Analysis of Text Decomposition and Privacy Distribution Techniques in Text Privatization

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Outline

Motivation

Research Questions

Methodology

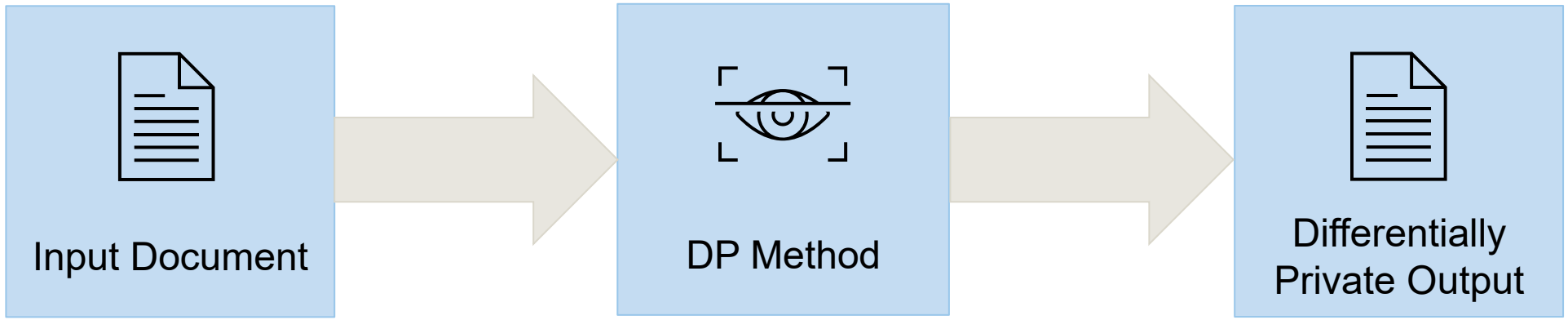
Results

Discussion

Limitations and Future Work

Motivation

What are we looking at?



Granularity of input text:	Perturbation of single words, sentences or the whole document
Privacy budget:	Epsilon parameter determines privacy level

Motivation

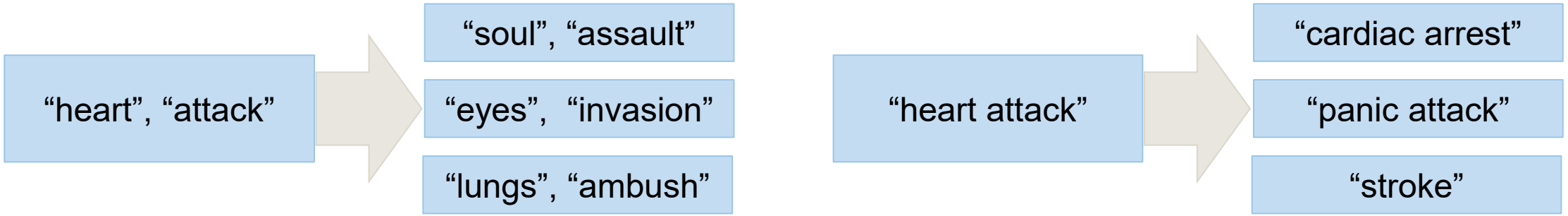
Why does decomposition matter?

Word-level

Collocations

Life	is	like	riding	a	bicycle.	To	keep	your	balance,	you	must	keep	moving.

Life is	like riding	a	bicycle.	To	keep your	balance,	you must	keep moving



Motivation

Why does privacy budget distribution matter?

- Not all parts of a document are equally sensitive
- E.g. nouns (boy, fox, dog) most often carry more sensitive information than articles (the, a, an)

Naive — Each unit gets assigned the same privacy budget

Distributed — Each unit gets a different privacy budget assigned based on its sensitivity

Naive:	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	= 14	
	Life	is	like	riding	a	bicycle.	To	keep	your	balance,	you	must	keep	moving.										
Distributed:	0.37	0.56	1.48	0.94	2.01	0.57	1.98	0.84	1.34	0.65	1.32	0.67	0.86	0.40									= 14	
	Life	is	like	riding	a	bicycle.	To	keep	your	balance,	you	must	keep	moving.										

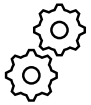
Research Questions

Research Questions

What are current methods for privacy budget distribution and for decomposition of text?

How can text decomposition and budget allocation methods be modularly combined for differentially private text rewriting?

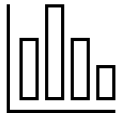
How can text decomposition and privacy budget allocation methods be combined to optimize the privacy-utility trade-off for differentially private text rewriting?



Methodology

Literature Review

Implementation

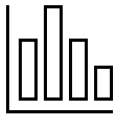


Benchmarking

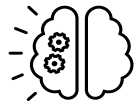
Methodology

RQ 1: What are current methods for privacy budget distribution and for decomposition of text?

Privacy Budget Distribution:

Statistical / Linguistic Feature-Based 	Keyword Extraction 	Explainable AI 
Information Content	YAKE KeyBERT	Attention Mechanism Integrated Gradients

Text Chunking:

Statistical Methods /Association Measures 	Dictionary based 	Rule based 
PMI Log-Likelihood-Ratio (LLR) t-score	WordNet	POS Patterns

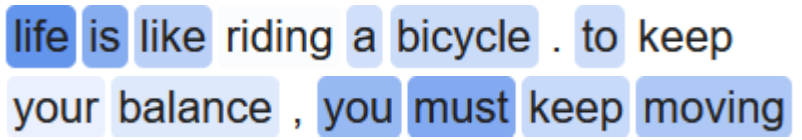
Examples

Keyword Extractor:

1. ('balance', 0.5735),
2. ('moving', 0.4452),
3. ('bicycle', 0.4226),
4. ('life', 0.41),

…

XAI:



Information Content:

Word	IC (bits)
animal	5.11
dog	8.96
husky	13.68

POS based Chunking:

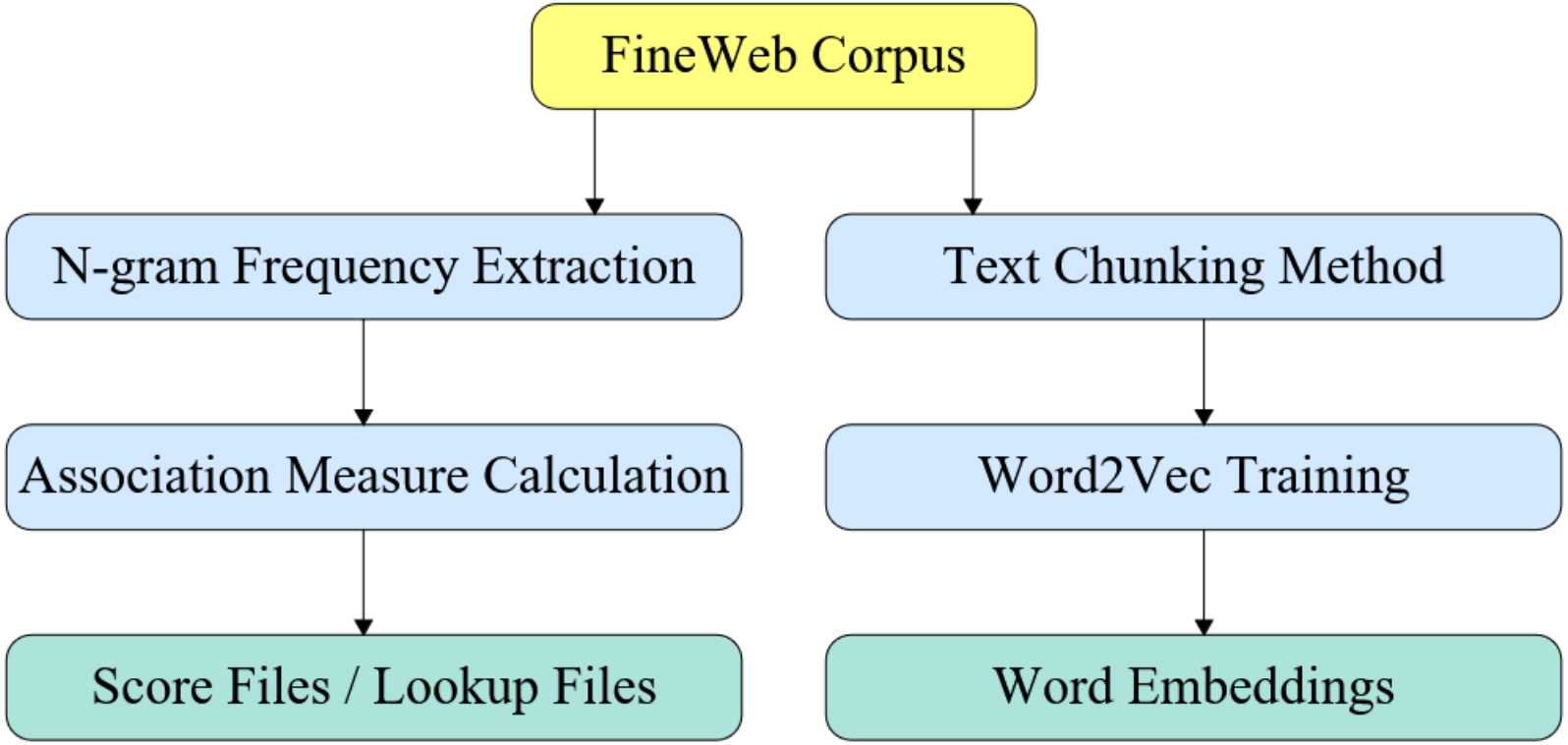
Text:	The	quick	brown	fox	jumps	over	the	lazy	dog
POS:	DT	JJ	JJ	NN	VB	IN	DT	JJ	NN

Noun Phrase: DT? JJ* NN+

	DT	JJ	JJ	NN
⇒	The	quick	brown	fox

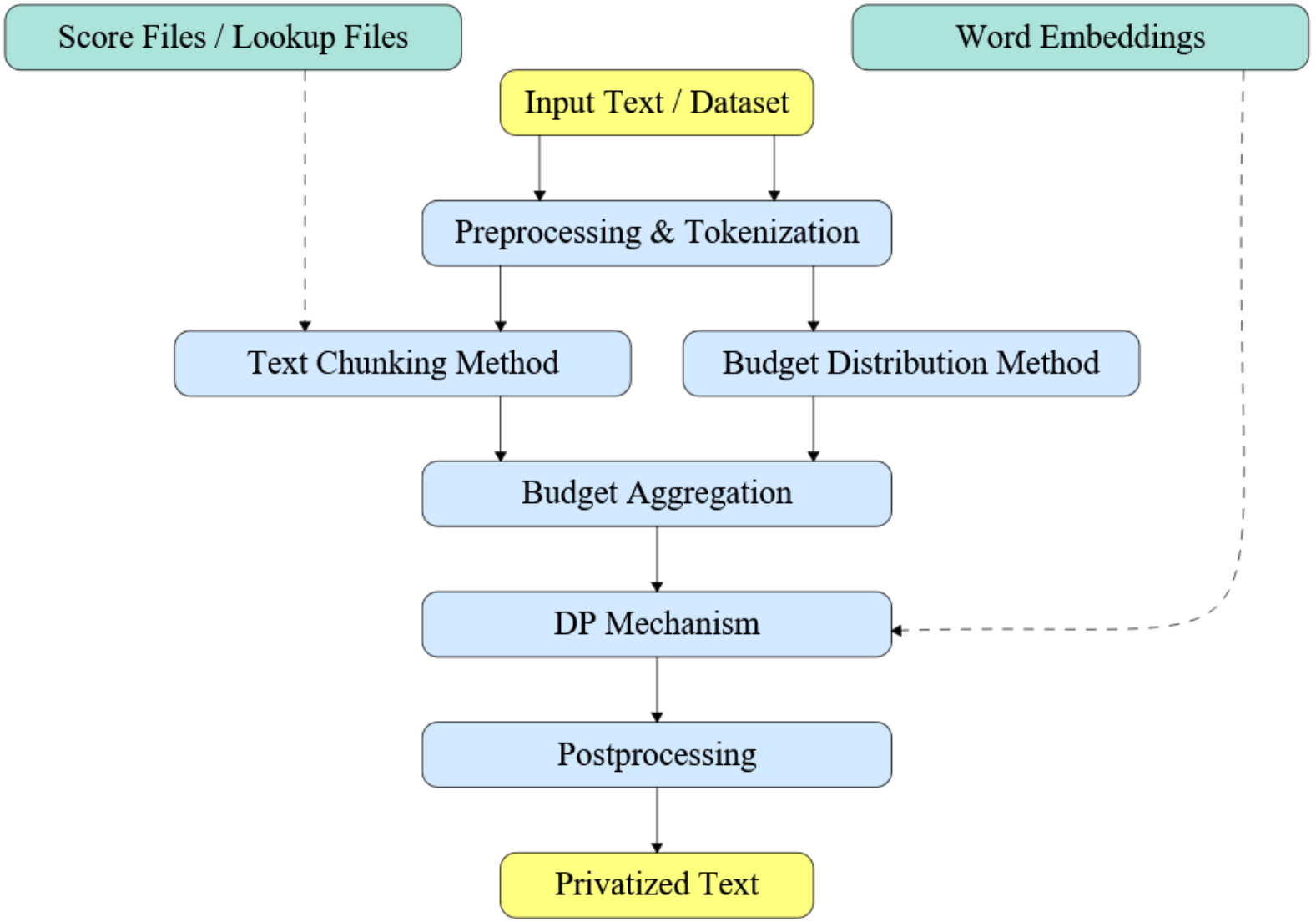
Methodology

RQ 2: How can text decomposition and budget allocation methods be modularly combined for differentially private text rewriting?



Methodology

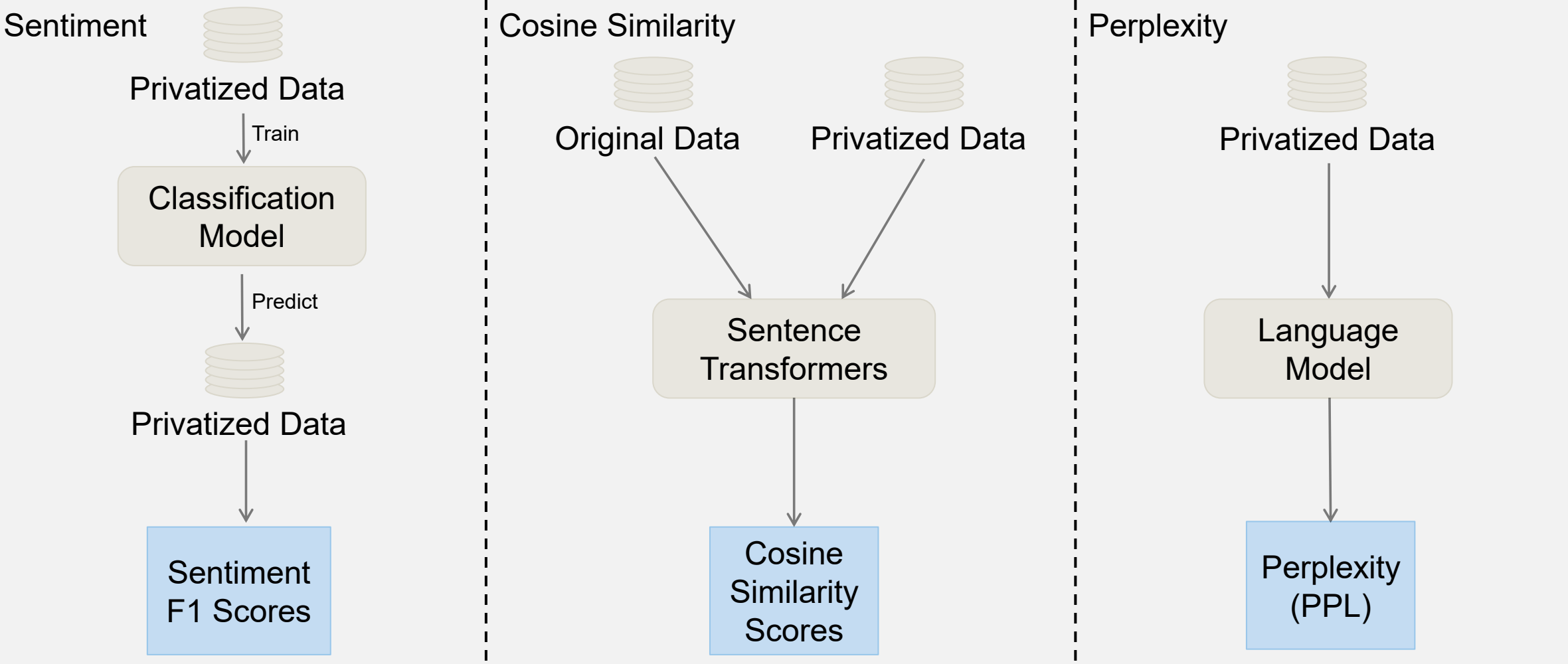
RQ 2: How can text decomposition and budget allocation methods be modularly combined for differentially private text rewriting?



Methodology

RQ 3: How can text decomposition and privacy budget allocation methods be combined to optimize the privacy-utility trade-off for differential private text rewriting?

Utility Experiments

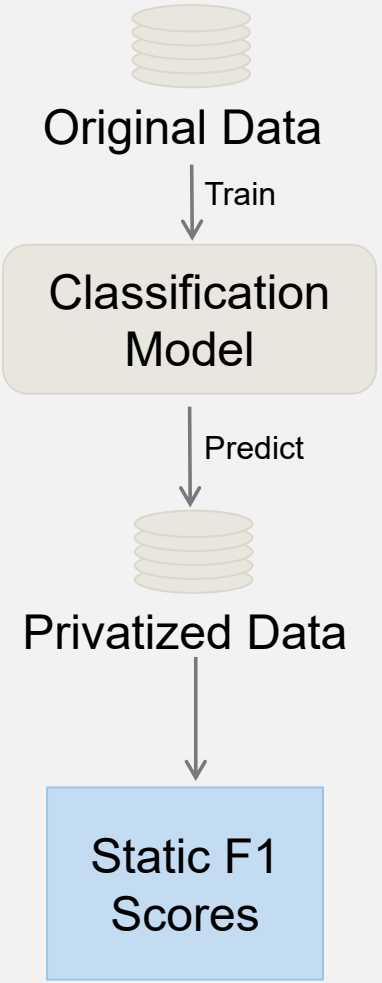


Methodology

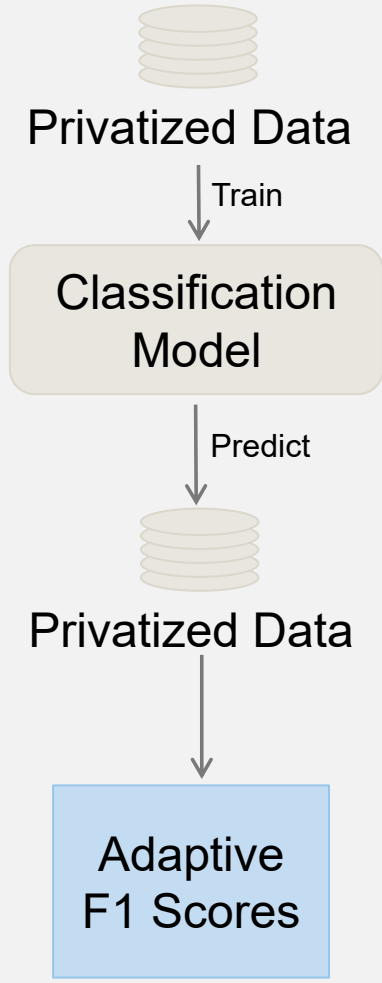
RQ 3: How can text decomposition and privacy budget allocation methods be combined to optimize the privacy-utility trade-off for differential private text rewriting?

Privacy Experiments

Static Attacker



Adaptive Attacker

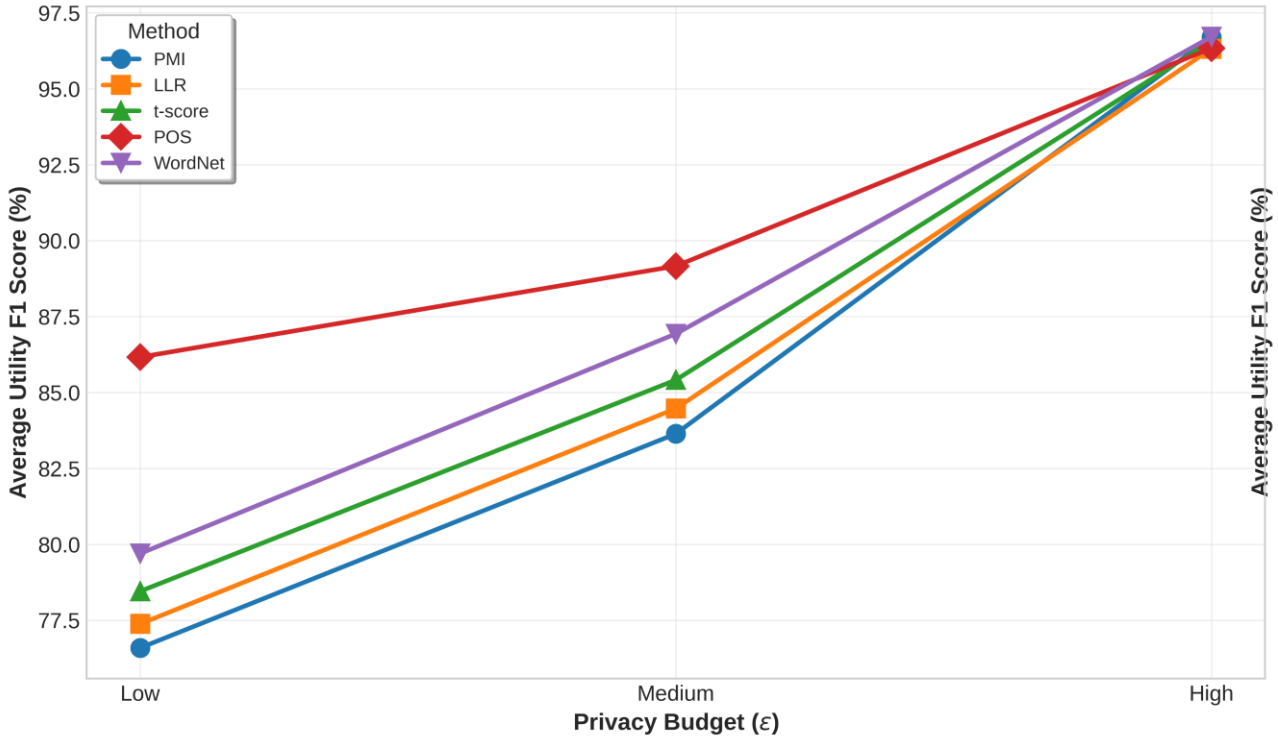


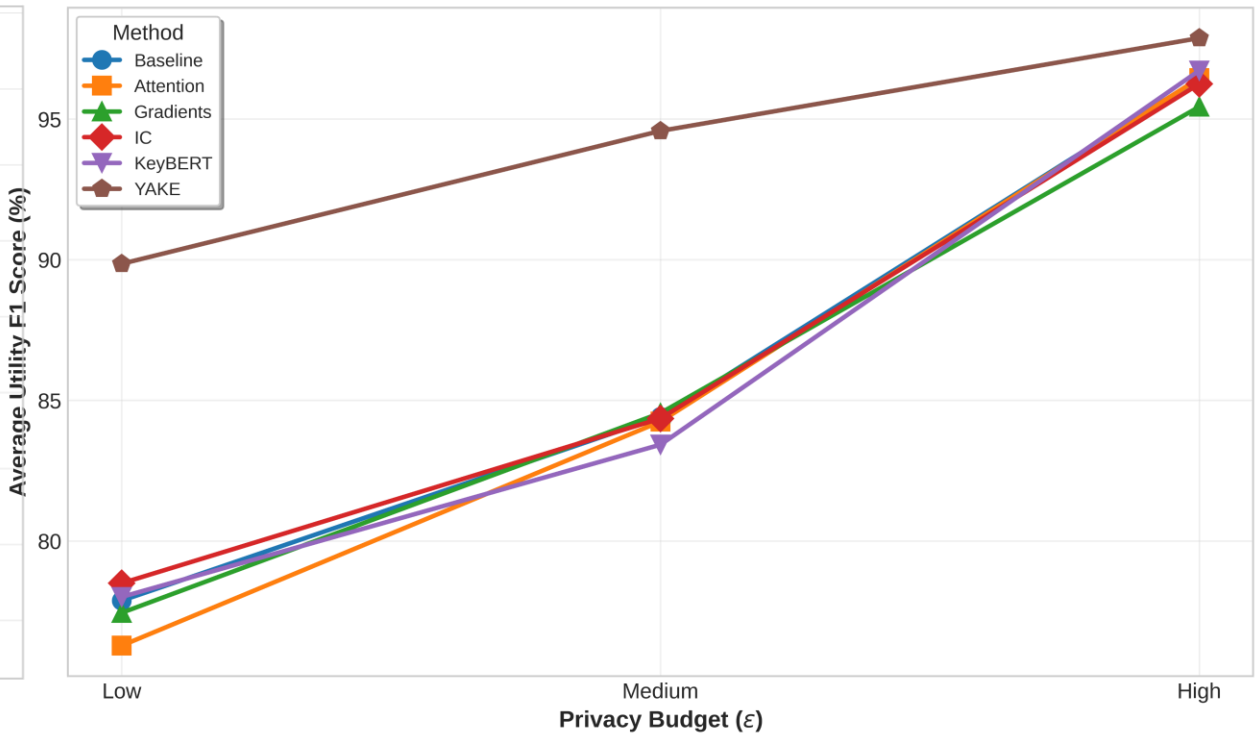
Results

Trustpilot $\varepsilon = 5.2$		Budget Distributor						Average Relative Gain
		Baseline	Attention	Gradients	IC	KeyBERT	YAKE	
Chunker	Baseline	Utility: $98.2_{0.4}$ / Adversary: $72.1_{1.0}$						
PMI	Utility F1	$76.1_{2.3}$	$67.2_{16.7}$	$76.8_{2.8}$	$75.2_{2.1}$	$75.5_{5.5}$	$88.6_{0.9}$	
	Static F1	$43.6_{4.3}$	$39.0_{0.5}$	$40.0_{1.4}$	$47.1_{5.5}$	$47.0_{5.9}$	$41.1_{3.5}$	
	Adaptive F1	$55.5_{3.8}$	$56.6_{1.7}$	$56.3_{1.2}$	$57.2_{2.3}$	$53.7_{2.0}$	$57.9_{1.2}$	
	Relative Gain	0.005	−0.100	0.002	−0.026	0.024	$\mathbf{0.100_{1}}$	0.001
LLR	Utility F1	$75.6_{0.3}$	$75.0_{0.5}$	$74.8_{3.6}$	$75.4_{0.9}$	$75.1_{1.4}$	$88.4_{0.8}$	
	Static F1	$45.1_{4.1}$	$42.1_{3.9}$	$44.0_{5.2}$	$41.6_{2.8}$	$43.0_{4.9}$	$47.5_{6.0}$	
	Adaptive F1	$56.7_{2.2}$	$55.1_{0.8}$	$55.9_{1.9}$	$55.5_{2.9}$	$55.7_{1.3}$	$58.3_{0.8}$	
	Relative Gain	−0.017	0.000	−0.013	−0.002	−0.007	$\mathbf{0.092_{1}}$	0.009
t-score	Utility F1	$76.5_{1.7}$	$75.8_{5.0}$	$75.9_{1.8}$	$76.4_{3.6}$	$76.6_{1.8}$	$89.5_{0.7}$	
	Static F1	$44.7_{4.2}$	$41.3_{2.1}$	$40.2_{1.0}$	$44.0_{1.8}$	$42.5_{2.7}$	$49.6_{3.4}$	
	Adaptive F1	$54.6_{0.6}$	$55.7_{1.2}$	$55.5_{2.9}$	$57.0_{0.8}$	$57.0_{2.4}$	$59.0_{1.9}$	
	Relative Gain	0.023	0.000	0.003	−0.012	−0.010	$\mathbf{0.093_{1}}$	0.016
POS	Utility F1	$82.5_{2.2}$	$85.7_{1.0}$	$84.9_{1.7}$	$86.2_{0.9}$	$85.0_{1.4}$	$92.6_{0.4}$	
	Static F1	$49.0_{1.9}$	$46.7_{3.6}$	$49.7_{3.5}$	$51.5_{3.1}$	$48.1_{9.1}$	$55.6_{7.5}$	
	Adaptive F1	$58.8_{1.1}$	$58.4_{0.7}$	$58.9_{3.0}$	$57.0_{3.8}$	$58.5_{1.9}$	$63.1_{1.2}$	
	Relative Gain	$\mathbf{0.024_{2}}$	$\mathbf{0.064_{2}}$	$\mathbf{0.048_{2}}$	$\mathbf{0.088_{1}}$	$\mathbf{0.055_{2}}$	0.068	**0.058**
WordNet	Utility F1	$78.7_{1.4}$	$77.6_{2.6}$	$74.7_{1.9}$	$79.2_{4.3}$	$77.8_{1.7}$	$90.2_{1.2}$	
	Static F1	$38.7_{2.8}$	$42.1_{7.5}$	$37.5_{0.4}$	$35.3_{5.1}$	$37.6_{0.3}$	$40.8_{1.8}$	
	Adaptive F1	$57.6_{0.3}$	$57.1_{1.2}$	$57.0_{1.4}$	$49.8_{12.8}$	$57.2_{0.1}$	$54.0_{8.4}$	
	Relative Gain	0.002	−0.001	−0.029	$\mathbf{0.116_{2}}$	−0.001	$\mathbf{0.170_{1,2}}$	0.043
Average Relative Gain		0.008	−0.007	0.002	0.033	0.012	**0.105**	—

Results

Average Utility F1 Scores for Text Chunking and Budget Distribution Methods across three Epsilon Values for Trustpilot



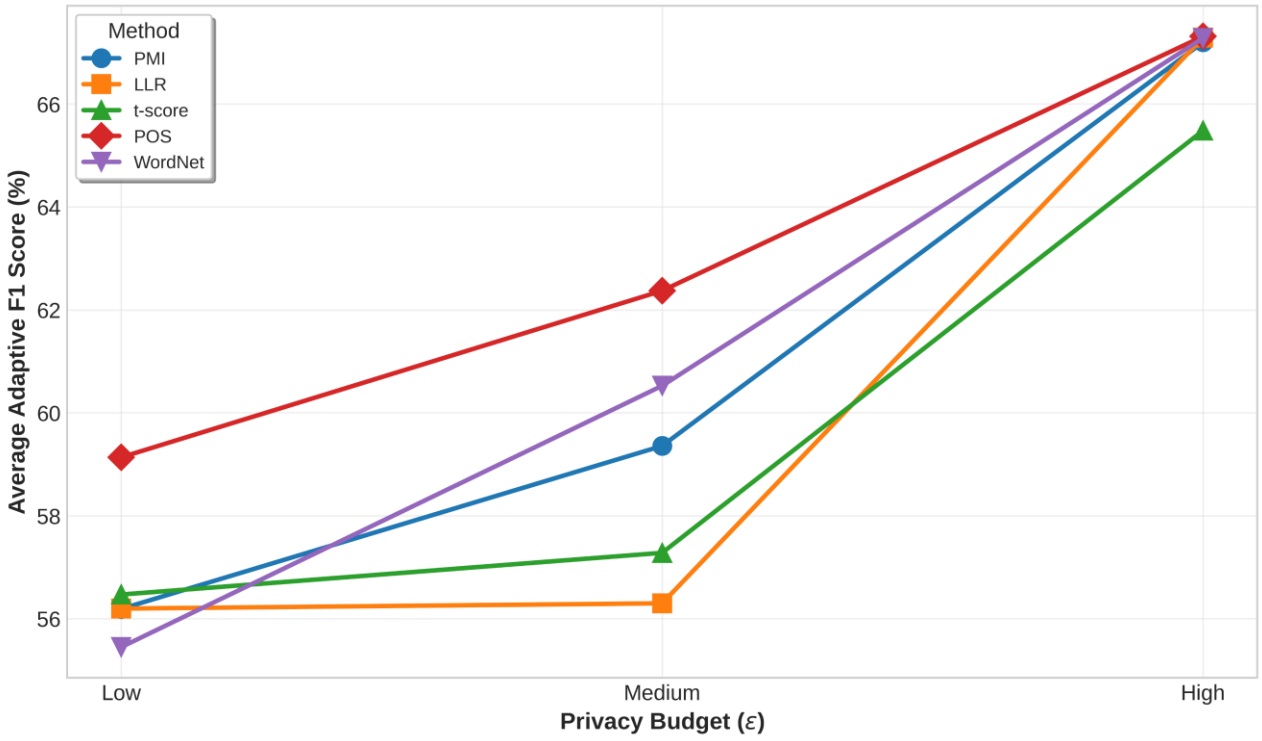


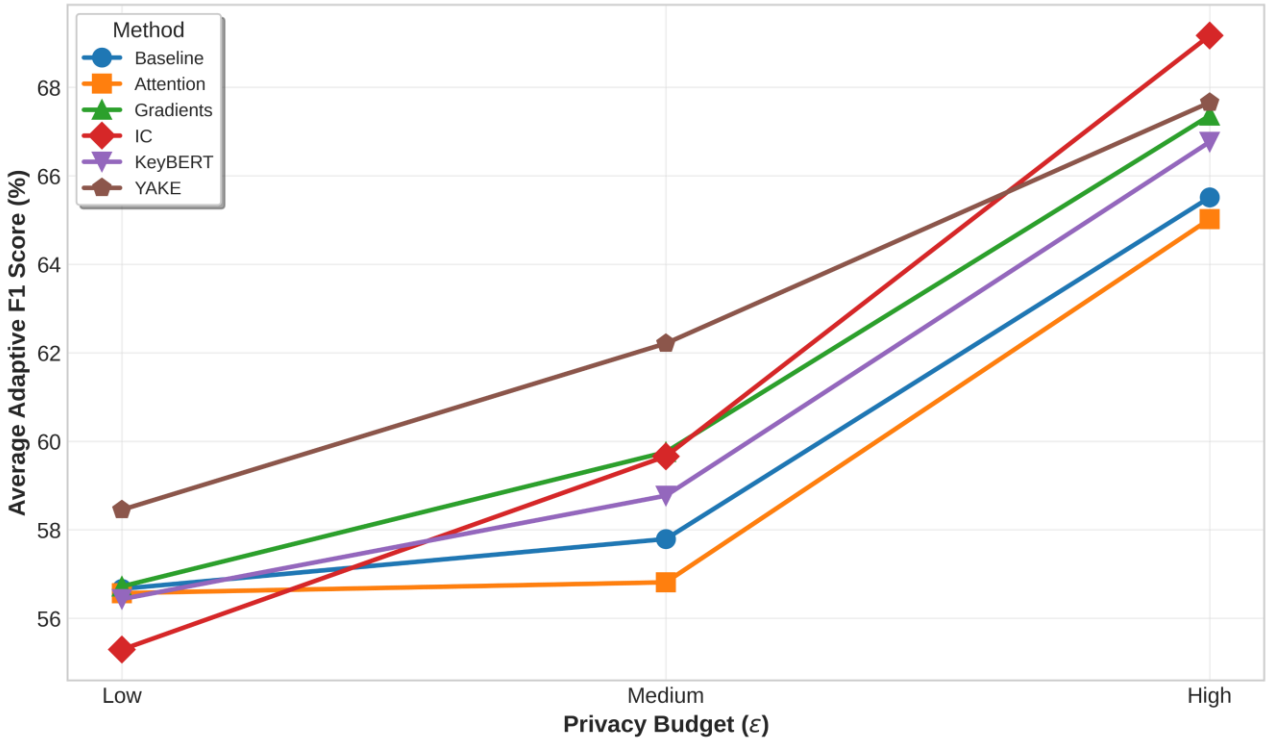
- small differences in Text Chunking methods
- big differences in Budget Distribution techniques

} only for lower ε => POS better, YAKE signficantly better

Results

Average Adaptive F1 Scores for Text Chunking and Budget Distribution Methods across three Epsilon Values for Trustpilot



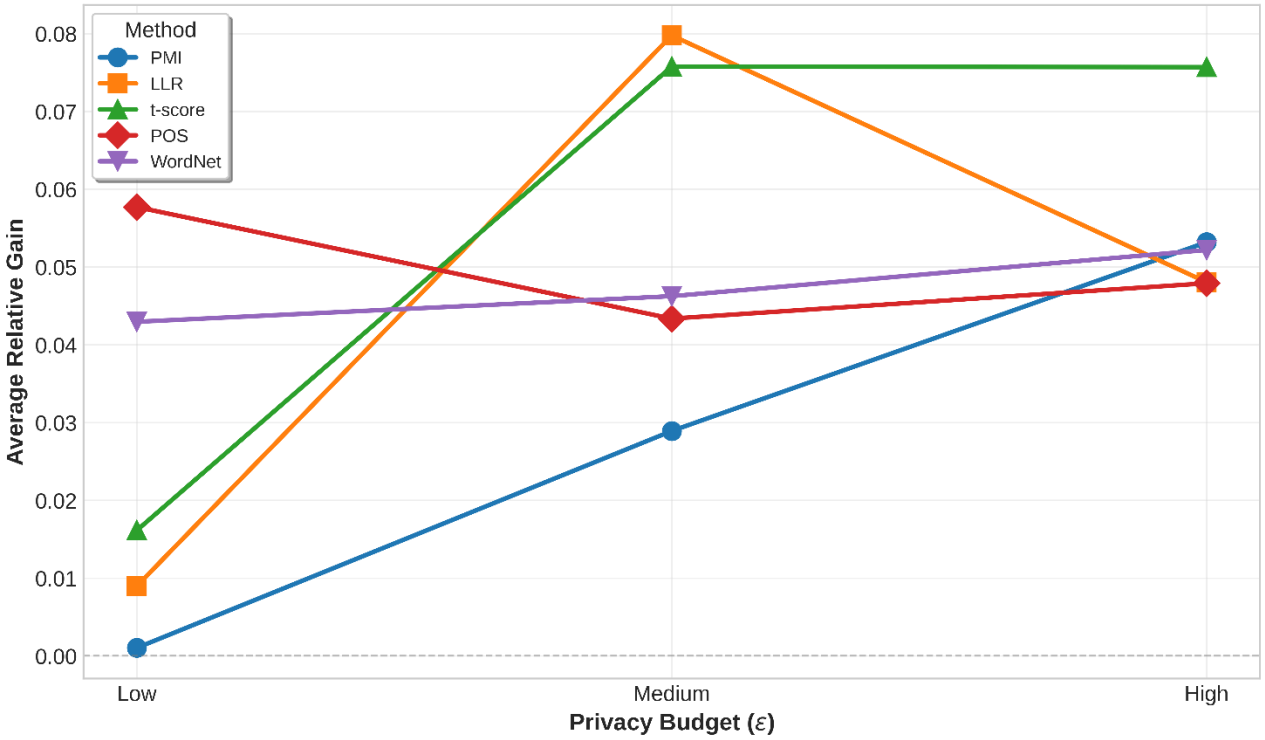


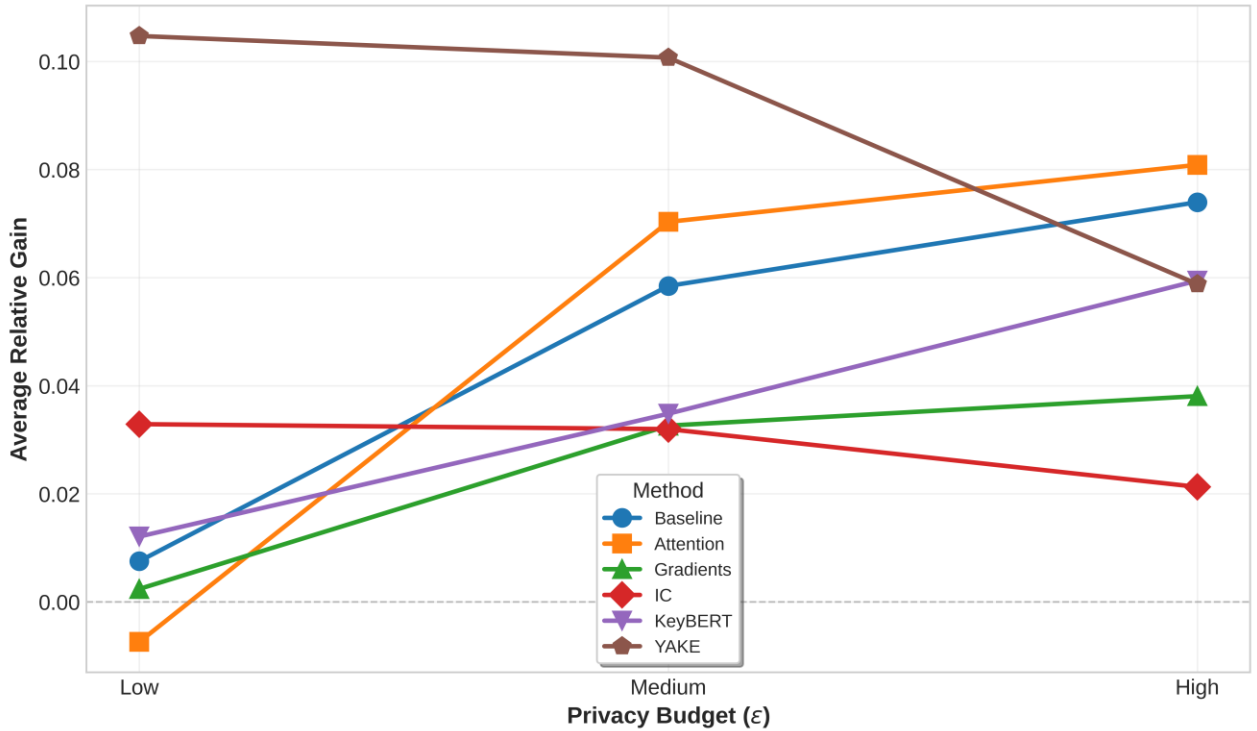
- bigger differences in Text Chunking methods
- still big differences in Budget Distribution techniques

} only for low ε => POS performs worse, YAKE perfoms worse

Results

Average RG for Text Chunking and Budget Distribution Methods across three Epsilon Values for the Trustpilot Dataset



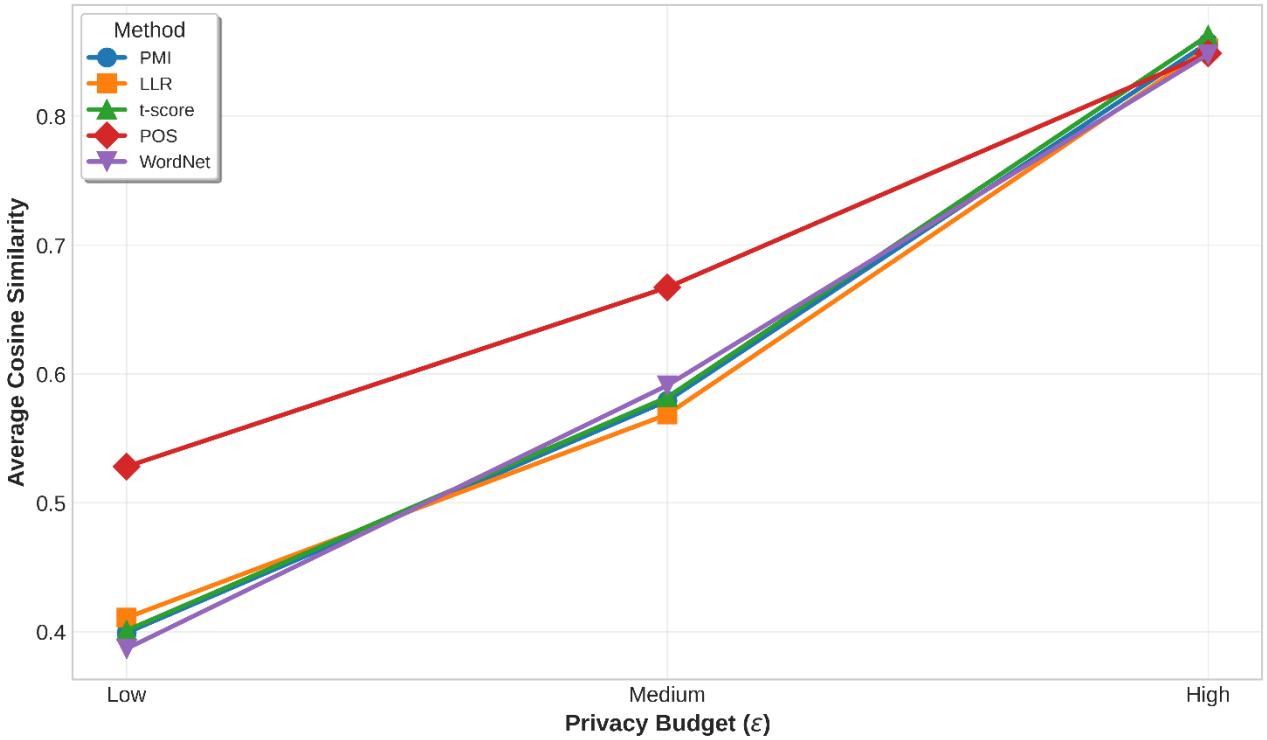


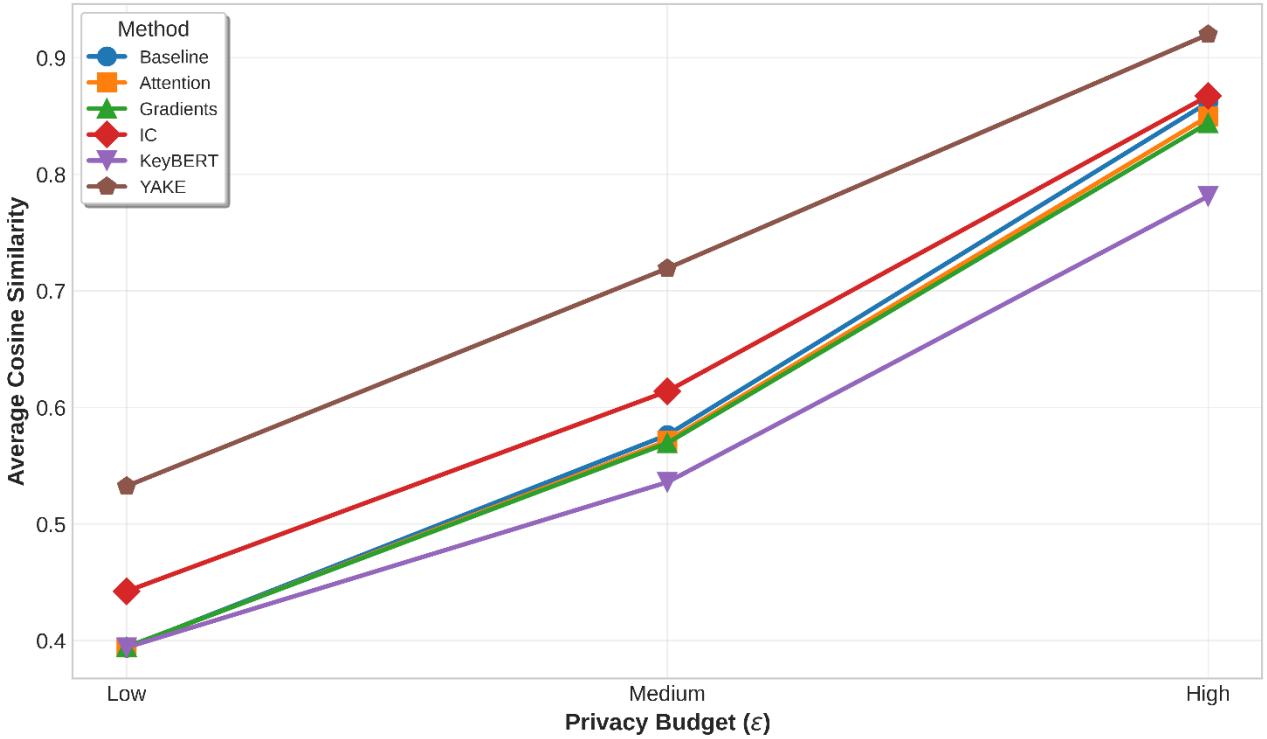
- big differences in Text Chunking methods
- YAKE again outlier in Budget Distribution methods

} for higher ε results are more similar

Results

Average CS Scores for Text Chunking and Budget Distribution Methods across three Epsilon Values

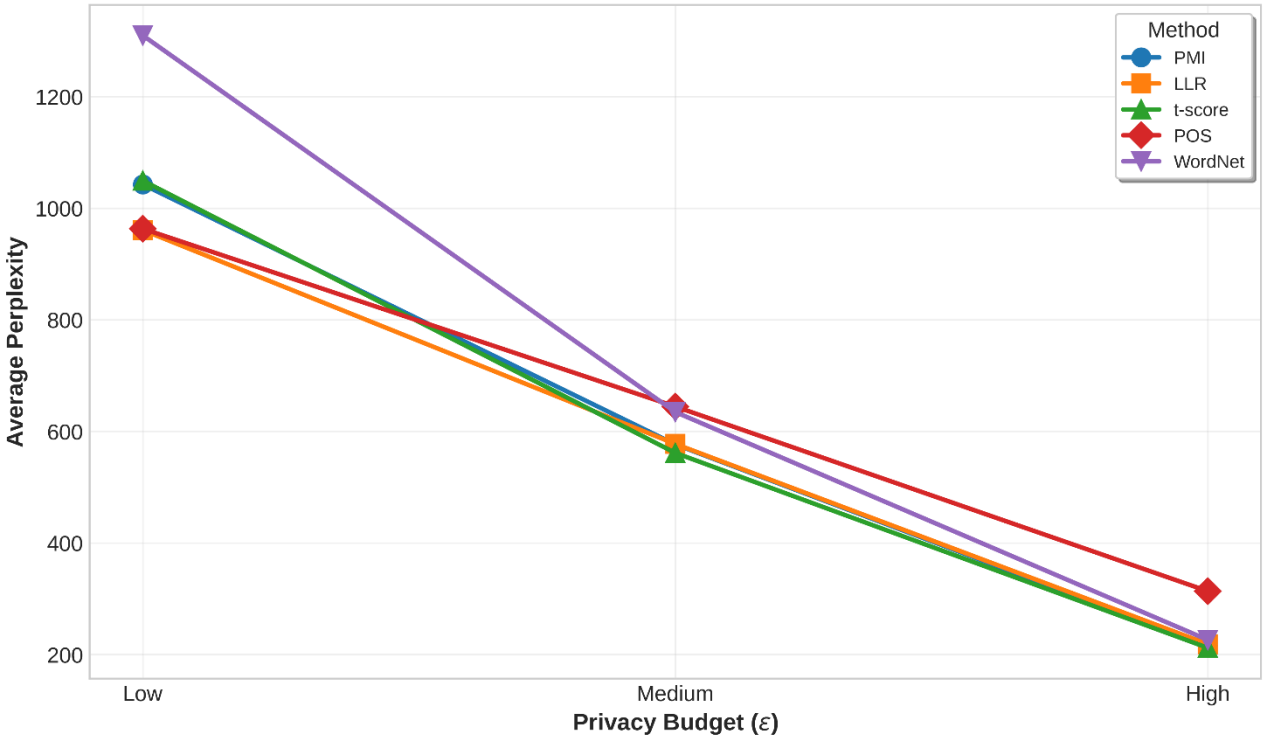


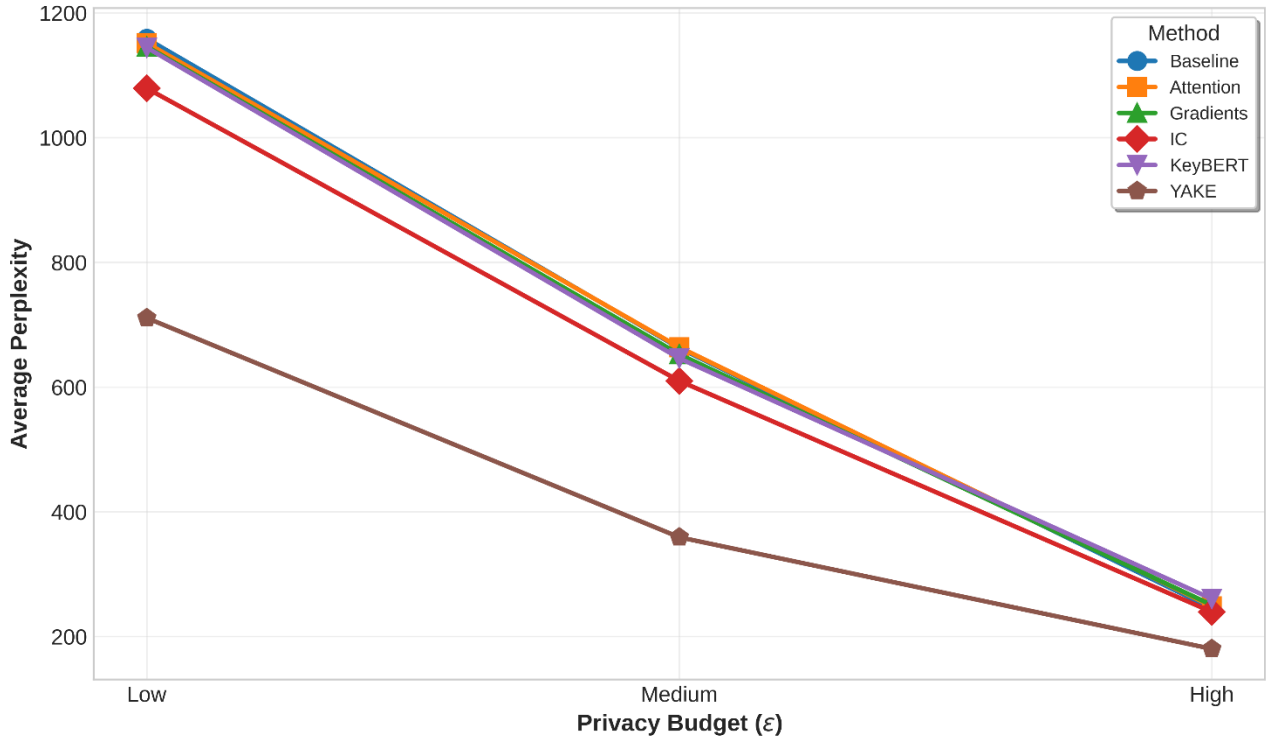


- POS highest utility for Text Chunking methods => For high ε nearly no difference in utility
- YAKE highest utility for Budget Distribution methods => Consistend across all ε values

Results

Average PPL Scores for Text Chunking and Budget Distribution Methods across three Epsilon Values





- Chunking Methods perform similarly except WordNet
- YAKE performs best for Budget Distribution methods

} for higher ε differences are less singificant

Discussion

Datasets

Yelp: low sentiment signal

Enron: no sentiment lables

Trustpilot: strong sentiment signal

All three datasets:
strong privacy signals

Cosine Similarity and Perplexity very similar across all three datasets

Complexity

Implemented methods vary in their computational complexity

Text Chunking:
PMI, LLR, t-score: very similar, score calculation once in beginning, then fast
WordNet: no preparation, fast
POS: needs training of grammar rules, POS tagging, slow

Budget Distribution:
YAKE: statistical, very fast
IC: WSD, look-ups, very fast
KeyBERT: embeddings, fast
Attention: attention layer, fast
Gradients: gradient comp., slow

Privacy-Utility Trade-offs

YAKE: very high utility, low privacy
⇒ highest relative gains overall
⇒ use only with low epsilon

POS: high utility, low privacy
⇒ high relative gain, low epsilon

Association measures:
LLR, and t-score outperform PMI
⇒ higher quality collocations
⇒ beat POS in med to high epsilon

Higher epsilon values:
Choice of methods less important
⇒ But high utility preserving methods perform poorly
⇒ Even lower privacy protection

Limitations and Future Work

Budget Aggregation

Currently, the privacy budget per chunk is added up.

But, this may not be the optimal method.
=> Longer n-grams biased towards higher epsilon budget.

Privacy Sensitivity

Privacy sensitivity is task-specific.

Our methods are tested against authorship and gender identification tasks.

More Mechansisms

We tested only one DP mechanism.

But there are more methods that perform better, but require more computation.

B.Sc.

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Backup

Trustpilot RG

Trustpilot $\varepsilon = 52$		Budget Distributor						Average Relative Gain
		Baseline	Attention	Gradients	IC	KeyBERT	YAKE	
Chunker	Baseline	Utility: $98.2_{0.4}$ / Adversary: $72.1_{1.0}$						
PMI	Utility F1	$82.0_{0.8}$	$80.6_{0.6}$	$84.0_{1.5}$	$79.1_{0.5}$	$82.4_{2.6}$	$93.8_{1.2}$	
	Static F1	$49.2_{2.0}$	$48.0_{1.8}$	$48.8_{2.0}$	$52.5_{0.8}$	$49.5_{1.9}$	$56.3_{2.9}$	
	Adaptive F1	$58.9_{0.8}$	$59.6_{0.9}$	$59.6_{2.2}$	$58.9_{2.9}$	$58.6_{0.8}$	$60.5_{4.7}$	
	Relative Gain	0.018	−0.005	0.029	−0.011	0.026	$\mathbf{0.117_{1}}$	0.029
LLR	Utility F1	$83.5_{2.0}$	$81.3_{1.6}$	$82.9_{1.8}$	$81.7_{3.9}$	$83.0_{3.6}$	$94.4_{0.3}$	
	Static F1	$48.2_{1.3}$	$51.3_{5.1}$	$50.5_{1.4}$	$54.9_{0.7}$	$44.4_{6.4}$	$56.4_{4.0}$	
	Adaptive F1	$55.3_{5.0}$	$53.6_{8.1}$	$56.0_{3.4}$	$58.2_{3.4}$	$54.3_{2.8}$	$60.5_{4.8}$	
	Relative Gain	0.084	0.085	$\mathbf{0.068_{2}}$	0.025	$\mathbf{0.093_{2}}$	$\mathbf{0.123_{1,2}}$	**0.080**
t-score	Utility F1	$82.3_{2.1}$	$84.9_{2.2}$	$84.3_{1.7}$	$84.1_{0.5}$	$82.6_{0.6}$	$94.3_{1.3}$	
	Static F1	$47.3_{0.8}$	$48.0_{0.6}$	$46.2_{8.3}$	$52.0_{1.9}$	$48.0_{2.6}$	$59.3_{1.3}$	
	Adaptive F1	$50.1_{12.7}$	$54.7_{6.0}$	$60.4_{0.4}$	$60.2_{1.6}$	$57.6_{1.3}$	$60.7_{3.5}$	
	Relative Gain	$\mathbf{0.143_{1,2}}$	0.106	0.022	0.022	0.044	0.118	0.076
POS	Utility F1	$88.6_{1.7}$	$90.6_{1.2}$	$86.4_{0.4}$	$88.1_{0.5}$	$85.6_{1.8}$	$95.7_{1.0}$	
	Static F1	$53.6_{2.6}$	$54.3_{2.7}$	$54.0_{2.8}$	$54.8_{2.9}$	$47.0_{8.8}$	$57.7_{2.3}$	
	Adaptive F1	$63.7_{0.3}$	$58.1_{3.5}$	$62.5_{0.7}$	$61.6_{0.5}$	$62.6_{0.7}$	$65.8_{0.7}$	
	Relative Gain	0.020	$\mathbf{0.117_{1,2}}$	0.014	0.043	0.004	0.062	0.043
WordNet	Utility F1	$85.7_{1.3}$	$83.8_{1.7}$	$85.1_{1.5}$	$88.8_{1.3}$	$83.4_{0.9}$	$94.8_{1.1}$	
	Static F1	$46.7_{1.3}$	$48.3_{2.4}$	$48.0_{1.9}$	$53.9_{4.9}$	$43.1_{1.6}$	$56.0_{1.3}$	
	Adaptive F1	$61.0_{0.7}$	$58.0_{2.2}$	$60.3_{1.3}$	$59.4_{1.9}$	$60.8_{1.0}$	$63.6_{3.6}$	
	Relative Gain	0.027	0.050	0.030	$\mathbf{0.081_{2}}$	0.007	$\mathbf{0.083_{1}}$	0.046
Average Relative Gain		0.058	0.070	0.033	0.032	0.035	**0.101**	—

Backup

Trustpilot RG

Trustpilot $\varepsilon = 260$		Budget Distributor						Average Relative Gain
		Baseline	Attention	Gradients	IC	KeyBERT	YAKE	
Chunker	Baseline	Utility: $98.2_{0.4}$ / Adversary: $72.1_{1.0}$						
PMI	Utility F1	$96.3_{0.4}$	$96.5_{0.4}$	$96.1_{0.7}$	$95.7_{1.3}$	$97.1_{0.0}$	$98.4_{0.4}$	
	Static F1	$64.7_{3.7}$	$67.8_{0.3}$	$66.4_{1.9}$	$66.0_{0.6}$	$63.8_{3.0}$	$57.5_{17.8}$	
	Adaptive F1	$61.4_{9.3}$	$69.3_{1.0}$	$67.1_{3.9}$	$69.5_{0.9}$	$66.8_{1.4}$	$69.1_{1.4}$	
	Relative Gain	$\mathbf{0.130_{1,2}}$	0.022	0.049	0.011	0.062	0.044	0.053
LLR	Utility F1	$95.5_{0.3}$	$96.1_{0.9}$	$95.6_{0.3}$	$96.1_{0.3}$	$96.7_{0.5}$	$98.0_{0.5}$	
	Static F1	$62.6_{8.4}$	$65.2_{2.1}$	$64.7_{1.0}$	$66.5_{1.3}$	$64.9_{1.5}$	$68.0_{0.6}$	
	Adaptive F1	$68.2_{1.9}$	$67.4_{1.9}$	$64.0_{2.5}$	$70.1_{1.1}$	$65.4_{2.7}$	$68.5_{4.1}$	
	Relative Gain	0.028	0.043	$\mathbf{0.085_{1,2}}$	0.007	$\mathbf{0.078_{2}}$	0.047	0.048
t-score	Utility F1	$96.3_{1.1}$	$95.7_{1.1}$	$94.9_{0.4}$	$97.5_{0.3}$	$96.6_{0.9}$	$98.4_{0.6}$	
	Static F1	$68.3_{1.3}$	$67.0_{0.6}$	$67.6_{1.2}$	$68.1_{1.4}$	$66.9_{0.7}$	$68.5_{1.3}$	
	Adaptive F1	$67.4_{1.8}$	$56.9_{18.8}$	$68.1_{0.8}$	$69.1_{1.7}$	$67.4_{2.3}$	$64.0_{9.1}$	
	Relative Gain	0.047	$\mathbf{0.186_{1,2}}$	0.022	$\mathbf{0.035_{2}}$	0.049	$\mathbf{0.115_{2}}$	**0.076**
POS	Utility F1	$97.3_{0.7}$	$96.5_{0.3}$	$94.7_{0.4}$	$95.9_{0.9}$	$96.6_{0.5}$	$97.0_{1.0}$	
	Static F1	$64.1_{1.5}$	$65.0_{2.1}$	$66.1_{0.8}$	$67.5_{0.4}$	$63.3_{2.6}$	$66.4_{2.5}$	
	Adaptive F1	$67.5_{1.6}$	$62.5_{8.5}$	$68.5_{1.2}$	$69.0_{0.1}$	$66.5_{2.5}$	$70.0_{0.1}$	
	Relative Gain	0.056	$\mathbf{0.116_{1}}$	0.015	0.020	0.063	0.017	0.048
WordNet	Utility F1	$96.7_{0.4}$	$97.5_{0.4}$	$95.9_{0.7}$	$96.1_{0.8}$	$96.6_{0.2}$	$97.5_{0.4}$	
	Static F1	$65.7_{0.7}$	$66.1_{1.8}$	$63.5_{2.3}$	$63.8_{2.6}$	$61.3_{1.9}$	$68.0_{0.8}$	
	Adaptive F1	$63.2_{10.2}$	$69.0_{1.7}$	$69.1_{2.0}$	$68.1_{1.5}$	$67.7_{1.4}$	$66.6_{4.1}$	
	Relative Gain	$\mathbf{0.109_{1}}$	0.036	0.018	0.034	0.045	0.070	0.052
Average Relative Gain		0.074	**0.081**	0.038	0.021	0.059	0.059	—

Backup

Trustpilot CS

$\varepsilon = 52$	Budget Distributor						Average
Chunker	Baseline	Attention	Gradients	IC	KeyBERT	YAKE	
PMI	0.525	0.521	0.521	0.577	0.492	**0.614_{1}**	0.542
LLR	0.529	0.527	0.527	0.583	0.496	**0.616_{1}**	0.546
t-score	0.525	0.522	0.522	0.580	0.492	**0.616_{1}**	0.543
POS	**0.618_{2}**	**0.618_{2}**	**0.618_{2}**	**0.655_{2}**	**0.603_{2}**	**$0.702_{1,2}$**	**0.636**
WordNet	0.529	0.522	0.523	0.595	0.482	**0.642_{1}**	0.549
Average	0.545	0.542	0.542	0.598	0.513	**0.638**	—

$\varepsilon = 5.2$	Budget Distributor						Average
Chunker	Baseline	Attention	Gradients	IC	KeyBERT	YAKE	
PMI	0.364	0.363	0.365	0.421	0.364	**0.425_{1}**	0.384
LLR	0.383	0.384	0.385	0.442	0.384	**0.443_{1}**	0.404
t-score	0.366	0.366	0.366	0.421	0.366	**0.425_{1}**	0.385
POS	**0.504_{2}**	**0.504_{2}**	**0.505_{2}**	**0.545_{2}**	**0.506_{2}**	**$0.574_{1,2}$**	**0.523**
WordNet	0.336	0.335	0.336	0.413	0.335	**0.418_{1}**	0.362
Average	0.391	0.390	0.391	0.448	0.391	**0.457**	—

$\varepsilon = 260$	Budget Distributor						Average
Chunker	Baseline	Attention	Gradients	IC	KeyBERT	YAKE	
PMI	0.855	0.841	0.835	0.864	0.759	**0.891_{1}**	0.841
LLR	0.849	0.835	0.828	0.860	0.755	**0.888_{1}**	0.836
t-score	**0.863_{2}**	**0.848_{2}**	**0.840_{2}**	**0.872_{2}**	0.763	**$0.899_{1,2}$**	**0.848**
POS	0.829	0.822	0.821	0.837	**0.784_{2}**	**0.868_{1}**	0.827
WordNet	0.833	0.820	0.810	0.849	0.735	**0.881_{1}**	0.821
Average	0.846	0.833	0.827	0.856	0.759	**0.885**	—

Backup

Trustpilot PPL

$\varepsilon = 5.2$	Budget Distributor						Average
Chunker	Baseline	Attention	Gradients	IC	KeyBERT	YAKE	
PMI	1497.2	1506.3	1498.5	1413.8	1492.3	**1098.5**$_1$	1417.8
LLR	**1348.2**$_2$	**1356.3**$_2$	**1345.2**$_2$	1272.8	**1324.9**$_2$	**1010.0**$_1$	**1276.2**
t-score	1478.9	1486.8	1467.4	1403.9	1473.6	**1061.0**$_1$	1395.2
POS	1356.2	1368.4	1372.6	**1266.7**$_2$	1361.9	**992.2**$_{1,2}$	1286.3
WordNet	2063.0	2065.0	2078.0	1850.2	2034.1	**1375.4**$_1$	1911.0
Average	1548.7	1556.6	1552.3	1441.5	1537.4	**1107.4**	—

$\varepsilon = 52$	Budget Distributor						Average
Chunker	Baseline	Attention	Gradients	IC	KeyBERT	YAKE	
PMI	800.9	793.6	787.4	705.9	769.9	**514.5**$_1$	728.7
LLR	765.0	762.9	**753.2**$_2$	**681.2**$_2$	745.8	**495.5**$_1$	700.6
t-score	**762.5**$_2$	**758.2**$_2$	754.5	682.6	**729.9**$_2$	**492.8**$_1$	**696.7**
POS	897.8	882.5	869.4	792.4	840.9	**533.8**$_1$	802.8
WordNet	939.3	942.1	932.2	792.9	930.8	**476.3**$_{1,2}$	835.6
Average	833.1	827.9	819.3	731.0	803.5	**502.6**	—

$\varepsilon = 260$	Budget Distributor						Average
Chunker	Baseline	Attention	Gradients	IC	KeyBERT	YAKE	
PMI	220.4	230.4	230.2	212.4	245.3	**171.1**$_1$	218.3
LLR	226.4	232.5	234.7	216.8	246.1	**171.4**$_1$	221.3
t-score	**215.0**$_2$	**219.9**$_2$	**225.7**$_2$	**207.5**$_2$	**240.9**$_2$	**165.6**$_{1,2}$	**212.4**
POS	352.2	349.4	353.8	335.6	356.1	**269.0**$_1$	336.0
WordNet	257.5	260.0	266.8	237.7	281.0	**169.0**$_1$	245.3
Average	254.3	258.4	262.2	242.0	273.9	**189.2**	—

Backup

Yelp RG

Yelp $\varepsilon = 18.7$		Budget Distributor						Average Relative Gain
		Baseline	Attention	Gradients	IC	KeyBERT	YAKE	
Chunker	Baseline	Utility: $87.8_{1.9}$ / Adversary: $94.4_{0.2}$						
PMI	Utility F1	$48.1_{0.0}$	$48.1_{0.0}$	$48.1_{0.0}$	$48.1_{0.0}$	$48.1_{0.0}$	$76.6_{3.2}$	
	Static F1	$14.8_{2.2}$	$15.3_{3.1}$	$14.8_{2.5}$	$14.9_{2.8}$	$13.6_{2.6}$	$55.5_{5.1}$	
	Adaptive F1	$77.6_{1.7}$	$76.5_{2.3}$	$77.1_{0.8}$	$77.7_{1.0}$	$77.4_{1.2}$	$88.7_{1.1}$	
	Relative Gain	−0.275	−0.263	−0.269	−0.276	−0.272	$\mathbf{-0.067_{1,2}}$	**−0.237**
LLR	Utility F1	$48.1_{0.0}$	$48.1_{0.0}$	$48.1_{0.0}$	$48.1_{0.0}$	$48.1_{0.0}$	$58.3_{17.7}$	
	Static F1	$12.8_{2.7}$	$12.4_{2.8}$	$12.7_{3.3}$	$13.3_{2.9}$	$13.5_{3.3}$	$53.7_{5.9}$	
	Adaptive F1	$75.7_{2.2}$	$76.2_{2.3}$	$76.5_{2.0}$	$77.2_{2.3}$	$75.6_{4.6}$	$87.4_{1.5}$	
	Relative Gain	$\mathbf{-0.254_{2}}$	$\mathbf{-0.260_{2}}$	$\mathbf{-0.263_{2}}$	$\mathbf{-0.270_{2}}$	$\mathbf{-0.254_{1,2}}$	−0.262	−0.261
t-score	Utility F1	$48.1_{0.0}$	$48.1_{0.0}$	$48.1_{0.0}$	$48.1_{0.0}$	$48.1_{0.0}$	$69.1_{18.2}$	
	Static F1	$12.2_{2.0}$	$12.6_{2.1}$	$12.1_{2.8}$	$13.5_{2.5}$	$12.7_{2.0}$	$55.9_{4.2}$	
	Adaptive F1	$76.7_{3.3}$	$77.1_{1.7}$	$77.4_{0.7}$	$77.6_{1.4}$	$76.6_{2.7}$	$88.0_{1.7}$	
	Relative Gain	−0.265	−0.270	−0.273	−0.275	−0.264	$\mathbf{-0.145_{1}}$	−0.249
POS	Utility F1	$48.1_{0.0}$	$48.1_{0.0}$	$48.1_{0.0}$	$48.1_{0.0}$	$48.1_{0.0}$	$65.2_{15.9}$	
	Static F1	$18.2_{3.9}$	$17.6_{3.5}$	$17.2_{3.4}$	$19.0_{3.1}$	$18.2_{3.4}$	$59.6_{4.5}$	
	Adaptive F1	$78.6_{2.6}$	$81.6_{0.4}$	$80.7_{2.8}$	$80.5_{0.5}$	$79.5_{1.1}$	$89.0_{1.4}$	
	Relative Gain	−0.285	−0.317	−0.308	−0.305	−0.295	$\mathbf{-0.200_{1}}$	−0.285
WordNet	Utility F1	$48.1_{0.0}$	$48.1_{0.0}$	$48.1_{0.0}$	$48.1_{0.0}$	$48.1_{0.0}$	$69.6_{18.7}$	
	Static F1	$15.1_{4.7}$	$14.6_{3.2}$	$14.3_{3.8}$	$15.4_{3.7}$	$14.4_{3.4}$	$62.6_{4.8}$	
	Adaptive F1	$78.8_{2.3}$	$80.3_{1.6}$	$80.7_{0.5}$	$79.0_{0.4}$	$78.7_{1.3}$	$90.4_{0.2}$	
	Relative Gain	−0.288	−0.303	−0.308	−0.289	−0.286	$\mathbf{-0.165_{1}}$	−0.273
Average Relative Gain		−0.274	−0.282	−0.284	−0.283	−0.274	**−0.168**	—

Backup

Yelp RG

Yelp $\varepsilon = 187$		Budget Distributor						Average Relative Gain
		Baseline	Attention	Gradients	IC	KeyBERT	YAKE	
Chunker	Baseline	Utility: $87.8_{1.9}$ / Adversary: $94.4_{0.2}$						
PMI	Utility F1	$48.1_{0.0}$	$48.1_{0.0}$	$48.1_{0.0}$	$48.1_{0.0}$	$51.1_{5.3}$	$85.3_{2.6}$	
	Static F1	$29.7_{4.5}$	$28.5_{5.9}$	$29.0_{4.4}$	$30.8_{5.5}$	$29.8_{4.9}$	$81.9_{1.8}$	
	Adaptive F1	$80.9_{0.8}$	$79.5_{2.9}$	$80.8_{1.6}$	$81.0_{2.9}$	$79.4_{0.5}$	$90.6_{1.5}$	
	Relative Gain	-0.309	-0.295	-0.308	-0.310	-0.259	$\mathbf{0.012_{1}}$	-0.245
LLR	Utility F1	$48.1_{0.0}$	$48.1_{0.0}$	$48.1_{0.0}$	$51.9_{6.7}$	$48.1_{0.0}$	$57.9_{12.8}$	
	Static F1	$28.2_{5.4}$	$28.5_{4.5}$	$29.5_{5.0}$	$29.8_{5.3}$	$29.6_{5.2}$	$39.0_{5.7}$	
	Adaptive F1	$81.4_{1.1}$	$80.8_{2.4}$	$79.6_{1.5}$	$80.0_{3.0}$	$80.2_{3.0}$	$83.6_{1.1}$	
	Relative Gain	-0.315	-0.309	$\mathbf{-0.296_{2}}$	-0.256	-0.302	$\mathbf{-0.227_{1}}$	-0.284
t-score	Utility F1	$48.1_{0.0}$	$48.1_{0.0}$	$48.1_{0.0}$	$48.1_{0.0}$	$51.0_{3.1}$	$83.2_{2.1}$	
	Static F1	$29.0_{4.2}$	$28.9_{5.2}$	$28.4_{4.5}$	$30.8_{5.4}$	$30.5_{5.7}$	$82.5_{1.2}$	
	Adaptive F1	$82.0_{0.9}$	$80.9_{2.0}$	$82.2_{2.6}$	$80.9_{1.5}$	$81.8_{2.2}$	$90.1_{1.2}$	
	Relative Gain	-0.321	-0.310	-0.324	-0.309	-0.285	$\mathbf{-0.006_{1}}$	-0.259
POS	Utility F1	$48.1_{0.0}$	$53.1_{8.7}$	$48.1_{0.0}$	$55.2_{8.4}$	$59.7_{12.3}$	$84.8_{0.8}$	
	Static F1	$32.7_{7.2}$	$33.3_{7.7}$	$32.3_{5.8}$	$33.7_{7.6}$	$33.3_{6.6}$	$78.2_{1.8}$	
	Adaptive F1	$80.0_{1.9}$	$82.3_{0.5}$	$83.5_{1.2}$	$84.6_{1.7}$	$82.3_{1.5}$	$90.3_{1.3}$	
	Relative Gain	-0.300	$\mathbf{-0.267_{2}}$	-0.337	-0.266	$\mathbf{-0.191_{2}}$	$\mathbf{0.009_{1}}$	$\mathbf{-0.225}$
WordNet	Utility F1	$56.3_{14.3}$	$48.1_{0.0}$	$48.1_{0.0}$	$57.7_{16.8}$	$53.5_{7.2}$	$86.5_{0.5}$	
	Static F1	$34.5_{5.1}$	$32.7_{6.6}$	$34.4_{5.9}$	$35.9_{5.5}$	$34.3_{5.3}$	$85.3_{0.8}$	
	Adaptive F1	$82.6_{2.1}$	$82.9_{1.7}$	$84.6_{1.9}$	$83.6_{1.1}$	$82.3_{2.5}$	$91.2_{0.5}$	
	Relative Gain	$\mathbf{-0.233_{2}}$	-0.331	-0.349	$\mathbf{-0.228_{2}}$	-0.263	$\mathbf{0.020_{1,2}}$	-0.231
Average Relative Gain		-0.296	-0.302	-0.323	-0.274	-0.260	-0.038	—

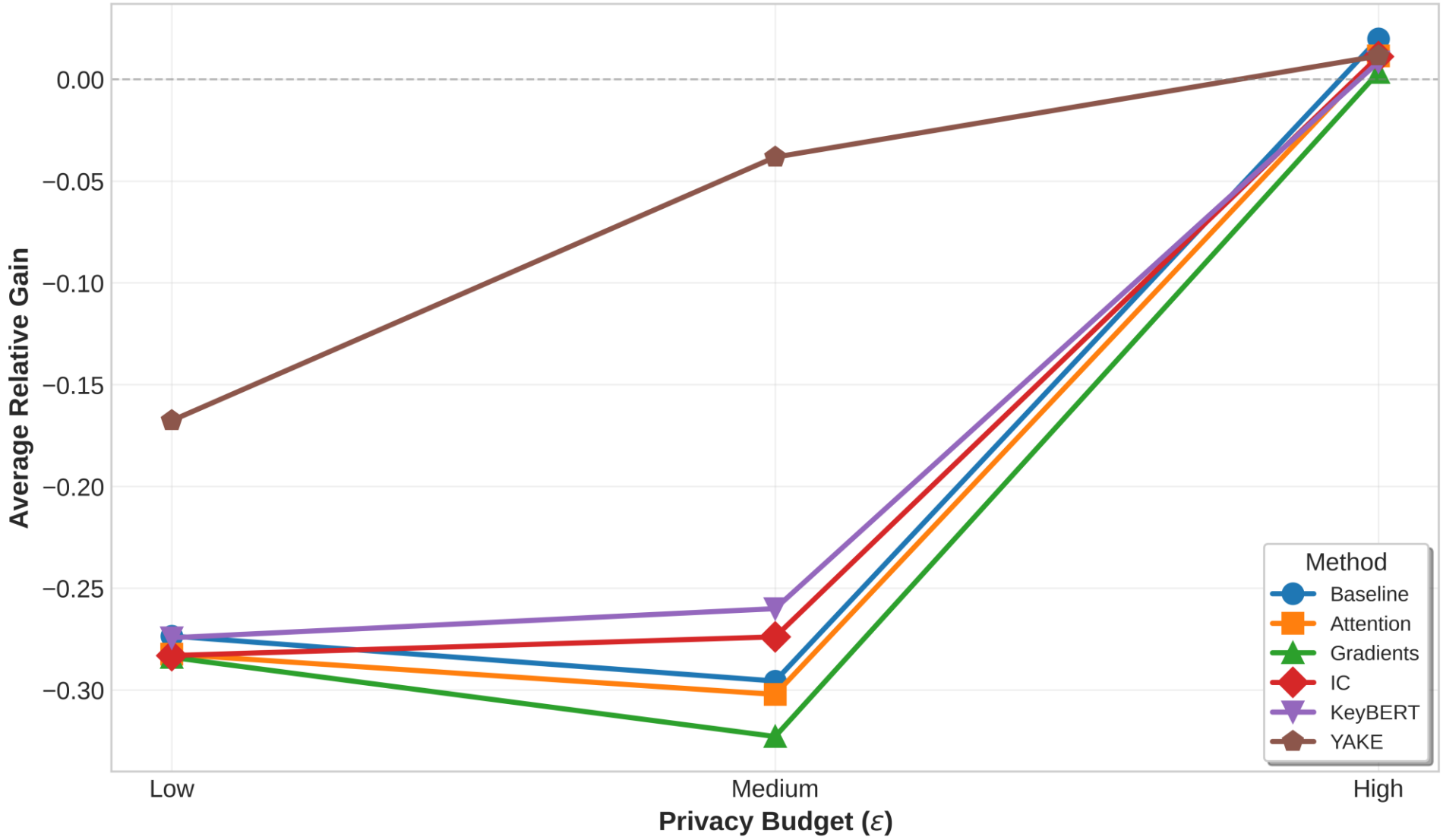
Backup

Yelp RG

Yelp $\varepsilon = 935$		Budget Distributor						Average Relative Gain
		Baseline	Attention	Gradients	IC	KeyBERT	YAKE	
Chunker	Baseline	Utility: $87.8_{1.9}$ / Adversary: $94.4_{0.2}$						
PMI	Utility F1	$84.9_{1.7}$	$84.0_{1.5}$	$83.0_{2.0}$	$85.1_{2.5}$	$85.1_{2.1}$	$86.7_{1.3}$	
	Static F1	$74.8_{1.8}$	$72.1_{2.5}$	$73.5_{2.5}$	$74.9_{2.4}$	$72.0_{1.9}$	$88.0_{1.8}$	
	Adaptive F1	$88.5_{1.6}$	$89.9_{1.4}$	$88.2_{0.9}$	$88.6_{1.6}$	$90.1_{0.6}$	$91.2_{0.8}$	
	Relative Gain	$\mathbf{0.029_{2}}$	0.004	0.011	$\mathbf{0.030_{1,2}}$	0.015	0.022	0.019
LLR	Utility F1	$86.0_{0.3}$	$83.9_{1.6}$	$86.1_{1.3}$	$84.5_{0.3}$	$84.5_{1.5}$	$87.9_{0.8}$	
	Static F1	$74.1_{1.9}$	$70.5_{2.5}$	$72.1_{2.5}$	$74.3_{2.3}$	$70.8_{3.2}$	$87.2_{1.3}$	
	Adaptive F1	$89.9_{1.9}$	$88.8_{2.1}$	$90.0_{1.1}$	$88.7_{1.4}$	$87.9_{1.1}$	$91.8_{1.2}$	
	Relative Gain	0.028	0.015	$\mathbf{0.027_{2}}$	0.024	$\mathbf{0.031_{1,2}}$	$\mathbf{0.029_{2}}$	**0.026**
t-score	Utility F1	$83.1_{4.3}$	$82.5_{1.8}$	$81.9_{2.3}$	$83.4_{1.8}$	$81.2_{1.7}$	$84.3_{1.8}$	
	Static F1	$76.0_{1.6}$	$72.9_{2.3}$	$73.9_{1.7}$	$76.2_{2.1}$	$72.4_{2.4}$	$87.6_{1.8}$	
	Adaptive F1	$89.2_{1.0}$	$87.7_{1.1}$	$89.0_{1.8}$	$88.8_{1.0}$	$89.3_{1.2}$	$91.5_{0.9}$	
	Relative Gain	0.002	$\mathbf{0.012_{1}}$	−0.010	0.010	−0.021	−0.008	−0.003
POS	Utility F1	$83.1_{2.3}$	$83.4_{1.1}$	$80.2_{1.9}$	$80.9_{1.8}$	$81.1_{1.6}$	$84.5_{1.7}$	
	Static F1	$64.5_{3.7}$	$63.4_{3.5}$	$62.8_{4.2}$	$64.9_{4.2}$	$63.1_{4.3}$	$84.1_{2.0}$	
	Adaptive F1	$87.8_{1.1}$	$87.0_{1.0}$	$88.6_{0.5}$	$89.4_{1.0}$	$88.2_{0.5}$	$90.5_{0.4}$	
	Relative Gain	0.017	$\mathbf{0.028_{1,2}}$	−0.025	−0.024	−0.010	0.004	−0.002
WordNet	Utility F1	$84.7_{0.5}$	$83.1_{1.6}$	$83.4_{1.0}$	$83.7_{2.2}$	$85.0_{0.8}$	$86.8_{1.7}$	
	Static F1	$74.9_{2.0}$	$72.5_{2.5}$	$73.7_{2.8}$	$74.9_{2.0}$	$71.7_{2.1}$	$88.4_{0.8}$	
	Adaptive F1	$88.8_{0.9}$	$89.4_{0.8}$	$88.5_{1.2}$	$88.5_{0.6}$	$89.0_{1.0}$	$92.3_{1.0}$	
	Relative Gain	0.024	−0.001	0.013	0.016	$\mathbf{0.026_{1}}$	0.011	0.015
Average Relative Gain		**0.020**	0.012	0.003	0.011	0.009	0.011	—

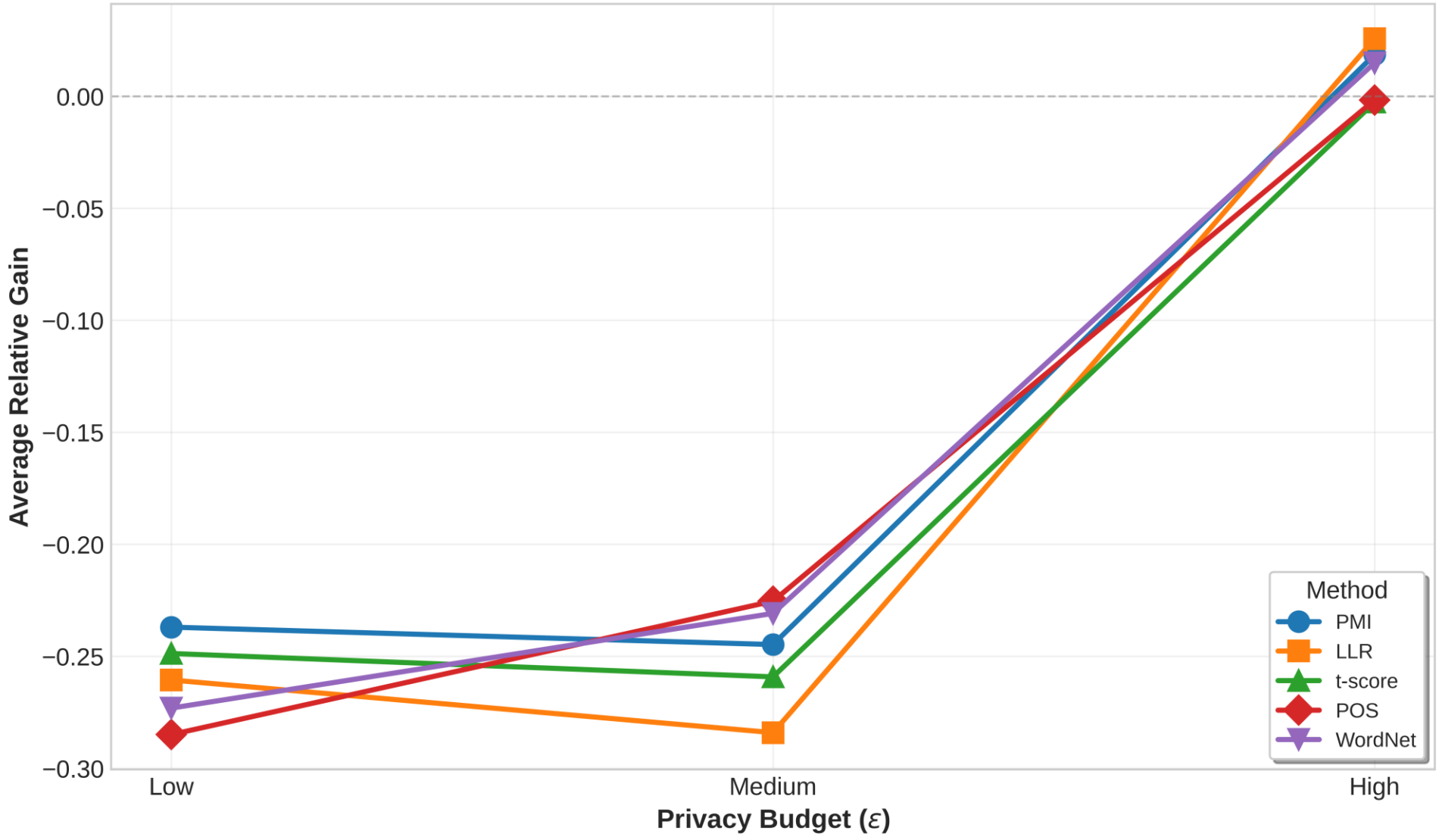
Backup

Yelp RG



Backup

Yelp RG



Backup

Yelp CS

$\varepsilon = 18.7$	Budget Distributor						Average
Chunker	Baseline	Attention	Gradients	IC	KeyBERT	YAKE	
PMI	0.348	0.349	0.349	0.380	0.348	$\mathbf{0.590_{1}}$	0.394
LLR	0.348	0.349	0.348	0.383	0.347	$\mathbf{0.594_{1}}$	0.395
t-score	0.362	0.363	0.362	0.396	0.362	$\mathbf{0.591_{1}}$	0.406
POS	$\mathbf{0.452_{2}}$	$\mathbf{0.453_{2}}$	$\mathbf{0.454_{2}}$	$\mathbf{0.472_{2}}$	$\mathbf{0.453_{2}}$	$\mathbf{0.712_{1,2}}$	**0.499**
WordNet	0.323	0.324	0.324	0.358	0.323	$\mathbf{0.593_{1}}$	0.374
Average	0.367	0.368	0.367	0.398	0.367	**0.616**	—

$\varepsilon = 187$	Budget Distributor						Average
Chunker	Baseline	Attention	Gradients	IC	KeyBERT	YAKE	
PMI	0.557	0.549	0.550	0.578	0.505	$\mathbf{0.829_{1}}$	0.595
LLR	0.549	0.544	0.543	0.572	0.499	$\mathbf{0.601_{1}}$	0.551
t-score	0.558	0.552	0.551	0.580	0.506	$\mathbf{0.832_{1}}$	0.596
POS	$\mathbf{0.646_{2}}$	$\mathbf{0.644_{2}}$	$\mathbf{0.645_{2}}$	$\mathbf{0.662_{2}}$	$\mathbf{0.620_{2}}$	$\mathbf{0.860_{1,2}}$	**0.679**
WordNet	0.568	0.558	0.560	0.588	0.503	$\mathbf{0.844_{1}}$	0.604
Average	0.576	0.569	0.570	0.596	0.527	**0.793**	—

$\varepsilon = 935$	Budget Distributor						Average
Chunker	Baseline	Attention	Gradients	IC	KeyBERT	YAKE	
PMI	0.887	0.874	0.873	0.883	0.796	$\mathbf{0.962_{1}}$	0.879
LLR	0.881	0.868	0.868	0.878	0.788	$\mathbf{0.962_{1}}$	0.874
t-score	$\mathbf{0.891_{2}}$	$\mathbf{0.877_{2}}$	$\mathbf{0.878_{2}}$	$\mathbf{0.887_{2}}$	0.796	$\mathbf{0.966_{1,2}}$	**0.882**
POS	0.869	0.863	0.863	0.869	$\mathbf{0.823_{2}}$	$\mathbf{0.941_{1}}$	0.871
WordNet	0.876	0.865	0.863	0.875	0.781	$\mathbf{0.962_{1}}$	0.870
Average	0.881	0.869	0.869	0.878	0.797	**0.959**	—

Backup

Yelp PPL

$\varepsilon = 18.7$	Budget Distributor						Average
Chunker	Baseline	Attention	Gradients	IC	KeyBERT	YAKE	
PMI	716.9	691.7	693.4	701.6	687.0	**321.8**$_1$	635.4
LLR	693.0	667.6	693.1	673.8	689.0	**314.0**$_1$	621.7
t-score	751.3	753.8	720.1	727.2	744.9	**312.2**$_1$	668.3
POS	**595.9**$_2$	**593.6**$_2$	**567.4**$_2$	**578.2**$_2$	**588.6**$_2$	**280.8**$_{1,2}$	**534.1**
WordNet	826.9	825.2	852.2	794.8	811.1	**296.1**$_1$	734.4
Average	716.8	706.4	705.2	695.1	704.1	**305.0**	—

$\varepsilon = 187$	Budget Distributor						Average
Chunker	Baseline	Attention	Gradients	IC	KeyBERT	YAKE	
PMI	483.8	486.1	**455.2**$_2$	462.9	480.0	**144.2**$_1$	**418.7**
LLR	490.8	491.6	490.9	471.3	485.3	**351.5**$_1$	463.6
t-score	**478.6**$_2$	**480.1**$_2$	479.9	**458.8**$_2$	**473.8**$_2$	**141.8**$_1$	418.8
POS	503.7	504.0	500.5	483.9	488.8	**159.3**$_1$	440.0
WordNet	520.5	523.4	494.1	495.7	520.4	**130.0**$_{1,2}$	447.3
Average	495.5	497.0	484.1	474.5	489.7	**185.4**	—

$\varepsilon = 935$	Budget Distributor						Average
Chunker	Baseline	Attention	Gradients	IC	KeyBERT	YAKE	
PMI	152.6	156.4	156.4	153.4	170.9	**99.0**$_1$	148.1
LLR	157.1	161.0	160.5	157.8	175.6	**99.0**$_1$	151.8
t-score	**150.9**$_2$	**154.4**$_2$	**154.4**$_2$	**151.7**$_2$	**169.4**$_2$	**98.0**$_1$	**146.5**
POS	198.0	198.5	199.3	197.1	207.0	**121.8**$_1$	186.9
WordNet	159.2	161.9	162.1	158.7	177.2	**95.5**$_{1,2}$	152.4
Average	163.5	166.5	166.6	163.7	180.0	**102.7**	—

Backup

Enron

Enron $\varepsilon = 5.3$		Budget Distributor					
		Baseline	Attention	Gradients	IC	KeyBERT	YAKE
Chunker	Baseline	Adversary: $33.0_{3.1}$					
PMI	Static F1	$3.1_{0.5}$	$3.3_{0.5}$	$3.2_{0.5}$	$3.4_{0.5}$	$2.8_{0.3}$	$6.0_{1.8}$
	Adaptive F1	$8.0_{3.8}$	$10.7_{0.3}$	$9.0_{1.4}$	$9.6_{2.0}$	$9.4_{1.0}$	$17.1_{2.6}$
LLR	Static F1	$3.3_{0.7}$	$2.7_{0.5}$	$3.2_{0.3}$	$2.9_{0.4}$	$3.2_{0.1}$	$6.3_{1.8}$
	Adaptive F1	$7.8_{1.3}$	$9.7_{0.9}$	$8.3_{1.5}$	$8.0_{2.5}$	$9.4_{0.4}$	$13.9_{2.9}$
t-score	Static F1	$2.6_{0.4}$	$2.8_{0.5}$	$3.2_{0.8}$	$2.7_{0.5}$	$3.0_{0.6}$	$6.1_{2.2}$
	Adaptive F1	$10.1_{0.9}$	$6.1_{4.8}$	$8.5_{0.7}$	$9.7_{0.3}$	$9.1_{1.9}$	$15.7_{1.9}$
POS	Static F1	$4.7_{1.2}$	$4.6_{1.4}$	$4.8_{1.4}$	$4.3_{1.1}$	$4.2_{1.2}$	$6.9_{2.0}$
	Adaptive F1	$11.0_{2.6}$	$13.6_{0.5}$	$15.7_{3.8}$	$13.9_{0.6}$	$12.4_{0.4}$	$17.8_{3.9}$
WordNet	Static F1	$2.3_{0.5}$	$2.7_{0.5}$	$2.6_{0.3}$	$3.1_{0.4}$	$2.2_{0.4}$	$6.1_{1.9}$
	Adaptive F1	$8.0_{2.0}$	$10.6_{0.1}$	$7.3_{3.3}$	$10.9_{0.9}$	$9.3_{1.6}$	$16.7_{1.8}$

Enron $\varepsilon = 53$		Budget Distributor					
		Baseline	Attention	Gradients	IC	KeyBERT	YAKE
Chunker	Baseline	Adversary: $33.0_{3.1}$					
PMI	Static F1	$5.3_{1.2}$	$5.3_{0.9}$	$5.1_{0.5}$	$4.8_{0.8}$	$4.8_{1.0}$	$7.9_{3.0}$
	Adaptive F1	$11.3_{2.9}$	$12.8_{4.4}$	$11.1_{1.4}$	$12.4_{3.7}$	$14.0_{0.4}$	$18.3_{3.3}$
LLR	Static F1	$5.4_{1.2}$	$5.1_{0.4}$	$5.2_{1.4}$	$5.6_{1.6}$	$5.7_{1.0}$	$8.5_{2.8}$
	Adaptive F1	$12.8_{2.2}$	$12.6_{1.3}$	$12.0_{3.7}$	$11.3_{5.0}$	$13.4_{1.7}$	$19.3_{1.5}$
t-score	Static F1	$5.2_{0.9}$	$4.6_{1.3}$	$4.8_{0.7}$	$5.3_{2.2}$	$4.2_{0.9}$	$8.2_{2.8}$
	Adaptive F1	$10.5_{3.9}$	$11.1_{3.7}$	$11.5_{3.0}$	$13.2_{1.7}$	$12.3_{2.1}$	$22.0_{1.4}$
POS	Static F1	$5.3_{0.8}$	$5.4_{0.9}$	$5.4_{0.7}$	$5.7_{1.3}$	$5.0_{1.3}$	$8.0_{2.6}$
	Adaptive F1	$13.4_{3.8}$	$14.4_{0.8}$	$14.8_{0.7}$	$14.7_{1.2}$	$11.8_{3.3}$	$20.0_{3.7}$
WordNet	Static F1	$4.9_{0.9}$	$4.5_{1.1}$	$5.2_{0.8}$	$4.4_{0.8}$	$5.4_{0.6}$	$8.6_{3.1}$
	Adaptive F1	$14.7_{2.6}$	$13.4_{2.4}$	$13.0_{2.8}$	$14.6_{2.6}$	$13.9_{0.8}$	$20.7_{1.1}$

Backup

Enron

Enron $\varepsilon = 265$		Budget Distributor					
		Baseline	Attention	Gradients	IC	KeyBERT	YAKE
Chunker	**Baseline**	Adversary: $33.0_{3.1}$					
PMI	Static F1	$10.7_{2.2}$	$11.2_{3.1}$	$10.1_{3.0}$	$11.1_{3.1}$	$10.3_{2.3}$	$13.0_{3.4}$
	Adaptive F1	$21.4_{2.6}$	$21.3_{2.0}$	$20.1_{4.9}$	$23.0_{1.1}$	$19.5_{4.5}$	$23.9_{1.6}$
LLR	Static F1	$11.4_{3.3}$	$10.9_{2.7}$	$10.8_{3.1}$	$10.3_{2.7}$	$10.3_{2.8}$	$12.6_{4.0}$
	Adaptive F1	$22.4_{1.5}$	$21.3_{3.2}$	$22.9_{0.3}$	$21.6_{3.3}$	$21.3_{2.7}$	$26.7_{2.5}$
t-score	Static F1	$10.7_{2.9}$	$9.8_{2.0}$	$9.9_{2.4}$	$11.3_{3.4}$	$10.3_{2.8}$	$12.5_{3.7}$
	Adaptive F1	$22.4_{1.0}$	$20.5_{0.8}$	$21.6_{0.8}$	$22.4_{0.9}$	$18.7_{5.5}$	$24.9_{4.2}$
POS	Static F1	$8.6_{2.1}$	$9.0_{2.0}$	$9.0_{2.3}$	$8.5_{2.4}$	$8.7_{1.7}$	$10.6_{3.4}$
	Adaptive F1	$21.2_{1.1}$	$22.2_{2.3}$	$20.3_{3.1}$	$20.6_{3.5}$	$21.3_{1.7}$	$24.8_{3.6}$
WordNet	Static F1	$10.4_{2.6}$	$9.8_{1.5}$	$10.4_{2.5}$	$10.7_{3.1}$	$10.3_{1.8}$	$13.5_{4.2}$
	Adaptive F1	$23.8_{0.6}$	$19.8_{3.8}$	$22.0_{1.4}$	$23.3_{1.6}$	$22.8_{1.5}$	$27.5_{1.4}$

Backup

Enron CS

$\varepsilon = 5.3$	Budget Distributor						Average
Chunker	Baseline	Attention	Gradients	IC	KeyBERT	YAKE	
PMI	0.393	0.393	0.394	0.451	0.394	**0.492**$_1$	0.420
LLR	0.408	0.408	0.408	0.467	0.408	**0.504**$_1$	0.434
t-score	0.385	0.385	0.386	0.444	0.385	**0.485**$_1$	0.412
POS	**0.540**$_2$	**0.540**$_2$	**0.541**$_2$	**0.580**$_2$	**0.541**$_2$	**0.629**$_{1,2}$	**0.562**
WordNet	0.394	0.394	0.393	0.459	0.393	**0.510**$_1$	0.424
Average	0.424	0.424	0.424	0.480	0.424	**0.524**	—

$\varepsilon = 53$	Budget Distributor						Average
Chunker	Baseline	Attention	Gradients	IC	KeyBERT	YAKE	
PMI	0.586	0.578	0.571	0.625	0.541	**0.705**$_1$	0.601
LLR	0.592	0.587	0.579	0.633	0.550	**0.708**$_1$	0.608
t-score	0.591	0.583	0.575	0.633	0.544	**0.712**$_1$	0.606
POS	**0.669**$_2$	**0.666**$_2$	**0.665**$_2$	**0.698**$_2$	**0.648**$_2$	**0.771**$_{1,2}$	**0.686**
WordNet	0.602	0.597	0.589	0.647	0.555	**0.736**$_1$	0.621
Average	0.608	0.602	0.596	0.647	0.568	**0.726**	—

$\varepsilon = 265$	Budget Distributor						Average
Chunker	Baseline	Attention	Gradients	IC	KeyBERT	YAKE	
PMI	0.861	0.846	0.833	0.868	0.778	**0.919**$_1$	0.851
LLR	0.857	0.842	0.832	0.865	0.780	**0.914**$_1$	0.848
t-score	**0.867**$_2$	**0.853**$_2$	**0.841**$_2$	**0.876**$_2$	0.786	**0.925**$_{1,2}$	**0.858**
POS	0.847	0.843	0.837	0.854	**0.809**$_2$	**0.897**$_1$	0.848
WordNet	0.858	0.846	0.836	0.870	0.782	**0.923**$_1$	0.853
Average	0.858	0.846	0.836	0.867	0.787	**0.916**	—

Backup

Enron PPL

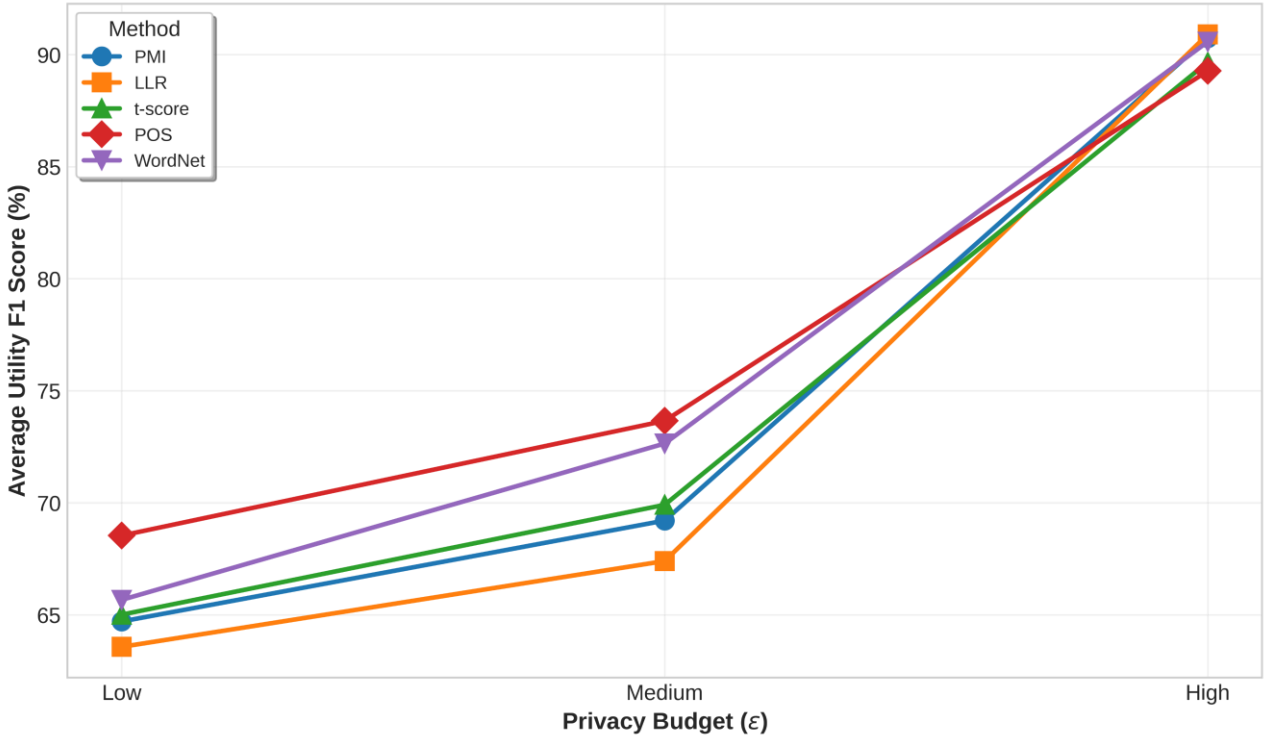
$\varepsilon = 5.3$	Budget Distributor						Average
Chunker	Baseline	Attention	Gradients	IC	KeyBERT	YAKE	
PMI	1164.5	1156.8	1152.4	1078.1	1164.4	**731.8**$_1$	1074.7
LLR	**1049.6**$_2$	**1072.4**$_2$	**1077.8**$_2$	**989.3**$_2$	**1050.2**$_2$	**666.4**$_{1,2}$	**984.3**
t-score	1223.5	1169.6	1154.5	1099.3	1149.8	**710.5**$_1$	1084.5
POS	1166.3	1126.8	1105.1	1082.1	1179.6	**756.3**$_1$	1069.4
WordNet	1448.8	1435.7	1412.8	1255.3	1413.9	**734.5**$_1$	1283.5
Average	1210.5	1192.2	1180.5	1100.8	1191.6	**719.9**	—

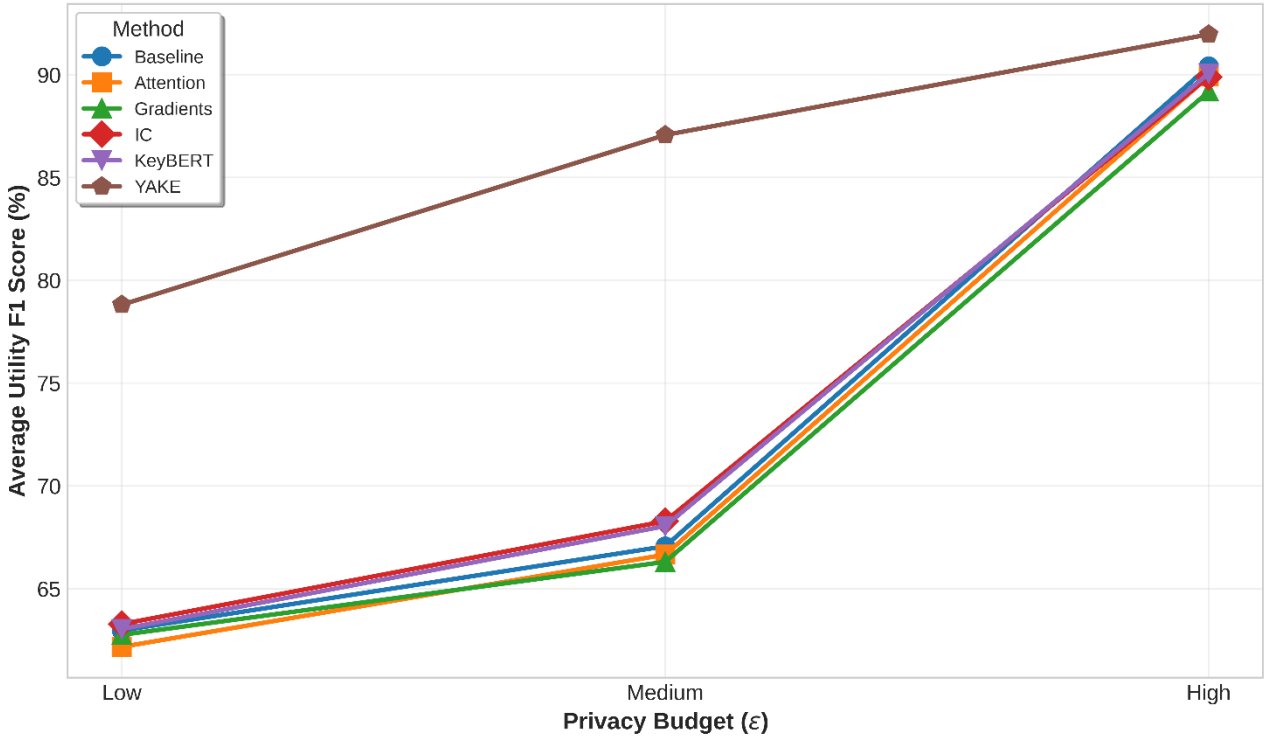
$\varepsilon = 53$	Budget Distributor						Average
Chunker	Baseline	Attention	Gradients	IC	KeyBERT	YAKE	
PMI	639.3	630.7	628.5	592.6	621.2	**383.9**$_1$	582.7
LLR	**612.8**$_2$	616.3	628.2	**578.4**$_2$	**599.6**$_2$	**375.5**$_1$	**568.5**
t-score	619.3	**611.4**$_2$	**612.1**$_2$	591.4	607.9	**370.7**$_1$	568.8
POS	734.0	781.9	707.8	726.0	718.4	**476.5**$_1$	690.8
WordNet	690.0	693.9	693.4	631.8	678.5	**339.7**$_{1,2}$	621.2
Average	659.1	666.9	654.0	624.0	645.1	**389.3**	—

$\varepsilon = 265$	Budget Distributor						Average
Chunker	Baseline	Attention	Gradients	IC	KeyBERT	YAKE	
PMI	287.7	294.0	296.0	284.5	302.1	**224.3**$_1$	281.4
LLR	289.6	293.0	295.5	290.5	300.6	**226.1**$_1$	282.6
t-score	**286.9**$_2$	**287.1**$_2$	**290.5**$_2$	**279.3**$_2$	**297.0**$_2$	**222.8**$_1$	**277.2**
POS	430.4	432.1	429.9	423.5	432.5	**359.1**$_1$	417.9
WordNet	294.3	295.4	299.3	285.1	303.0	**209.5**$_{1,2}$	281.1
Average	317.8	320.3	322.2	312.6	327.0	**248.4**	—

Backup

Utility Trustpilot + Yelp





Backup

Adaptive F1 all Datasets