Bibliothèque nationale
du Luxembourg

Fine grained language identification in multilingual corpus with OCR errors

CENL Network Group “AI in Libraries” Webinars 2023

30.5.2023 14:00 CET

Yves Maurer
Deputy Head of IT
National Library of Luxembourg

National Library of Luxembourg

Founded in 1789
New building: 2019

Heritage, public and university library

40. 000 users
More than 1.8M printed items
75.000 ejournals, 900.000 ebooks
Head of network of 89 libraries

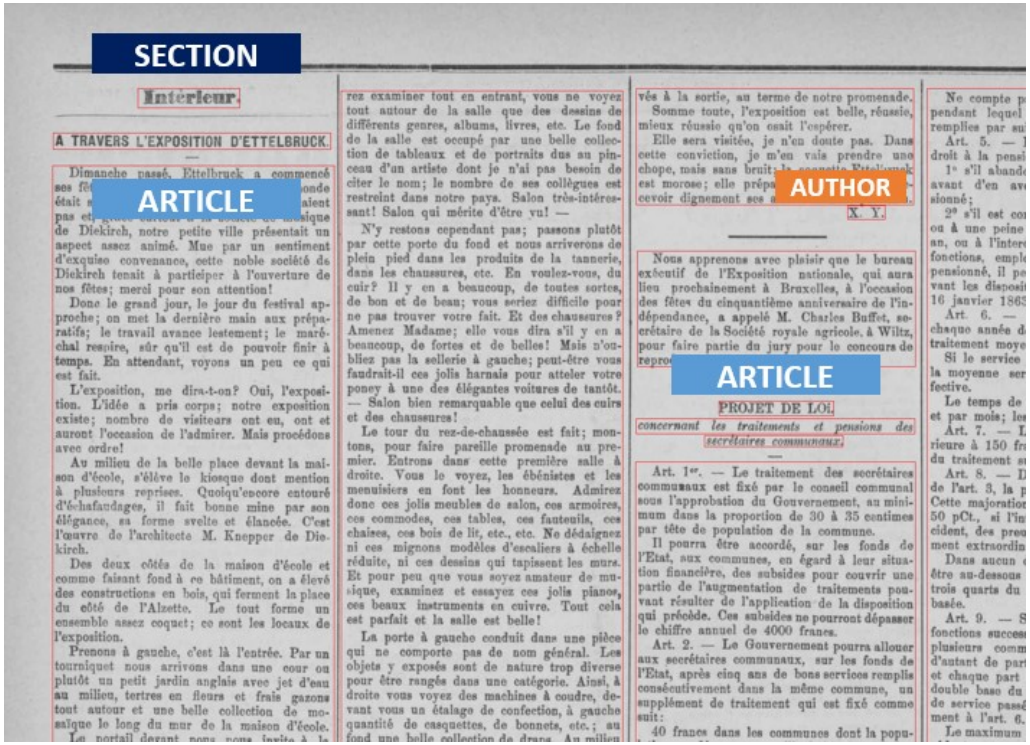
1.2 Million digitised pages

eluxemburgensia.lu

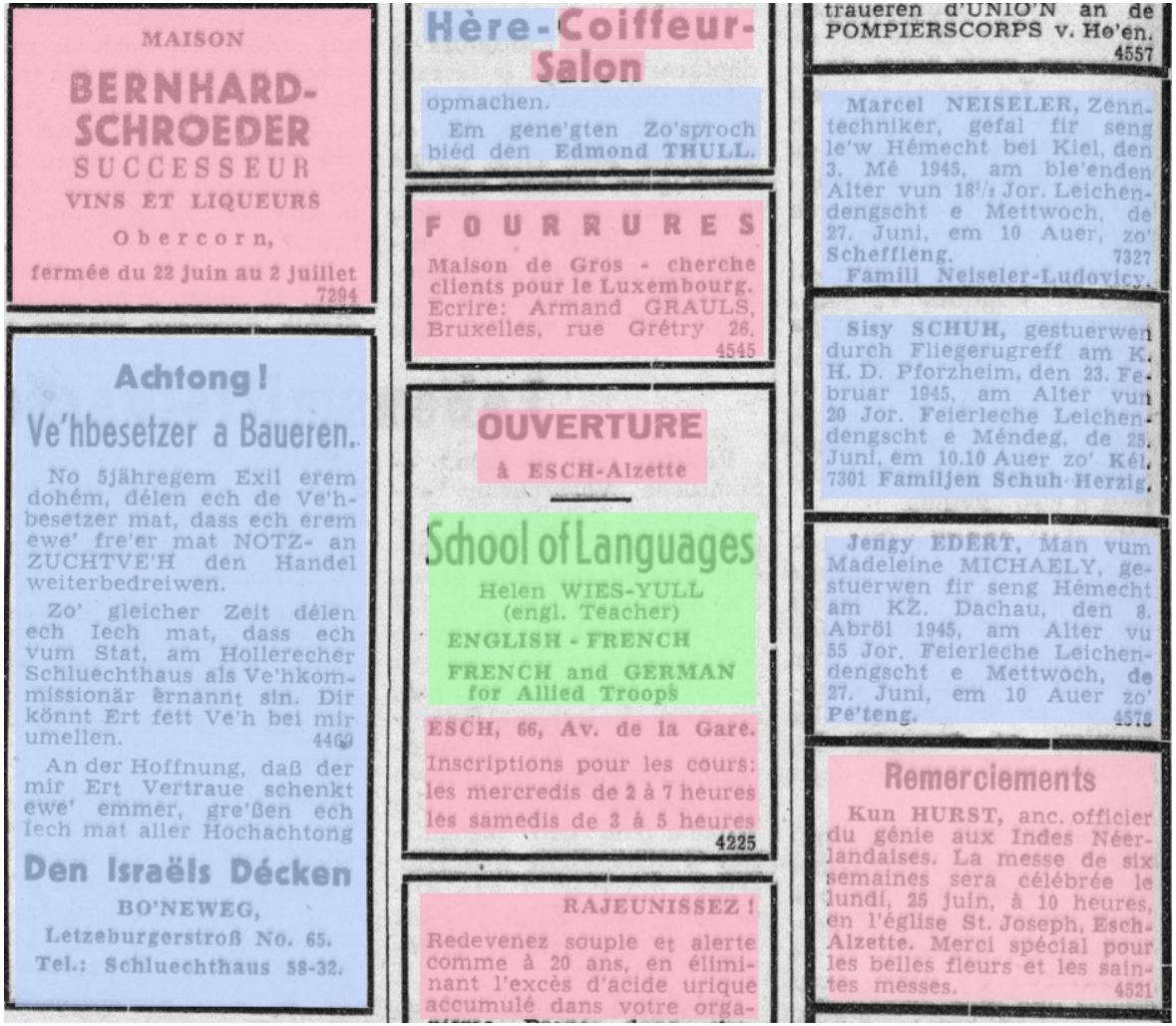
2003-2006	• Image only • Newspapers, postcards, books, manuscripts
2006+	• Luxembourg newspapers • Image & rich metadata (METS/ALTO)
2015	• 15 medieval manuscripts with metadata • 441 books with METS/ALTO
2016+	• Newspapers, books, postcards etc.

Layout segmentation

- Issue > Section > Article > Paragraphs
- Search works on articles



Multilingual newspapers



MAISON

BERNHARD-SCHROEDER

SUCCESSEUR

VINS ET LIQUEURS

Obercorn,

fermée du 22 juin au 2 juillet

7294

Achtong!

Ve'hbesetzer a Baueren.

No 5jähregem Exil erem dohém, délen ech de Ve'hbesetzer mat, dass ech erem ewe' fre'er mat NOTZ- an ZUCHTVE'H den Handel weiterbedreiwen.

Zo' gleicher Zeit délen ech Iech mat, dass ech vum Stat, am Hollerecher Schluechthaus als Ve'hkommissionär ernannt sin. Dir könnt Ert fett Ve'h bei mir umellen. 4469

An der Hoffnung, daß der mir Ert Vertraue schenkt ewe' emmer, gre'ßen ech Iech mat aller Hochachtong

Den Israëls Décken

BO'NEWEG,

Letzeburgerstroß No. 65.

Tel.: Schluechthaus 58-32.

Hère-Coiffeur-Salon

opmachen.

Em gene'gten Zo'sproch biéd den Edmond THULL.

FOURRURES

Maison de Gros - cherche clients pour le Luxembourg. Ecrire: Armand GRAULS, Bruxelles, rue Grétry 26. 4545

OUVERTURE

à ESCH-Alzette

School of Languages

Helen WIES-YULL

(engl. Teacher)

ENGLISH - FRENCH

FRENCH and GERMAN for Allied Troops

ESCH, 66, Av. de la Gare.

Inscriptions pour les cours:

les mercredis de 2 à 7 heures

les samedis de 3 à 5 heures

4225

RAJEUNISSEZ !

Redevenez souple et alerte comme à 20 ans, en éliminant l'excès d'acide urique accumulé dans votre orga-

trauéren d'UNIO'N an de POMPIERSCORPS v. He'en. 4557

Marcel NEISELER, Zenntechniker, gefal fir seng le'w Hémecht bei Kiel, den 3. Mé 1945, am ble'enden Alter vun 18½ Jor. Leichendengscht e Mettwoch, de 27. Juni, em 10 Auer, zo' Scheffleng. 7327

Famill Neiseler-Ludovicy.

Sisy SCHUH, gestuerwen durch Fliegerugreff am K. H. D. Pforzheim, den 23. Februar 1945, am Alter vun 20 Jor. Feierleche Leichendengscht e Méndeg, de 25. Juni, em 10.10 Auer zo' Kél. 7301 Familjen Schuh-Herzig.

Jengy EDERT, Man vum Madeleine MICHAELY, gestuerwen fir seng Hémecht am KZ. Dachau, den 8. Abröl 1945, am Alter vu 55 Jor. Feierleche Leichendengscht e Mettwoch, de 27. Juni, em 10 Auer zo' Pe'teng. 4578

Remerciements

Kun HURST, anc. officier du génie aux Indes Néerlandaises. La messe de six semaines sera célébrée le lundi, 25 juin, à 10 heures, en l'église St. Joseph, Esch-Alzette. Merci spécial pour les belles fleurs et les saintes messes. 4521

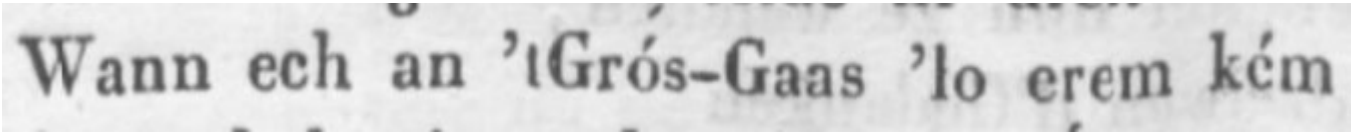
Why identify the language?

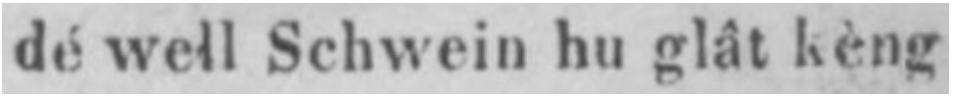
- Interesting by itself for multilingual country
- Full text search
- Better OCR by also using language specific dictionaries
- AI Projects since 2020
  - Topic modelling
  - Transformers
  - …

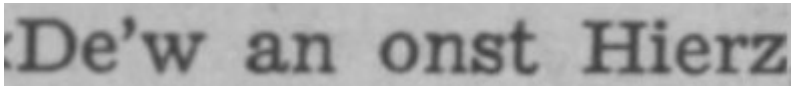
Starting out

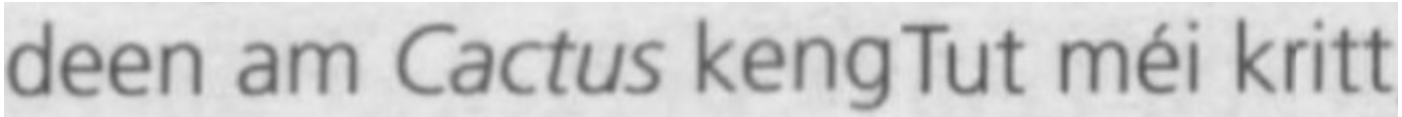
- We knew that languages are:
  - German (roughly 60%)
  - French (~ 40%)
  - Luxembourgish (~ 1%)
  - English (~ 0.1%)
  - Unknown long tail of other languages
- Need for method which supports Luxembourgish

Luxembourgish

- Luxembourgish case is hard since corpus is 1841 – 2010 and spelling was only standardized in 1975.
- 1846 

- 1869 

- 1947 

- 2007 

Challenges

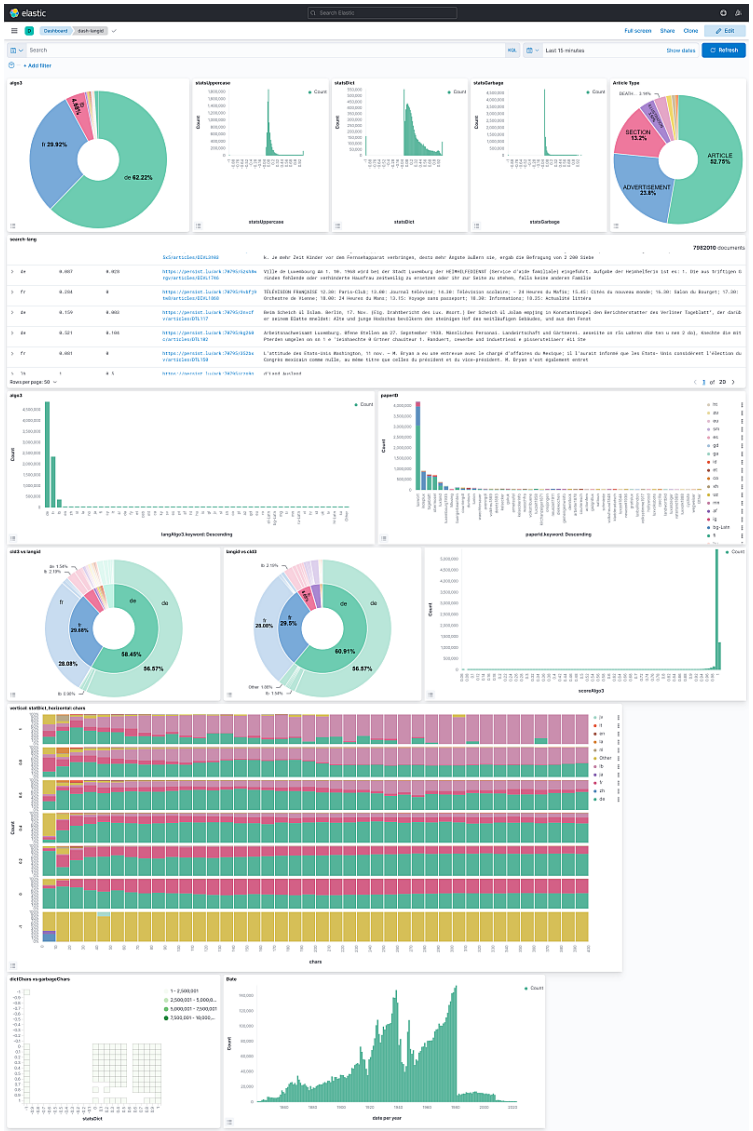
- OCR errors
- Multilingual content inside a single article
- Articles without language (e.g. train time tables, sports results, …)
- Very uneven distribution of languages
- How to identify long tail of minority languages
- How to limit false positives
- Luxembourgish is often not supported, e.g. langdetect, lingua-py
- Limited time-frame : 3 months (project team of 2)

Features

- 3 base algorithms
  - CLD3 (google)
  - Langid (University of Melbourne)
  - Fasttext (lid218e from https://github.com/facebookresearch/fairseq/tree/nllb#lid-model)
- Stop words for Luxembourgish
- Dictionaries for each language
- Garbage Tokens
- Uppercase letters
- Length of text
- Newspaper identifier

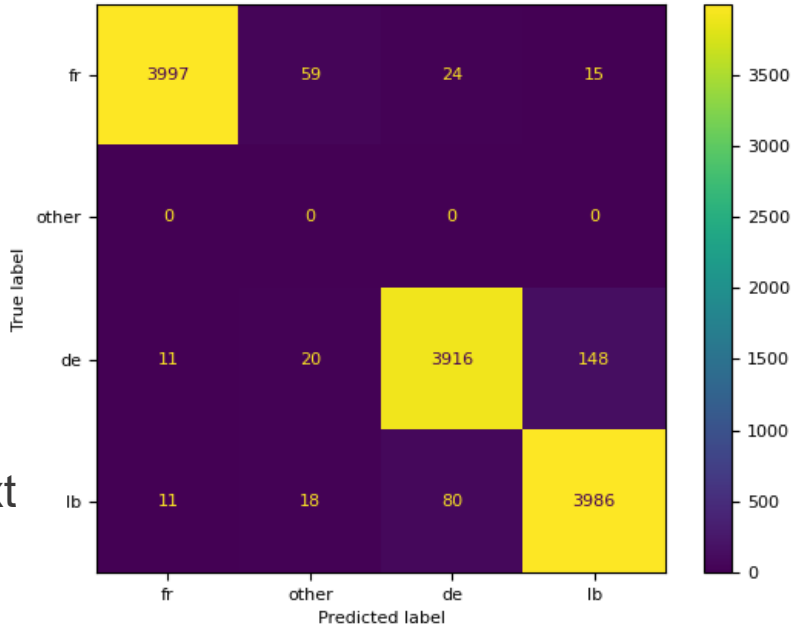
Feature evaluation process

- Extract full-texts
- Compute all features
- Load into elasticsearch
- Evaluate using Kibana
- Extract lists to csv



Compare cld3, fasttext & langid

- First try with ground truth set (4095 * 3)
  - French, German, Luxembourgish
- Best: 97.4% Accuracy
  - langid+LB stopwords
- Disadvantages
  - Real data is skewed
  - Error rate dwarfs true positives
  - No GT for all languages



Confusion matrix for fastText

Combine : Majority vote

- If fastText == CLD3 -> fastText, otherwise langid
- Test on 100 000 articles. Investigate 300 cases where langid gets outvoted

	de	fr	lb	da	en	nl	zh	jv	br	eo	eu	fi	la	et	oc	ga	sv	pl	sk	no	it	cy	ht
de	30	17	49	52	49	9	1	2	2	0	1	2	3	1	1	0	5	2	1	1	0	1	0
fr	1	14	15	2	2	0	0	0	0	1	0	0	0	0	2	2	0	0	0	1	1	0	0
lb	8	6	3	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

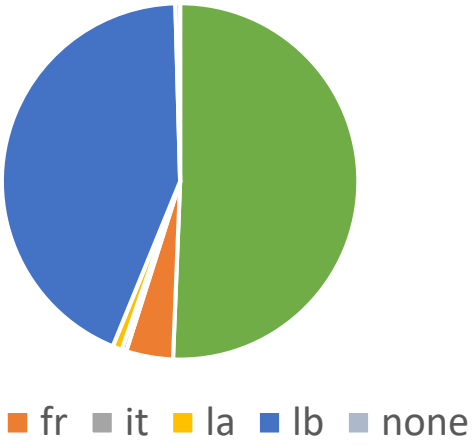
Voting

	de	fr	lb	da	en	nl	af	ca	pt	vi	hu	it	cs
de	181	7	22	3	2	6	6	0	2	0	1	0	1
fr	9	24	8	1	1	0	0	2	0	2	0	1	0
lb	2	0	16	0	0	2	0	0	0	0	0	0	0

Should we use stopwords?

- Random sample of 100 000 articles
  - real distribution of languages
- Check manually all 235 cases when stopwords overrule langid
  - Aim: avoid false positives (LB is only around 1% of corpus)

	#correct	Accuracy
stopwords for Luxembourgish	102	43.22
Langid	109	46.19
CLD3	173	73.31
fastText	183	77.54



Identify “minority” languages

- Examine cases langid=cld3=fasttext and not de, fr, lb or en
- 3317 cases from 8 million reviewed in Excel

algo-new	cld3	fasttext	langid	id	LINK	correct other	textStart
af	af	af	af	http	https://persist.l		TEKKA, die ideale KrankenverH
it	it	it	it	http	https://persist.l	it	I celebrl prodotti itnliani alia pc
nl	nl	nl	nl	http	https://persist.l	nl	Vcor ons kantoor in Luxemburg
nl	nl	nl	nl	http	https://persist.l		Generalstaatsanwalt Louis Sab
af	af	af	af	http	https://persist.l		Josiane Graas (T.C. Arquebusie
es	es	es	es	http	https://persist.l	es	Embajada de Espana Informac
ro	ro	ro	ro	http	https://persist.l		Ã®louA v-oi cadeaux utilei
it	it	it	it	http	https://persist.l		Sur notre photo le Trio dâ€™Ar
es	es	es	es	http	https://persist.l	es	EMBAJADA DE ESPANA Rectific
ro	ro	ro	ro	http	https://persist.l		Octane de Marcus Adams
es	es	es	es	http	https://persist.l	es	Embajada de Espaha Informac

cld3=fasttext=langid agreement on minority languages

		by agreement	correct	%
Italian	it	427	285	66.74
Portuguese	pt	77	50	64.94
Dutch	nl	263	38	14.45
Polish	pl	98	43	43.88
Spanish	es	47	10	21.28
Danish	da	37	2	5.41
Hungarian	hu	30	5	16.67
Esperanto	eo	9	6	66.67
Bosnian	bs	1	1	100
Croation	hr	4	3	75

Computing other features

- Fix list of allowed languages and use dictionaries to compute len(tokens in dict) / len(tokens)
- Detect bad OCR using heuristics
- Count uppercase letters
  - langid tends to favor to English for Uppercase strings
- Length of text
  - Short texts are ambiguous

Final algorithm

- General case:

If chars < 12: unknown

If garbage > 50%: unknown

If cld3=fasttext: x=cld3 else x=langid

- Per language, specific rules, e.g.:

If chars < 40 or dict < 50%: unknown

- For really small languages, have a fixed list

Minority languages – filtering data

- Use articles found previously to visualize their properties in Kibana
- Determine filter that allows all GT articles through
- E.g. Polish:

Ground Truth:	85
Algorithm:	1635
Filter: Dict > 30% and Uppercase < 70% and chars > 60 and Garbage < 20%	
Filtered:	242

- Validate the 242 articles, found 83 more

Results of filtering

Language	algo	Filter	Ground Truth	Additional	Total real	Percentage from algo	Percentage from Filter
Portuguese	4309	298	111	100	211	4.9	70.81
Polish	1635	242	85	83	168	10.28	69.42
Dutch	20720	769	52	27	79	0.38	10.27
Spanish	4825	226	20	12	32	0.66	14.16
Esperanto	753	25	11	4	15	1.99	60
Hungarian	2676	45	8	6	14	0.52	31.11
Croation	993	9	3	5	8	0.81	88.89
Ido	0	0	2	2	4	0	0
Danish	6530	32	2	0	2	0.03	6.25
Bosnian	781	9	2	0	2	0.26	22.22
Gaelic	879	21	2	0	2	0.23	9.52
Slovenian	1848	46	1	0	1	0.05	2.17

Going into production

- Integrated into METS – MODS

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<dmdSec ID="MODSMD_MAP4">
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        </mods:titleInfo>
      ▼<mods:language>
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        </mods:language>
      </mods:mods>
    </xmlData>
  </mdWrap>
</dmdSec>
```

- Determined language for Manuscripts and Posters (no OCR) from catalogue data
- Set book language to catalogue data

Online since 27.4.2023

eLuxemburgensia Home Search

Sterbefälle

Article • Bürger- und Beamten-Zeitung • Wednesday, 24 December 1902

Publicité 5 Page 3

Advertisement • Bürger- und Beamten-Zeitung • Wednesday, 24 December 1902

Heitere Ecke.

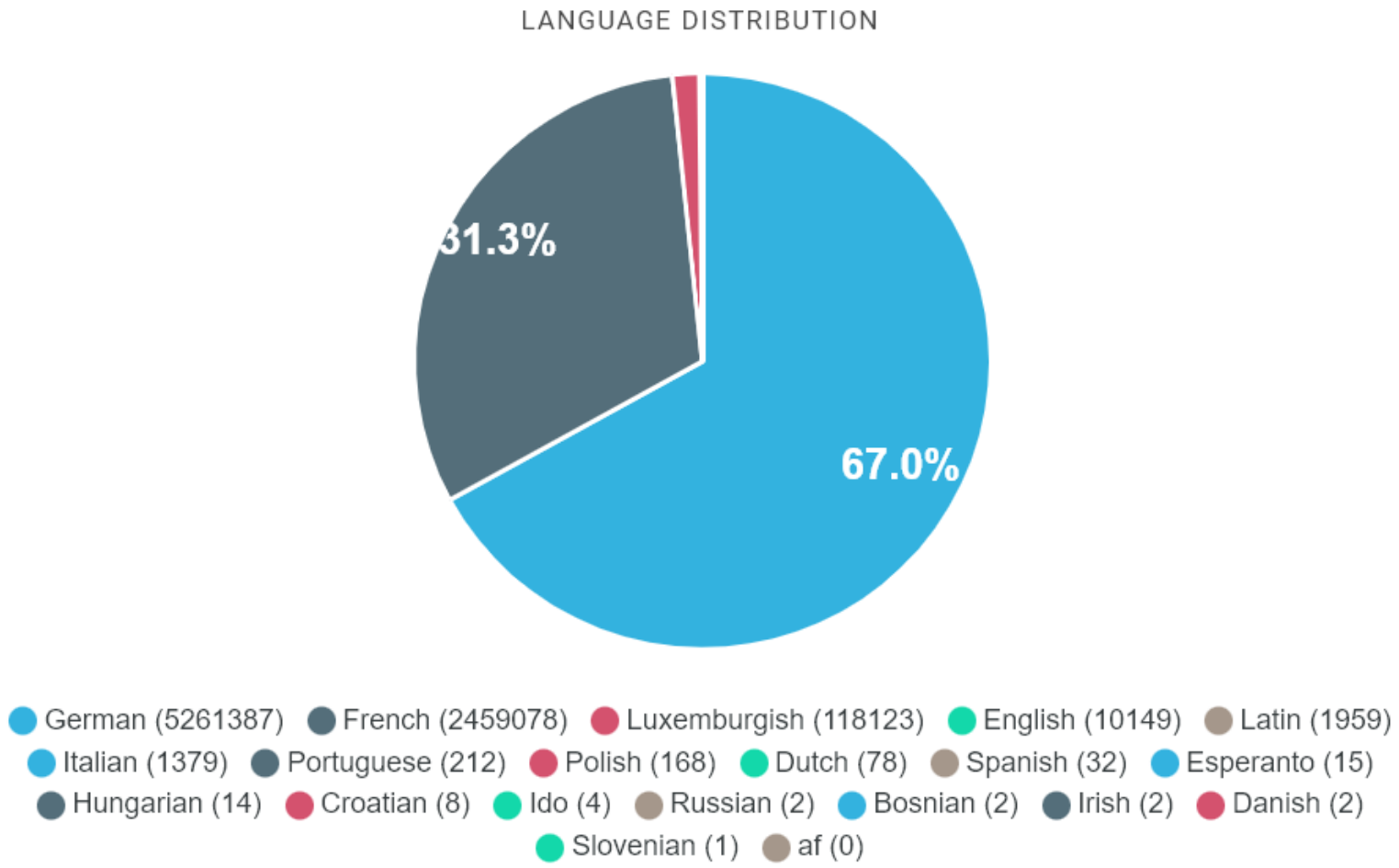
Article • Bürger- und Beamten-Zeitung • Wednesday, 24 December 1902

Languages

Search Facet

- German (5261387)
- French (2459078)
- Luxemburgish (118123)
- English (10149)
- Latin (1959)
- Italian (1379)
- Portuguese (212)
- Polish (168)
- Dutch (78)
- Spanish (32)
- Esperanto (15)
- Hungarian (14)
- Croatian (8)
- Ido (4)
- Danish (2)
- Irish (2)
- Bosnian (2)
- Russian (2)
- Slovenian (1)

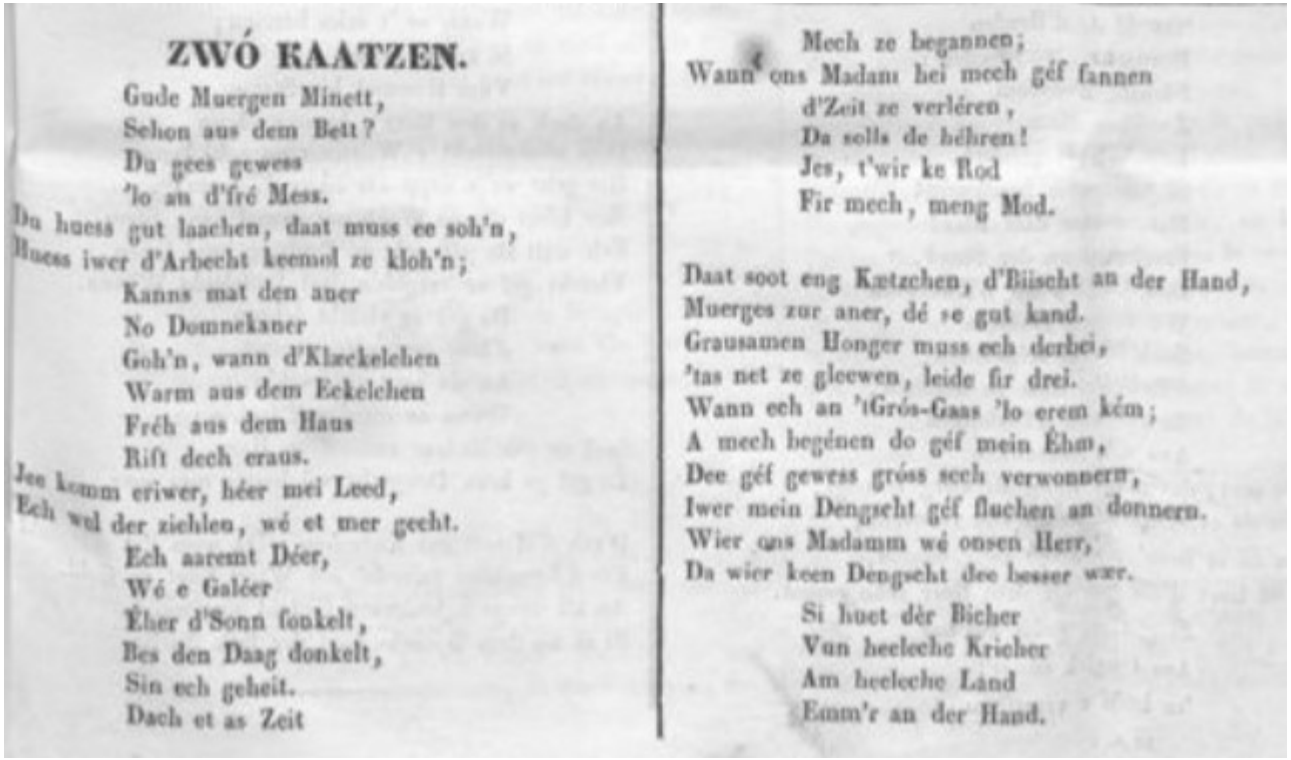
Languages in eluxemburgensia



Interesting finds

First Luxembourgish (1846) in the collection

https://persist.lu/ark:70795/83sbwv/pages/1/articles/DTL35



ZWÓ KAATZEN.

Gude Muergen Minett,
Schon aus dem Bett?
Du gees gewess
'lo an d'fré Mess.
Du huess gut laachen, daat muss ee soh'n,
Huess iwer d'Arbecht keemol ze kloh'n;
Kanns mat den aner
No Domnekaner
Goh'n, wann d'Kæckelchen
Warm aus dem Eckelchen
Fréh aus dem Haus
Rift dech eraus.
Jee komm eriwer, héer mei Leed,
Ech wel der zichlen, wé et mer geeht.
Ech aaremt Déer,
Wé e Galéer
Éher d'Sonn fonkelt,
Bes den Daag donkelt,
Sin ech geheit.
Dach et as Zeit
Mech ze begannen;
Wann ons Madam hei mech géf fannen
d'Zeit ze verléren,
Da solls de héhren!
Jes, t'wir ke Rod
Fir mech, meng Mod.

Daat soot eng Kætzchen, d'Biischt an der Hand,
Muerges zur aner, dé se gut kand.
Grausamen Honger muss ech derbei,
'tas net ze gleewen, leide fir drei.
Wann ech an 'tGrós-Gaas 'lo erem kém;
A mech begénen do géf mein Éhm,
Dee géf gewess gróss seeh verwonnern,
Iwer mein Dengsght géf fluchen an donnern.
Wier ons Madamm wé onsen Herr,
Da wier keen Dengsght dee besser wær.
Si huet dèr Bicher
Vun heeleche Kricher
Am heeleche Land
Emm'r an der Hand.

Finds : Immigration from Italy

1882: https://persist.lu/ark:70795/89dsqk/pages/3/articles/DTL55

Briefkasten.

☞ Sign. Ha., Luss. Dica alla Sua sorella Ang. che oggi arriva alla bella età di anni 34. Adesso o mai!

1904: https://persist.lu/ark:70795/g320c1/pages/4/articles/DTL49

La pagina dei fratelli italiano.

Guerra —

I campi seminati di morti, i lugubri ossarii eretti alla memoria delle innocenti vittime non valgono a distogliere i due potenti imperi Russo e Giapponese dal pigliare le armi. La diplomazia europea che assiste fredda e unita allo scannarsi di due popoli non puo comprendere quanti dolori, quanti lutti, quante lagrime farà versare la pazzesca ambizione di due potenti. 2 miliardi 500 milioni non meno costerà . . . . . .

Quanta forza, quanta energia, quante vite umane! Ed il popolo che piange i suoi cari, il popolo che piange i suoi figli, mira e tace a tale scempio. Quando il torpore che lo avvince scomparirà? Quando in uno slancio sublime di fraterna solidarietà spezzerà le catene che lo tiene avvinto? Rispondiamo noi.

Quando le camorre, le maffie, i tristi connubii, le schifose alleanze saranno scomparse; quando l'istruzione, la scienza avrà fatto scomparire tutte le idiote superstizioni di amor patrio di bandiere di nazionalismo, allora la guerra sarà diventata impossibile. Povero Tolstoi! povero Zolas! quanto avete fatto per combattere quest' Idra! G. I.

Togliamo dal „Grido di Milano".

Una sepolta Viva.

A San Pietro presso Cava dei Tirreni fu scoperta una povera donna sepolta viva da quindici anni in un sotterraneo. Essa fu sequestrata da due suoi fratelli — preti — per carpirle l'eredità paterna. Il fatto ci fa inorridire. Oltre le angoscie d'una donna sotterrata viva per quindici lunghi anni, vi è l'infamia dei due predicatori di Cristo, o l'avidità dell'oro.

Non bastava il Medioevo tenebroso, la strage degli Albigesi, i misteri dell' Inquisizione ecc.; non bastavano i misteri dei conventi, le funzioni sacerdotali, le inversioni ripugnanti, i delitti feroci e raffinati, tutta l'aureola gloriosa del prete: oggi — proprio oggi — secolo di civiltà e progresso, due jene, che salmodiano laudi al Signore — bontà e carità — compiono le azioni più orrende che non sono spiegabili dalla passionalità dell'uomo o dall'ascetismo cieco, ma solamente da un istinto di lucro che li rende freddi per quindici anni, e non lascia loro un sussalto, ne un ravvedimento

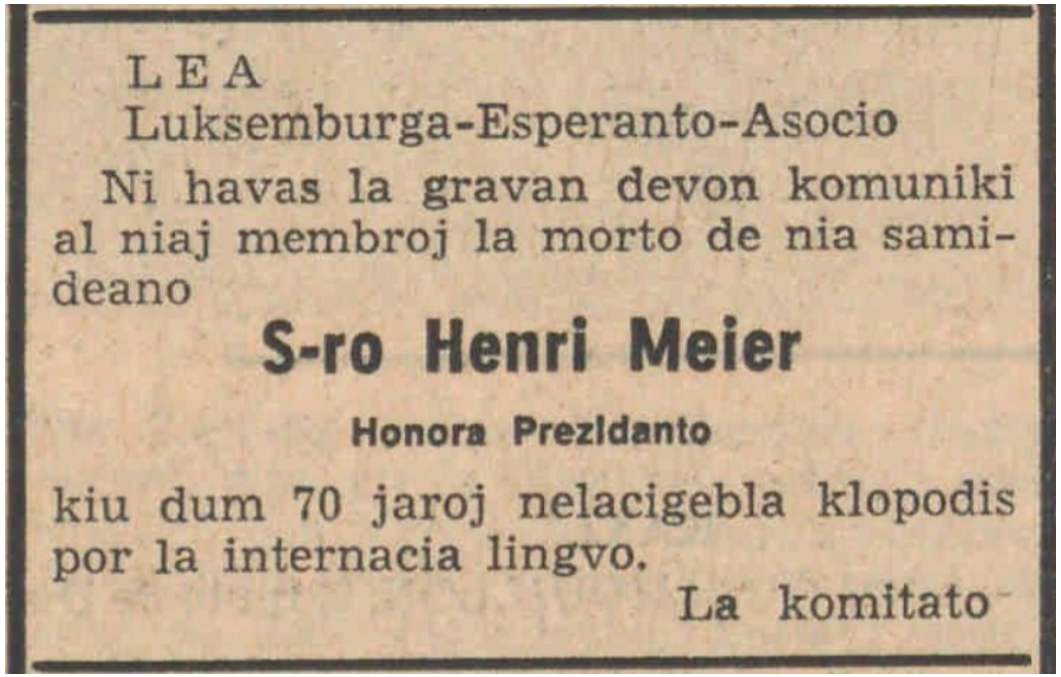
La pietà, la carità, la rassegnazione che questi

R. È un giornaletto.
P. Un giornaletto!
R. Si, il, „Seme".
P. Oh bella, non l'ho mai inteso nominare; e di che tratta?
R. Ecco mi spiego in due parole: Questo giornaletto sorti a Terni per iniziativa del compagno Paoloni, poi morì per . . . . . ora si è preso l'incarico il compagno editore Mongini come fece per altri giornali, percio speriamo che non muoia più.
P. A quale scopo serve questo giornale?
R. Caspita porta il nome con se; serve per seminare nella mente digiuna ed offuscata del proletariato le idee del Socialismo, per la emancipazione, ossia per la trasformazione della decrepita e barcollante società attuale e . . . . . .
P. Scurami quanto costa?
R. Un centesimo in Italia, e due all' Estero.
P. Costa una mia chioneria, vendimene uno.
R. O questo solo; è un numero di saggio che ha mandato l'editore . . . .
P. Per . . . . .

Finds: Esperanto

Death notice in Esperanto

1973 https://persist.lu/ark:70795/hwpvbp3hq/pages/12/articles/DIVL2016



L E A
Luksemburga-Esperanto-Asocio

Ni havas la gravan devon komuniki al niaj membroj la morto de nia samideano

S-ro Henri Meier

Honora Prezidanto

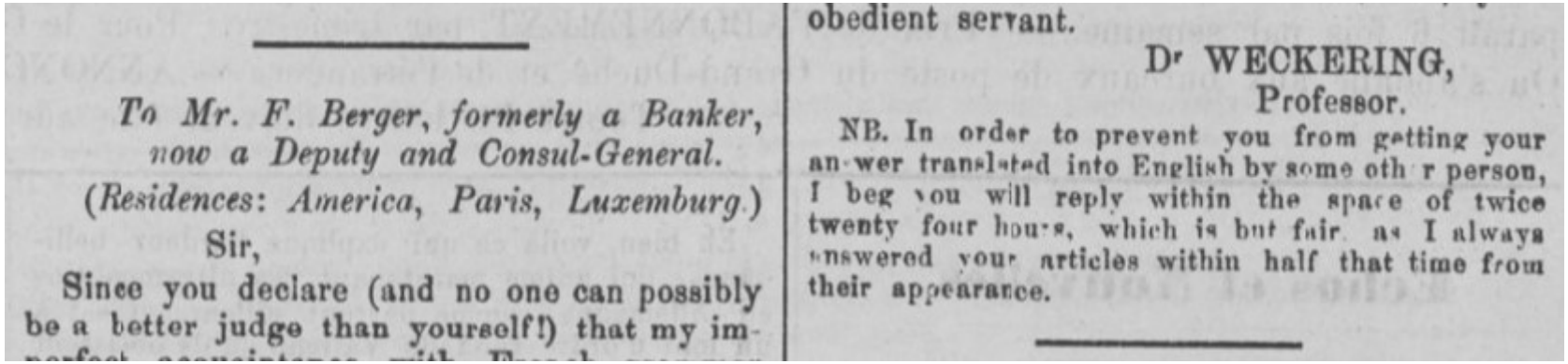
kiu dum 70 jaroj nelacigebla klopodis por la internacia lingvo.

La komitato

Finds: English textbook controversy

First article in English

1880: https://persist.lu/ark:70795/qhbcqf/pages/2/articles/DTL56



To Mr. F. Berger, formerly a Banker, now a Deputy and Consul-General.

(*Residences: America, Paris, Luxemburg.*)

Sir,

Since you declare (and no one can possibly be a better judge than yourself!) that my im-

obedient servant.

Dr WECKERING,
Professor.

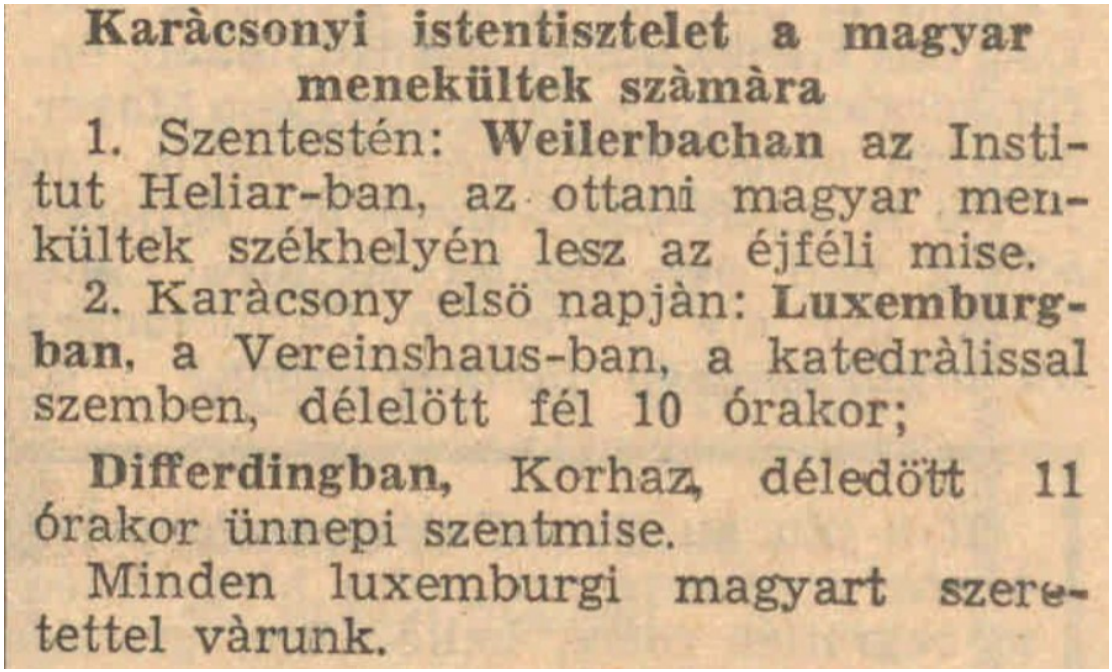
NB. In order to prevent you from getting your answer translated into English by some other person, I beg you will reply within the space of twice twenty four hours, which is but fair as I always answered your articles within half that time from their appearance.

Finds: Hungarian

23.10 - 4.11.1956: Hungarian Uprising

22.12.1956: Christmas services for refugees

https://persist.lu/ark:70795/3rz30pqx1/pages/5/articles/DIVL404



Karàcsonyi istentisztelet a magyar menekültek szàmàra

1. Szentestén: **Weilerbachan** az Institut Heliar-ban, az ottani magyar menkültek székhelyén lesz az éjféli mise.

2. Karàcsony elsö napjàn: **Luxemburgban**, a Vereinshaus-ban, a katedràlissal szemben, délelött fél 10 órakor;

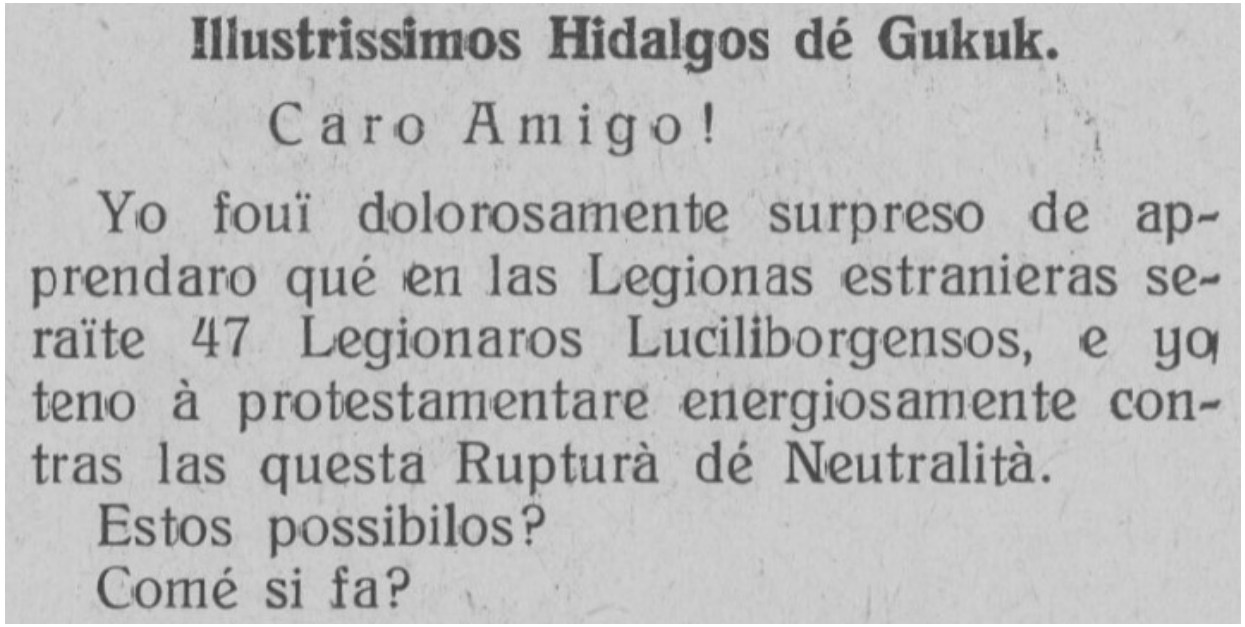
Differdingban, Korhaz, déledött 11 órakor ünnepi szentmise.

Minden luxemburgi magyart szeretettel vàrunk.

Finds: invented Language

Satiric article, “fake” Spanish

1925 https://persist.lu/ark:70795/2747qp1fh/pages/2/articles/DTL92



Illustrissimos Hidalgos dé Gukuk.

Caro Amigo!

Yo fouï dolorosamente surpreso de apprendaro qué en las Legionas estranieras seraïte 47 Legionaros Luciliborgensos, e yo teno à protestamentare energiosamente contras las questa Ruptura dé Neutralità.

Estos possibilos?

Comé si fa?

Questions?

https://eluxemburgensia.lu

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