Large Scale Genealogical Information Extraction From Handwritten Québec Parish Records

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ICDAR 2023

August 21, 2023

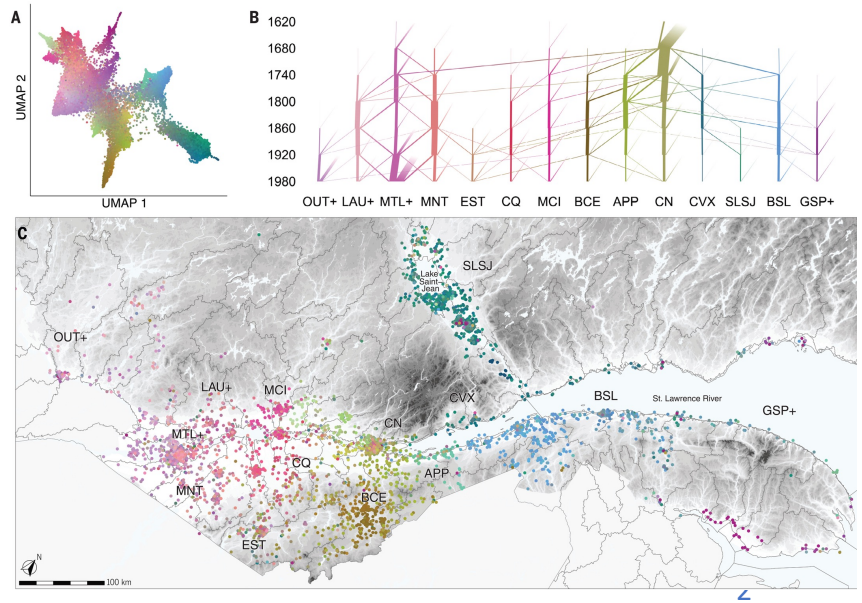
TEKLIA

UQAC
Université du Québec
à Chicoutimi

The Balsac project

Goal: a large genealogical database of the Quebec population

On the genes, genealogies, and geographies of Quebec
Science, 25 May 2023



The e-Balsac project

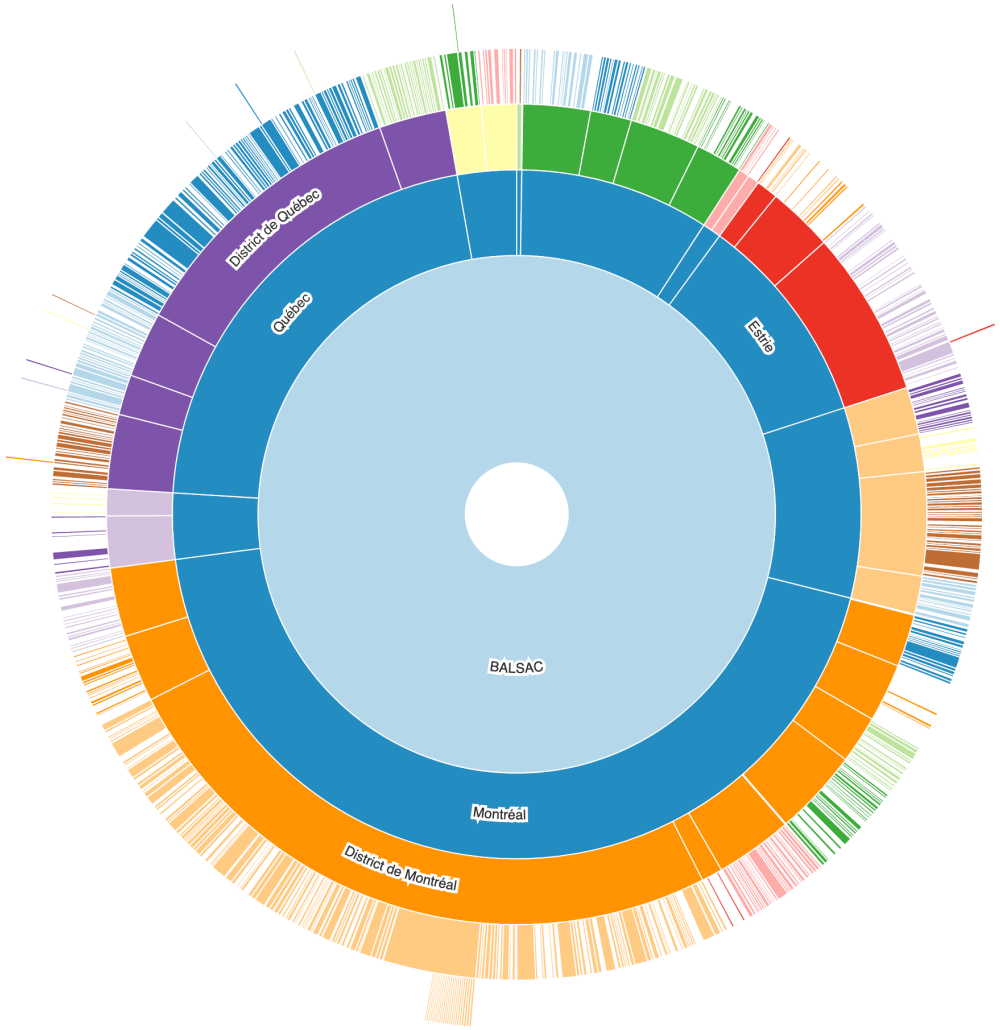
- Database built for more than 50 years
- Extracted from transcribed parish and civil registers
- First only marriages, now birth and death records
- Manual transcription is no longer feasible: the Quebec population was multiplied by 6 between 1851 and 1961

Goal : Automatic processing of the Québec parish registers 1850-1920

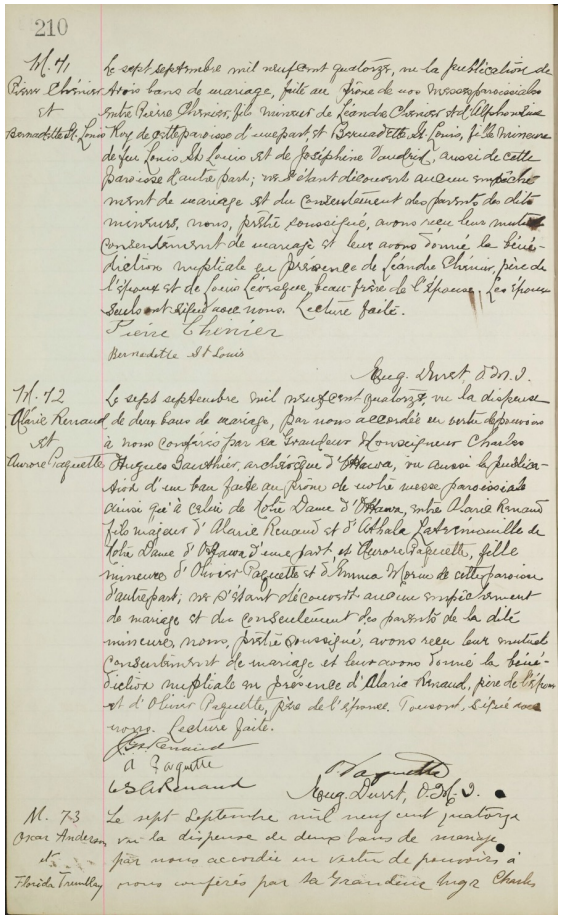
Québec civil and parish registers

Birth, marriage and death records for the Quebec population between 1850 and 1916

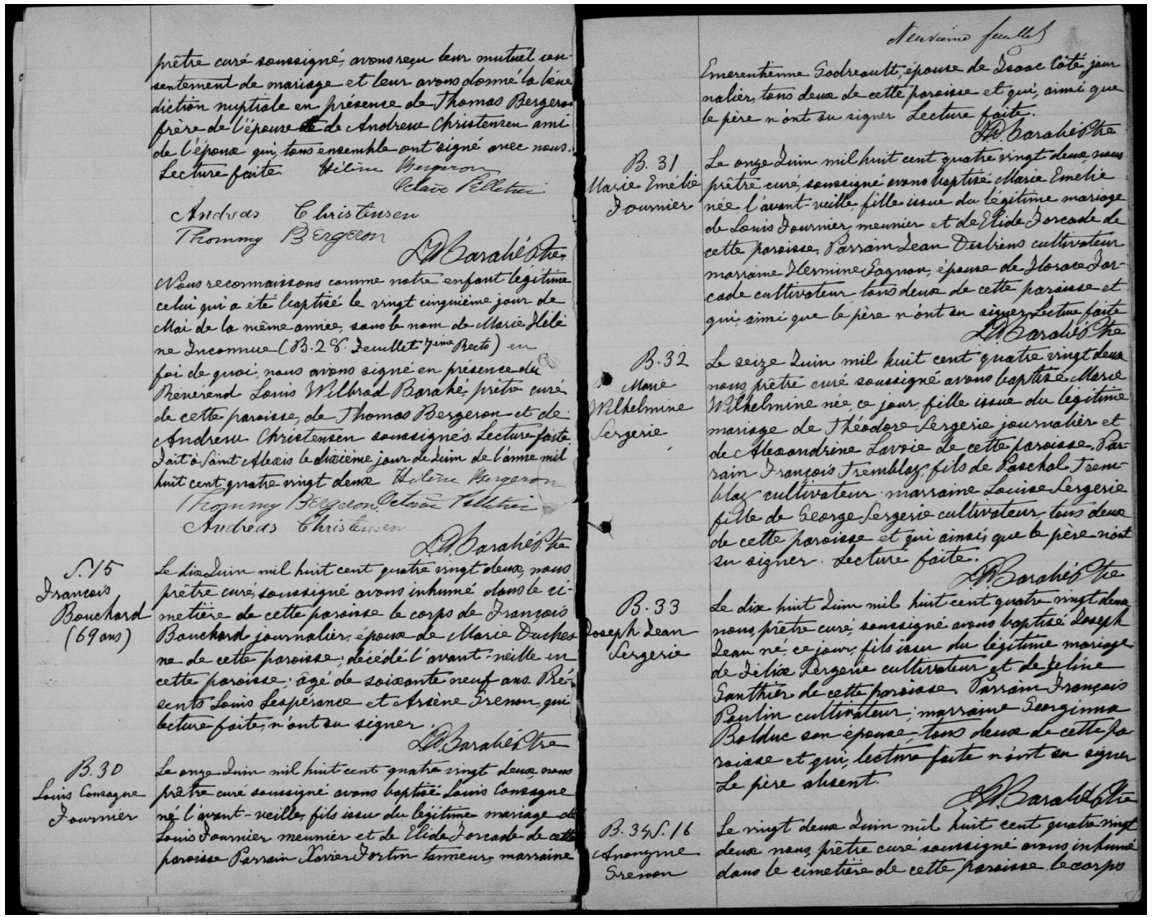
10 centers
36 districts
1,985 parishes
44,742 registers
1,995,646 images



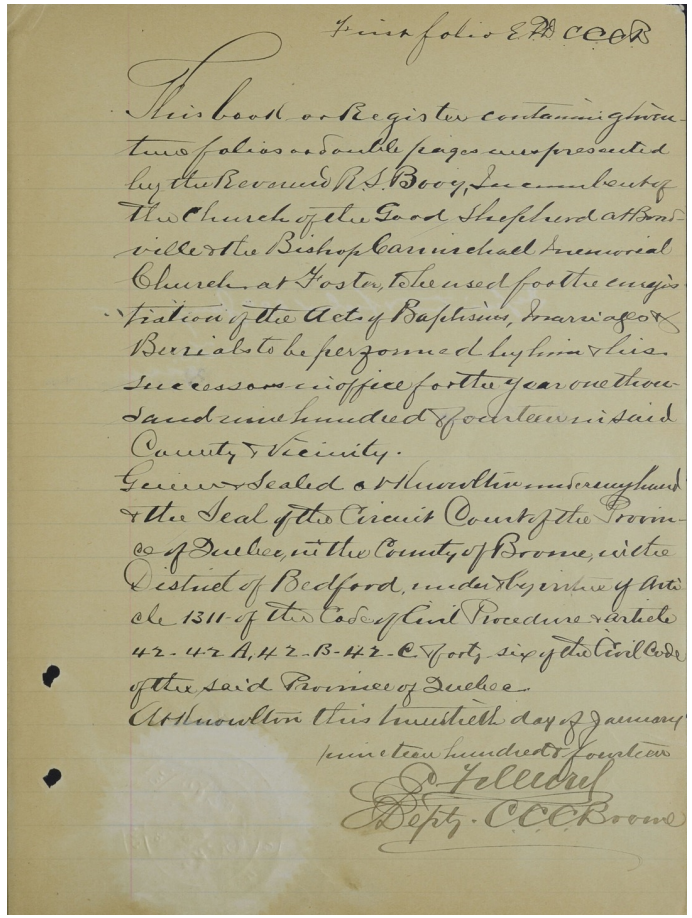
Québec civil and parish registers



Notre Dame de Grâce de Hull, 1914

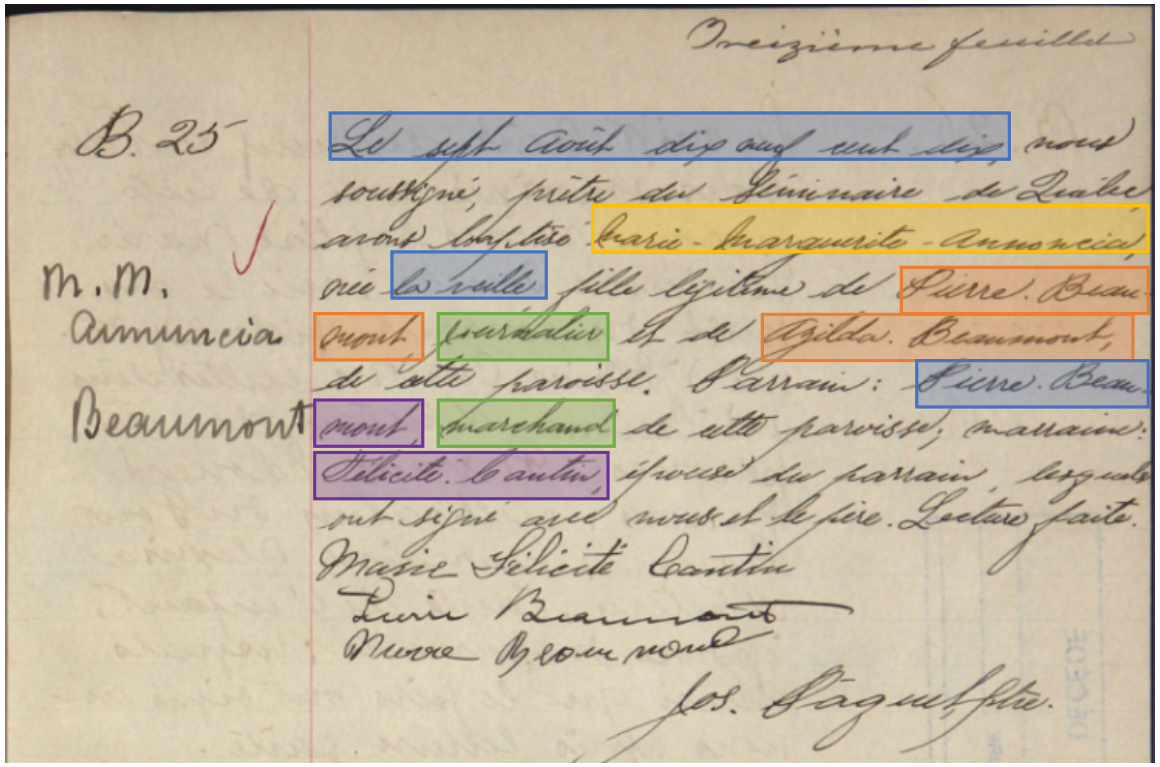


District of Chicoutimi, Saint-Alexis-de-Bagot, 1882

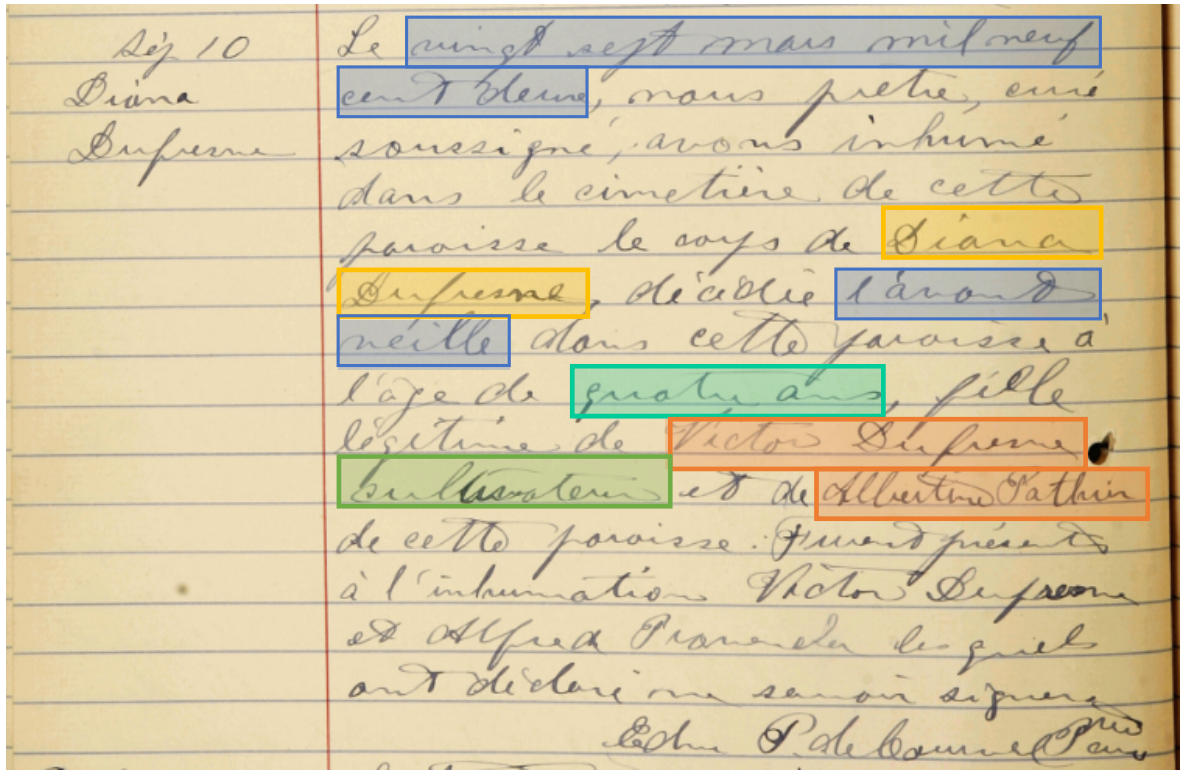


Foster's Bishop Carmichael Memorial Church et Bondville's Christ Church of the Good Sheperd, 1914

Québec civil and parish registers



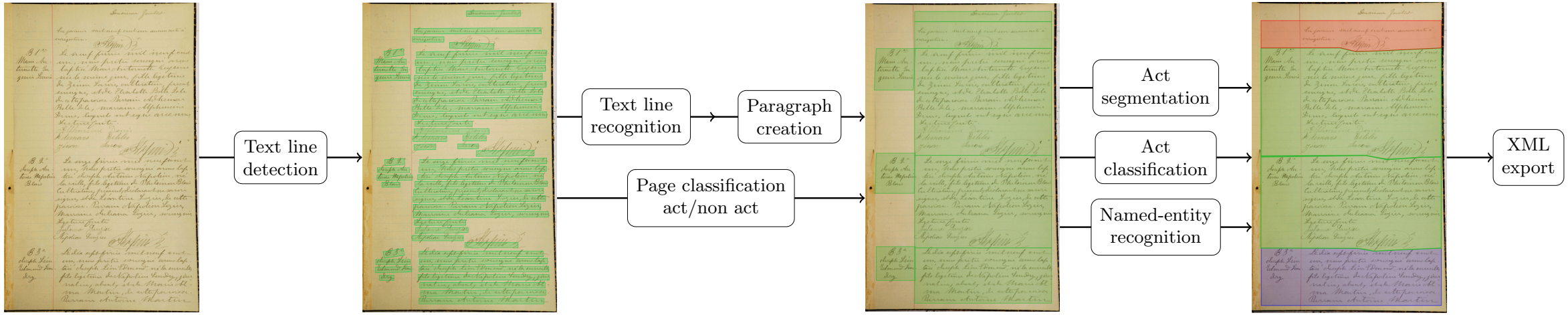
Birth act



Death of a single person act

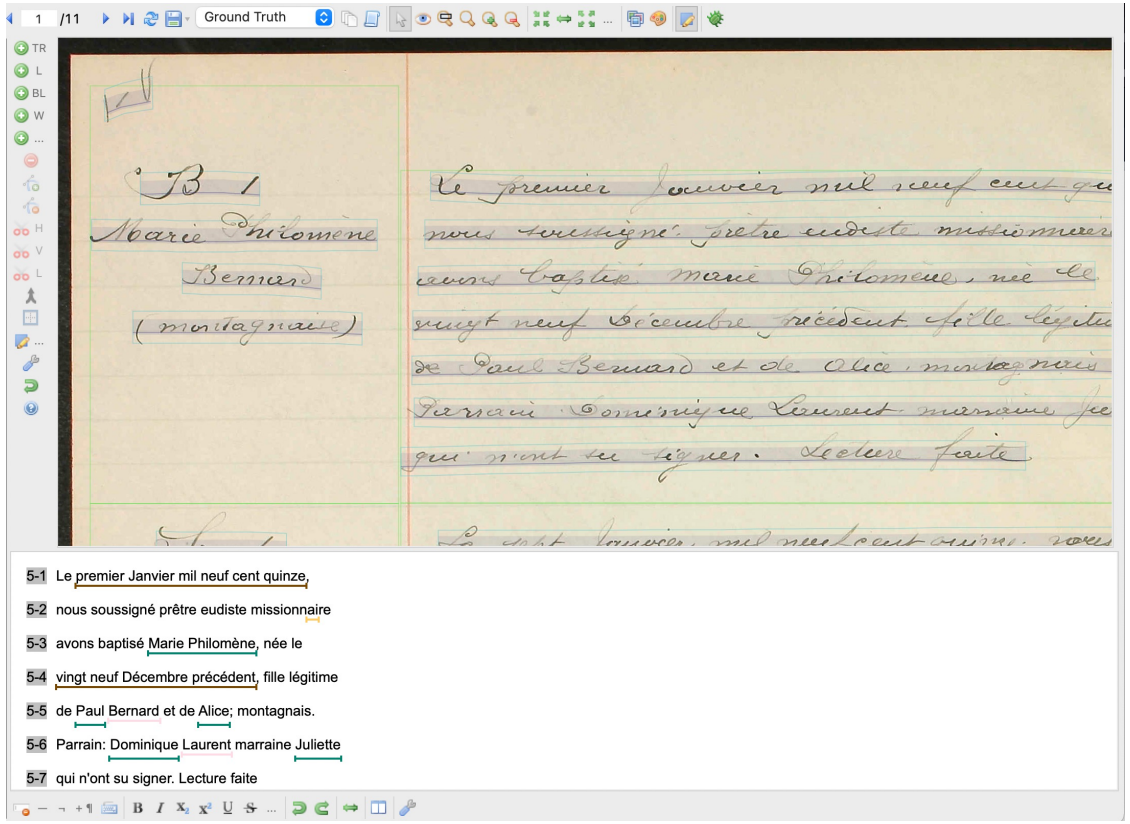
Date; Subject of the act; Parents; Spouse; Age; Occupation; Godfather/godmother

Overview of the document processing workflow



- A classical workflow
- Late decision strategy: all information is consolidated at export stage

Ground truth generation



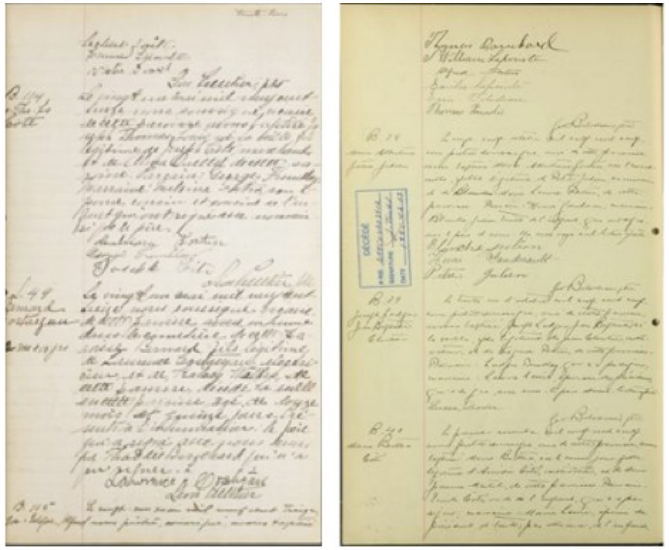
- Automatic line detection + correction
- Manual transcription
- Named-entity annotation + relations
- Annotation : 0,05% of the full corpus

	pages	acts	lines	words	entities
count	896	2,661	45,479	205,165	25,564

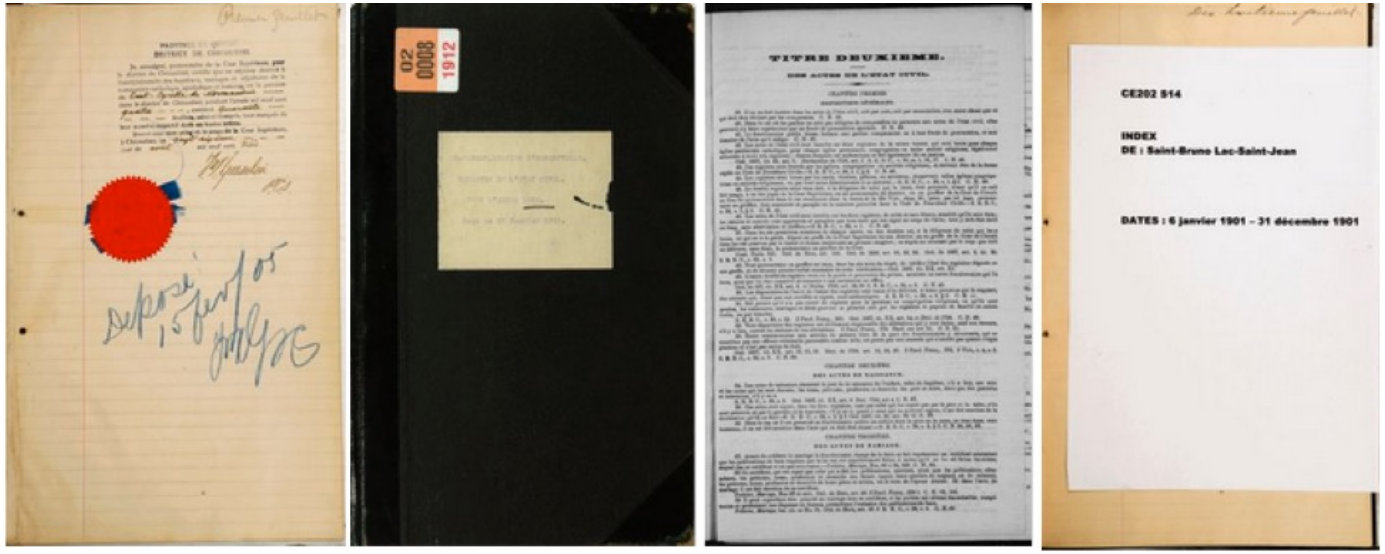
	entities			
	PER	*LOC*	*DATE*	*OCC*
count	15,810	2,823	4,551	2,380

CoNLL (Eng)
1390 pages - 301,418 words - 35,089 entities

Page types: Act vs Non Act



Acts



Non acts

Large corpus contains both relevant and irrelevant pages, but both must be annotated

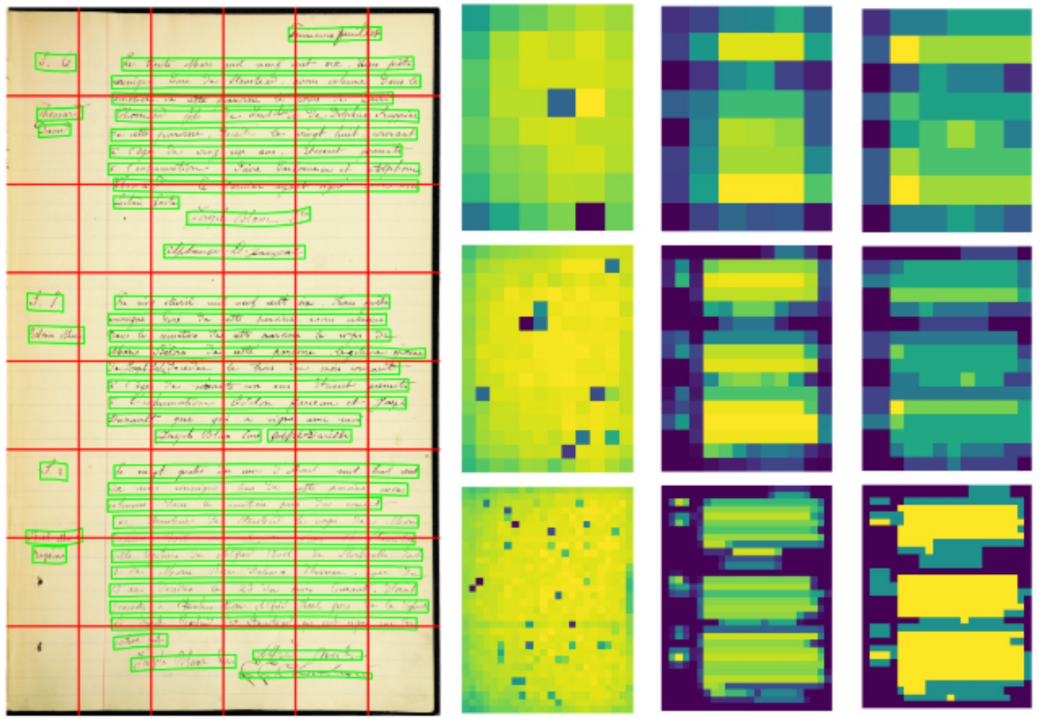
Page types: Act vs Non Act

Pages containing acts are very homogenous

Non act pages are very diverse

Training of an outlier detector with isolation forest

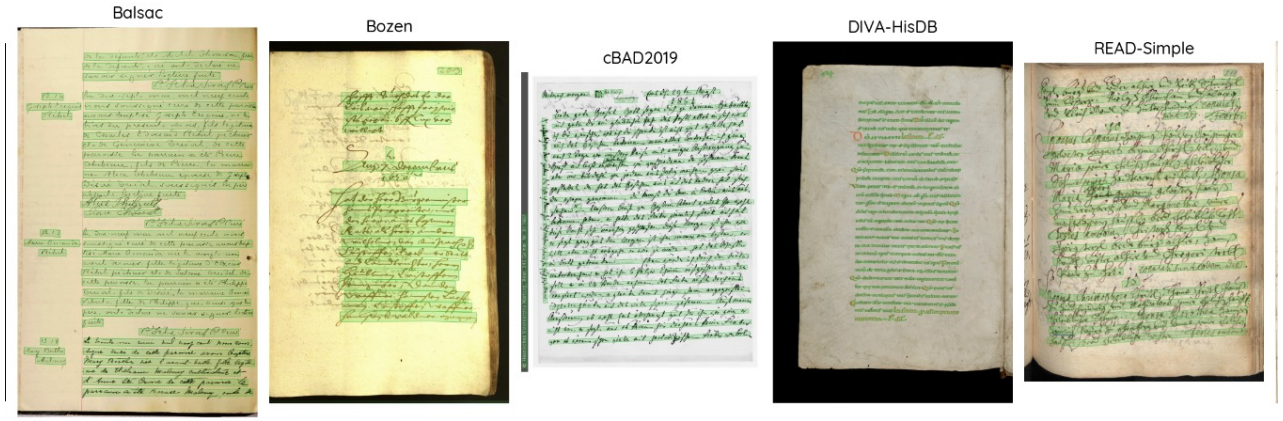
100% recall on acts, 97% f-score



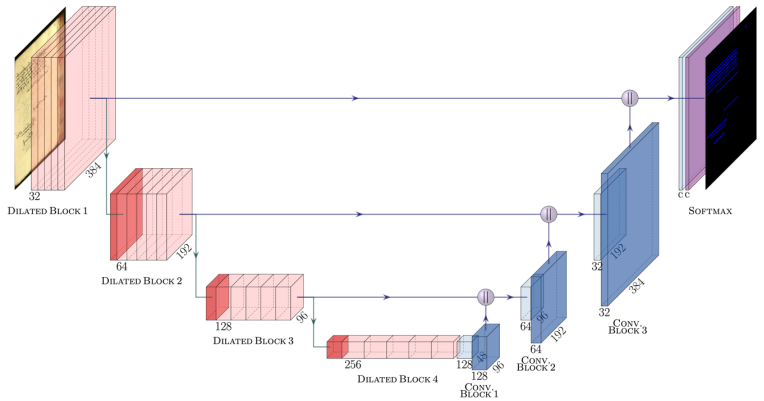
Pixels vs Lines density vs Line counts
for different grid sizes
(8x6), (16x12), (32x24

Text line detection

- Different models tested
- Trained on a large corpus of multiple documents



Multiple Document Datasets Pre-training Improves Text Line Detection With Deep Neural Networks, Boillet, Kermorvant and Paquet, ICPR, 2020



Doc-UFCN model

https://gitlab.teklia.com/dla/doc-ufcn

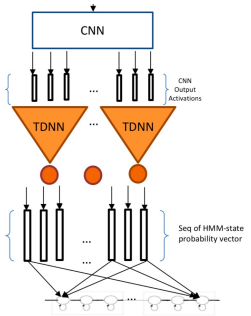
	IoU	AP@.50	AP@.75	mAP
Doc-UFCN	0.87	**0.98**	**0.91**	**0.76**
dhSegment	0.74	0.94	0.54	0.51
ARU-Net	**0.98**	0.76	0.20	0.34

Handwritten Text Recognition

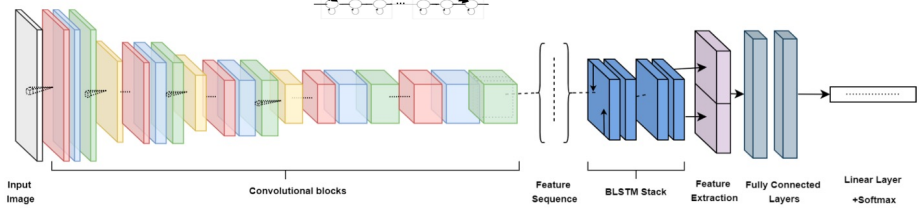
- Kaldi and PyLaia tested
- Trained/tested on Balsac annotated corpus only

	train		val		test	
	CER	WER	CER	WER	CER	WER
Kaldi	4.13	12.36	6.22	**17.10**	6.41	**17.41**
PyLaia (no LM)	2.52	9.67	6.53	19.75	6.92	20.41
PyLaia (with LM)	**2.24**	**8.27**	**5.90**	17.16	**6.29**	17.92

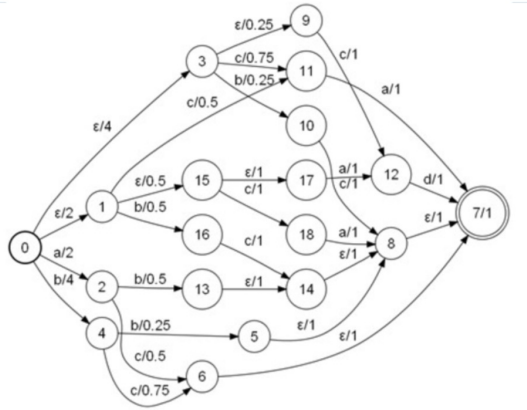
Kaldi
CNN/TDNN + HMM



PyLaia
CNN+biLSTM



+



Language model
Ngrams

Integration of LM in PyLaia: https://github.com/jpuigcerver/PyLaia

Named-Entity Recognition

- Spacy, Stanza and Flair libraries tested
- Trained/tested on Balsac annotated corpus only
- Prediction at paragraph level

	Text	Precision	Recall	F1-score
Stanza	manual	77.9	85.5	81.5
Stanza	auto.	69.7	78.3	73.7
Flair	manual	**93.7**	**93.1**	**93.4**
Flair	auto.	**86.0**	**85.6**	**85.8**
Spacy	manual	83.1	83.6	83.4
Spacy	auto.	74.5	76.7	75.6

Manual transcription versus HTR (auto)

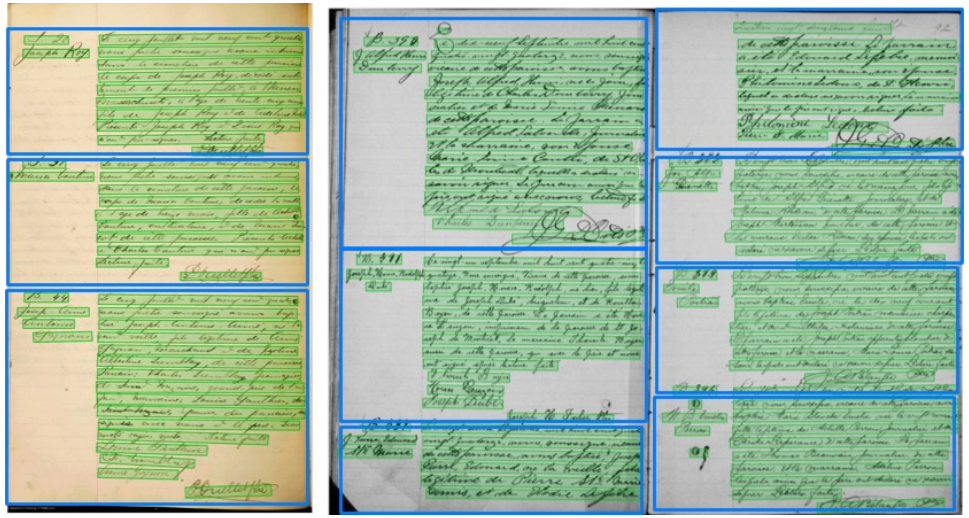
A Comprehensive Study of Open-source Libraries for Named Entity Recognition on Handwritten Historical Documents; Bizon, Miret, Bonhomme and Kermorvant. DAS 2022

Pierre H . Marchand , ptre Le _DATE seize janvier mil neuf cent trois nous prêtre soussigné avons baptisé _PRENOM Joseph Louis Amand né _DATE la veille , fils légitime de _PERSONNE Joseph Toupin _PROFESSION cultivateur et de _PERSONNE Huard Toupin de _LIEU_RESIDENCE cette paroisse . Parrain _PERSONNE Louis Toupin _PROFESSION journalier , marraine _PERSONNE Jeanne Toupin épouse du parrain tous deux de _LIEU_RESIDENCE cette paroisse les sec ainsi que le père ont signé avec nous . Lecture faite . Jeanne Toupin Louis Toupin Joseph Coupin H . Shille Lessard Ptre Le _DATE dix neuf janvier , mil neuf cent trois , nous prêtre soussigné avons baptisé _PRENOM Jean Charles Audre , né _DATE ce jour , fils légitime de _PERSONNE Aimé Turcotte _PROFESSION cultivateur et de _PERSONNE Adrienne machand de _LIEU_RESIDENCE cette paroisse , du parrain , _PRENOM Sémin _PROFESSION marchand , fils de Ferdinand Blanche _PROFESSION Cultivateur , de _LIEU_RESIDENCE Balisceau , marraine _PERSONNE Blanche Mongrain fille de Jec Louis Mongrain Auavigateur de _LIEU_RESIDENCE cette paroisse , lesquels ainsi que le père ont signé avec nous . Lecture faite - Blanche Mongrain Dem Marchand Aimé Turcotte cinq a Emile Messard ptre

https://demo.arkindex.org/element/7fe3d786-068f-48c9-ae63-86db2f986c4c

Act Segmentation

- Text lines and entities must be grouped by act
- On a page, one can find one/several full acts, a beginning or and end of act
- Act detection model combining text line layout and keywords (date, and “lecture faite”)



Including Keyword Position in Image-based Models for Act Segmentation of Historical Registers; Boillet, Maarand, Paquet & Kermorvant; HIP2021

Structuring the result in meaningful units is crucial and can be tricky

Deliver the results

Consolidation of the text and entities at act level for 44 742 registers

Export to gitlab to benefit from version management

Issue on export time: 800 hours !

Raw sql optimization for queries + SSD: 8 hours

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<Register id="9d6e041c-d510-4db8-b646-6106e4c3a5b0" name="test_balsac_export_v2">
  <Acts>
    <Act id="003f73e1-33e7-47c3-8e38-e87d75c63b5a" elem_type="act" name="4"
      act_type="act_start" act_type_score="0.78" act_class="N/A" act_class_score="0"
      page_id="54adb4cc-590e-488c-94b1-c9466d43c5bd"
      balsac_ref="02C_CE202S18_1913_018.jp2"
      polygon="[[34, 5424], [3273, 5461], [3278, 5004], [39, 4966], [34, 5424]]">
      <Paragraphs>
        <Paragraph id="13fb5714-7150-417e-ad83-06850858db85" score="0.465"
          rect="(974, 5069, 2276, 230)">
          <Lines>
            <Line id="6467f9ed-37cc-46ea-992a-9c8254d24d44" score="0.5816"
            rect="(978, 5069, 2276, 89)">Le dix neuf aout mil neuf cent</Line>
            <Line id="26327126-d1c5-430d-ab9e-7f3da533e302" score="0.5942"
            rect="(974, 5211, 2280, 88)">treize ,  nous curé soussigné avons</Line>
          </Lines>
          <text_with_entities>Le <date id="23b814af-f856-42eb-a0b5-61f98591712f"
          name="dix neuf aout mil neuf cent
    treize">dix neuf aout mil neuf cent
    treize</date> ,  nous curé soussigné avons</text_with_entities>
        </Paragraph>
      </Paragraphs>
    </Act>
  </Acts>
</Register>
```

Results: quantitative information

Type	Count
Parishes	1 985
Registers	44 742
Pages	2 635 038
Acts	5 591 535
Paragraphs	15 668 671
Text lines	111 270 929

Entities	Count
Occupations	4 624 291
Locations	5 429 807
Dates	8 655 893
Persons	30 986 429

Results: automatic data validation with act template

	Field	Birth	Death (married person)	Death (single person)
Record	Date of the record	✓	✓	✓
	Place of the record	(✓)	(✓)	(✓)
Subject	Name of the subject	✓	✓	✓
	Date of the event	(✓)	(✓)	(✓)
	Age of the subject	(✓)	(✓)	(✓)
Father	Name of the father	✓		✓
	Occupation of the father	(✓)		(✓)
	Residency of the father	(✓)		(✓)
Mother	Name of the mother	✓		✓
	Occupation of the mother	(✓)		(✓)
	Residence of the mother	(✓)		(✓)
Spouse	Name of the spouse		✓	
	Occupation of the spouse		(✓)	
	Residency of the spouse		(✓)	
Godfather	Name of the godfather	(✓)		
	Occupation of the godfather	(✓)		
	Residence of the godfather	(✓)		
Godmother	Name of the godmother	(✓)		
	Occupation of the godmother	(✓)		
	Residence of the godmother	(✓)		
Witnesses	Names of the witnesses		(✓)	(✓)

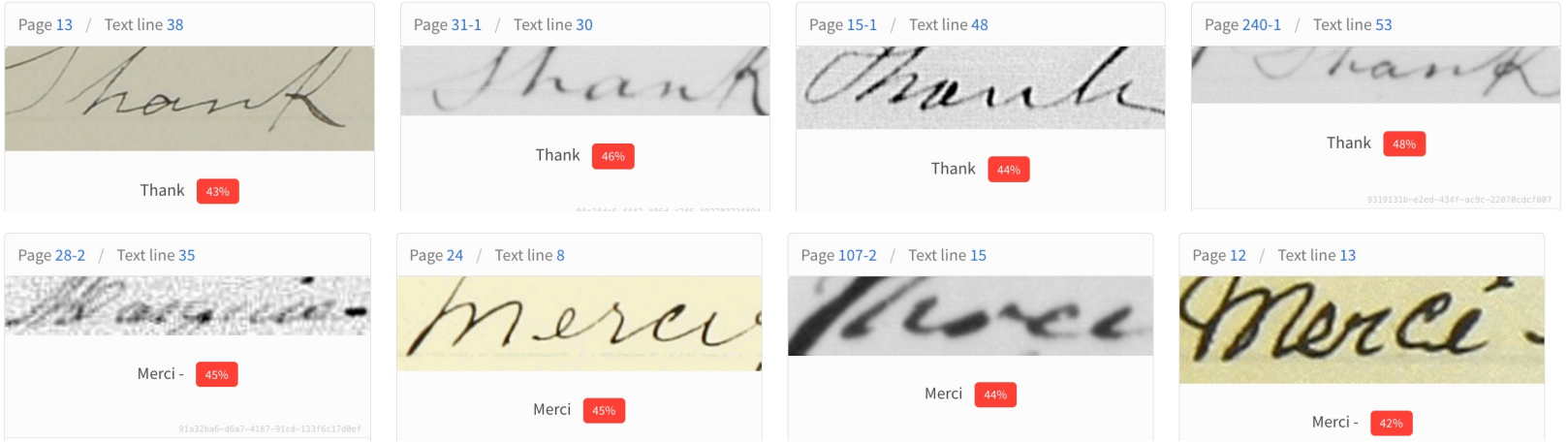
type	Birth act	Death act
Valid	75.5%	69.0%
Fusion	19.9%	18.2%
Invalid	7.1%	8.9%
Special	0.4%	3.2%

Data presence validation: ✓ mandatory, (✓) optional

Conclusions

- Annotation of a representative sample of the full corpus is crucial (it means annotating irrelevant pages)
- Structuring the result in meaningful units is crucial and can be tricky
- Unsupervised metrics of the full process are needed to improve the quality
- Automatic processing but under human monitoring
- The workflow would be simpler now using end-to-end transformer models : See "*Key-value information extraction from full handwritten pages*" at 5:30pm

Thank you !



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