Current Semantic-change Quantification Methods Struggle with Discovery in the Wild

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code/data

Change in the meaning of words over time

The section of a cylinder cut by any ***plane*** *inclined to its axis is an ellipsis*

(19th century)

Schlechtweg et al. (2020)

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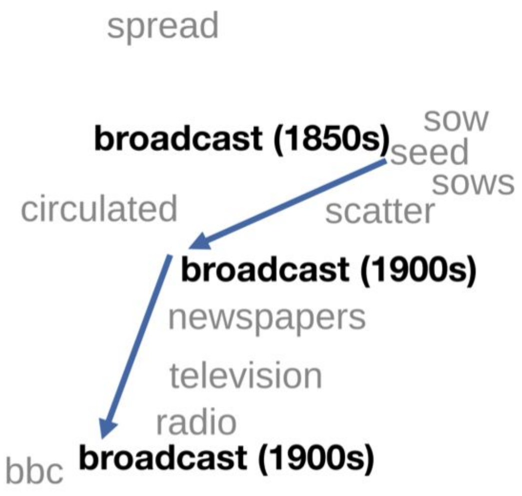
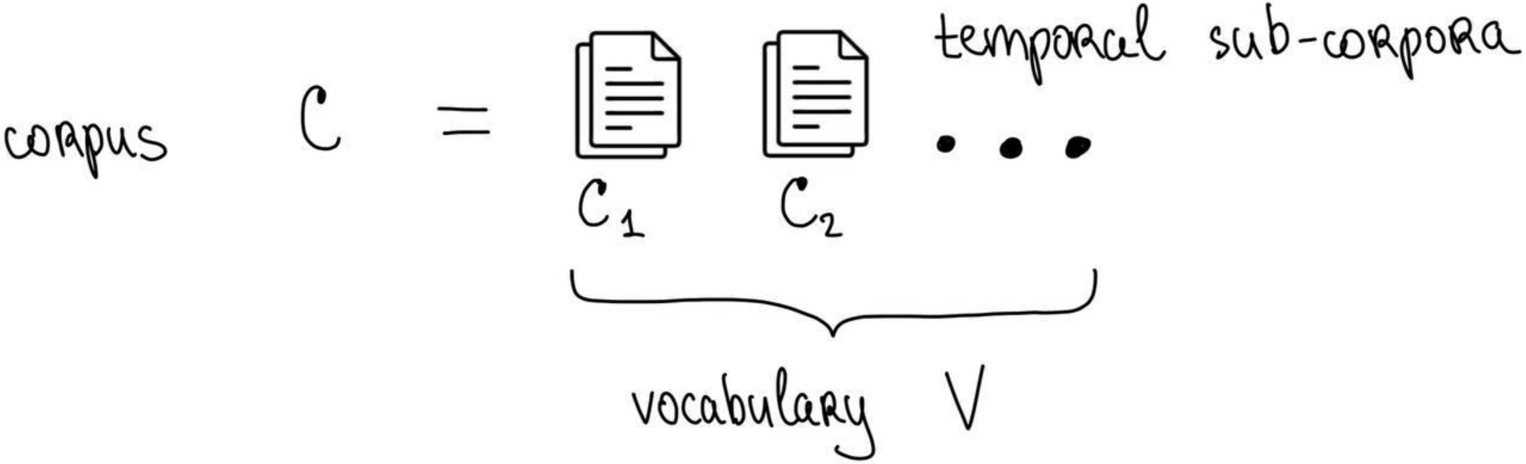


Schlechtweg et al. (2020)

Hamilton et al. (2016)



temporal sub-corpora

corpus $C = C_1 \; C_2 \; \dots$

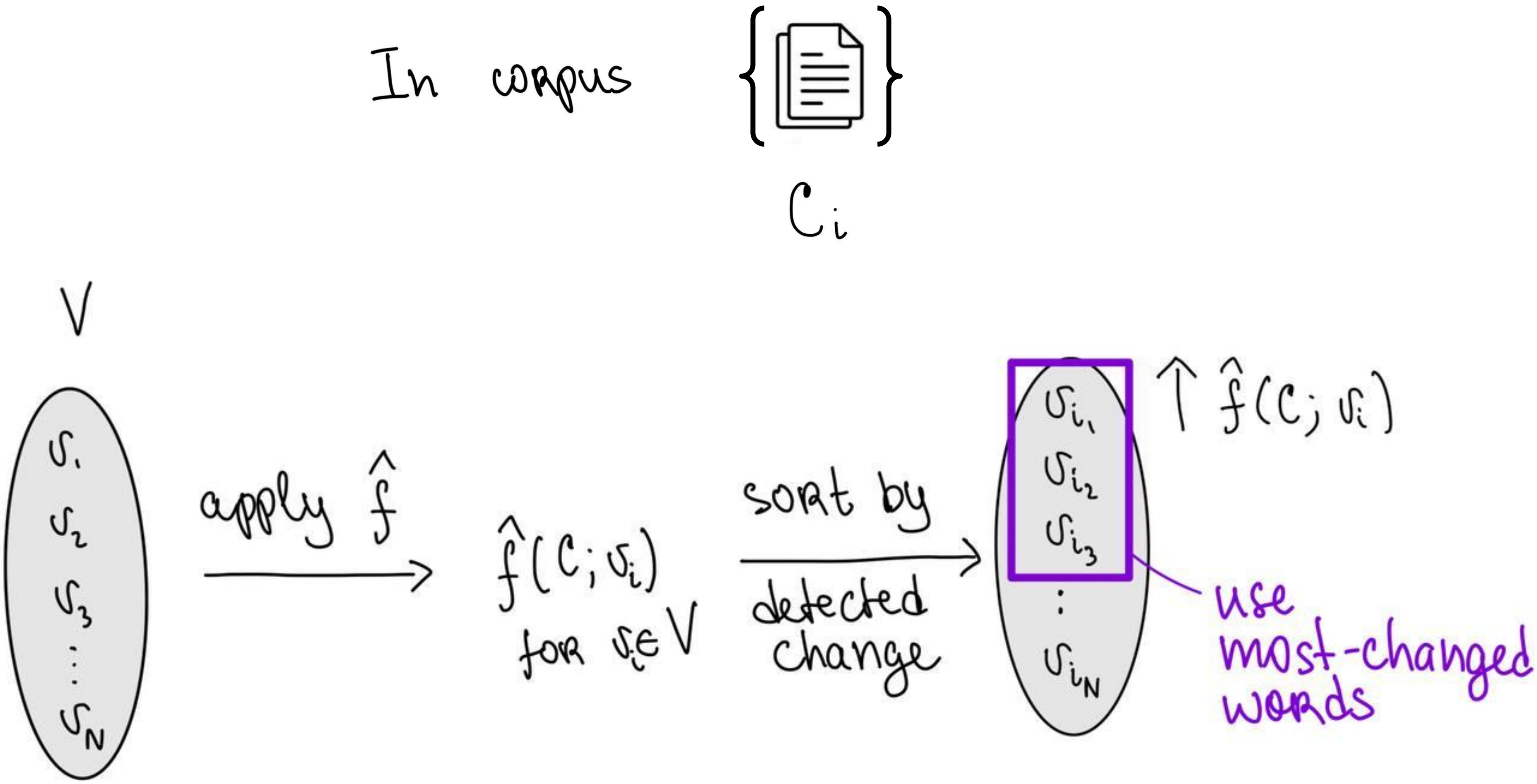
vocabulary V

temporal sub-corpora

corpus $C = \underbrace{C_1 \quad C_2 \quad \dots}_{\text{vocabulary } V}$

semantic-change quantification

scorer $\hat{f} : C, V \rightarrow [0, 1]$


In corpus
C_i
V
v_1
v_2
v_3
$\vdots$
v_N
apply $\hat{f}$
$\hat{f}(C; v_i)$
for $v_i \in V$
sort by
detected change
v_{i_1}
v_{i_2}
v_{i_3}
$\vdots$
v_{i_N}
$\uparrow \hat{f}(C; v_i)$
use most-changed words

Semantic-change detection

Generally semantic-change detection methods are evaluated on a set of benchmarks where

$T \subseteq V$

Schlechtweg et al. (2020), Del Tredici et al. (2019), Kutuzov and Pivovarova (2021), ...

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However, this evaluation doesn't illustrate discovery performance of $\hat{f}$ outside T

Evaluating semantic-change *discovery*

Without **$\ell(v, C)$** for all **$v \in V$**, it is challenging to evaluate semantic-change discovery.

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Kurtyigit et al. (2021)

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Alternative: two mutually complementary approaches

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[ranking-based] how well do semantic-change quantification methods ($\hat{f}$) rank known high changes?

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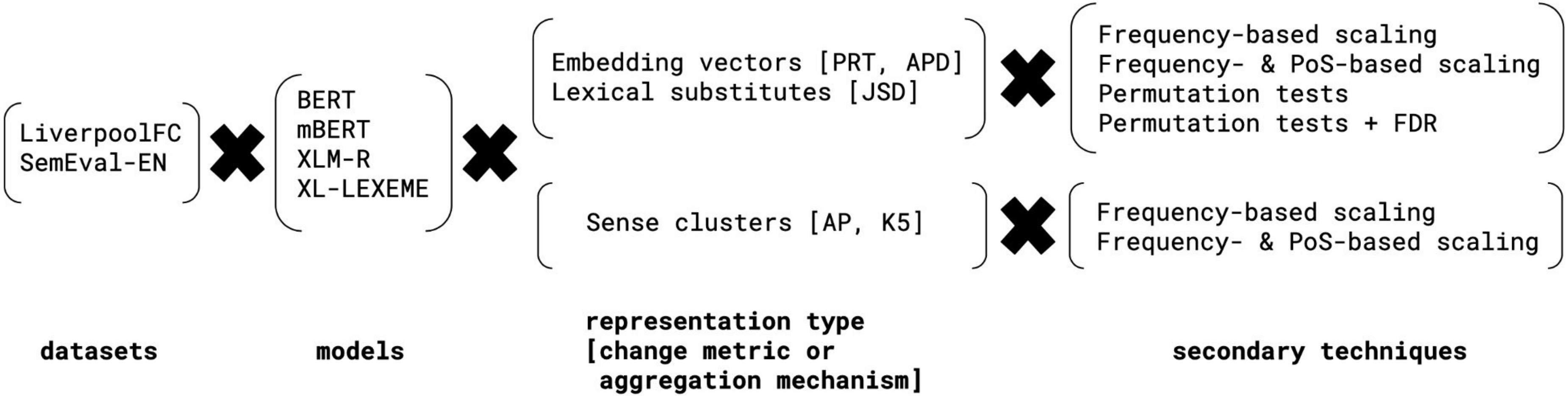
Alternative: two mutually complementary approaches

[ranking-based] how well do semantic-change quantification methods ($\hat{f}$) rank known high changes?

[annotations-based] are terms **$v \in V$** ranked high by semantic-change quantification methods ($\hat{f}$) in fact genuine semantic changes?

Evaluating semantic-change *discovery*



LiverpoolFC
SemEval-EN

×

BERT
mBERT
XLM-R
XL-LEXEME

×

Embedding vectors [PRT, APD]
Lexical substitutes [JSD]

×

Frequency-based scaling
Frequency- & PoS-based scaling
Permutation tests
Permutation tests + FDR

Sense clusters [AP, K5]

×

Frequency-based scaling
Frequency- & PoS-based scaling

datasets

models

representation type [change metric or aggregation mechanism]

secondary techniques

Ranking-based evaluation

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Within T (annotated subset of V) consider $T^* = \{t \in T \text{ such that } \ell(C, t) > \beta\}$

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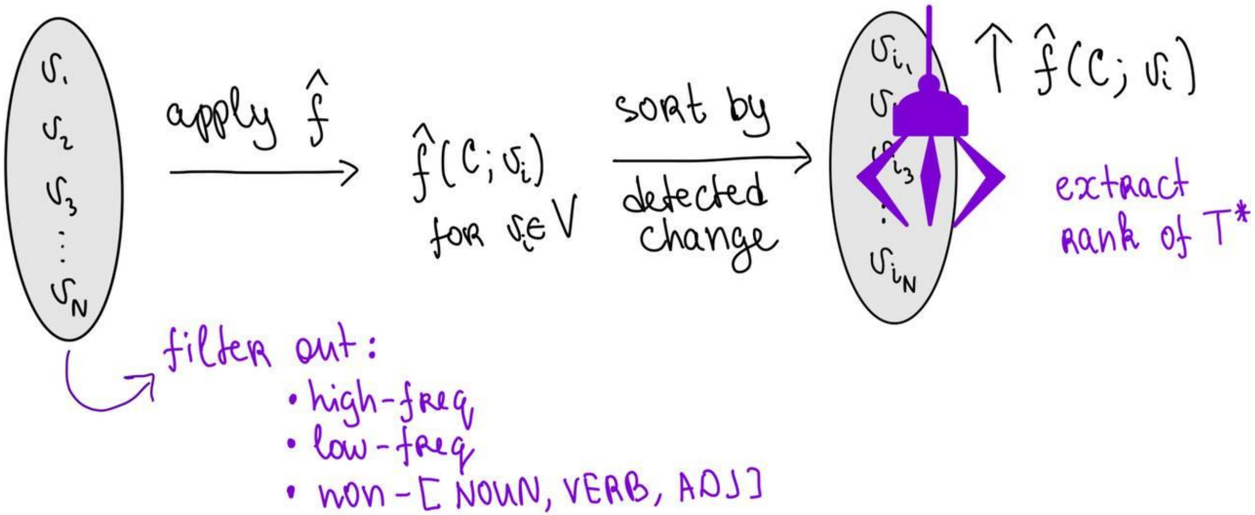
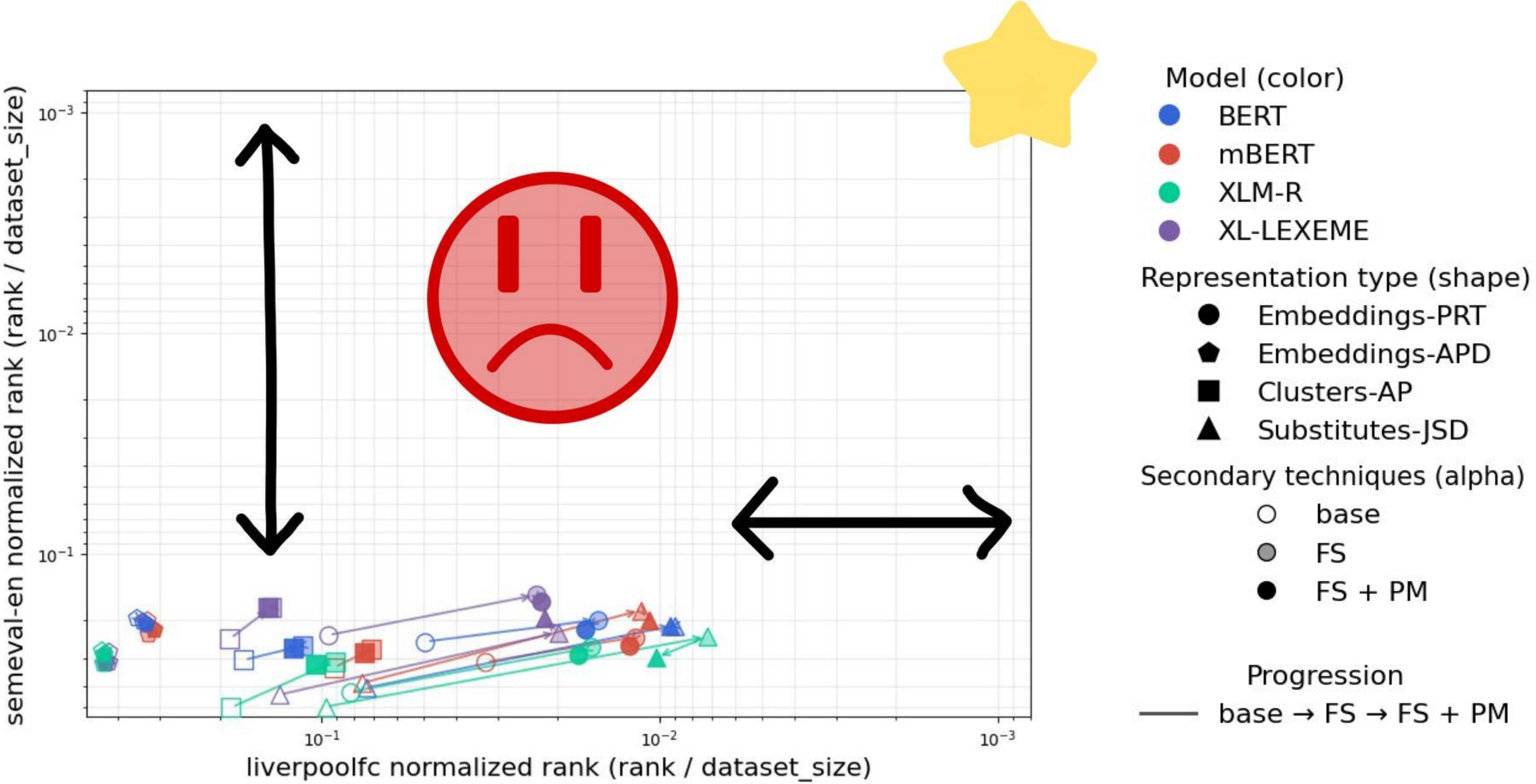
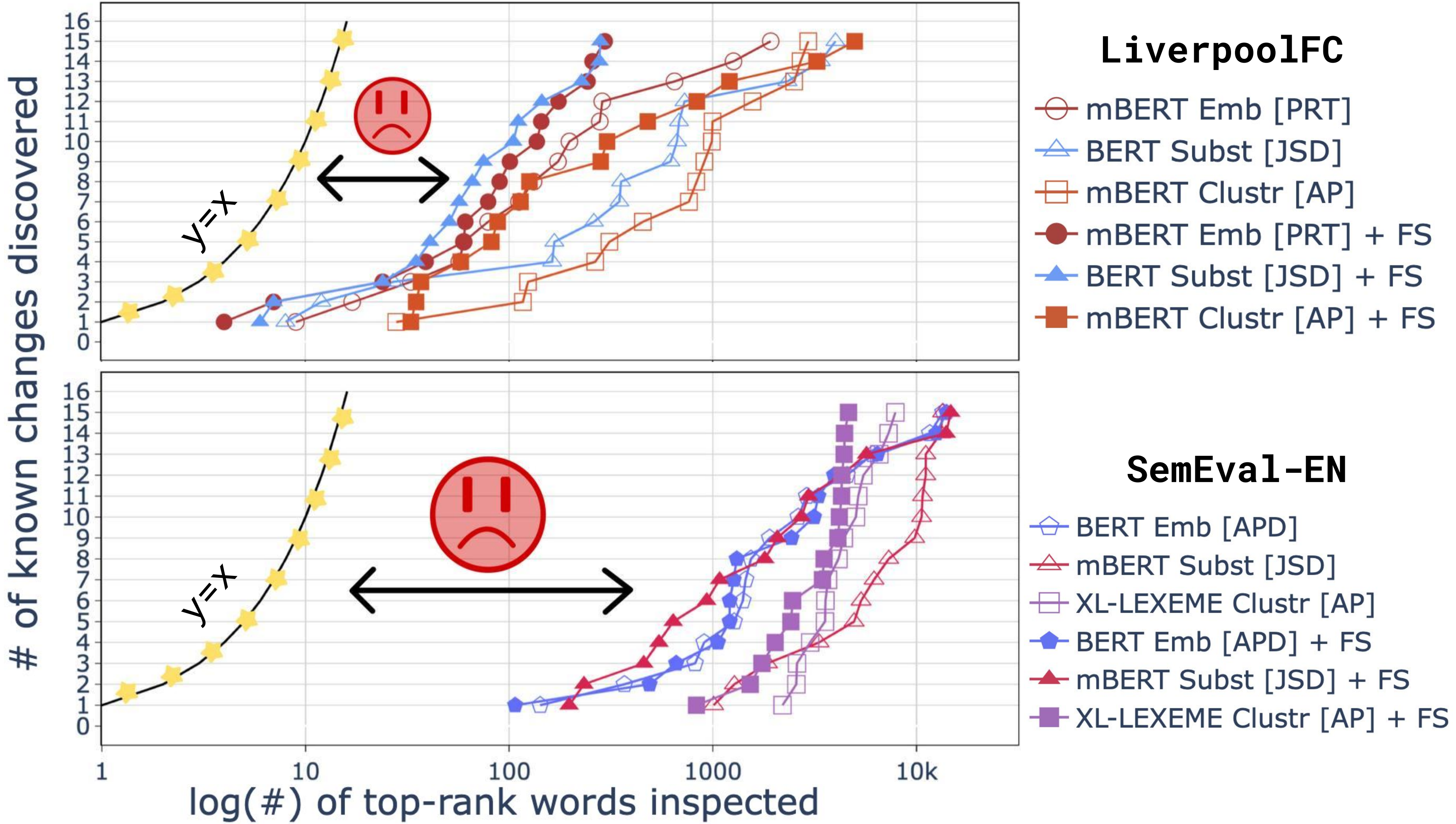


For both datasets: semantic-change quantification methods struggle at ranking T* high




LiverpoolFC
mBERT Emb [PRT]
BERT Subst [JSD]
mBERT Clustr [AP]
mBERT Emb [PRT] + FS
BERT Subst [JSD] + FS
mBERT Clustr [AP] + FS
SemEval-EN
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mBERT Subst [JSD]
XL-LEXEME Clustr [AP]
BERT Emb [APD] + FS
mBERT Subst [JSD] + FS
XL-LEXEME Clustr [AP] + FS
y=x
y=x
# of known changes discovered
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
log(#) of top-rank words inspected
1
10
100
1000
10k

Annotations-based evaluation 🔍

Ranking of T* alone **doesn't give** full understanding about ***discovery***.

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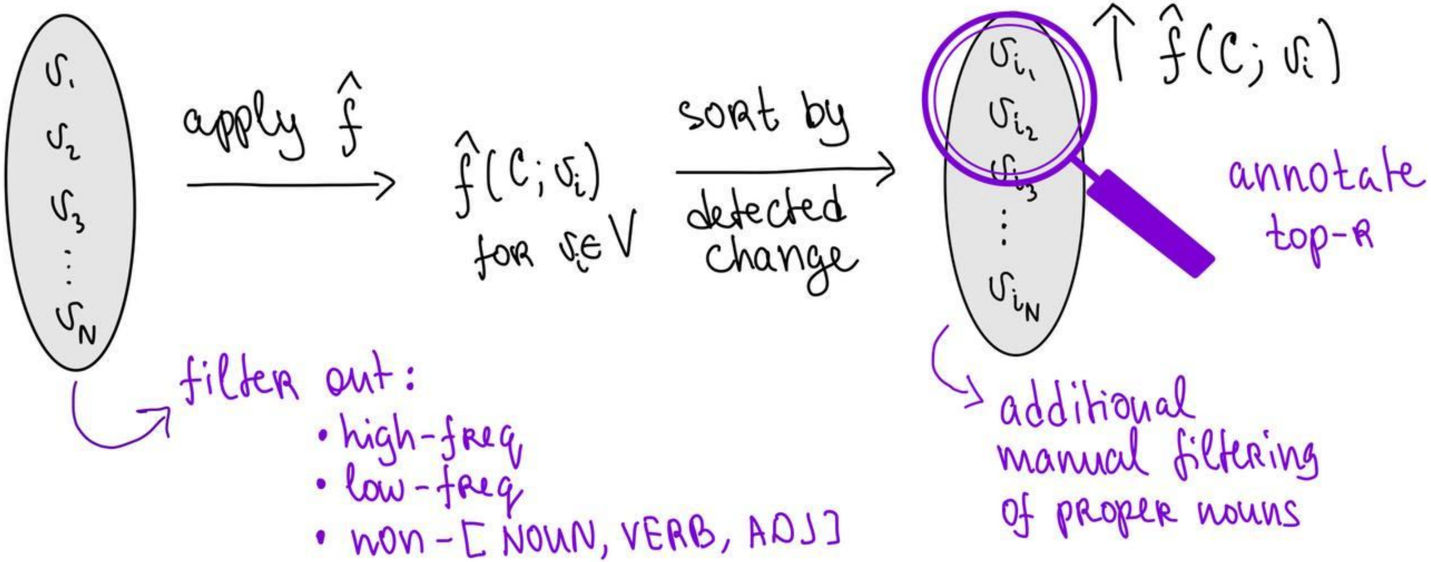

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We select k=15 and annotate top–k-ranked changes (Del Tredici et al., 2019)

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GROUP 1

[S1] *you will observe that the two circles partly described on the plate for the purpose of determining the opening of the box are circles standing upright on the ground* ***plane*** *and not laying on it as are the circles in plate 10*

[S2] …

[S3] …

[S4] …

[S5] *the section of a cylinder cut by any* ***plane*** *inclined to its axis is an ellipsis*

GROUP 2

[S1] *chief of staff and his* ***plane*** *lands in two hours*

[S2] …

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[S2] …	**[S2]** …
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[S4] …	**[S4]** …
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(c) What are the sentences whose senses appear in group 1 but not in group 2 (and vice versa)?

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[S1] *you will observe that the two circles partly described on the plate for the purpose of determining the opening of the box are circles standing upright on the ground **plane** and not laying on it as are the circles in plate 10* **[S2]** … **[S3]** … **[S4]** … **[S5]** *the section of a cylinder cut by any **plane** inclined to its axis is an ellipsis*	**[S1]** *chief of staff and his **plane** lands in two hours* **[S2]** … **[S3]** … **[S4]** … **[S5]** *what the hell is you were supposed to be on the **plane** fifteen minutes ago*

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We recruit English speakers who annotate

- 76+ words in SemEval-EN and
- 83+ words in LiverpoolFC

for semantic change using this approach

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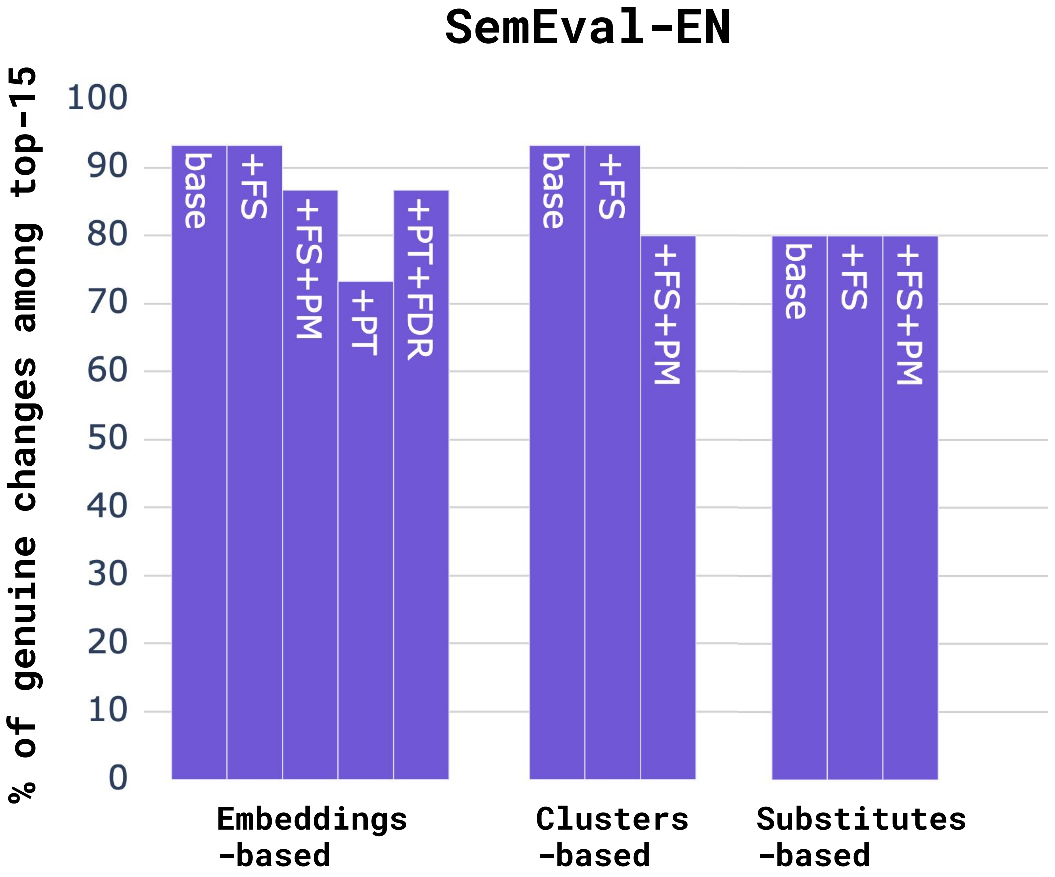
SemEval-EN
% of genuine changes among top-15
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70
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50
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30
20
10
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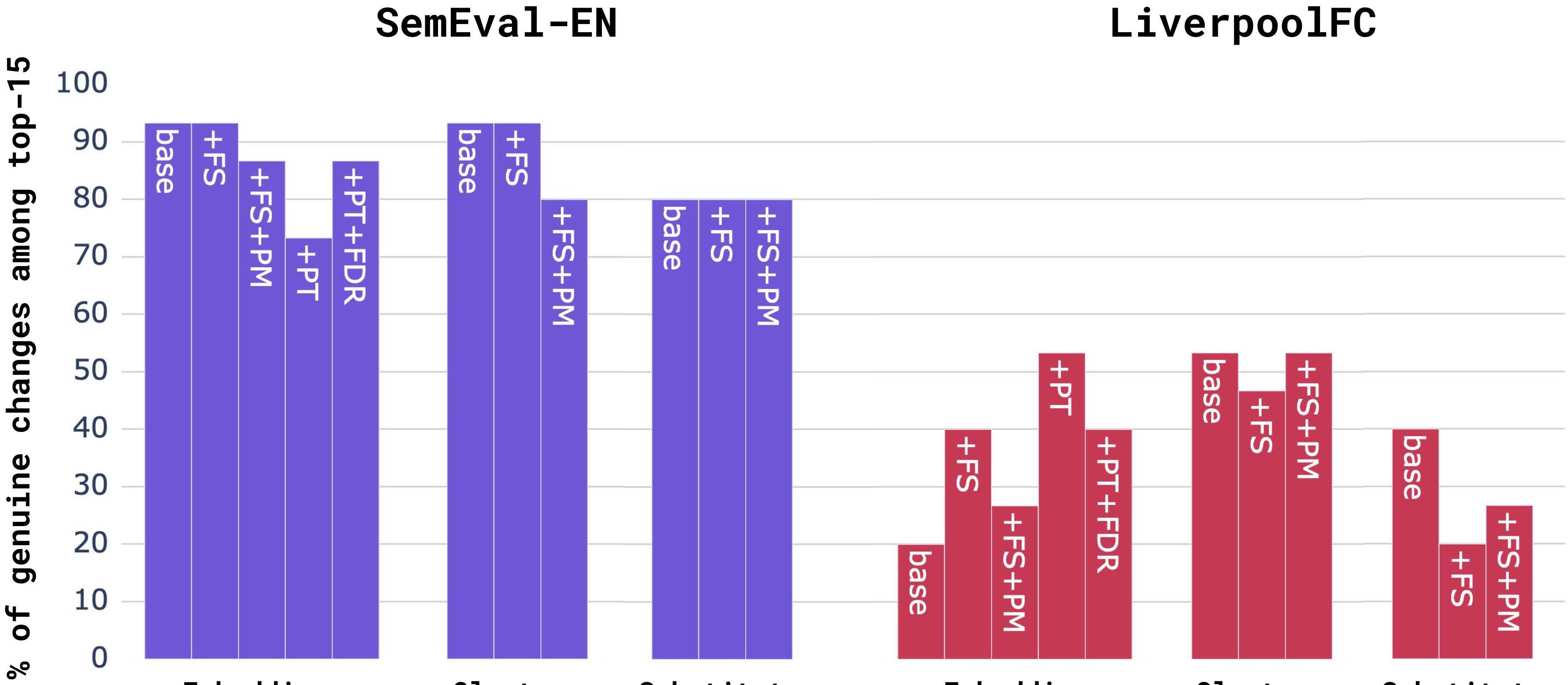
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Discussion

Short-term semantic change in LiverpoolFC

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- "Data bursts" (Kutuzov et al., 2022)

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- need to excel at ***quantifying*** and ***discovering*** short-term semantic change

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≈ recall-like metric

≈ precision-like metric

two different perspectives, but together they give a better understanding of **semantic-change discovery**

Thank you!

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code/data: