

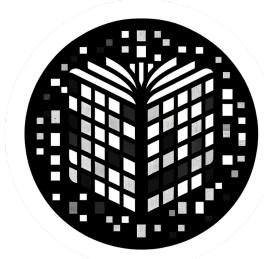
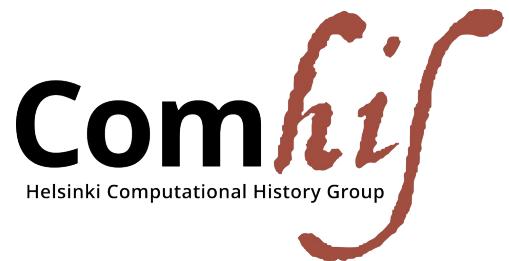
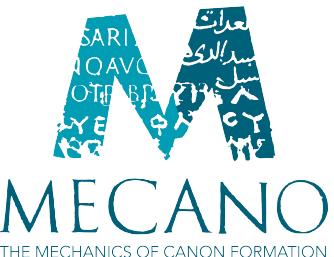
Can AI "Understand" Historical Archives?

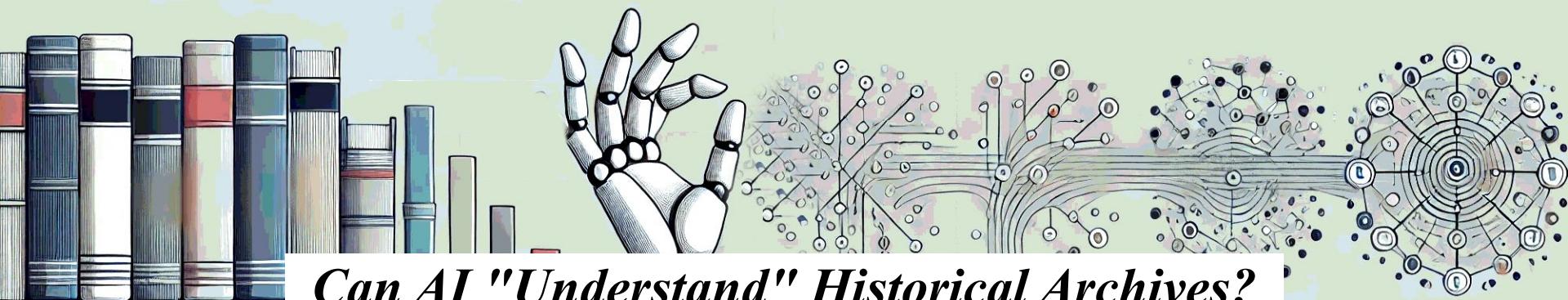
From Digital Humanities and Computational History to A Case Study on Multimodal Latin Detection

Yu Wu 吳隅

Department of Digital Humanities, Faculty of Arts, University of Helsinki

2.11.2025





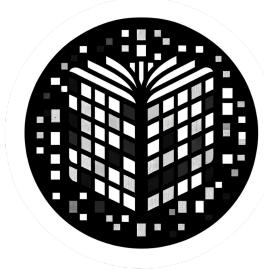
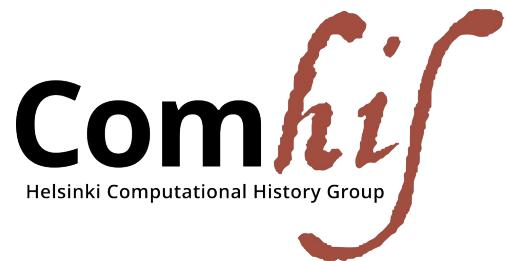
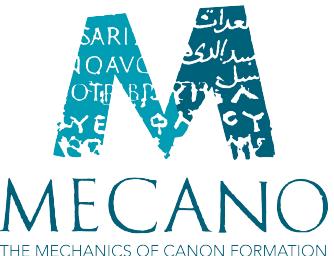
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Keep being a bridge between science and humanities...

- BEng & MSc in Computer Science, 2017-2024, at ShanghaiTech
 - MSc research in Vision-Language Reasoning, advised by Prof. Xuming He
- PhD student in ...
 - Doctoral Researcher in Digital Humanities, at University of Helsinki
 - Doctoral Programme of Computer Science
 - Doctoral Network of Computational Analysis of Semantic Change Across Different Environments (CASCADE), part of Marie Skłodowska-Curie Actions
 - Topic: Adapting computational methods to challenges in historical research at scale
 - Generally, Computational Linguistic-focused
 - Collaborating with 4 other universities in EU, 10 PhD students in total
 - Proposal Title: Semantic Search and Analysis for Large-scale Historical Documents
- What else done before?

自我介绍

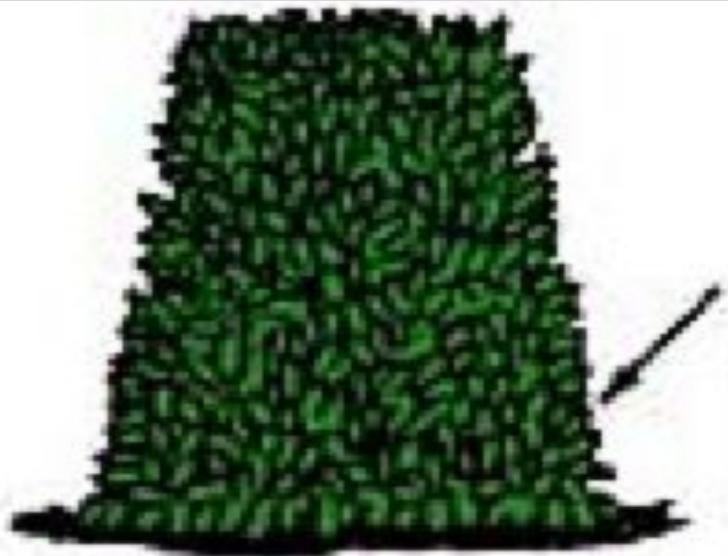
- 一个有理想的音乐爱好者
- 音乐社并建群
- 于5月并建群
- 于7月和启发
- 主要目和启发



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What kind of science is humanities research?

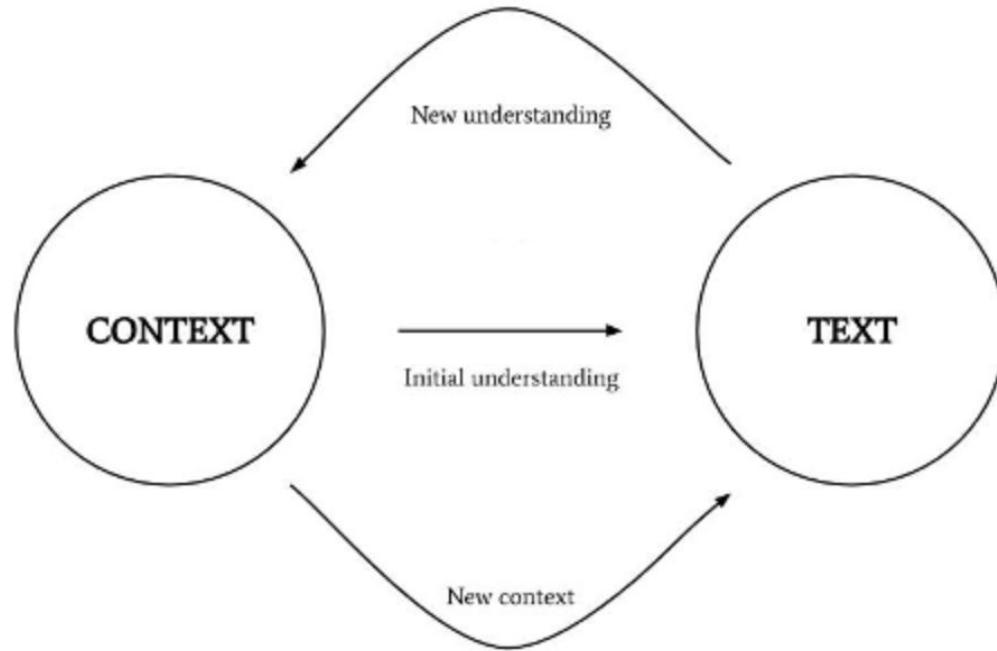


Correct



Incorrect

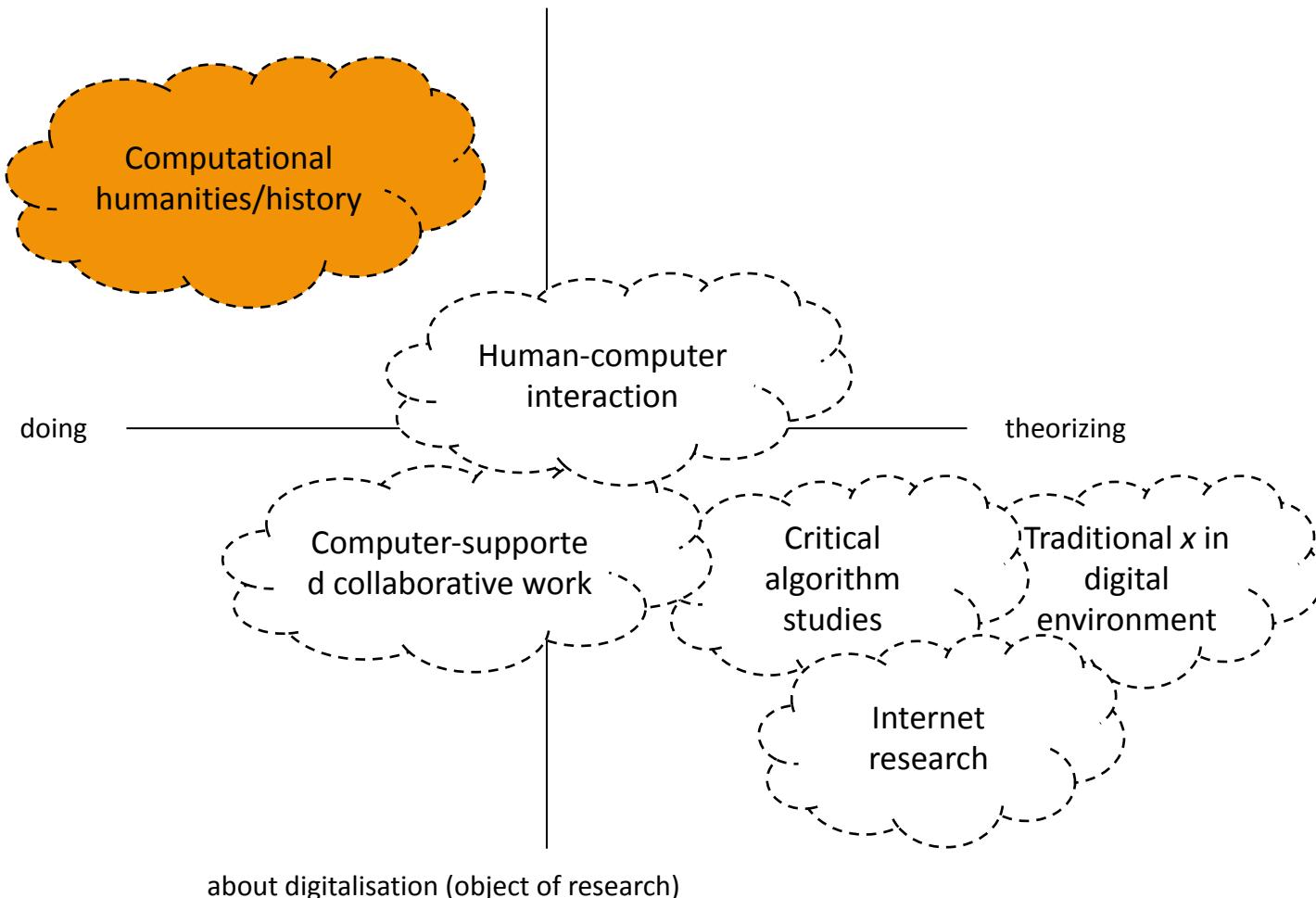
Hermeneutic circle 阐释学循环 (in some contrast to a more linear understanding of a research process)



NB! Context can mean a plenty of different things based on how it is defined in particular research (not necessarily a text).

Digital Humanities Map

using digitalisation (tool for research)



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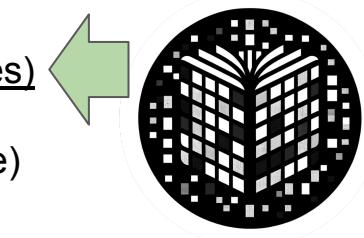
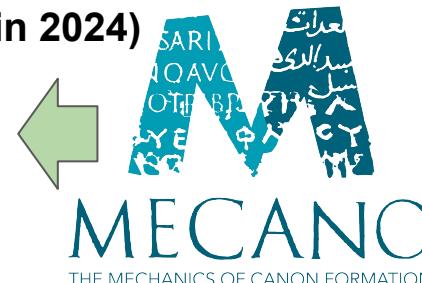
Helsinki Computational History Group, current cycle

Professors

Mikko Tolonen (History/DH), PI
Eetu Mäkelä (CS)

Doctoral researchers (5 new in 2024)

Kira Hinderks (History)
Iiro Tihonen (History/DH)
Ville Vaara (History/DH)
Ruilin Wang (Computer science)
Jonas Fischer (History)
Ke Shu (Digital Humanities)
Yu Wu (Computer science)
Arianna Moretti (Digital Humanities)
David Rosson (Data science)
Ari Vesalainen (Computer science)
Ümit Bedretdin (NLP)
Lassi Saario (Philosophy)



Postdoctoral researchers

Lidia Pivovarova (CS/NLP)

Tanja Säily (Linguistics) -> Tenure track Helsinki
Mark Hill (History/DH) -> Lecturer KCL
Yann Ryan (History/DH) -> Lecturer Leiden
Maciej Janicki (CS/NLP) -> CSC
Jani Marjanen (History) -> Lecturer Helsinki
Antti Kanner (Linguistics/NLP) -> Turku
Simon Hengchen (NLP) -> Gothenburg

DARIAH-FI Infrastructure coordinator

Inés Matres (Museology)

Research Assistants

Enes Yıldiloğlu (DH)
Mengdi Zhang (DH)

What

New understanding of the development of public discourse and knowledge production in early modern Europe.

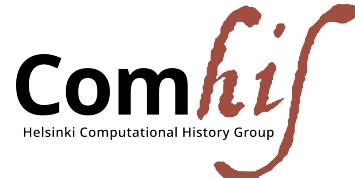
How

Building an analysis ecosystem Octavo based on metadata and full-text collections (Britain, Sweden, Finland, and CERL) to model Europe.

Why

Big data approach to early modern resources is impossible without systematic cleaning and integration of metadata to full-text collections.

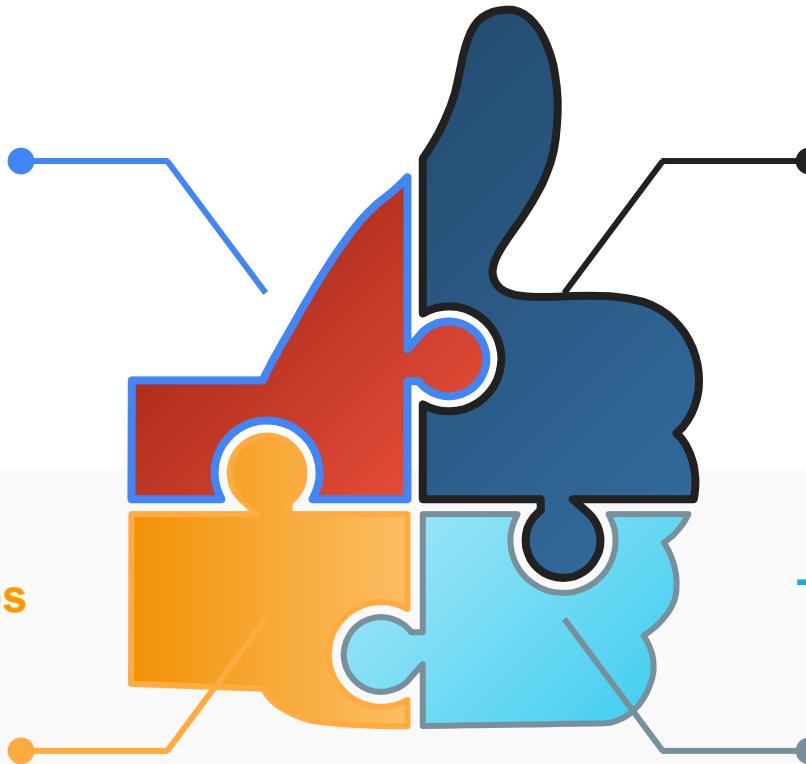
Analysing Early Modern Public Communication Helsinki Computational History Group



COMHIS aim (as of 2017): Understanding public communication covering the early modern Europe

Movement of ideas

- Metadata work based on several different library catalogues
- genres (poetry, pamphleteering); intellectual traditions (natural law tradition, ancient texts)
- text reuse: genres (historical works, quoting practices)



Research data releases

- ESTC; Fennica; Kunglica; CERL; ECCO text reuse (+ EEBO text reuse); Finnish Newspapers

Conceptual change

- concepts are crucial, but not directly jumping into this for various reasons
- Theoretical underpinning (historians + linguists)
- Concepts as linguistic objects (linguists + historians + CS)

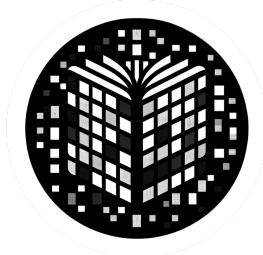
Tools for others

- UIs, APIs, shiny apps etc.

AI Related Projects in DH and COMHIS

- Started in 2024: CASCADE, 2 PhDs; MECANO, 2 PhDs (Marie Curie Training Networks); AI DOC, 1 PhD
 - CASCADE = Semantic Historical Change and AI; MECANO = Historical canon formation using ML methods; AI Doc = Computer vision and LLM development for historical research
- Example use cases
 - Translation mining (together with TurkuNLP)
 - ECCO ocr post correction
 - Latin detection in ECCO
 - Eighteenth-century printer's ornament variants (Laura involved)

CASCADE Network in MSCA



This international network of 10 doctoral research projects aims to train new researchers in developing and using creative methods for analyzing how the meaning of words changes in different situations. They will focus on understanding how language expresses meaning in various contexts, particularly over time.



Funded by
the European Union

The Marie Skłodowska-Curie Actions fund excellent research and innovation and equip researchers at all stages of their career with new knowledge and skills, through mobility across borders and exposure to different sectors and disciplines. The MSCA help build Europe's capacity for research and innovation by investing in the long-term careers of excellent researchers.



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Background

Why Latin extraction important?

- Latin is the primary written language of Western Europe historically, appears to be quotations and terminology in modern languages
- Crucial evidence to study:
 - Language evolution
 - Interplay between classical and modern thought
 - Dissemination of ideas

Why challenging for automation?

- Wide variations/categories in usage
- Complex page layouts
- Inconsistent print and scan quality
- Low resource for training

Only one off-the-shelf tool available!

Latin Detection by Large Language Models

Question: Could (multimodal) large language models detect the Latin language segments in the historical pages?

[67]

" [This being a Year of Unity]
" We beg your Hearing patiently.

The private Policies, Law-Suits, Conversations, &c. &c. I pass over, and come to the Patent which was granted to Mr. Colley Cibber, Mr. Wilks, Mr. Booth, and Sir Richard Steele, after the Accession of his late Majestie, not only for the Reason I mention'd before, but because I have much to say in my own History of the same Kind on thos Subjects in which I was the † Buſtle Major-General, as Wilks had been some few Years before: And if in my Relations there are any cloſe Refemblances of Paſſages to Mr. Cibber's Apology, I shall continue to quote them, to illuſtrate mine, as I before promis'd.

Well then, in the Year 1718, the Patent was given, whereby the Stage came under the sole Management of three Actors, and a Gentleman who had long been acquainted with theatric Affairs. Under this auspicious Triumvirate, A new theatric golden Age arſt.

Redeunt Saturnia Regnū.

An acting Author now was a Judge of Dramatic Authors.

Tuus jam regnat Apollo.

Oh, ye Gods! give me, give me, this great Bon. That I o'er Bards may rule, and rule alone.

Then may I follow my great Exemplar

Paffius Equeſtis:
O mihi tam longe maneat pars ultima Vite
Spiritus & quantum sat erit MEA dicere fata,
Non me Carminibus, &c.

Quo me BACCHUS rapis tui plenus, &c.

Gentle Reader, you will excuse this Rhapsody when I tell you I am writing it at One o'Clock this Morning,

† Vide C. Cibber's Account of Wilks.

[6']\n\"[This being a Year of Unity]\n\" We beg your Hearing patiently.\nThe private Policies, Law-Suits, Conversations, &c. &c. I pass over, and come to the Patent which was granted to Mr. Colley Cibber, Mr. Wilks, Mr. Booth, and Sir Richard Steele, after the Accession of his late Majestie, not only for the Reason I mention'd before, but because I have much to say in my own History of the same Kind on thos Subjects in which I was the † Buſtle Major-General, as Wilks had been some few Years before: And if in my Relations there are any cloſe Refemblances of Paſſages to Mr. Cibber's Apology, I shall continue to quote them, to illuſtrate mine, as I before promis'd.

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Prediction

[67]

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Benchmark: Annotating the Dataset

724 pages with categorized Latin regions and texts

- Pages from one Latin and one non-Latin labeled books in ECCO
- 3 historians annotated, 1 Latin expert checked, visually
- All the regions mapped back to OCR texts, post-corrected
- 12 segment-level categories annotated for Latin usage

SYNTAXIS construed. 169

have me me dicere to speak quod what attinet belongs ad
te to you? spectat ad homines it concerns all men vivere
to live benē well.

Accusativus an accusative case cum genitivo with a ge-
nitive subjicitur is put after his impersonalibus these verbs
impersonal, pœnitet it repents, tædet it wearies, miseret,
miserescit it pities, pudet it shames, piget it grieves: ut
as, Si if vixisset he had lived ad centesimum annum to
the hundredth year non pœniteret it would not have re-
pentedit eum him senectutis suæ of his old age. Miseret me
tui, I pity you.

Category	Count
1. Direct Quote	258
2. Independent	196
3. Footnote	191
4. Code-switching	100
5. Bilingual	55
6. Emblematic	34
7. Indices and Catalogs	30
8. Legal	30
9. Ecclesiastical	23
10. Tables and Charts	11
11. Dictionary	9
12. Side-note	8

Benchmark: Evaluation Metrics

Binary F1 score and anti-noise token F1

- Binary F1: Latin/Non-Latin predictions
- Token-based F1: Latin texts and predictions
 - Extract n-grams and compute noisy one-to-one mappings and calculate True Positive, False Positive and False Negative
 - Within an edit distance threshold (0.2)

$$F_1 = \frac{2}{\text{recall}^{-1} + \text{precision}^{-1}} = 2 \frac{\text{precision} \cdot \text{recall}}{\text{precision} + \text{recall}}$$

GT:

```
menologia in qua fluxus muliebris menstruus phaenomena periodi  
vitia cum medendi metodo ad rationes mechanicas exiguntur
```

Pred:

```
emmnenologia in qua fluxus muliebris menstrui phaenomena periodi  
vitia cum medendi metodo ad rationes mechanicas exiguntur
```

Models and Prompts

- Proprietary frontier Multimodal LLM via API: GPT-4.1
- Open source textual and visual LLMs
 - Qwen3, Qwen2.5-VL
 - Deepseek-R1
 - ...
- Baseline: Lingua (a statistical n-gram-based language identification model)
- Input: page text only; page image only; text and image
- Output: text list
- The basic prompt
 - Identify and extract all segments written in Latin (e.g., Classical or Medieval Latin) from the provided image, using the accompanying OCR text as a reference. Return the results as a list of strings in the JSON format: ["text1", "text2", ...].



OCR Text: {page_text}

Model Results - Best Performance

Model		Page Level			Token Level		
		F1	Precision	Recall	F1	Precision	Recall
Image + Text Input	GPT-4.1	96.03	82.51	99.83	84.59	88.49	83.54
	Qwen2.5-VL-32B-Instruct	96.18	82.94	99.66	84.32	86.90	83.99
	InternVL3-38B-Instruct	95.62	92.32	99.16	84.24	84.43	86.67
Image Input	Qwen2.5-VL-72B-Instruct	98.82	98.66	98.99	80.00	82.36	79.72
	Qwen2.5-VL-32B-Instruct	96.80	94.40	99.33	79.82	82.64	79.18
Text Input	Qwen3-MoE-A22B-235B	96.90	94.13	99.83	86.54	89.16	86.00
	Deepseek-R1-671B	97.53	95.34	99.83	87.00	89.69	86.17
	Deepseek-R1-Distill-Llama-70B	96.18	92.94	99.66	84.26	87.81	83.62
Baseline	Lingua	92.58	86.32	99.83	77.14	77.31	80.07

- The baseline is strong, but many LLMs are stronger
- Over 85% Latin words could be found precisely, **promising for application!**
- Open-source reasoning models outperform the best multimodal models

Model Results - Scales

Model		Page Level			Token Level		
		F1	Precision	Recall	F1	Precision	Recall
Image + Text Input	InternVL3-38B-Instruct	95.62	92.32	99.16	84.24	84.43	86.67
	InternVL3-14B-Instruct	94.28	90.42	98.48	81.36	82.63	83.87
	InternVL3-8B-Instruct	90.54	86.39	95.12	69.04	65.87	82.10
Image Input	Qwen2.5-VL-72B-Instruct	98.82	98.66	98.99	80.00	82.36	79.72
	Qwen2.5-VL-32B-Instruct	96.80	94.40	99.33	79.82	82.64	79.18
	Qwen2.5-VL-7B-Instruct	95.75	96.74	94.78	71.42	76.99	70.39
Text Input	Qwen3-32B	95.90	93.45	98.48	84.29	87.29	83.73
	Qwen3-14B	96.61	94.96	98.32	84.78	88.10	83.71
	Qwen3-4B	88.45	87.36	89.56	75.38	76.30	77.20
Baseline	Lingua	92.58	86.32	99.83	77.14	77.31	80.07

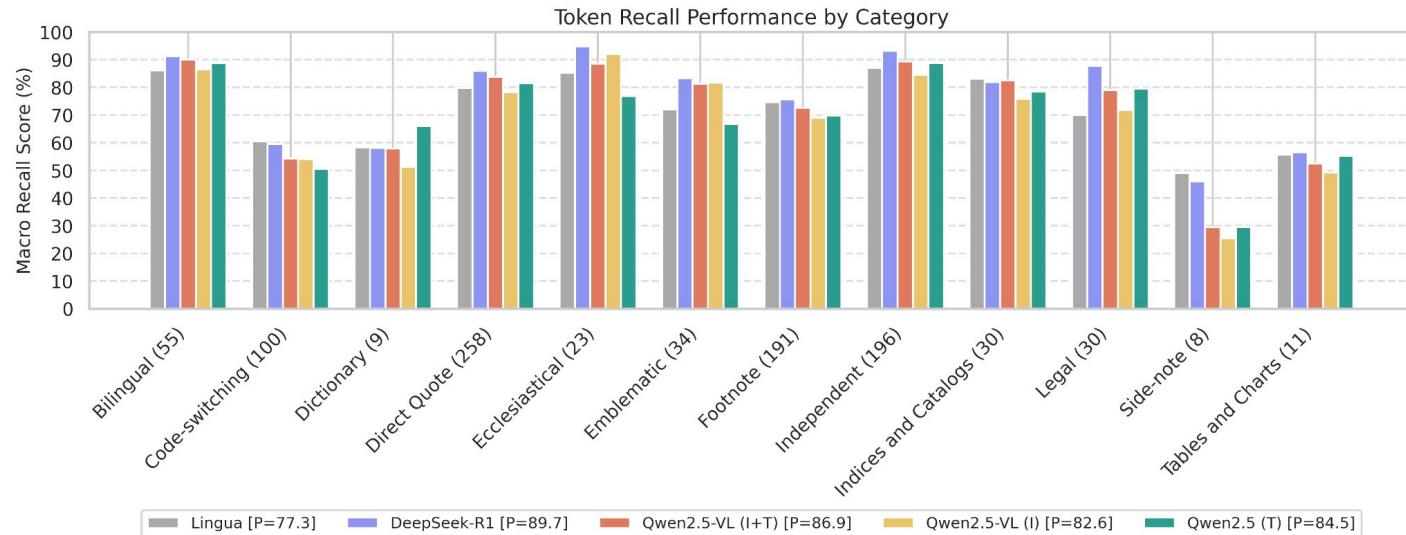
- Models under 10B perform poorly
- Performance saturates among larger models
- Latest Qwen3 with effective thinking mode works parameter-efficiently

Model Results - Modalities

Model		Page Level			Token Level		
		F1	Precision	Recall	F1	Precision	Recall
Image + Text Input	InternVL3-38B-Instruct	95.62	92.32	99.16	84.24	84.43	86.67
	InternVL3-14B-Instruct	94.28	90.42	98.48	81.36	82.63	83.87
	InternVL3-8B-Instruct	90.54	86.39	95.12	69.04	65.87	82.10
Image Input	InternVL3-38B-Instruct	89.51	87.22	91.92	56.53	61.11	55.61
	InternVL3-14B-Instruct	90.16	87.86	92.59	53.51	56.46	55.08
	InternVL3-8B-Instruct	90.82	88.50	93.27	60.22	60.30	65.63
Text Input	Qwen2.5-32B-Instruct	97.26	99.13	95.45	81.57	84.46	80.99
	Qwen2.5-7B-Instruct	91.86	92.49	91.25	60.52	65.78	64.57
Baseline	Lingua	92.58	86.32	99.83	77.14	77.31	80.07

- Multimodal inputs (I+T) generally improve performance
- Some models have limited visual capability
- OCR text is still important for the task

Recall Results by Categories

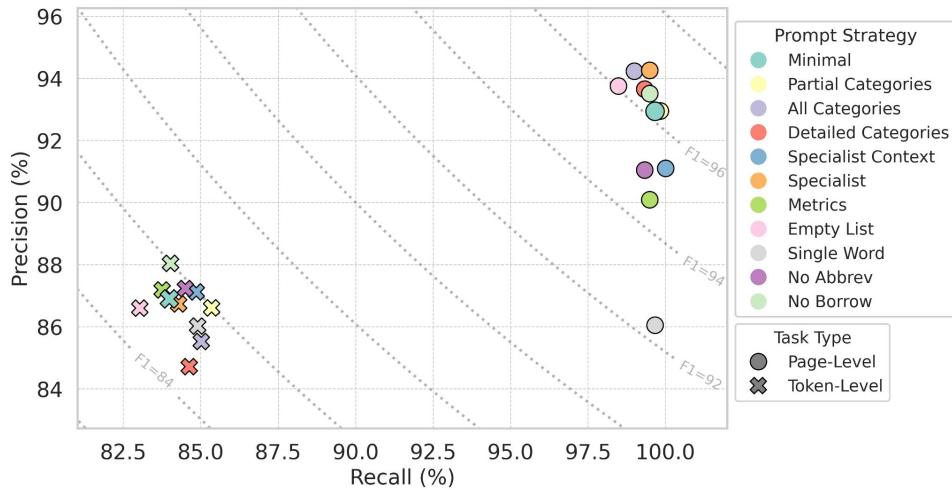


- Still hard to retrieve all the detailed cases (side-note, code-switching, ...)
 - OCR text quality problems on some specific categories
- Lack of deep understanding on Latin functions (best macro-F1 only reaches 21% in categorized predictions)

Prompt Modification Experiments

How: add more instructions onto the minimal prompt, on Qwen2.5-VL-32B

- Marginal fluctuations
 - Trade-off between P and R
-
- ❖ **Partial Categories:** $R \uparrow P \downarrow$
 - ❖ **Detailed Categories:** token $F1 \downarrow$
 - ❖ **Including Single Words:** $R \uparrow P \downarrow$
 - ❖ **Excluding Borrowed Words:**
slightly improve overall performance



E.g., **Partial Categories:** Pay particular attention to identifying Latin segments in code-switching, dictionaries, footnotes, sidenotes, tables, and charts, while maintaining accuracy across all other categories.

Behavior on Non-Latin Pages

- Mostly over-detect Latin, while FP token amount is acceptable
- Qwen2.5-32B is an exception
- Lingua performs poorly, leading to severe limitations in application

MODEL DETAILS				PAGE	TOKEN
Model	Variant	Size	Mode	Neg. Recall	FP Rate
Lingua	-	-	T	27.69	2.64
Qwen2.5	VL	32B	I+T	65.38	2.66
	VL	32B	I	73.08	2.09
	-	32B	T	96.15	0.17
DeepSeek-R1	-	671B	T	77.69	0.43

Neg. Recall: Non-Latin page recall

FP Rate: False positive token percentage on non-Latin pages

Qualitative Study

Pros

Index: 134 | ecold and page: 1435800600 117 | categories: Short quotes_LATIN | metric2score: F1: 100.0 P: 100.0 R: 100.0

S E R M O N V. 117

degree of humanity, clemency, order, tranquillity, and other social virtues, to which in the administration of government we have attained in modern times, had any one been then alive to have made a fair representation of them."

The life of Christ blends these opposite and seemingly irreconcileable excellencies. It avoids their extravagance, and supplies their defects. The courage of our Lord was active in encountering the dangers to which he was exposed, and passive under the aggravated calamities which the malice of his foes heaped upon him. Yet his fortitude was removed from every appearance of rashness; and his patience was equally exempt from a sordid pusillanimity and flagrant apathy. He was firm without obstinacy, and humble without meanness. In the general tenor of his life he was mild and gentle; the promoter of peace among other men, and the strictest observer of it in his own behaviour. But when great and real occasions called for different deportment, he displayed a nobleness of mind, a contempt of danger and death, such as the importance of his mission required from him, and such as the consciousness of rectitude could alone inspire.

To the virtues of Christ, whether we consider them as too sublime to excite any sentiments of presumptuous emulation, or too rational not to justify our endeavours to imitate them; whether we examine his private or public conduct; may in a nobler sense be applied the beautiful and animated language, in which a celebrated orator of antiquity has extolled those arts, by which he was himself distinguished. "Adolescentiam alium, beneficium obsecrant, secundas res ornant, adversis præfigunt ac foliatum praebent, delectant domi, non impeditur foris, pernoctant noluntum, peregrinatur, rulicantur."

R. 3 1874

Cons

Index: 325 | ecold and page: 0877380288 86 | categories: Code-switching_LATIN | metric2score: F1: 68.97 P: 71.43 R: 66.67

86 *The Examination* Lit. GT

a Fellow I am. **Qui** agreeth with its Substantive in Cafe, Gender, and Number.

Q. But is **qui** a Relative in this manner of speaking?

A. No, it is rather an Indefinite.

Q. Of what else is the Relative governed?

A. Sometimes of a Noun Partitive or Distributive, as, **Quarum rerum utram minus velim, non facile possum** **exitimare**, of which two things whether I would with Jeff will have, I cannot easily determine. **Quarum rerum** are the Genitive Cafe and Plural Number governed of **utram**.

Q. Why is the Relative sometimes put in the Genitive Cafe?

A. By reason of a Substantive coming next after it; as, **Ego illum non novi, cuius causa hoc incipit**; I know him nor, for whose Cause thou begannest this Matter.

Cuius is the Genitive Cafe, governed of the Substantive **cuius** that cometh next after it.

Q. Is it not otherwise governed of a Substantive?

A. Yes, sometimes; as, **Omnia tibi dabuntur, quibus opus habes**; all things shall be given thee, wher thou hast need of. **Quibus** is the Ablative governed of **opus**.

Q. How is the Relative governed?

A. Sometimes of an Adverb; as, **Cui utrum obviam procedam, nondum sciat**, whom whether I shall go to meet, I have not yet determined.

Cui is the Dative Cafe governed of the Adverb **utrum**.

Q. Of what is the Relative governed when it is put in the Ablative Cafe with this sign than?

A. Of the Comparative Degree coming after it; as, **Vtius virtus, qua nihil sit melius**; vte Virtue, than which nothing is better.

Quod is the Ablative Cafe governed of **melius**, which is an Adjective of the Comparative Degree.

Q. When is the Relative not governed at all?

A. When it is put in the Ablative Cafe absolute; as, **Quoniam erat Julius Cesar, quo Imperatore, Romanum Britanniam ingressus fuit?** how worthy a Man was Julius Cesar, under whose Conduct the Roman first entered into Britain? **Quo Imperatore** is the Ablative Cafe absolute.

Q. Wh-

Other Errors by LLMs

308 LETTERS

dent from History, that this mock Senate, this Senate in Burlesque, was compos'd of a Parcel of Scoundrels who had never seen *Pharsalia*. For can you or any one believe, that if they had been of real Senatorian Rank, *Cæsar* would have us'd them as he did, who hang'd up as many of them as fell into his Hands? But let us now see what *Sempronius* is pleas'd to reply to *Portius*.

*Not all the Pomp and Majesty of Rome
Can raise her Senate more than Cato's Pre-
sence.*

— *O, my Portius!*
*Could but I call that wondrous Man my Fo-
ther,*
Would but thy Sister Marcia be propitious
*To thy Friend's Vows, I might be blest in
deed.*

*Port. Alas, Sempronius! wouldst thou
talk of Love*
*To Marcia, while her Father's Life's in
danger?*
Thou mightst as well court the pale tremblin'
Vestal,
When she beholds the Holy Flame expiring
Sempr. The more I see the Wonders of thy
Race,
The more I'm charm'd. Thou must take her
my Portius,
The World has all its Eyes on Cato's Son.
Thy Father's Merit sets thee up to Vice;

GT:
Pred:
sempronius portius marcia pharsalia cato vesta

Definition misunderstanding

- 1) Roman named entities
- 2) Common anglicized Latin phrases (e.g. “e.g.”, “etc.”, etc.)
- 3) Jargon within otherwise English text

were not annotated as Latin.

This is hard to be fully fixed by simply tuning the prompt!

Other Errors by LLMs

of the Church of ENGLAND.

" corruption, accustoming ourselvēs by little and little, to
" comprehend and bear the Majestēt of God." And S.
Cyprian. " If he be made the Temple of God, I ask, Of Epis. 73.
" what God? If he answēr, Of the Creator, he could not
" be His Temple, because he did not believe in him. If
" he say, Of Christ, neither can he be made His Temple,
" because he denies Christ to be God. Or if he say, Of
" the Holy Ghost, yet since theſe Three are One, how can
" the Holy Ghost be reconciled to that Man, who is an
" Enemy either to the Father or to the Son?"

Very and Eternal God] The moft notorious Oppoſer of
the Godhead of the Holy Ghost, was *Macedonius*, Patri-
arch of *Conſtantinople*. The Heresy itſelf is called the He-
reſy of the *Pneumatomachi*, or *Fighters againſt the Spirit* ;
as denying the Divinity of the Holy Ghost, and afferting
that he is only a created Energy or Power, attending upon
and miniftring unto the Son. In order to put a Stop to
this Heresy, the firſt Council of *Conſtantinople*, to theſe
Words in the *Nicene Creed*, *I believe in the Holy Ghost*,
added, *The Lord, and Giver of Life, who proceeded from
the Father and the Son, Who with the Father and the Son
together is worshipped and glorified, Who ſpoke by the Pro-
phets.* See *Pearlson* on the Creed, p. 325.

A R T I C L E VI.
*Of the Sufficiency of the Holy Scriptures
for Salvation.*

HOLY Scripture containeth all Things
necessary to Salvation: So that whatfo-
ever is not read therein, nor may be proved
thereby, is not to be required of any Man,
that it ſhould be believed as an Article of the
Faith, or be thought requisite or necessary to
Salvation. In the Name of the holy Scripture
we do understand thoſe Canonical Books of
the Old and New Testament, of whose Au-
thority was never any Doubt in the Church.

Of

15

GT:

Pred:
credo in spiritum sanctum dominum et vivificantem qui ex
patre filioque procedit qui cum patre et filio adoratur et
conglorificatur qui locutus est per prophetas

Hallucinations

- 1) Repeated output
- 2) Unrelated output
- 3) Unexpected action

(e.g. translation)

An unsolved issue even in the
latest LLMs.

Takeaways

- An initial fine-grained data annotation pipeline served by LLMs
- Open-source LLMs have potential for large-scale applications
- Be careful with the output limitations, e.g. errors and hallucinations
- Be careful with the computational resource and efficiency
 - Coarse-to-fine strategy may help
- Remember: they barely understand how Latin functions in 18th-century documents

Thanks for listening!

