# NON-LITERAL TEXT REUSE IN HISTORICAL TEXTS: AN APPROACH TO IDENTIFY REUSE TRANSFORMATIONS AND ITS APPLICATION TO BIBLICAL REUSE

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# PHD STUDY

- PhD student at the Georg-August University School of Science (GAUSS), Program in Computer Science (PCS)
- Topic: Historical Text Reuse Style (the way text is reused) Investigation
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  - Dr. Marco Büchler

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# INTRODUCTION

# TEXT REUSE

Text Reuse:

- spoken and written repetition of text across time and space.

For example:

- citations, allusions, translations.

Detection methods are needed in different scholarly fields.

- They help to ensure clean libraries or identify fragmentary authors.

Text is often modified during the reuse process.

Paraphrasing and non-literal reuse challenges many approaches:

- Alzahrani et al. (2012)
  - study n-gram-, syntax-, and semantic-based detection approaches;
  - they find: as soon as reuse is slightly modified (words changed) most approaches fail.
- Barrón-Cedeño et al. (2013)
  - experiment with paraphrasing to improve plagiarism detection;
  - they found that complex paraphrasing with a high density challenges plagiarism detection, and
  - that lexical substitution is the most frequent plagiarism technique.

# TEXT REUSE DETECTION

Not only Alzahrani et al.'s but most NLP research focuses on English, although many inflecting languages exist. Ancient languages are particularly problematic as they come with:

- variants due to transmission.
- incomplete testimonials.
- diverse reuse.

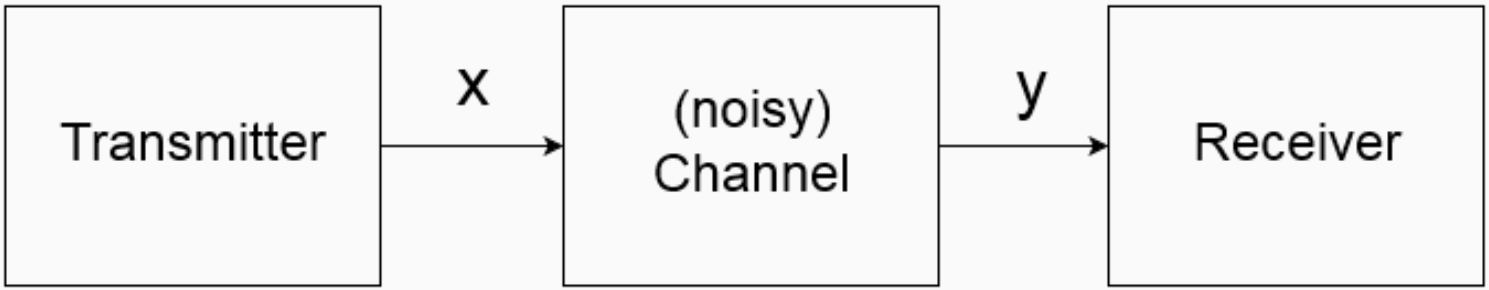
One solution: Reuse Style Investigation.

- i.e., how is reuse generally transferred and how literal is it?

# APPROACH

Inspired by Shannon's noisy-channel (Shannon, 1949) & the Kolmogorov Complexity (Li and Vitáni, 2008), we study Ancient Greek and Latin text reuse to understand how text is transferred.

- We identify operations that characterize word changes.
- We show how linguistic resources can help detect non-literal reuse.
- We complement the automated approach with a manual analysis.



# METHODOLOGY

# RESEARCH QUESTIONS

- RQ1. What is the extent of non-literal reuse in our datasets?
- RQ2. How is the non-literally reused text modified in our datasets?
  - RQ2.1. How can linguistic resources support the discovery of non-literal reuse?
  - RQ2.2. What are the limitations of an automated classification approach relying on linguistic resources?

# STUDY DESIGN

We:

1. define operations reflecting literal reuse and semantic replacements.
2. develop an algorithm that looks for identical, similar words, morphological changes and semantic changes.
3. apply it to our two data-sets (next slide).
4. manually analyze a smaller sample of our reuse using further operations.

# DATA-SETS - ANCIENT GREEK AND LATIN DATA-SET

"Salvation for the Rich"
Clement of Alexandria
Christian theologian, 2nd cent.

- Known for his retelling of biblical excerpts
- Reuse annotated by Biblindex team (Mellerin, 2014; Mellerin, 2016)
- We obtain 199 verse-reuse-pairs
- Pointing to 15 Bible books

Extracts from 12 works & 2 collections
Bernard of Clairvaux
French abbot, 12th cent.

- Known for his influence on the Cistercian order and his work in biblical studies
- Reuse extracted by Biblindex team (Mellerin, 2014; Mellerin, 2016)
- We obtain 162 verse-reuse-pairs
- Pointing to 31 Bible books

# BIBLICAL REUSE EXAMPLES

| more literal | Bible verse | Bernard reuse |
|---|---|---|
| **Proverbs 18 3** | **impius cum in profundum venerit** peccatorum **contemnit** sed sequitur eum ignominia et obprobrium (*When the wicked man is come into the depth of sins, also contempt comes but ignominy and reproach follow him)* | **Impius** , **cum venerit in profundum** malorum , **contemnit** (*When the wicked man is come into the depth of evil*) |

| less literal | Bible verse | Clement reuse |
|---|---|---|
| **1Cor 13 13** | νυνὶ **δὲ μένει πίστις** , **ἐλπίς** , **ἀγάπη** , **τὰ τρία ταῦτα μείζων δὲ τούτων ἡ ἀγάπη** (*And now remain faith, hope, love, these three; but the greatest of those is love.*) | **πίστει** καὶ **ἐλπίδι** καὶ **ἀγάπῃ** (*faith, and hope, and love* - in dative case) |
| | | **ἀγάπην** , **πίστιν** , **ἐλπίδα** (*love, faith, hope* - in accusative case) |
| | | **μένει δὲ τὰ τρία ταῦτα** , **πίστις** , **ἐλπίς** , **ἀγάπη** · **μείζων δὲ** ἐν **τούτοις ἡ ἀγάπη** *(and remain these three, faith, hope, love; but the greatest among them is love)* |

| non-literal | Bible verse | Clement reuse |
|---|---|---|
| **Mt 12 35** | ὁ ἀγαθὸς ἄνθρωπος ἐκ τοῦ ἀγαθοῦ θησαυροῦ ἐκβάλλει ἀγαθά , καὶ ὁ **πονηρὸς** ἄνθρωπος ἐκ τοῦ πονηροῦ θησαυροῦ ἐκβάλλει **πονηρά** . (*A good man out of good storage brings out good things , and an evil man out of the evil storage brings evil things .*) | Ψυχῆς , τὰ δὲ ἐκτός , κἂν μὲν ἡ ψυχὴ χρῆται καλῶς , καλὰ καὶ ταῦτα δοκεῖ , ἐὰν δὲ **πονηρῶς** , **πονηρά** , ὁ κελεύων ἀπαλλοτριοῦν τὰ ὑπάρχοντα (*[are whitin the] soul, and some are out, and if the soul uses them good, those things are also thought of as good, but if [they are used as] bad, [they are thought of as] bad; he who commands the renouncement of possessions*) |

# LINGUISTIC SUPPORT – LEMMA RESOURCES

We aggregate:

- Biblindex' Lemma Lists
  - 65,537 Biblical Greek entries
  - 315,021 Latin entries
- Classical Language Tool Kit (CLTK) (Johnson et al., 2014)
  - 953,907 Ancient Greek words
  - 270,228 Latin words
- Greek New Testament of the Society of Biblical Literature[1] & Septuaginta (Rahlfs, 1935a; UPenn) 59,510 word-lemma-pairs

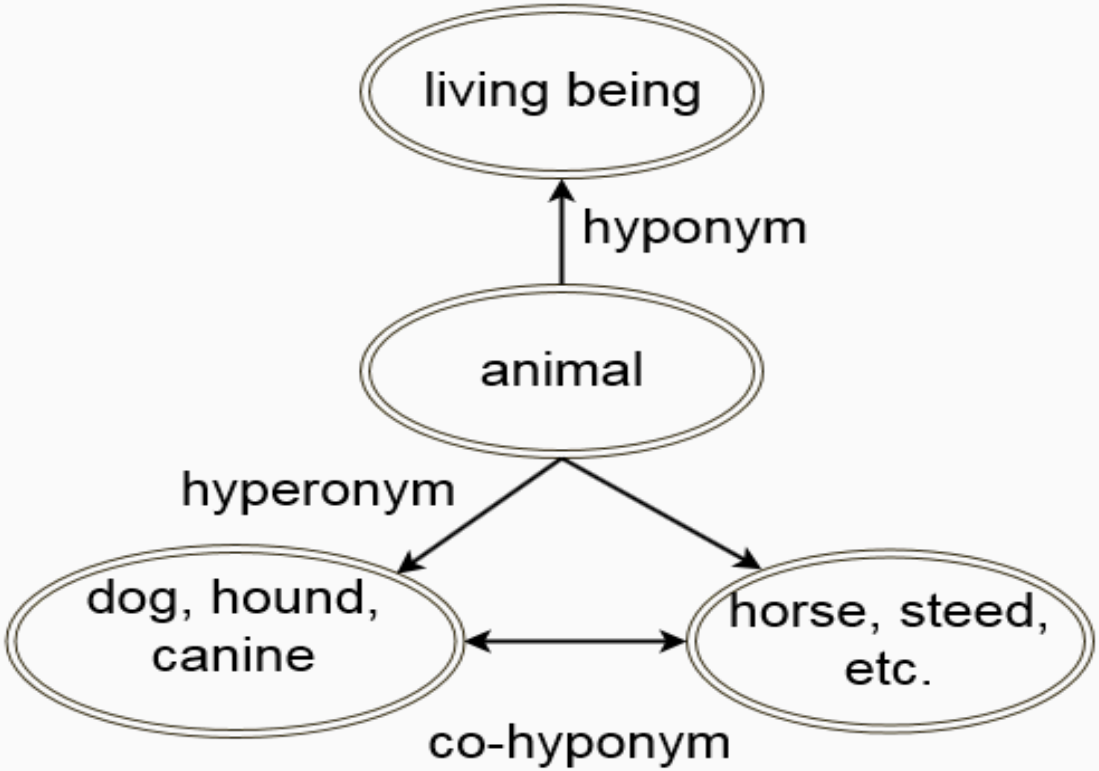
[1] Logos Bible Software `http://sblgnt.com/about/`

# LINGUISTIC SUPPORT – ANCIENT GREEK WORDNET (AGWN)

99K synsets

of which 33K contain Ancient Greek and 27K Latin words

(Bizzoni et al., 2014; Minozzi, 2009)



# TRANFORMATION OPERATIONS

**Table 1:** Operation list for the automated approach

| operation | description | example |
|---|---|---|
| *NOP(reuse_word, orig_word)* | Original and reuse word are equal. | *NOP(maledictus,maledictus)* |
| *upper(reuse_word, orig_word)* | Word is lowercase in reuse and uppercase in original. | *upper(kai,Kai)* - in Greek |
| *lower(reuse_word, orig_word)* | Word is uppercase in reuse and lowercase in original. | *lower(Gloriam,gloriam)* |
| *lem(reuse_word, orig_word)* | Lemmatization leads to equality of reuse and original. | *lem(penetrat,penetrabit)* |
| *repl_syn(reuse_word, orig_word)* | Reuse word replaced with a synonym to match original word. | *repl_syn(magnificavit,glorificavit)* |
| *repl_hyper(reuse_word, orig_word)* | Word in Bible verse is a hyperonym of the reused word. | *hyper(cupit,habens)* |
| *repl_hypo(reuse_word, orig_word)* | Word in Bible verse is a hyponym of the reused word. | *hypo(dederit,tollet)* |
| *repl_co-hypo(reuse_word, orig_word)* | Reused word and original have the same hyperonym. | *repl_co-hypo(magnificavit,fecit)* |
| *NOPmorph(reuse_tags, orig_tags)* | Case or PoS did not change between reused and original word. | *NOPmorph(na,na)* |
| *repl_pos(reuse_tag, orig_tag)* | Reuse and original contain the same cognate, but PoS changed. | *repl_pos(n,a)* |
| *repl_case(reuse_tag, orig_tag)* | Reuse and original have the same cognate, but the case changed. | *repl_case(g,d)* - cases genitive, dative |
| *lemma_missing(reuse_word, orig_word)* | Lemma unknown for reuse or original word. | *lemma_missing(tentari, inlectus)* |
| *no_rel_found(reuse_wword, orig_word)* | Relation for reuse or original word not found in AGWN. | *no_rel_found(gloria,arguitur)* |

# QUALITATIVE COMPLEMENT

We manually analyze:

- 60 Ancient Greek & 100 Latin instances
- 192 &. 224 replacements
- Using `ins(word)`, `del(word)` and replacements:
  - `NOP`, `lem`, `repl_syn`, `repl_hyper`, `repl_hypo`, `repl_co-hypo`
- We assign morphological categories from Perseus' tag-set (Bamman and Crane 2011)
  - E.g., `repl_case_a_g` `repl_num_s_p`

**Table 2:** Excerpt from Perseus' tag-set

| Category | Value | Tag |
|---|---|---|
| person | first person | 1 |
| | second person | 2 |
| | third person | 3 |
| number | singular | s |
| | plural | p |
| | dual | d |
| tense | present | p |
| | imperfect | i |
| | perfect | r |
| | pluperfect | l |
| | future perfect | t |
| | future | f |
| | aorist | a |

# RESULTS

# LITERAL SHARE OF THE REUSE (RQ1)

What is the extent of non-literal reuse in our datasets?

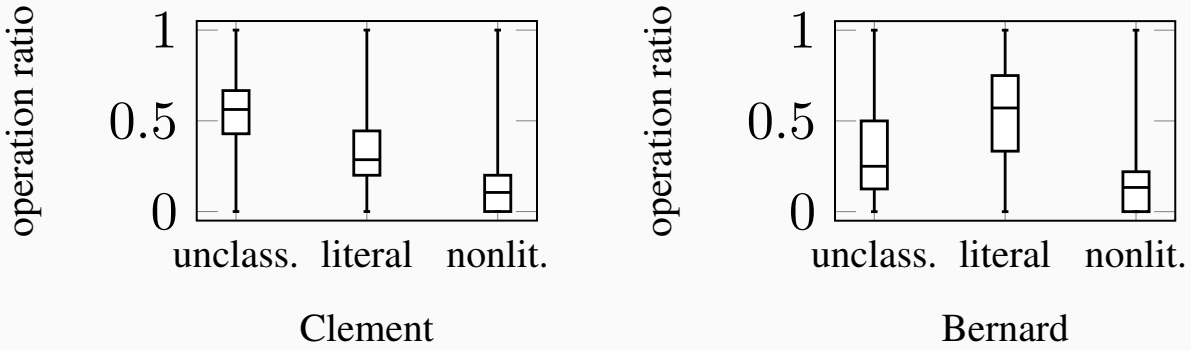



**Figure 1:** Ratios of operations in reuse instances. literal: NOP, lem, lower, etc.; nonlit: syn, hyper, etc.

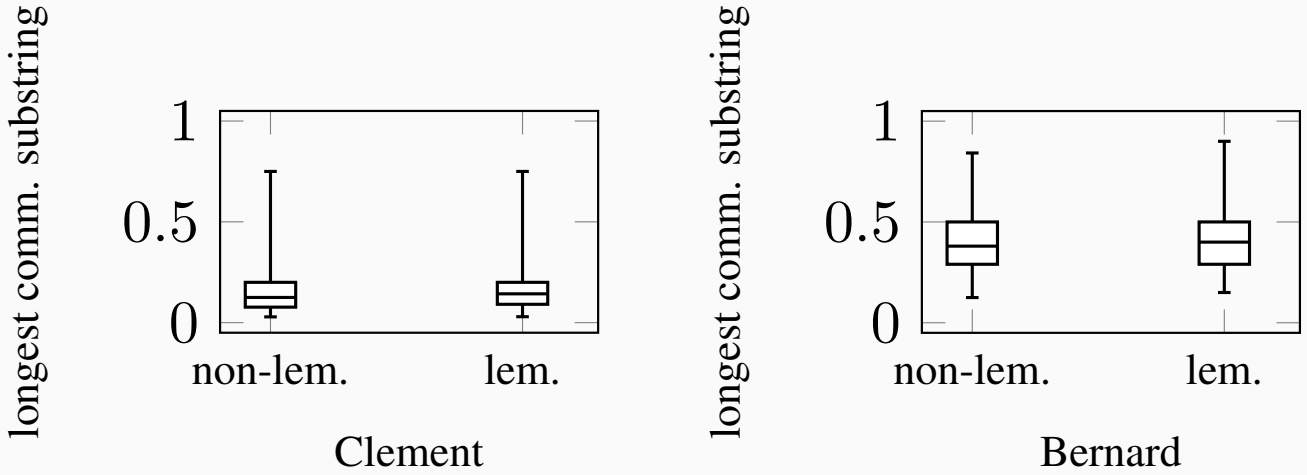



**Figure 2:** Ratios of literal overlap between reuse instances and originals.

# AUTOMATED APPROACH (RQ2.1)

How is the non-literally reused text modified in our datasets? (RQ2)
How can linguistic resources support the discovery of non-literal reuse? (RQ2.1)

**Table 3:** Absolute numbers of operations identified automatically.

| | literal | | | | non-literal | | | | unclassified | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | NOP | upper | lower | lem | syn | hyper | hypo | co-hypo | no_rel_found | lem_missing | total |
| Greek | 337 | 6 | 0 | 356 | 153 | 20 | 14 | 101 | 563 | 639 | 2189 |
| Latin | 587 | 0 | 44 | 102 | 60 | 14 | 28 | 68 | 347 | 85 | 1335 |

# AUTOMATED APPROACH (RQ2.1) - COVERAGE VALUES

Operations that successfully looked up a lemma: `lem_success`={`lem, syn, repl_hyper, repl_hypo, repl_co-hypo, no_rel_found`}, with `lem_missing` representing not found tokens in the lemmata.

$$\text{COV}_{\text{lem}} = \frac{\sum_{\text{Occ}(o)} o \in \text{lem\_success}}{\sum_{\text{Occ}(o)} o \in \text{lem\_success} \cup \{\text{lem\_missing}\}}$$

$$\text{COV}_{\text{AGWN}} = \frac{\sum_{\text{Occ}(o)} o \in \text{agwn\_success}}{\sum_{\text{Occ}(o)} o \in \text{agwn\_success} \cup \{\text{no\_rel\_found}\}}$$

We obtain a $\text{cov}_{\text{lem}}$ of **0.65** for our Greek and **0.88** for the Latin data-set. And a $\text{cov}_{\text{AGWN}}$ of **0.34** for our Greek and **0.33** for our Latin data-set.

Language resources help to get an idea of reuse components.

# QUALITATIVE APPROACH (RQ2.2)

How is the non-literally reused text modified in our data-sets? (RQ2)
What are the limitations of an automated classification approach relying on linguistic resources? (RQ2.2)

**Table 4:** Exceptions that prevent applying the operations.

| Exception | Quantity | |
|---|---|---|
| | Clement | Bernard |
| Word changed to antonym | 1[2] | 0 |
| Synonym and morphology changed | 1 | 16 |
| More than one morphological category changed | 1 | 7 |
| Synonym is multi-word expression | 3 | 5 |
| Many-to-many | 0 | 1[3] |

[2] "**the** God, the good (**one**)" (Clement) vs. "**none** is good but the God" (Bible).
[3] "judged calmly" (Bernard) vs. "fake friend" (Sal 12 18).

# DISCUSSION

- RQ1. The reuse is significantly non-literal
  - Techniques beyond stemming & even semantic closeness are required; suggestion: conceptualizing
- RQ2.1. Our results show
  - the possibility of supporting reuse detection with linguistic resources
- RQ2.2. Qualitative complement
  - especially the exceptions show that reuse detection needs looser relation (multi-to-multi-word) associations or implicit expert knowledge.

# CONCLUSION AND FUTURE WORK

# SUMMARY

We contributed:

- an automated approach to characterize how text is transformed between reuse and original,
- an application of the approach to two text data-sets where reuse was manually identified,
- empirical data based on the automated approach, complemented by a manual identification.

# FUTURE WORK

A more comprehensive study could strengthen the findings:

- using larger reuse data-sets,
- additional languages (inflecting vs. non-inflecting),

An automated approach for deriving an original text excerpt would be learning edit scripts (Kehrer, 2014, Chawathe et al., 1996).

# Thank you!

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# APPENDIX

# BIBLINDEX BIBLE EDITIONS AND CLEMENT EDITION

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New Testament:

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Latin Bible:

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Clement Edition:

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