye	1547	1547	6,186
DU RYER P.	Lisandre et Caliste	1632	1632	11,984
BUSSY-RABUTIN R. de	Les Lettres	1666	1720	11,807
VOLTAIRE	Essay sur l'histoire générale et sur les moeurs	1756	1756	16,224
RÉTIF DE LA BRETONNE N.-E.	Le Paysan perversi ou les Dangers de la ville	1776	1776	16,141

Presto core

Author	Title	1st ed.	used ed.	Tokens
RABELAIS Fr.	Pantagruel	1532	1542	45,371
RABELAIS Fr.	Gargantua	1534	1542	50,499
FLORES J. de	La Deplourable fin de Flamete	1535	1536	30,580
SCEVE M.	Saulsaye	1547	1547	6,182
DU BELLAY J.	La deffence, et illustration...	1549	1549	20,974
ANONYME	Sottie pour le cry de la bazoche	1549	1912	5,055
DES PÉRIERS B.	Nouvelles recreations et joyeux devis	1558	1561	81,471
RONCARD P. de	Discours des Miseres de ce temps	1562	1563	6,451
BUCHANAN G.	Jephthé, ou le veu	1567	1567	17,147
MONTAIGNE M. de	Essais	1580	1580	224,183
URFÉ H. d'	L'Astrée, première partie	1607	1607	241,160
BÉROALDE DE VERVILLE Fr.	Le Moyen de parvenir	1616	1616	148,460
COLLETET G.	Le Trébuchement de l'yvrongne	1627	1627	2,713
BALZAC J.-L. GUEZ de	Le Prince	1631	1631	61,629
DU RYER P.	Lisandre et Caliste	1632	1632	21,507
PEIRESC N. CI.	Lettres : t. 7 : lettres à divers : 1602-1637	1637	1898	87,931
ASSOUCY Ch. d'	Poésies et lettres...	1653	1653	32,459
BUSSY-RABUTIN R. de	Les Lettres	1666	1720	192,622
SCUDÉRY M. de	Mathilde	1667	1667	77,331
QUINAULT Ph.	Thésée	1675	1675	13,329
ESPRIT J.	La Fausseté des vertus humaines	1678	1710	175,131
CHARLEVAL J.-L.	Poésies	1693	1759	12,111
REGNARD J.-Fr.	Les Folies amoureuses	1704	1820	18,161
DACIER A.	Des causes de la corruption du goust	1714	1714	65,273
RACINE L.	La grâce	1720	1742	13,308
BOISSY L. de	Les Dehors trompeurs, ou l'Homme du jour	1740	1813	24,796
VOLTAIRE	Essay sur l'histoire générale et sur les moeurs	1756	1756	416,924
COLLECTIF	Encyclopédie (tome 7)	1757	1757	1,600,920
ALEMBERT d'	Lettre à M. Rousseau	1759	1759	14,182
SAINTE-LAMBERT J.-Fr. de	Les Saisons	1769	1769	29,575
RÉTIF DE LA BRETONNE N.-E.	Le Paysan perversi ou les Dangers de la ville	1776	1776	270,651
MIRABEAU H.-G. Riqueti	Lettres originales écrites du donjon...	1780	1792	346,662
COLLIN D'HARLEVILLE J.-Fr.	L'Inconstant	1786	1805	16,578
LA PÉROUSE J.-Fr.	Voyage de La Pérouse autour du monde	1797	1797	338,344