Author Obfuscation

Attacking the State of the Art in Authorship Verification

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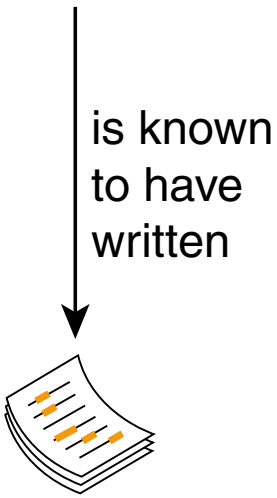
www.webis.de

Obfuscation vs. Identification

Introduction

Alice



Obfuscation vs. Identification

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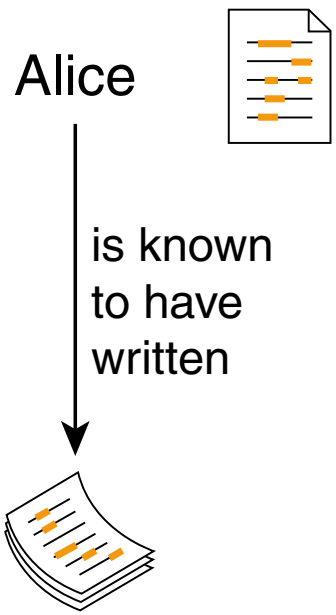

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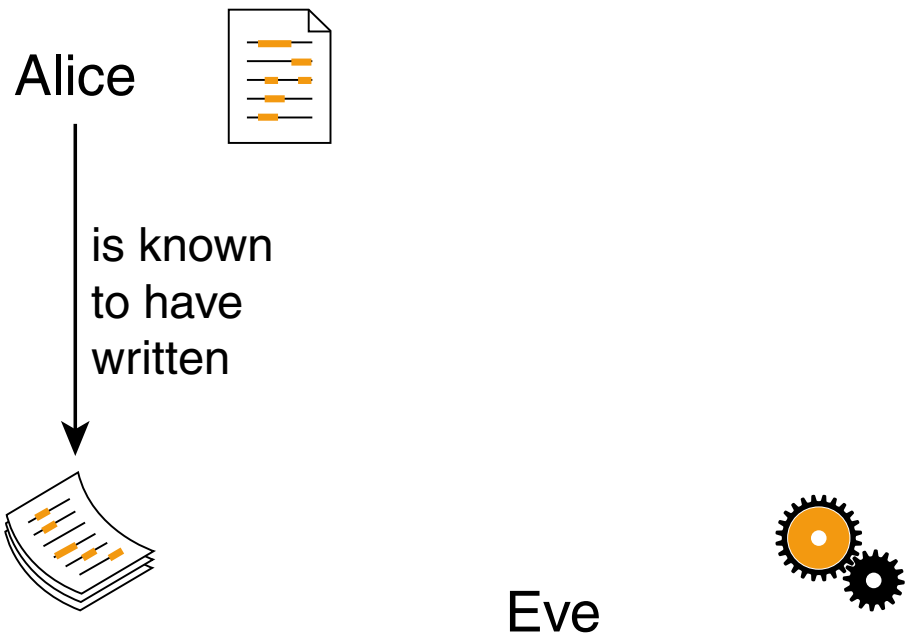

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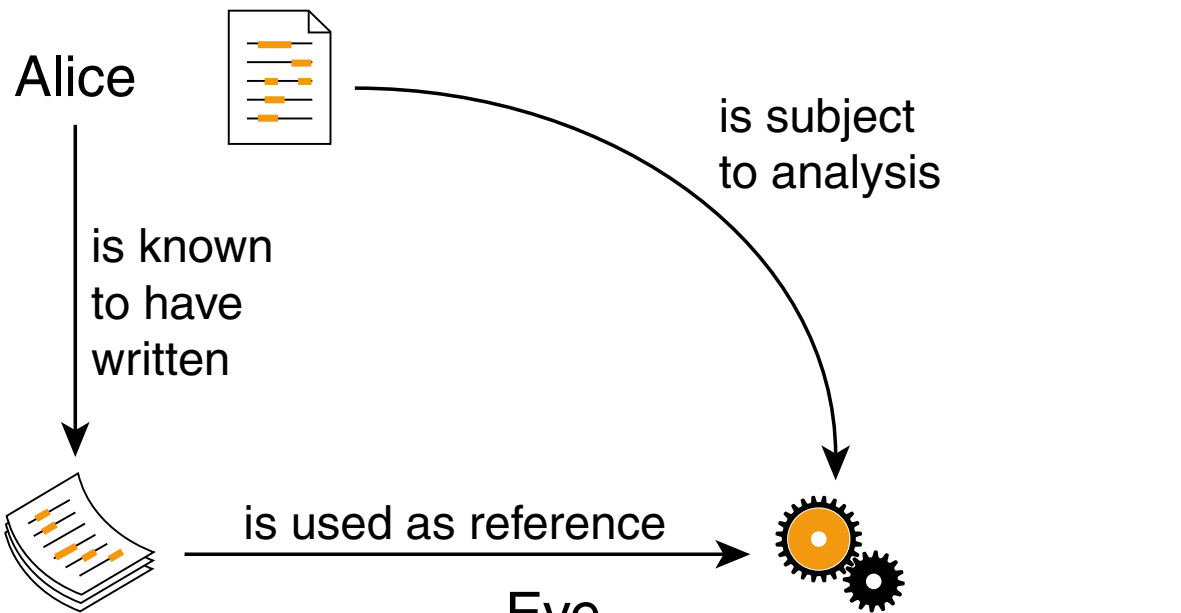

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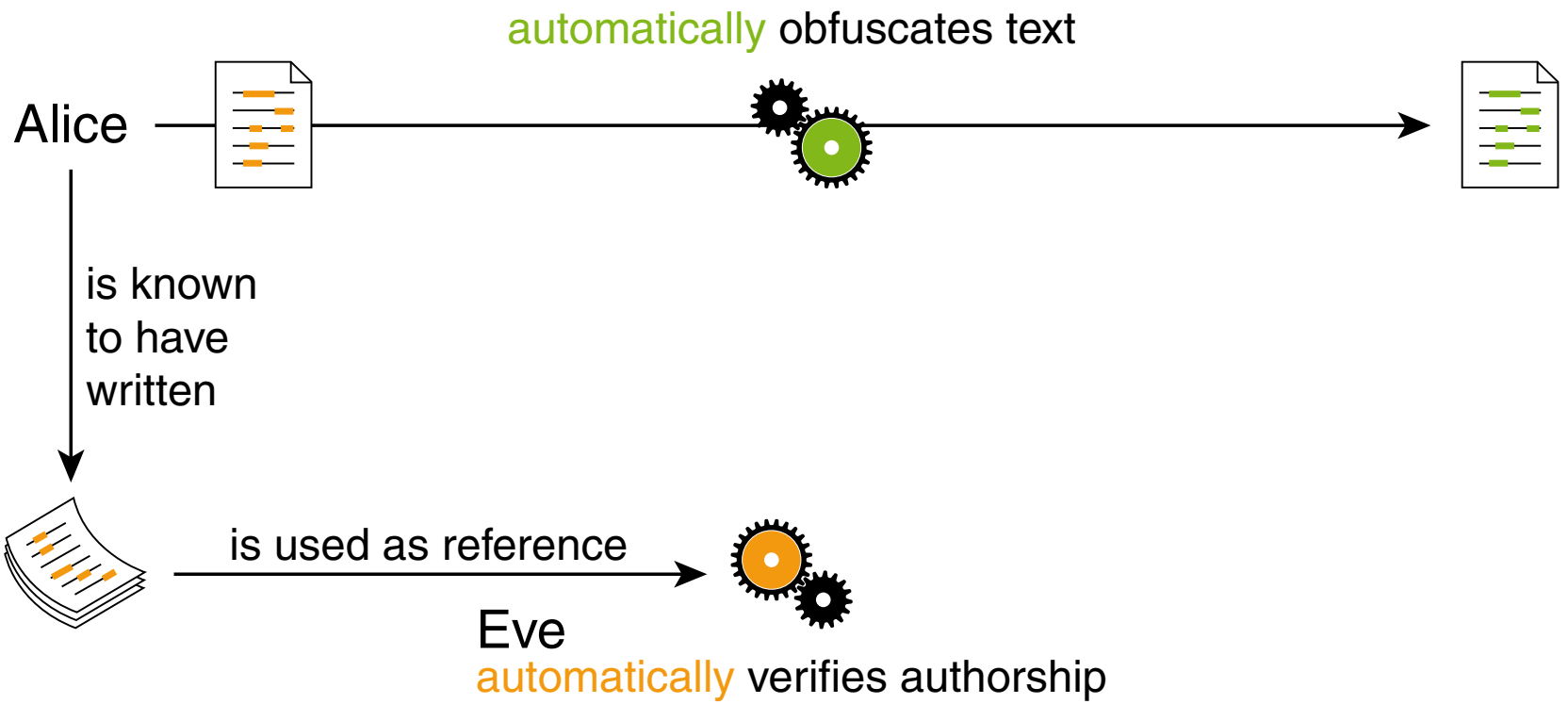

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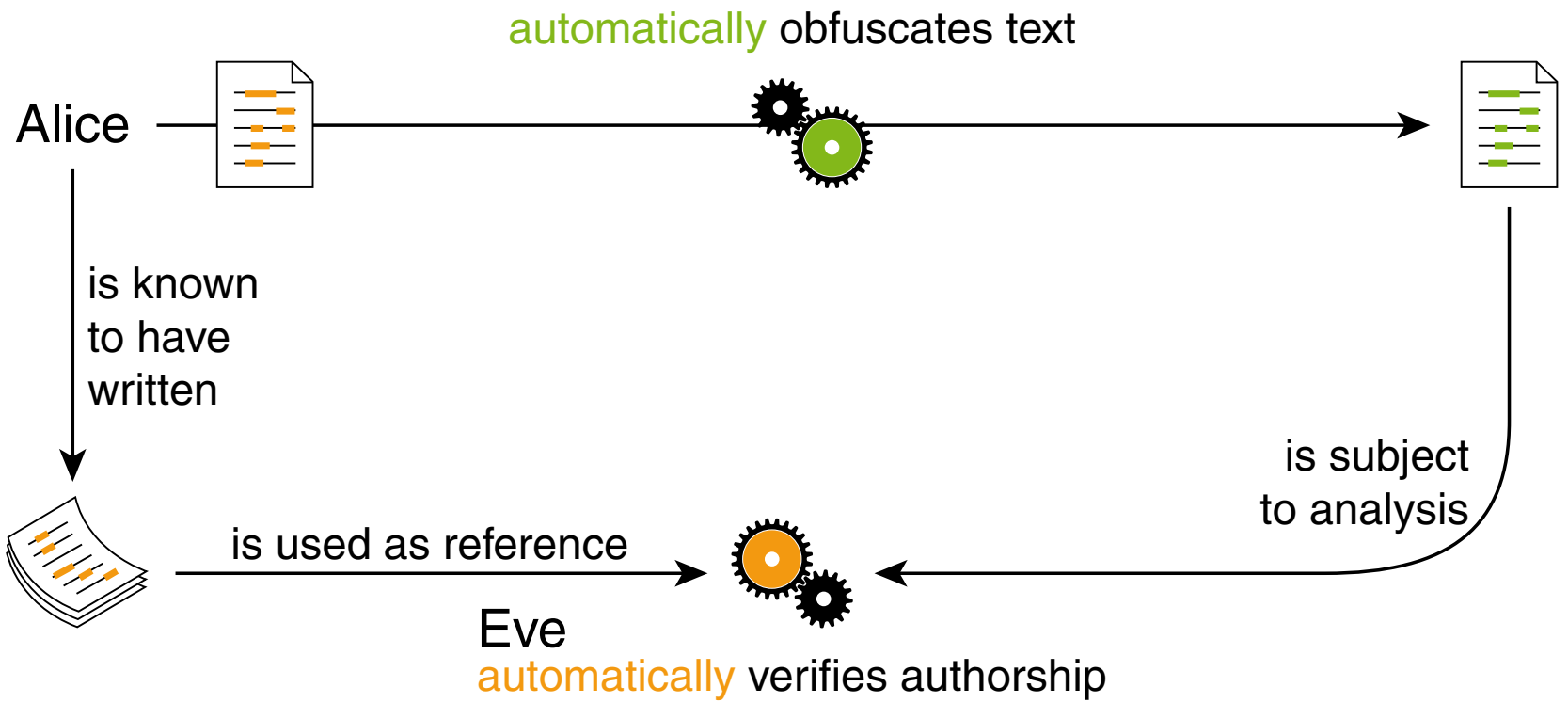

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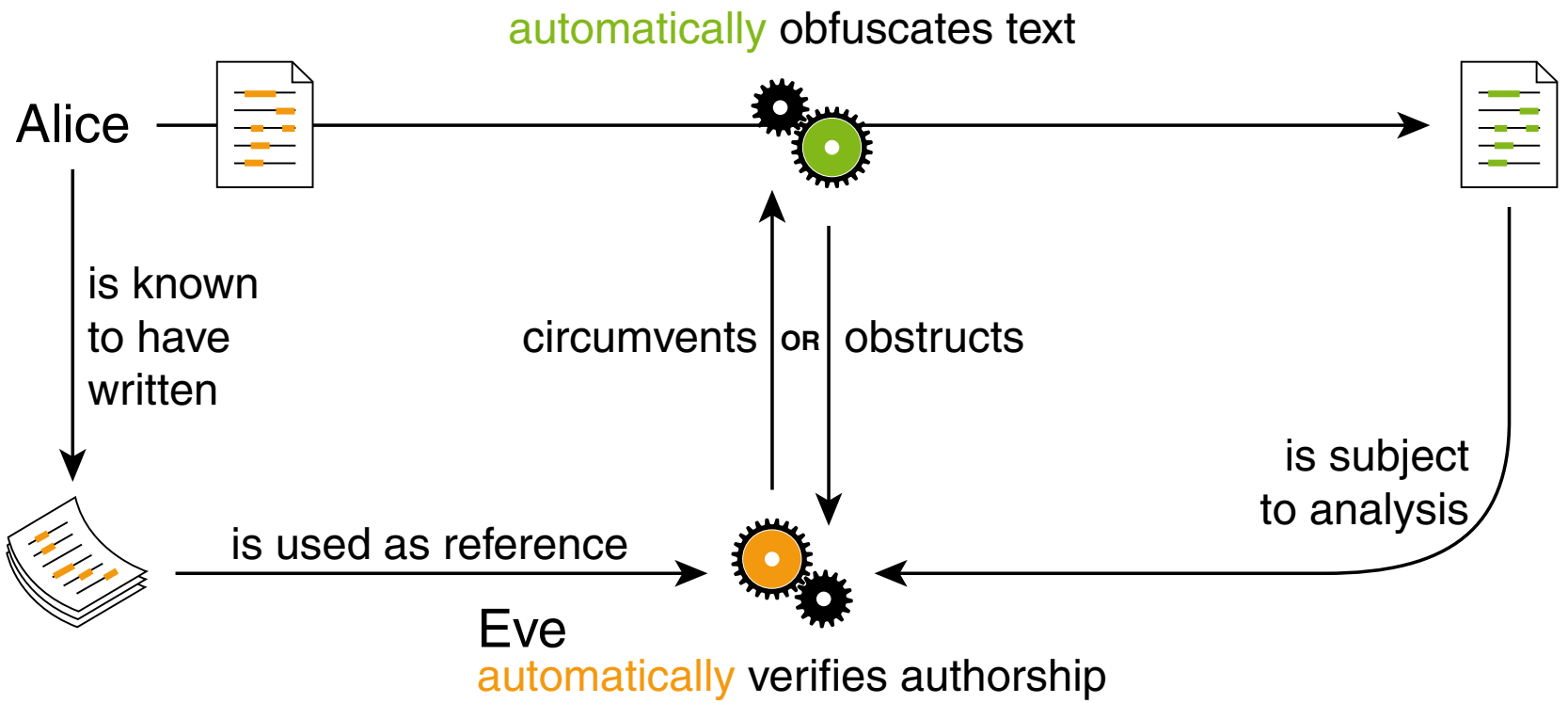

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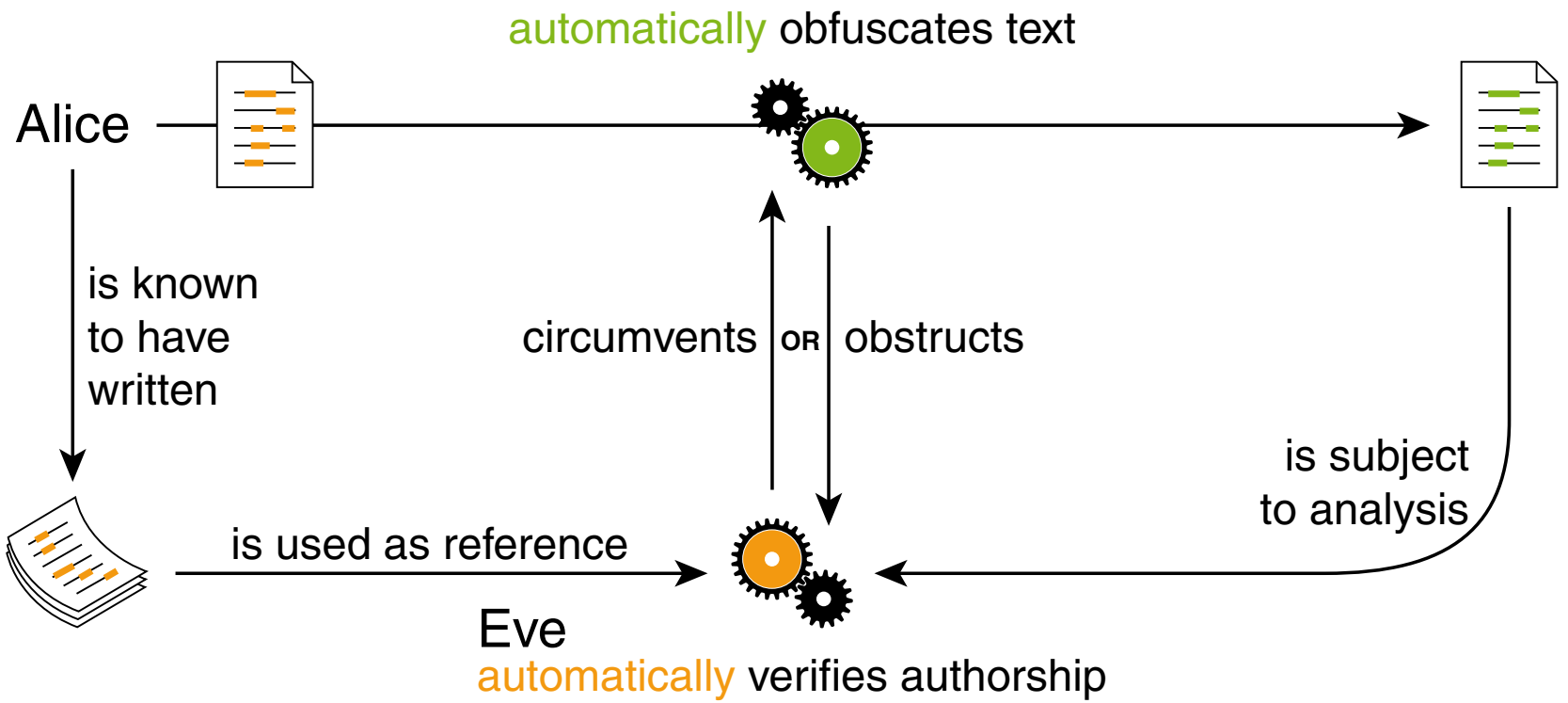

Author masking:

Given two documents by the same author, paraphrase the designated one so that the author cannot be verified anymore.

vs.

Authorship verification:

Given two documents, decide whether they have been written by the same author.

Obfuscation vs. Identification

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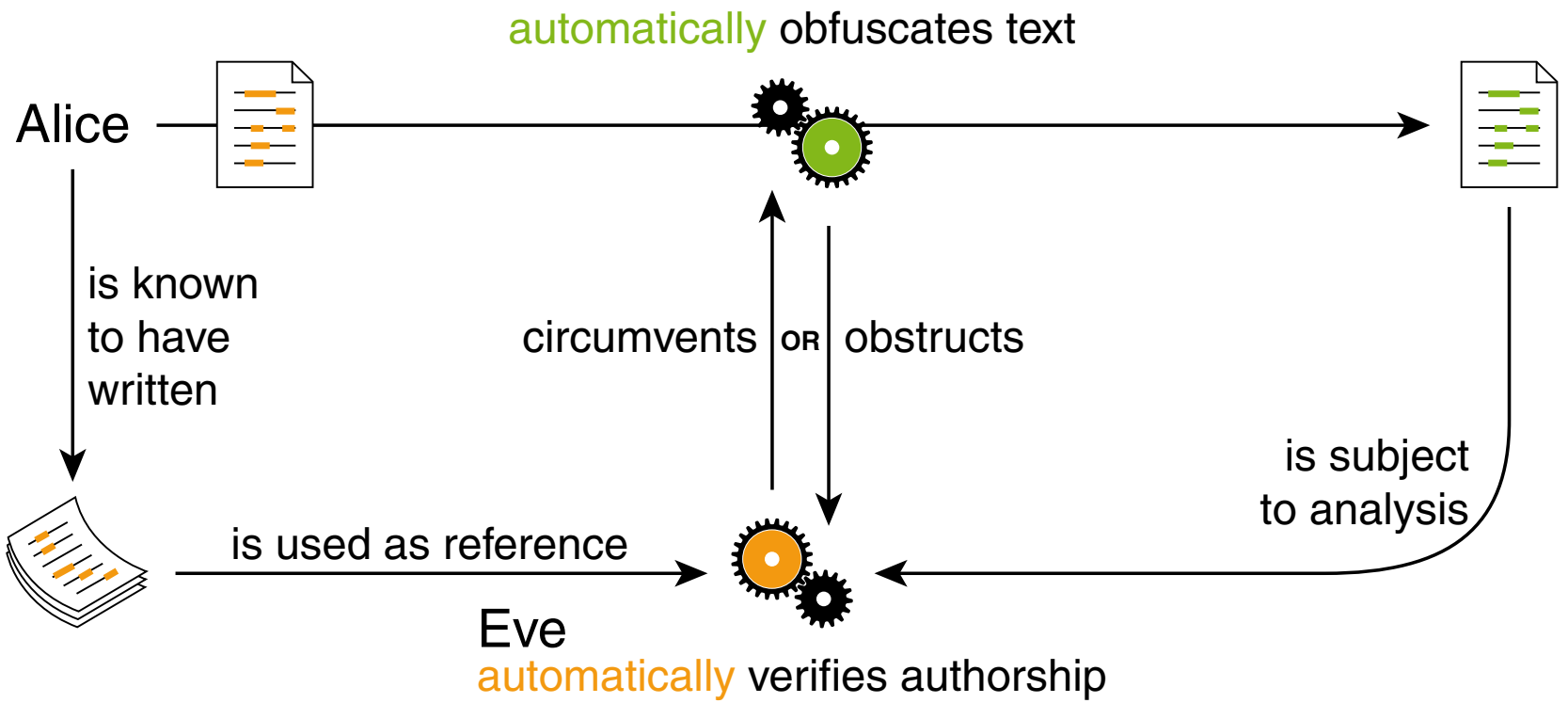


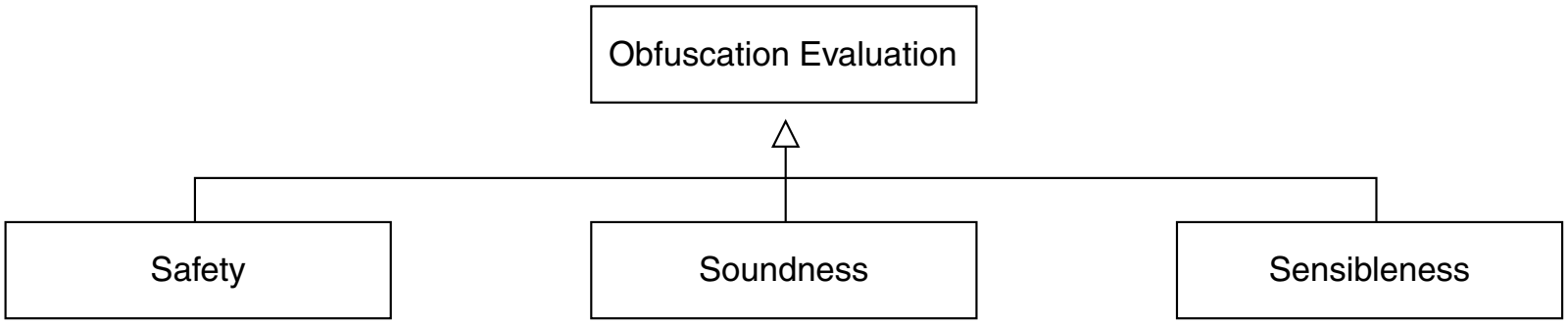
Key questions

- How vulnerable are verification approaches to obfuscation?
- How successful are obfuscation approaches against verification?
- Which technology will ultimately dominate the other?

Obfuscation Evaluation

Obfuscation Evaluation

Taxonomy of Evaluation Dimensions

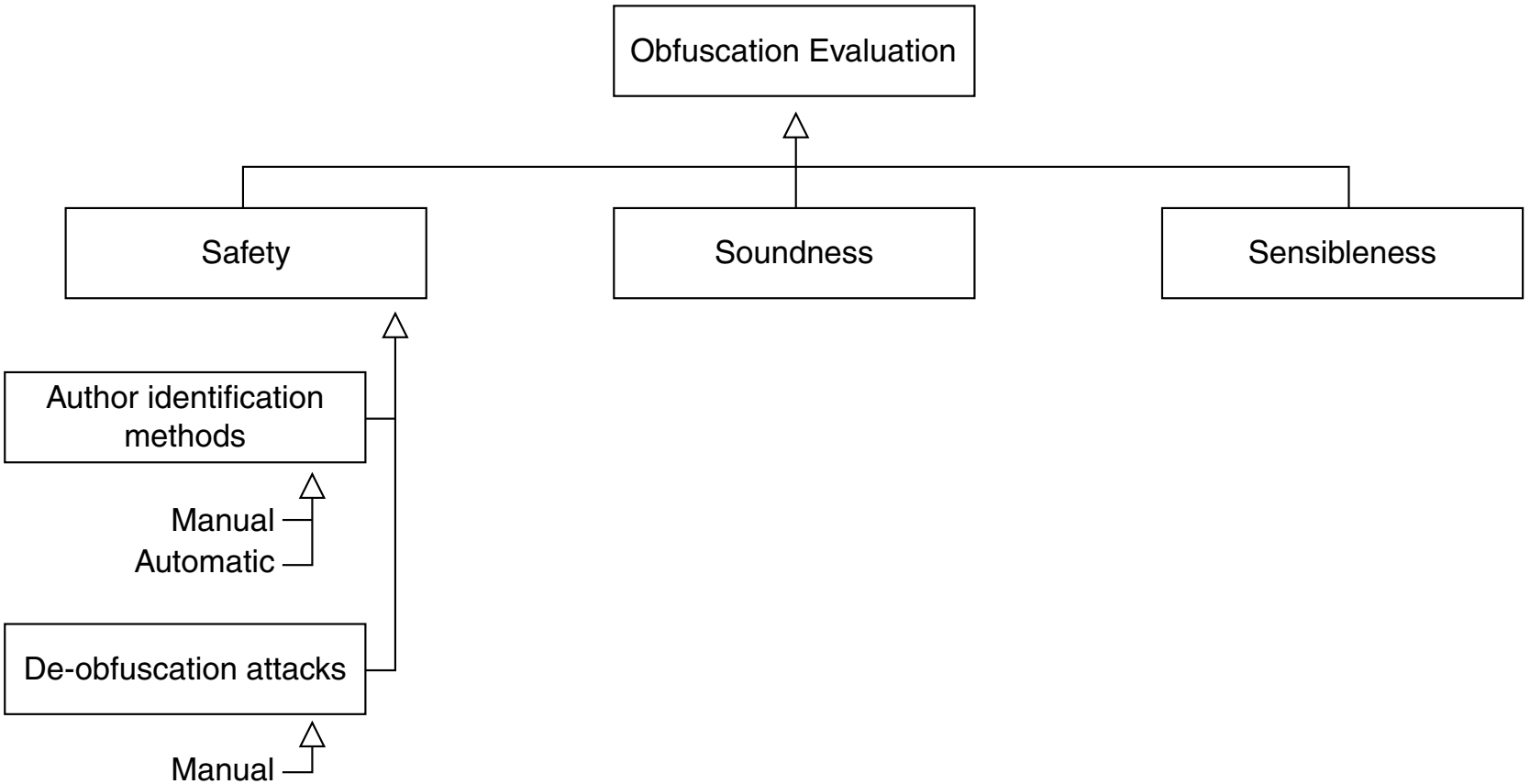


We call an obfuscation software

- **safe**, if its obfuscated texts can not be attributed to their original authors,
- **sound**, if its obfuscated texts are textually entailed by their originals, and
- **sensible**, if its obfuscated texts are well-formed and inconspicuous.

Obfuscation Evaluation

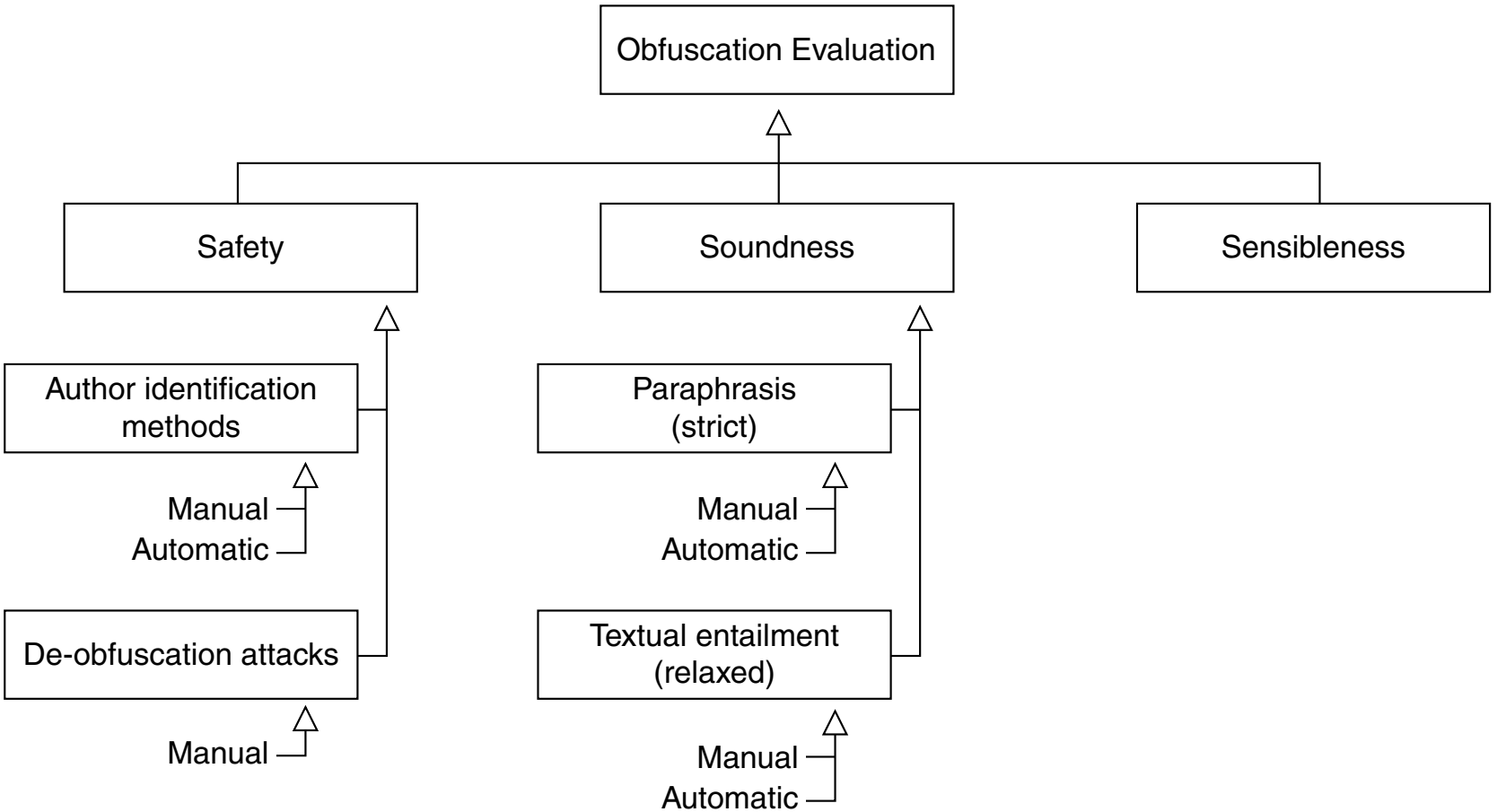
Taxonomy of Evaluation Dimensions



- Manual safety evaluation against forensic linguists not scalable
- Automatic safety evaluation requires large amount of implementations
- Several obfsucation approaches can be undone

Obfuscation Evaluation

Taxonomy of Evaluation Dimensions



- Paraphrase: obfuscation restates the original with different words
- Textual entailment: obfuscation follows logically from original
- Support manual review with visual text comparison

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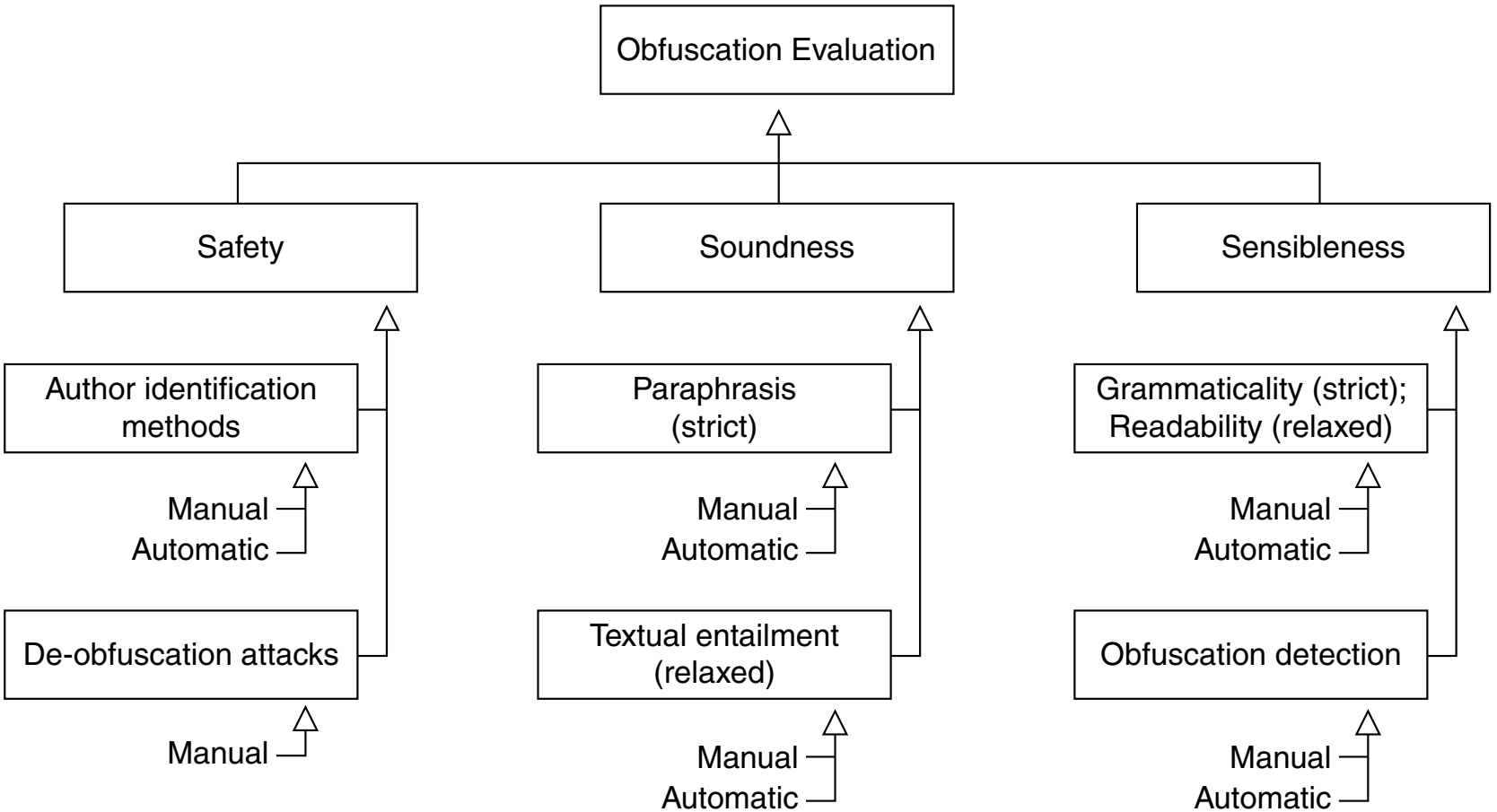

- Relax grammaticality: machine translation also not perfect, yet useful
- Hiding obfuscation useful to avoid in-depth (manual) forensic analysis
- Automatic evaluation involves cutting edge research

Obfuscation Evaluation

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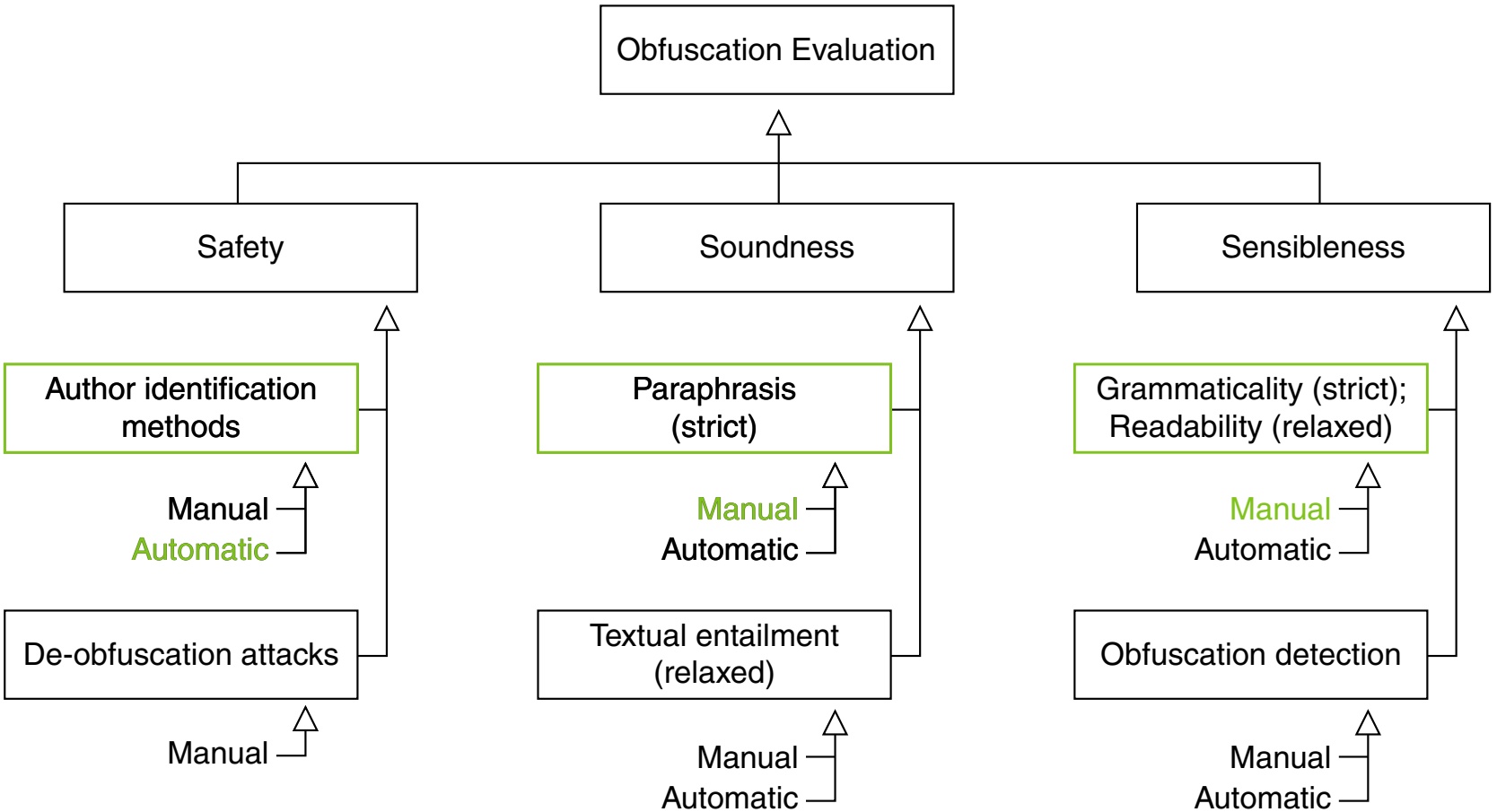
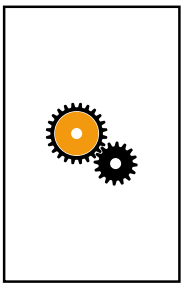
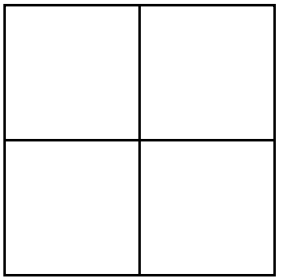


- Evaluations conducted in our shared task

Obfuscation Evaluation

Shared Task Setup





Obfuscation Evaluation

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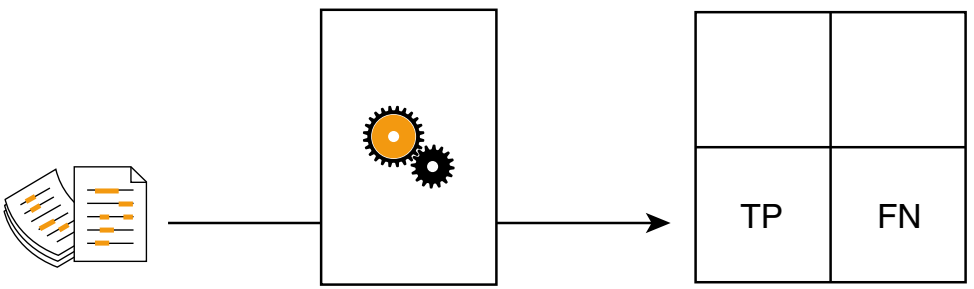
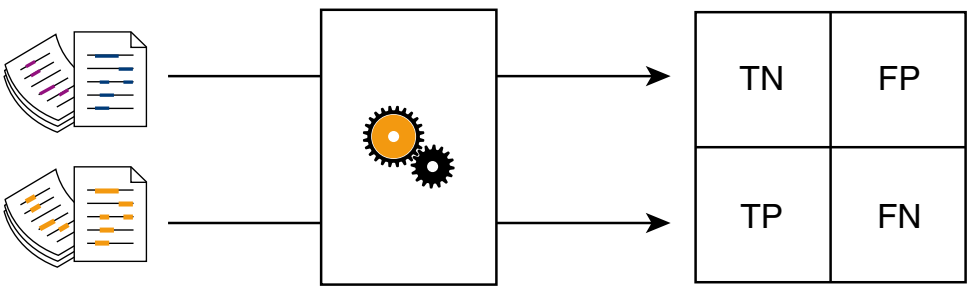


Obfuscation Evaluation

Shared Task Setup

PAN 13/14/15: Authorship Verification | Evaluation



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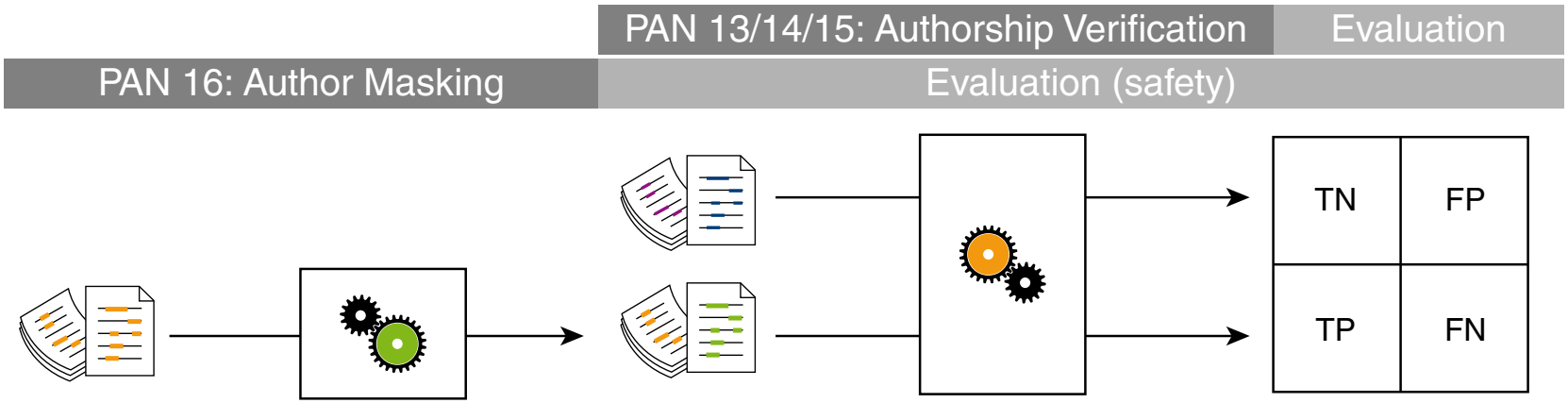

This setup tells us

- whether an obfuscator can defeat a verifier

Obfuscation Evaluation

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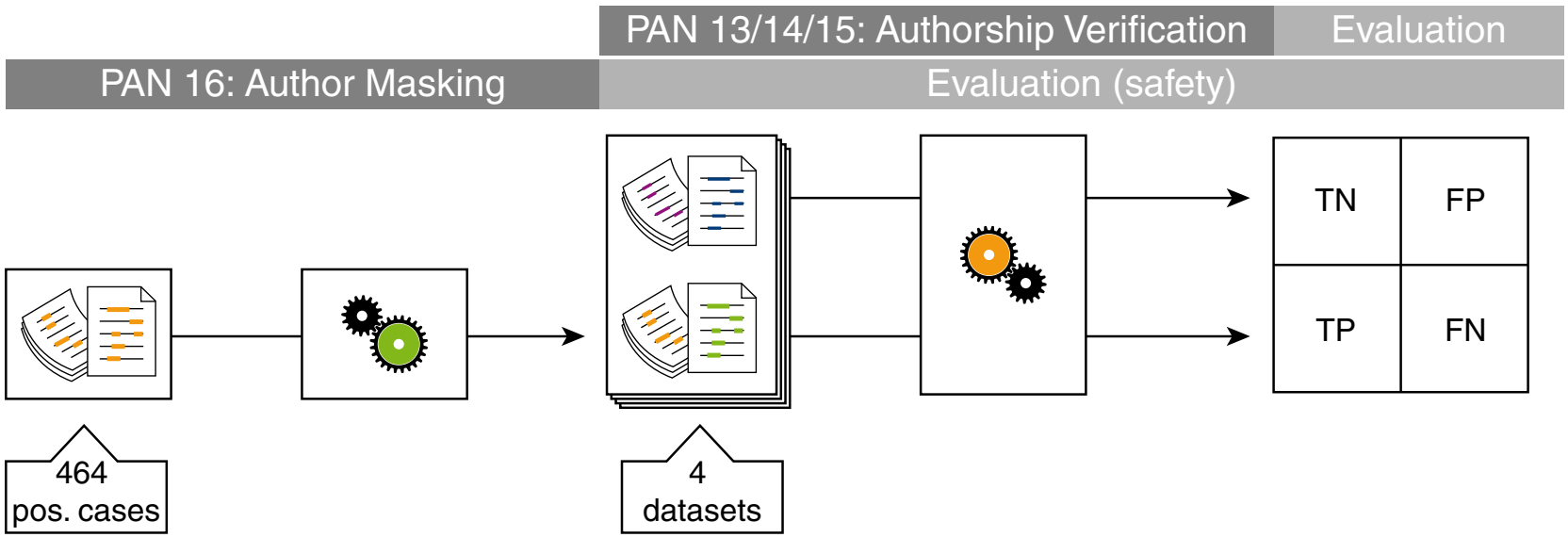

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- whether an obfuscator can defeat a verifier
- whether an obfuscator can defeat a verifier in general

Obfuscation Evaluation

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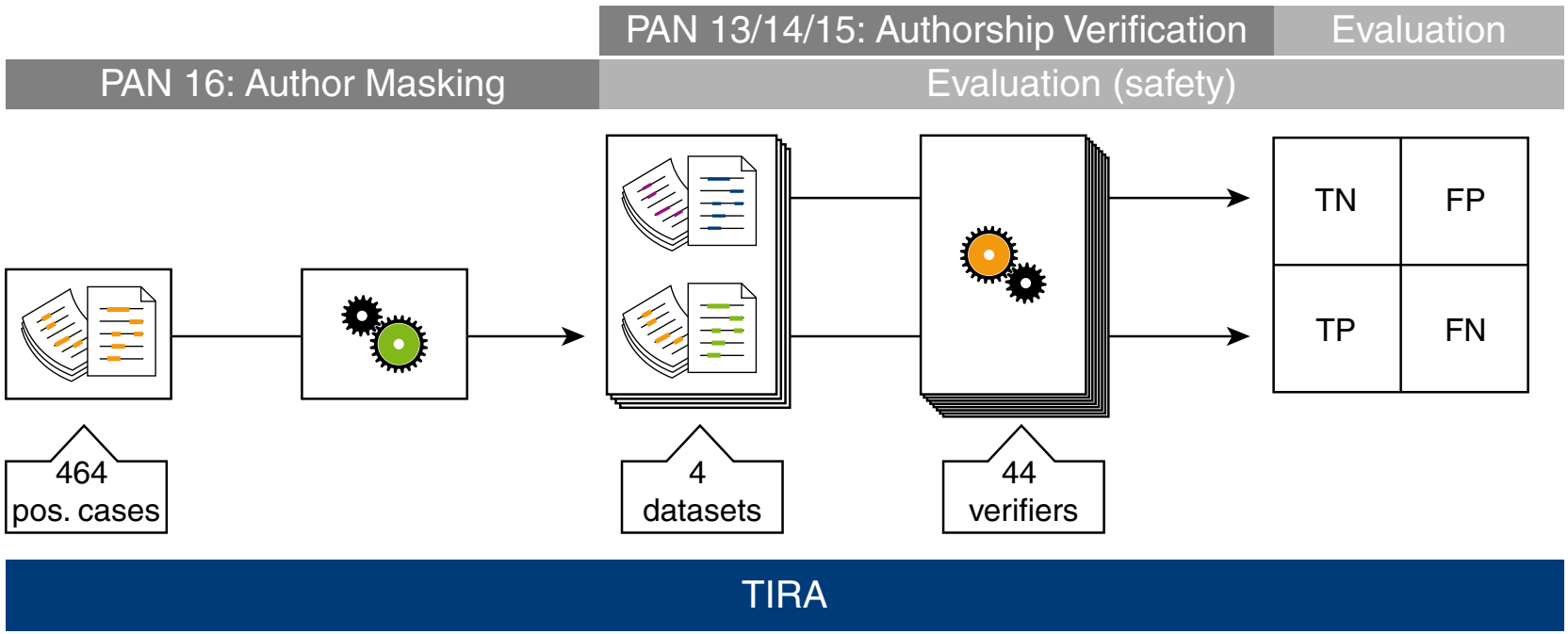

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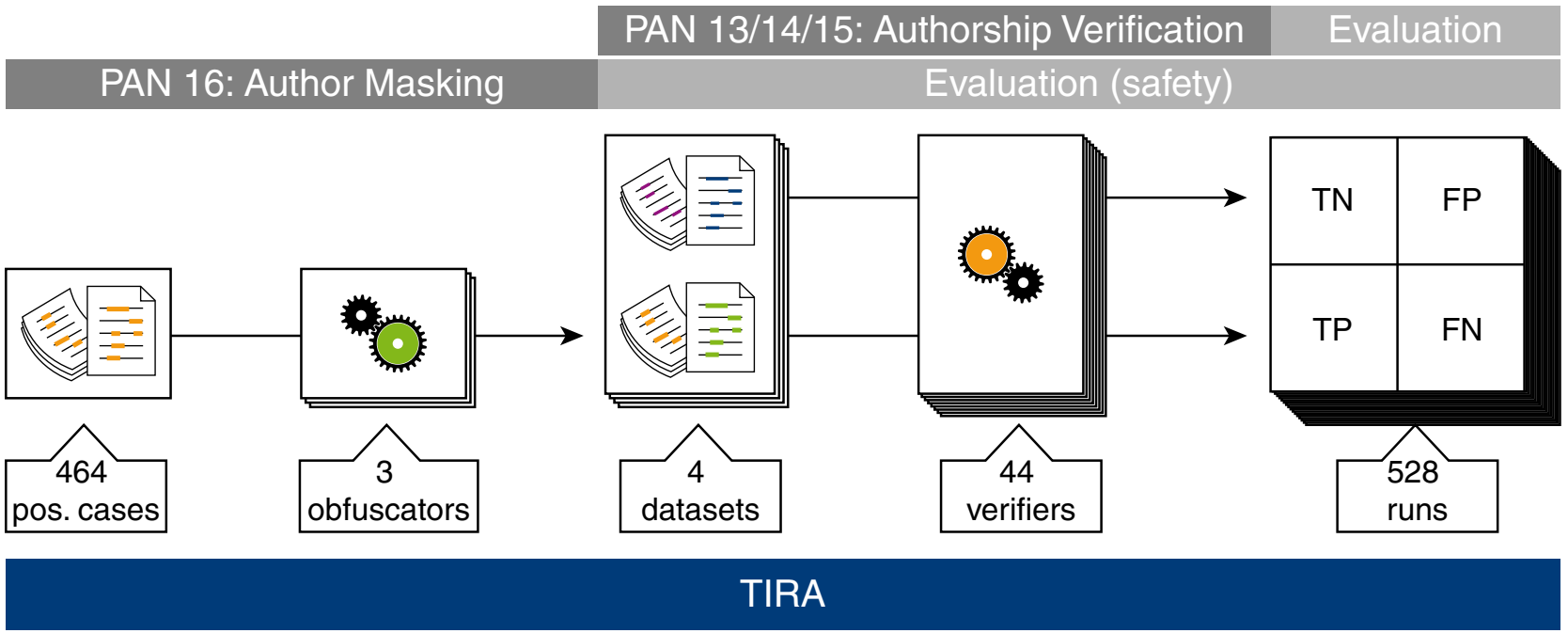

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Obfuscation Evaluation

Measuring Obfuscation Impact

Performance without obfuscation

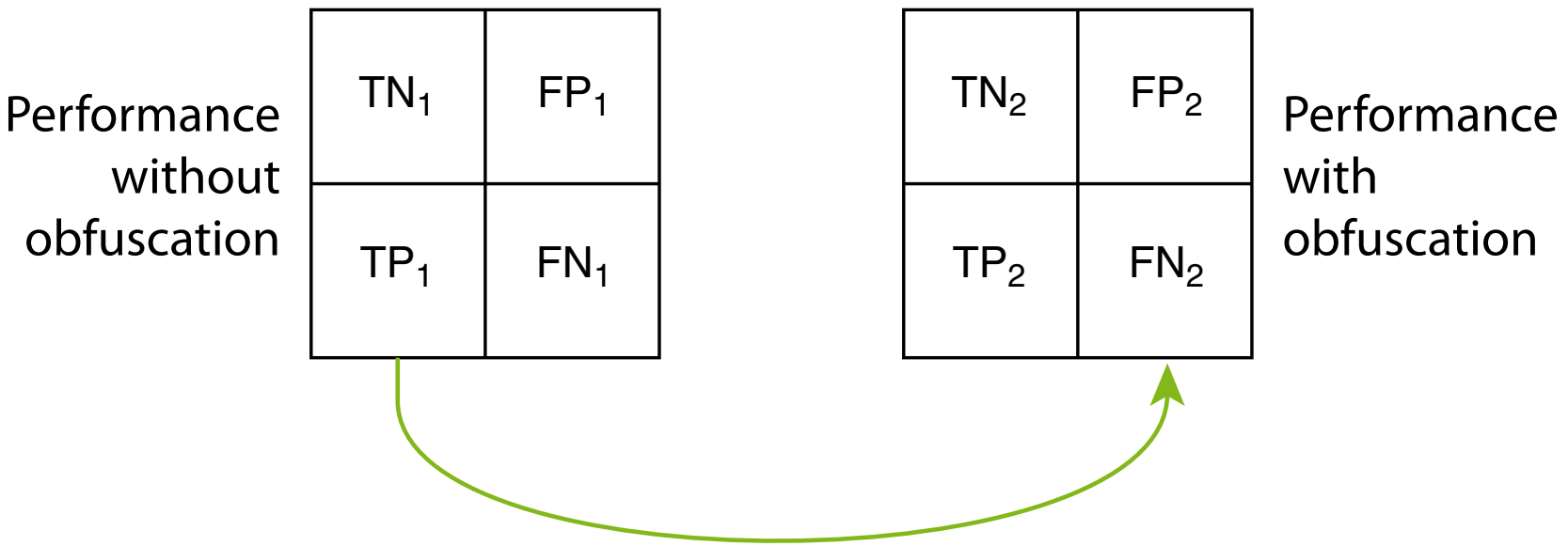
TN_1	FP_1
TP_1	FN_1

TN_2	FP_2
TP_2	FN_2

Performance with obfuscation

Obfuscation Evaluation

Measuring Obfuscation Impact



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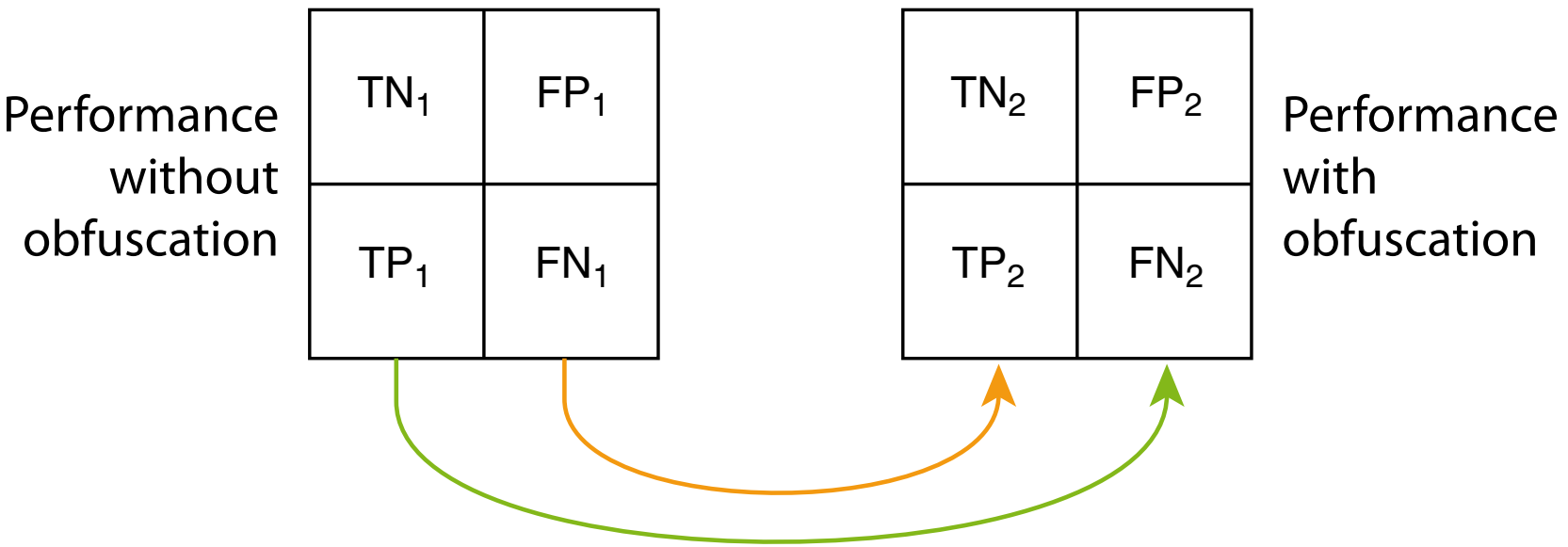

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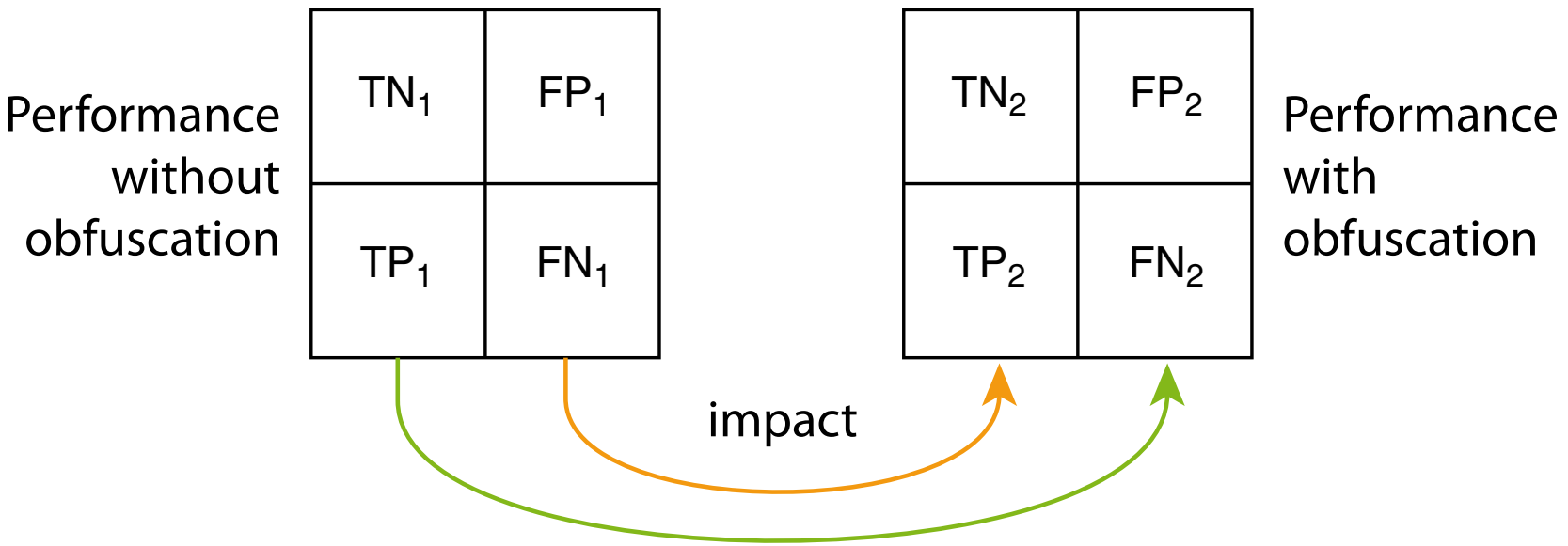

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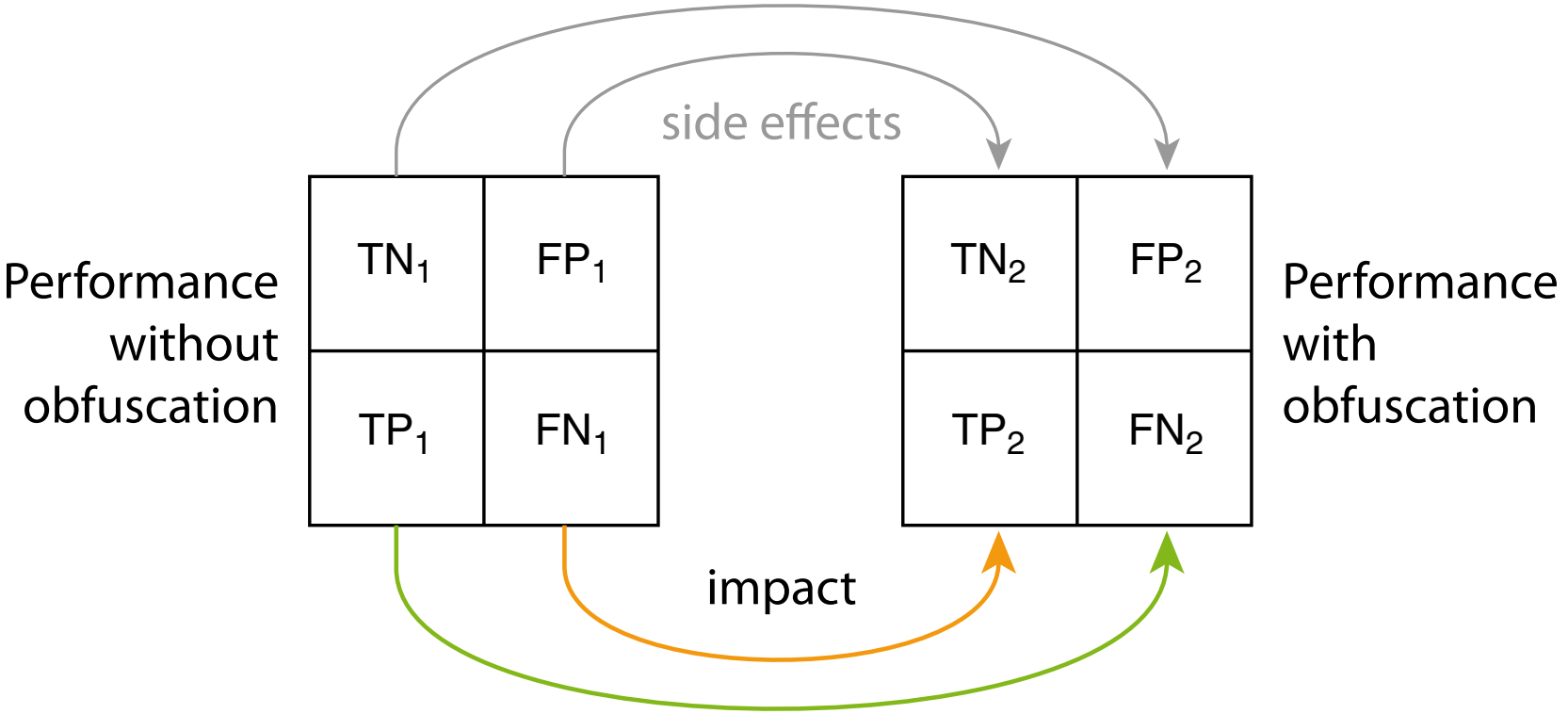
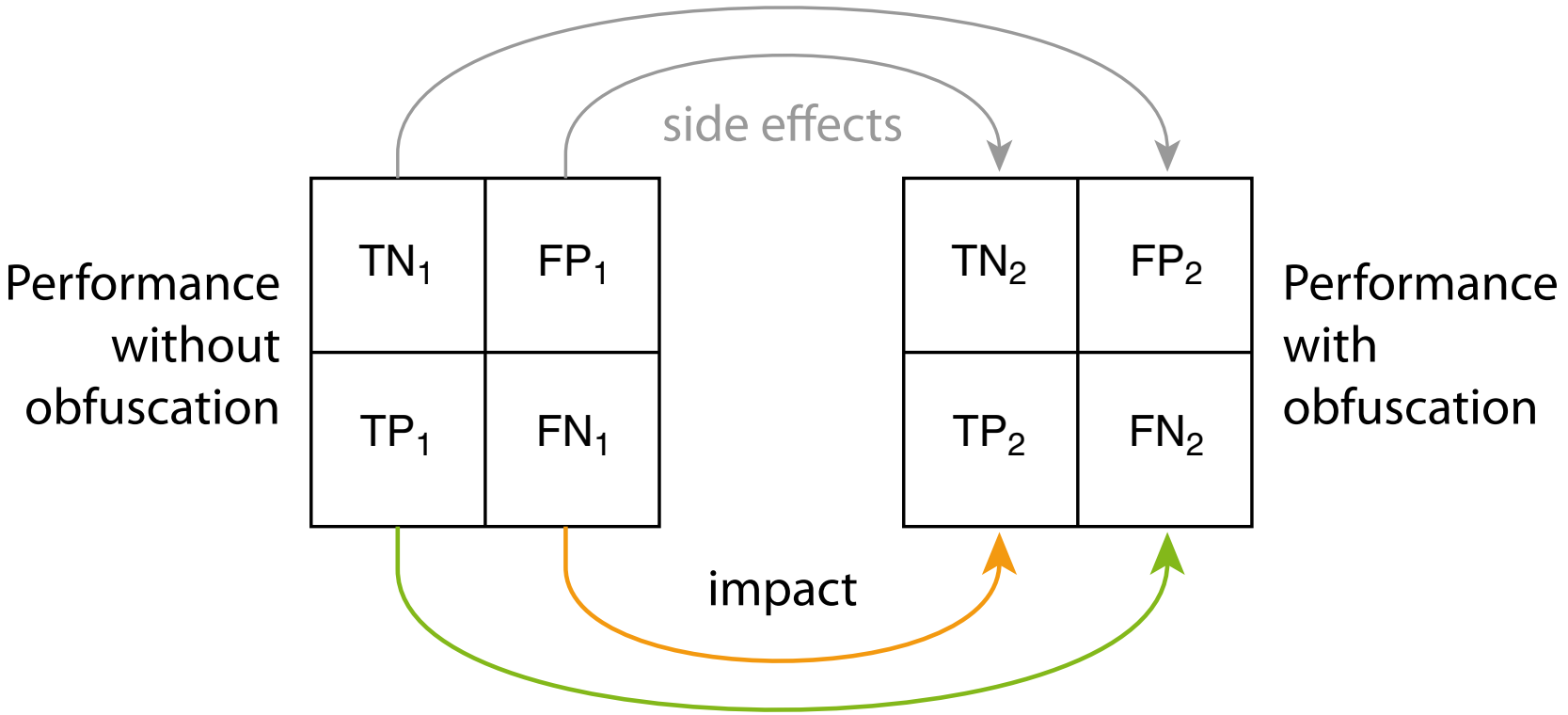


- Side effects indicate that the verifier employs corpus-relative features
- Corpus-relative features are an anti-pattern since verification cases do not come in groups

Obfuscation Evaluation

Measuring Obfuscation Impact

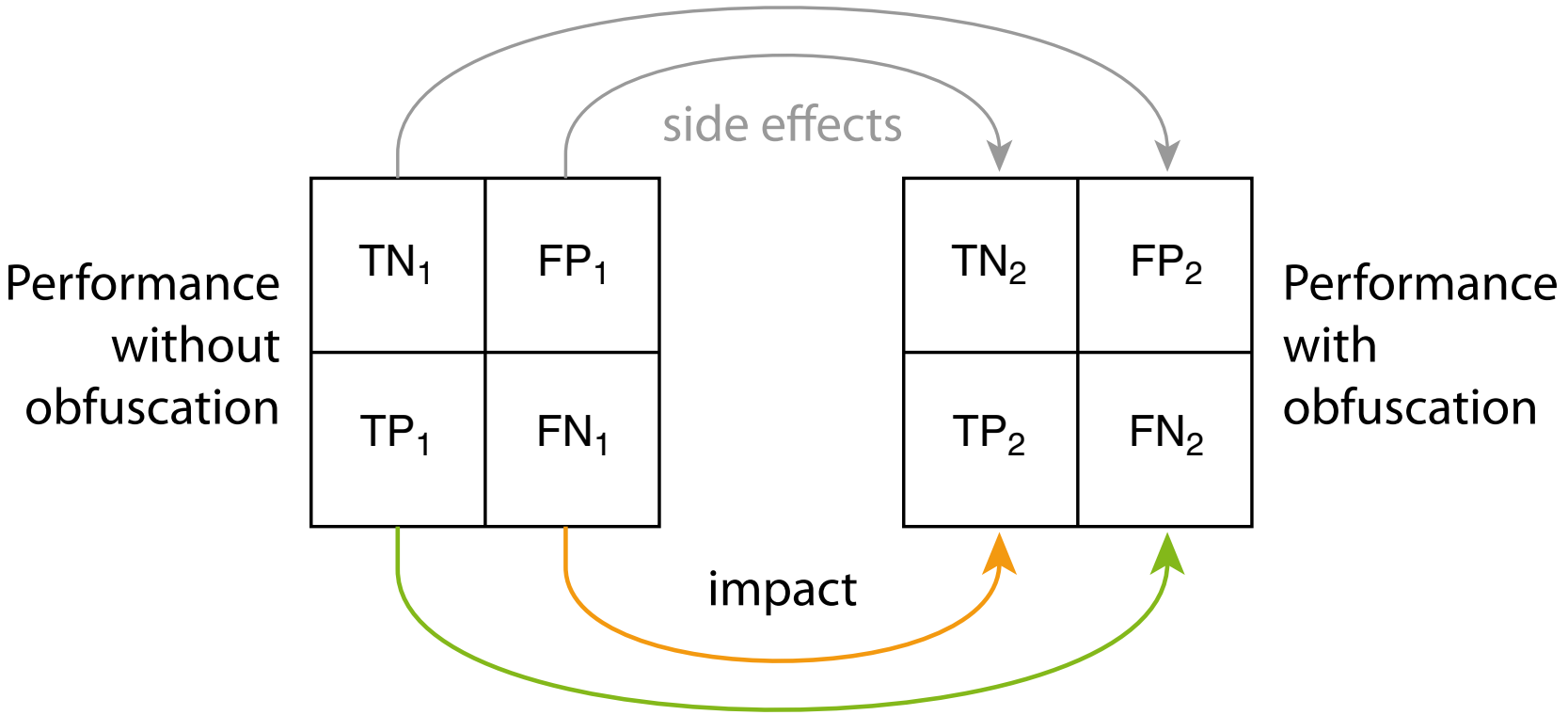


$$\mathrm{rec}_1 = \frac{\mathrm{TP}_1}{\mathrm{TP}_1 + \mathrm{FN}_1} \qquad \mathrm{rec}_2 = \frac{\mathrm{TP}_2}{\mathrm{TP}_2 + \mathrm{FN}_2}$$

$$\Delta_{\mathrm{rec}} = \mathrm{rec}_2 - \mathrm{rec}_1$$

Obfuscation Evaluation

Measuring Obfuscation Impact



$$\text{imp} = \begin{cases} -\frac{\Delta_{\text{rec}}}{\text{rec}_1} & \text{if } \Delta_{\text{rec}} < 0, \\ -\frac{\Delta_{\text{rec}}}{1-\text{rec}_1} & \text{else.} \end{cases}$$

Obfuscation Evaluation

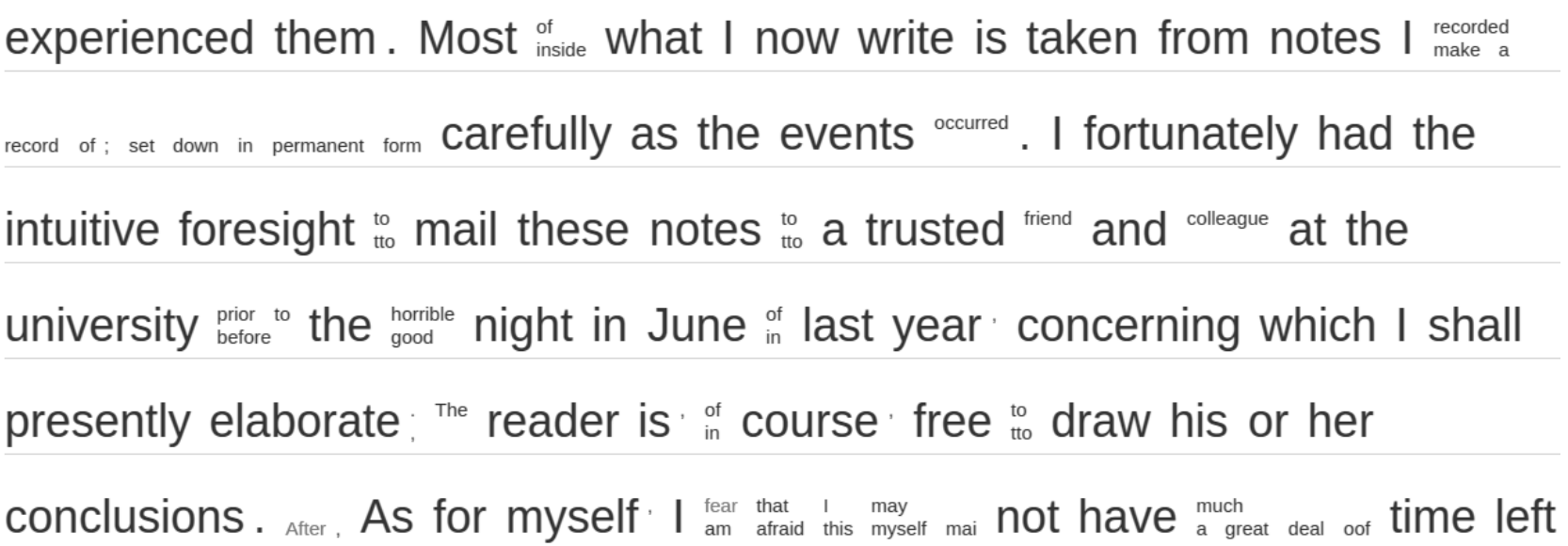
Safety Evaluation Results

Obfuscator	**Dataset**	**Pos. cases**	avg $\triangle_{rec}$	avg imp
Mihaylova *et al.*	PAN13	14	**-0.2778**	**0.4690**
Keswani *et al.*	PAN13	14	-0.2361	0.4245
Mansoorizadeh *et al.*	PAN13	14	-0.0933	0.1442
Mihaylova *et al.*	PAN14 EE	100	**-0.2304**	**0.4891**
Keswani *et al.*	PAN14 EE	100	-0.1873	0.4058
Mansoorizadeh *et al.*	PAN14 EE	100	-0.1038	0.2512
Mihaylova *et al.*	PAN14 EN	100	**-0.2456**	**0.4750**
Keswani *et al.*	PAN14 EN	100	-0.1783	0.3769
Mansoorizadeh *et al.*	PAN14 EN	100	-0.0958	0.2345
Mihaylova *et al.*	PAN15	250	**-0.2009**	**0.3649**
Keswani *et al.*	PAN15	250	-0.1298	0.2543
Mansoorizadeh *et al.*	PAN15	250	-0.0994	0.1952

Obfuscation Approaches

Obfuscation Approaches

Mihaylova et al.



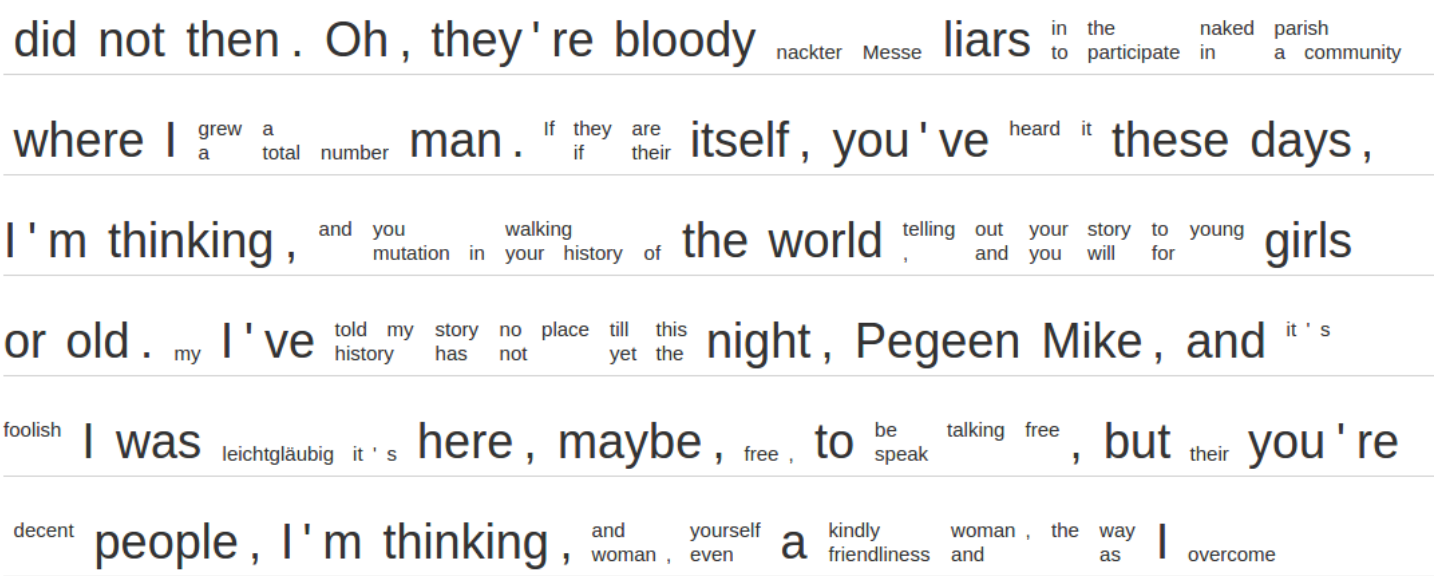
- Targets 6 style features: sentence length, punctuation, stop words, parts of speech, all caps, word frequencies
- Computation of expected values based on background corpus
- Obfuscation towards the average using rule-based text operations; 14 rules

Observations

- Unfitting replacements, semantic distortions, overdone error insertion

Obfuscation Approaches

Keswani et al.



- Round-trip translation English – German – French – English
- Based on Moses SMT toolkit, trained on Europarl corpus

Observations

- Fragments of non-English text remain from translation
- Europarl corpus ill-suited for the genres of the test datasets
- Text unsound and unreadable

Obfuscation Approaches

Mansoorizadeh et al.

run - time system organization called the JRE . This approach has some advantages and disadvantages and it is worth comparing these three options in order to appreciate the implications for the Java coffee developer . The compiler translates the source code into machine car code for the relevant hardware / OS combination . Strictly speaking there are two stages : compilation of program units (usually files) , followed by ‘ linking ’ when the complete accomplished

- Conservative paraphrasing: at most 1 word per sentence replaced
- Replacement candidates chosen among 200 most frequent words
- Replacements obtained from WordNet, based on word similarity
- Selection based on commonness under 4-gram language model

Observations

- Lots of problems with genre-specific terminology

Obfuscation Evaluation

Peer Evaluation

- Given training runs of each obfuscator, evaluate their performance
- Participants anonymized; yet, self-identification likely
- 3 participating teams, 1 independent (i.e., without obfuscator submission): Mihaylova et al., Mansoorizadeh et al., and Liebeck et al.

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Safety

- In all cases, based on GLAD verification system
- 2 rank Mihaylova $\succ$ Keswani $\succ$ Mansoorizadeh (in agreement with us)
- Mansoorizadeh ranks Keswani $\succ$ Mansoorizadeh $\succ$ Mihaylova

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Soundness

- Liebeck employ SemEval STS measure, scoring from 5 (best) to 0 (worst)
- All obfuscators score >4
- Mihaylova and Mansoorizadeh assign scores manually
- 2 rank Mansoorizadeh $\succ$ Mihaylova $\succ$ Keswani (in agreement with us)
- Mihaylova ranks Mihaylova $\succ$ Mansoorizadeh $\succ$ Keswani

Obfuscation Evaluation

Peer Evaluation (cont'd)

Sensibleness

- All assessors resort to manual review
- Scales include 0-5 (Mansoorizadeh), 0-2 (Liebeck), 0,1 (Mihaylova)
- All rank Mansoorizadeh $\succ$ Mihaylova $\succ$ Keswani (in agreement with us)

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Organizer Evaluation wrt. Soundness and Sensibleness

Sensibleness

- School grading 1-5 (fail) of 1 text per obfuscator per dataset
- Our ranking: Mansoorizadeh (2) $\succ$ Mihaylova (4-5) $\succ$ Keswani (5)

Soundness

- After grading, reading the originals, and comparison with Diff visualization
- Judgment of whole texts on scale 0 ("incorrect"), 1 ("passable"), 2 ("correct")
- Our ranking: Mansoorizadeh (1+) $\succ$ Mihaylova (0+) $\succ$ Keswani (0)

Conclusion

Summary

- 3 author obfuscators vs. 44 authorship verifiers in 4 settings
- Authorship verifiers represent the state of the art as per PAN'13/14/15
- Obfuscators flip on average from 20% up to 49% of true positive decisions
- Even conservative obfuscation has significant impact

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Take-away messages

- State of the art in authorship verification vulnerable to obfuscation
- Automatic obfuscation is feasible, yet far from perfection
- Hardly any authorship researcher considers obfuscation a threat
- Better ways of assessing soundness and sensibleness at scale needed

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Neither can live while the other survives

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Thank you for your attention!