Infusing Finetuning with Semantic Dependencies

Zhaofeng Wu, Hao Peng, and Noah Smith

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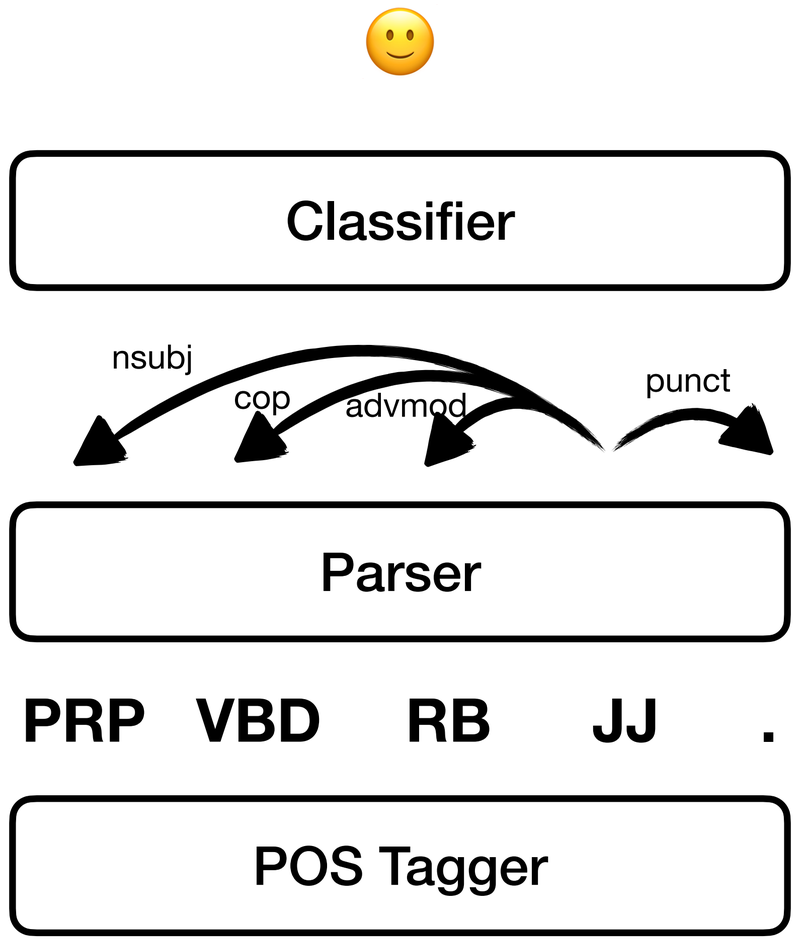
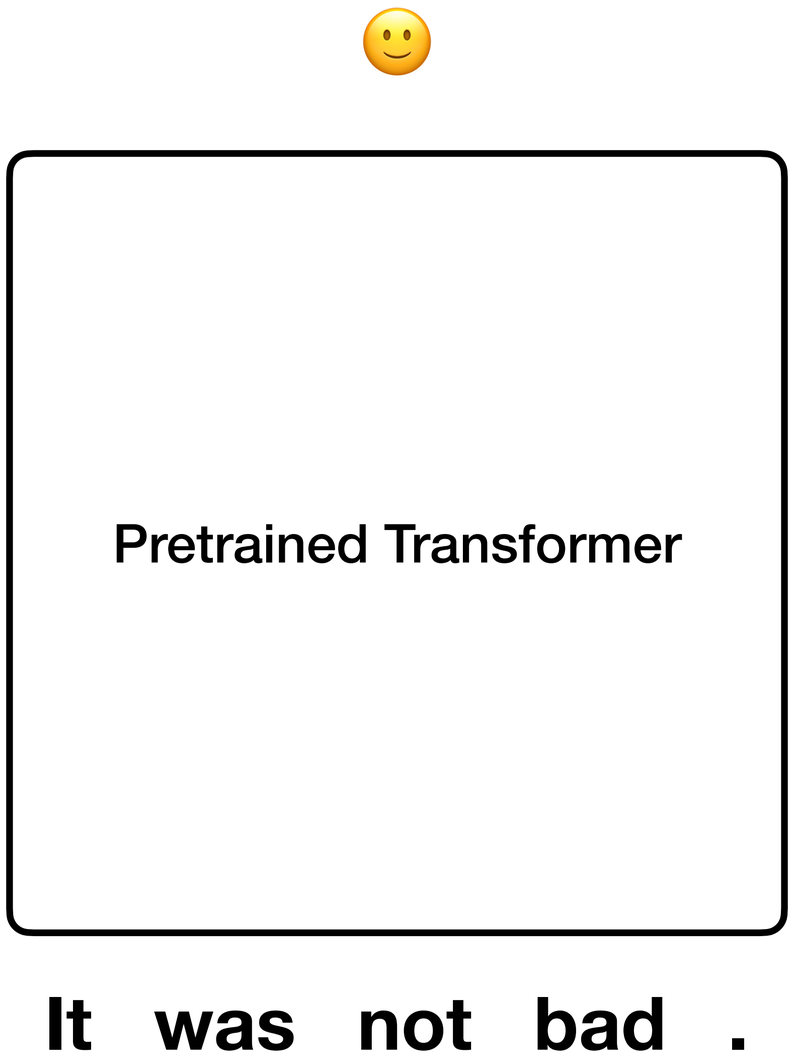
PAUL G. ALLEN SCHOOL
OF COMPUTER SCIENCE & ENGINEERING

Motivation


Classifier
nsubj
cop
advmod
punct
Parser
PRP VBD RB JJ .
POS Tagger
It was not bad .

Devlin et al. (2018); Liu et al. (2019b)

Motivation



Hewitt and Manning (2019); Tenney et al. (2019); Liu et al. (2019a)

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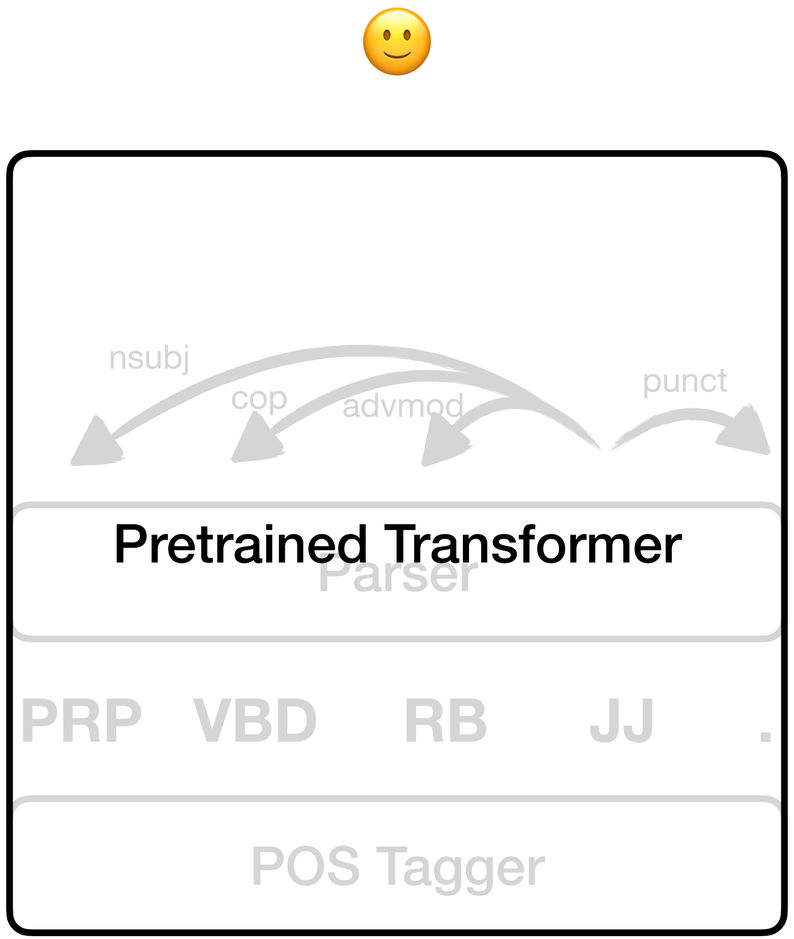

Would semantics help?

Introduction

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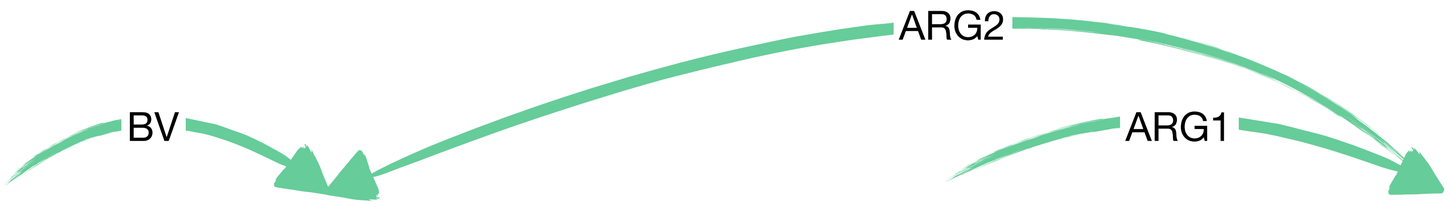
- … and the explicit incorporation of semantic information:

  1. Improves downstream task performance
  2. Helps guard against frequent yet invalid heuristics
  3. Better captures nuanced linguistic phenomena
  4. Increases training sample efficiency

Adapted from WSJ #20209013

Operationalizing “Meaning”



This technique is impossible to adopt .

DELPH-IN MRS-Derived Dependencies (**DM**; Ivanova et al., 2012)

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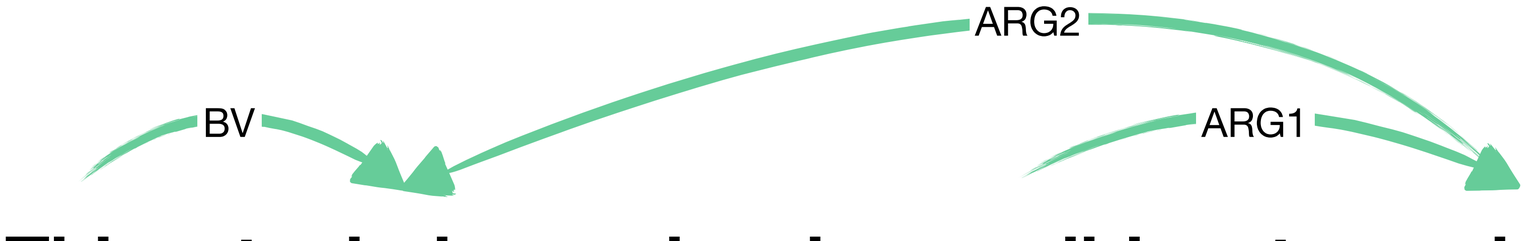

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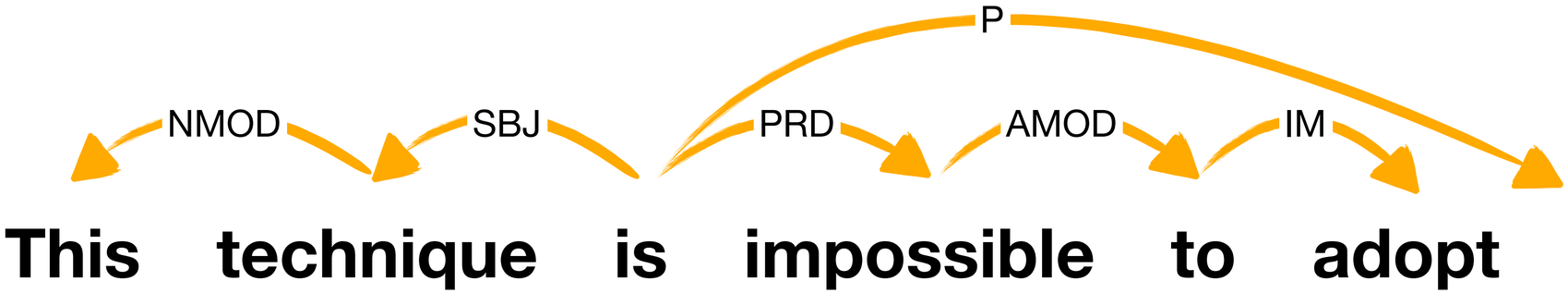
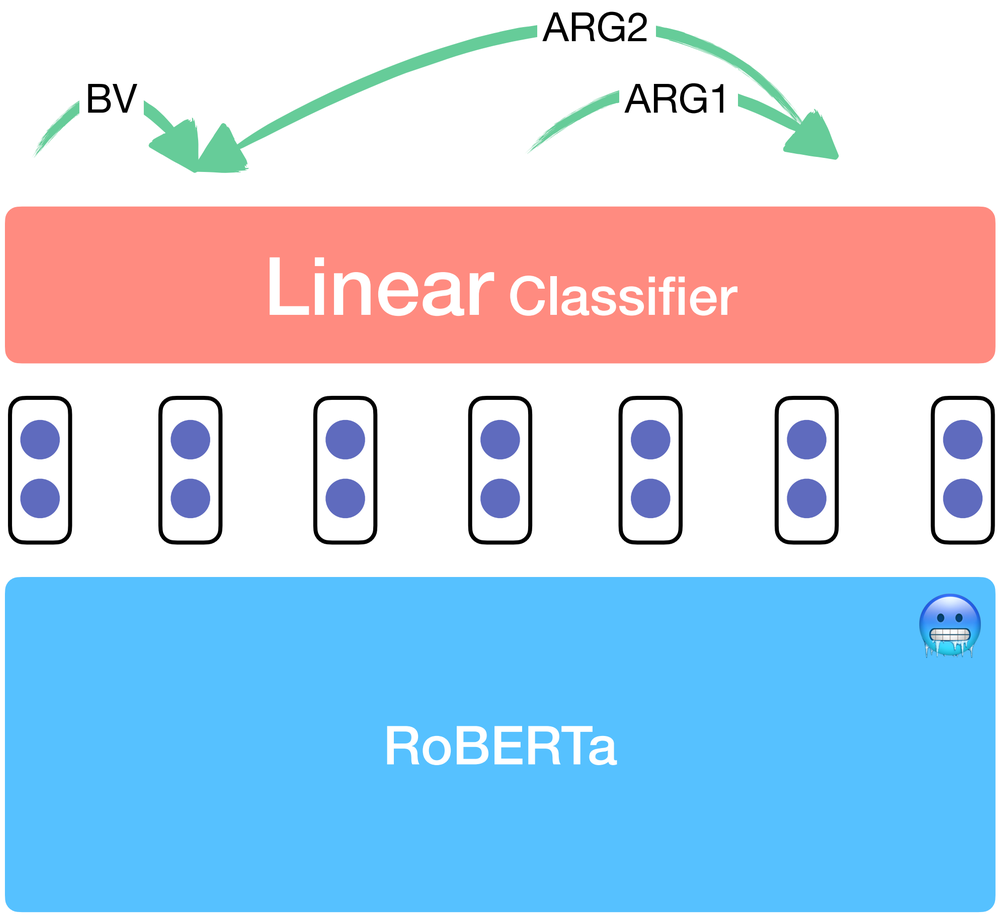


Stanford Dependencies (**SD**; de Marneffe et al., 2006)

Probing RoBERTa with Semantics



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Probing model (Shi et al., 2016; Adi et al., 2017)

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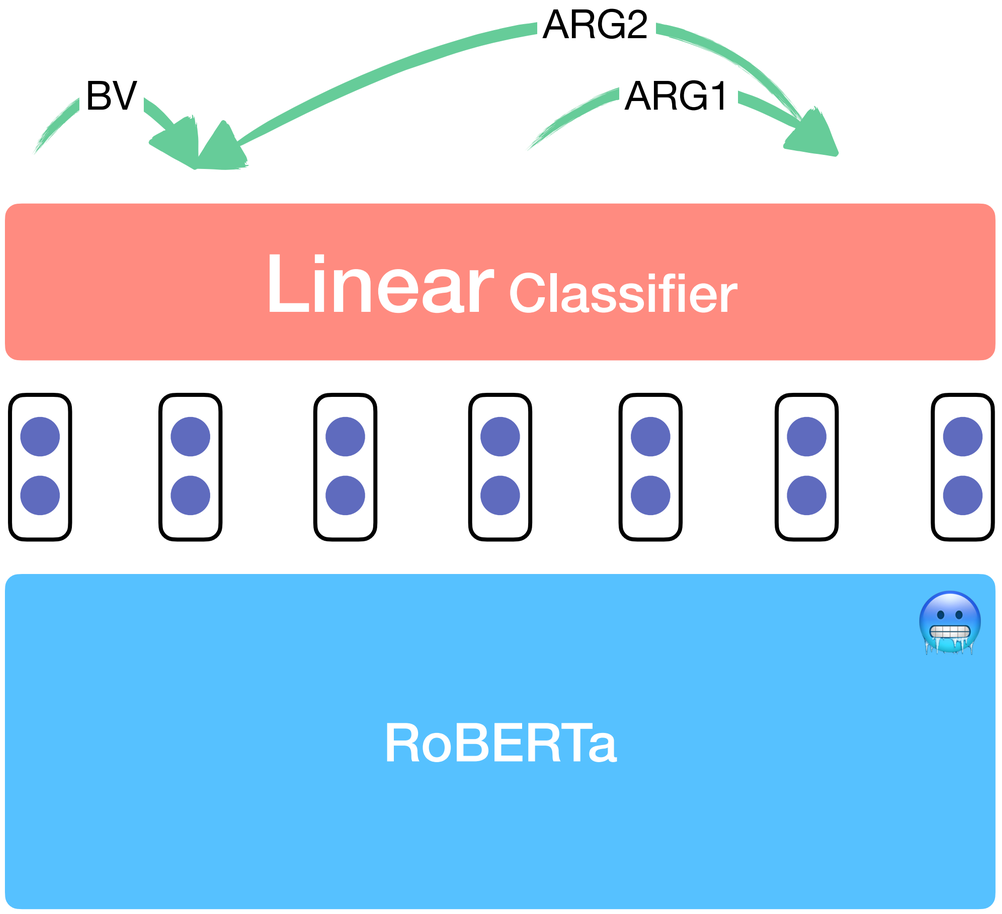

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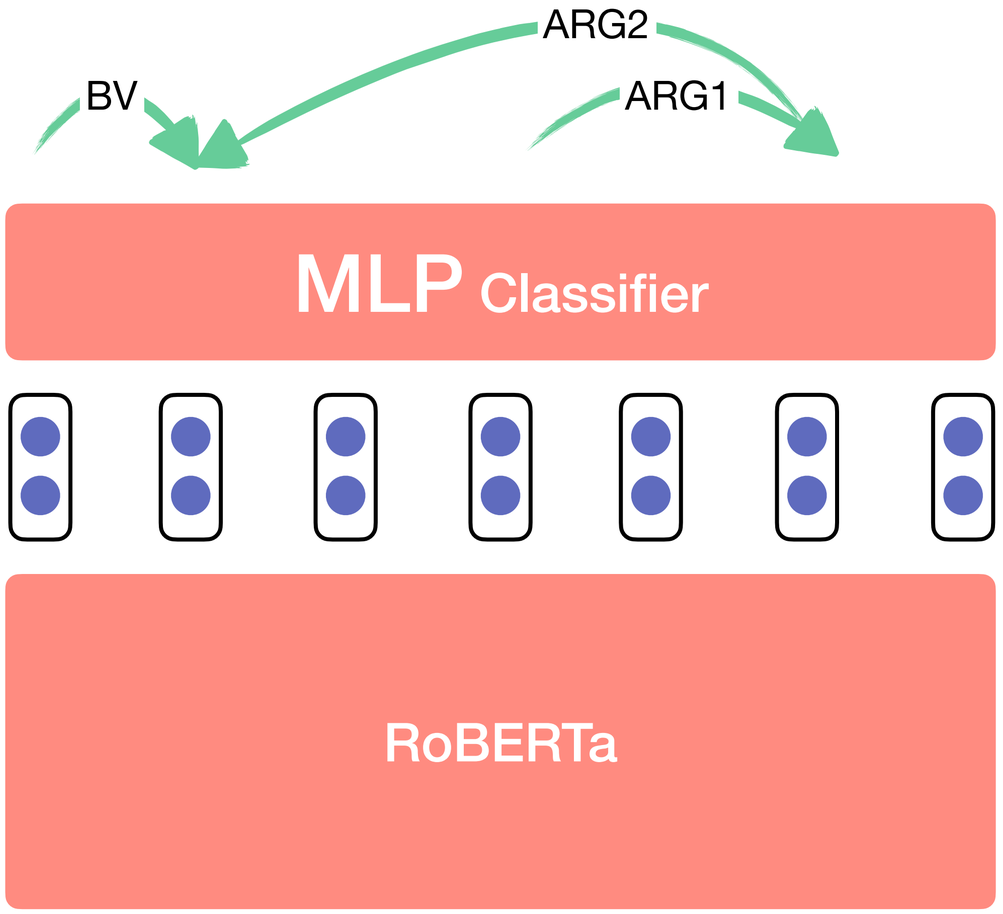

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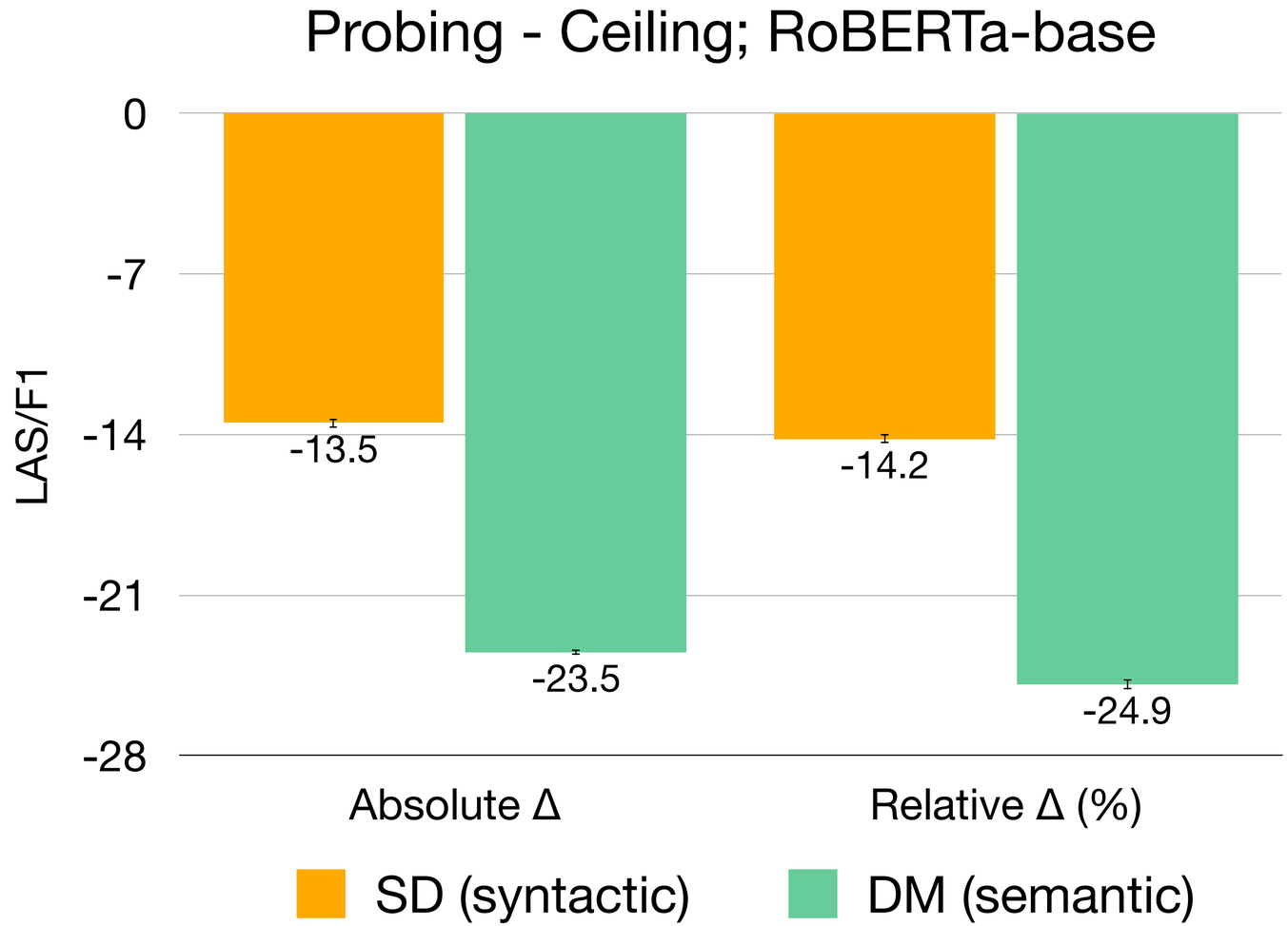
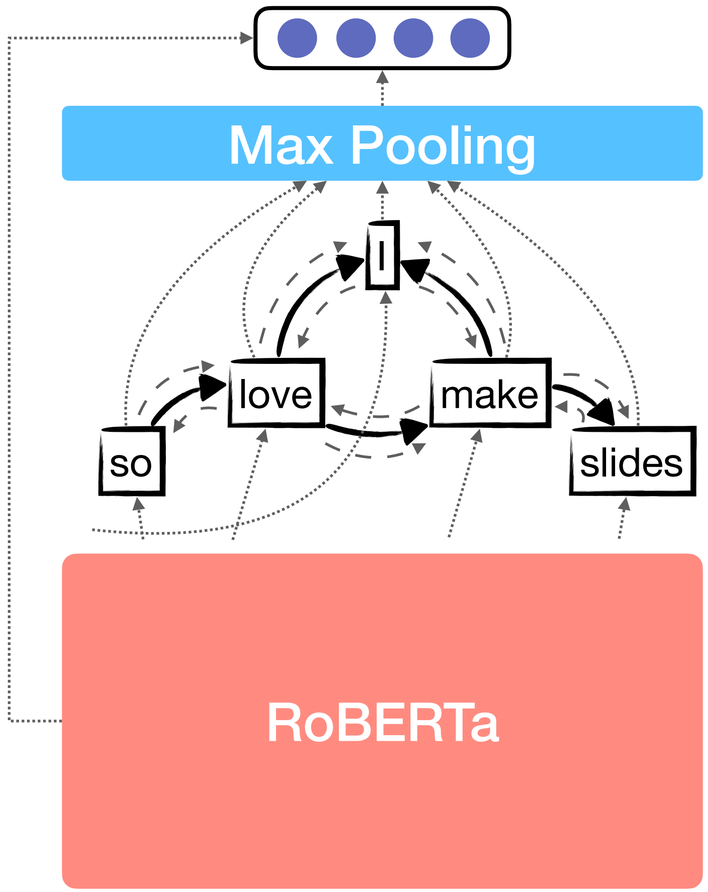
Ceiling model (Dozat and Manning, 2017, 2018)

Probing RoBERTa with Semantics



Can we use semantics to augment pretrained transformers?

Semantics-Infused Finetuning (SIFT)



I so love to make slides .

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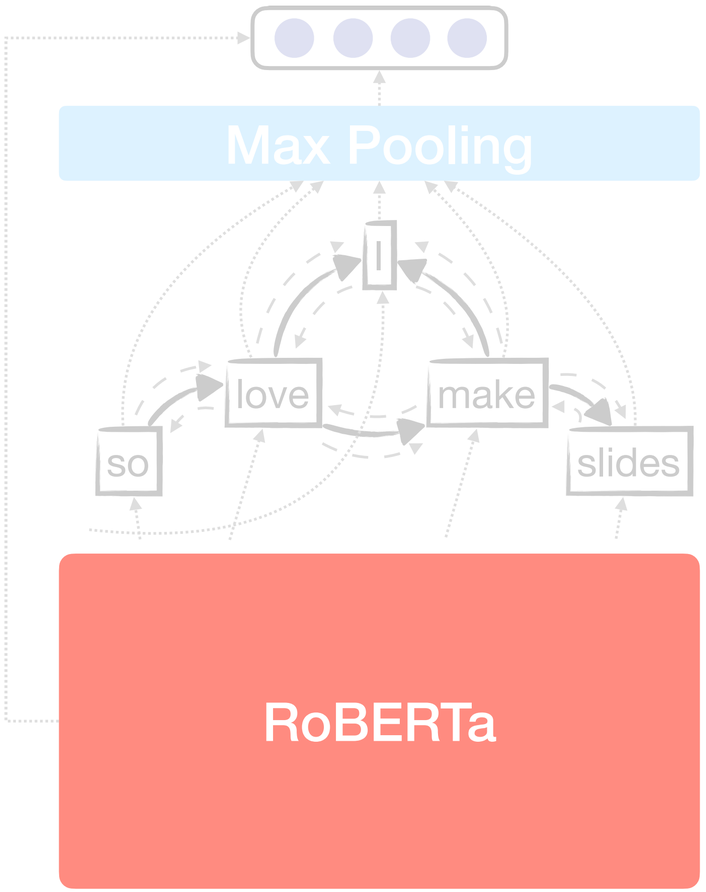

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Che et al. (2019)

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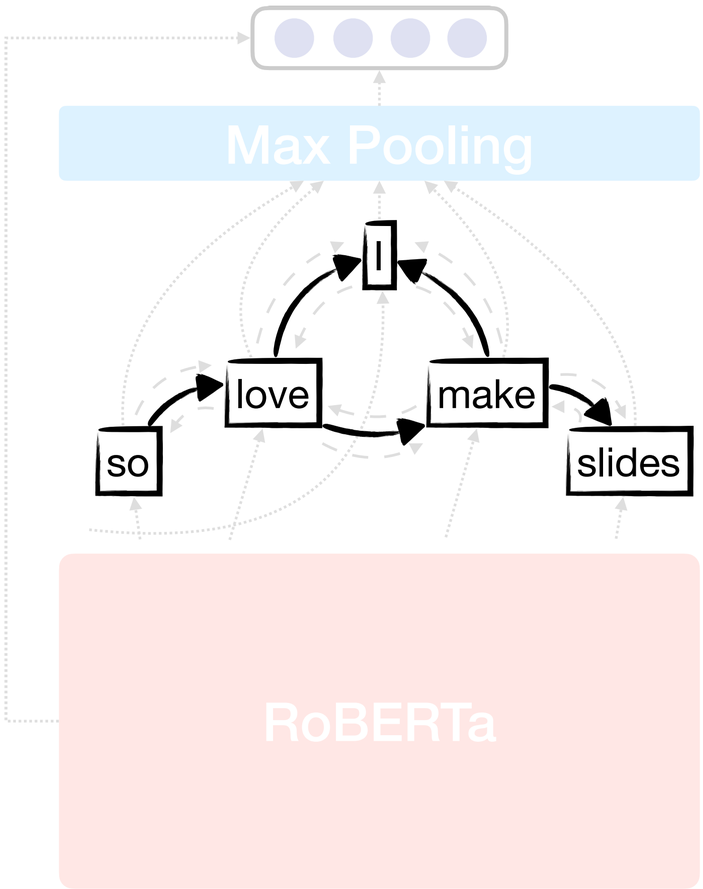

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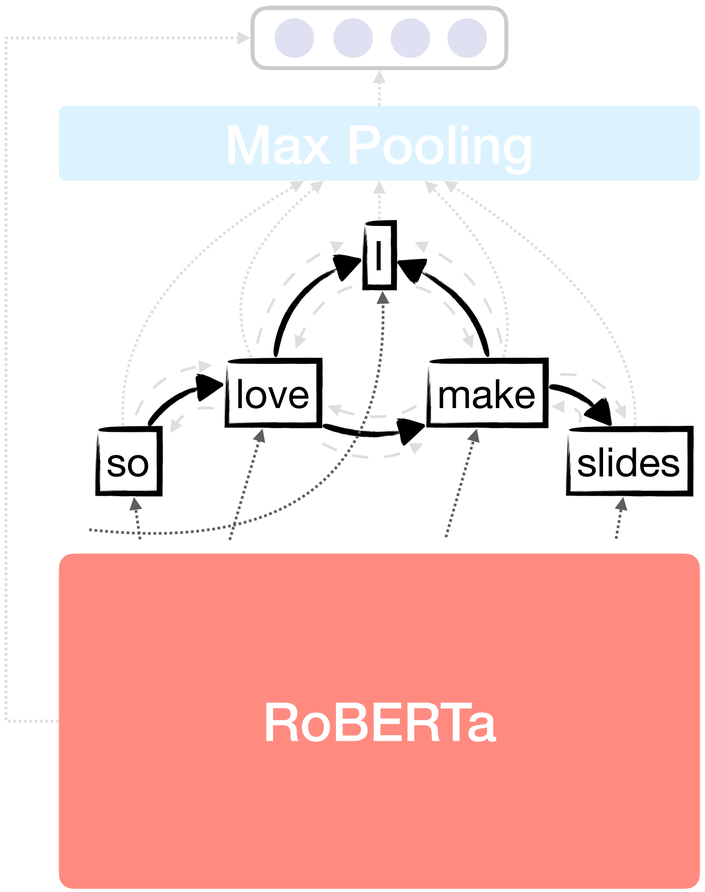

Schlichtkrull et al. (2017)

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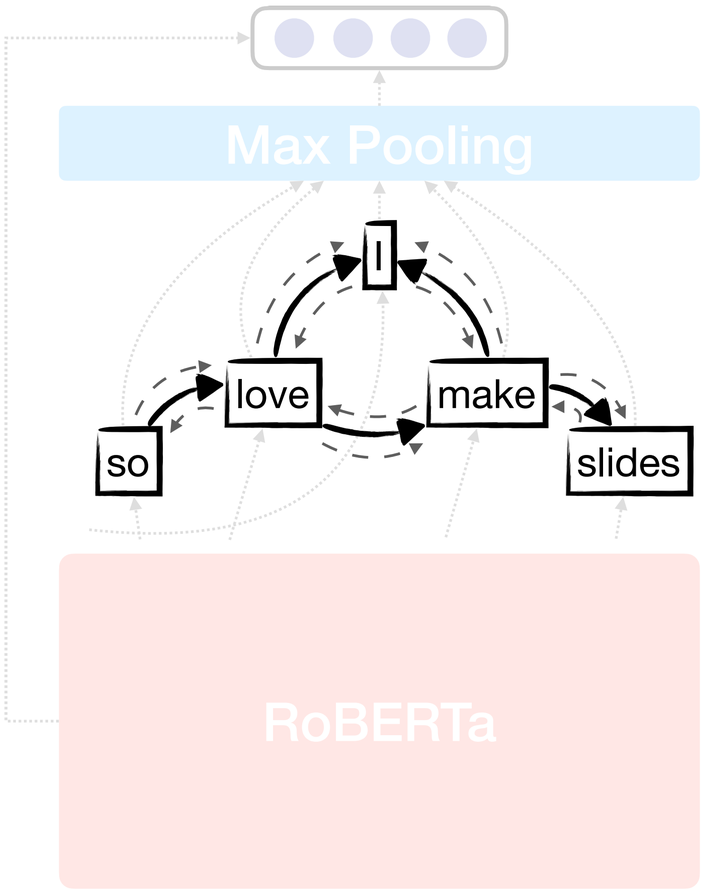

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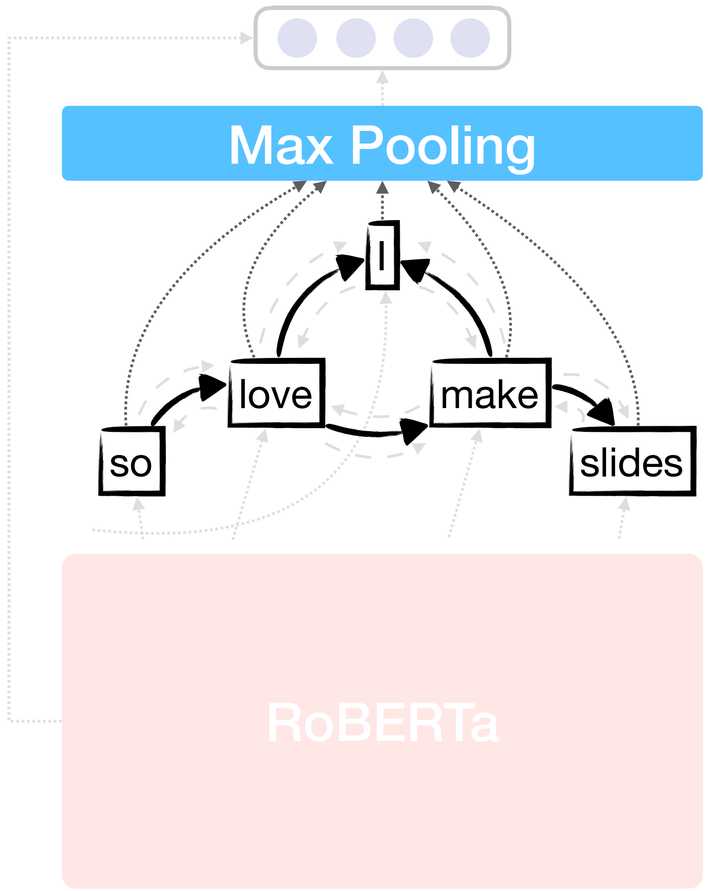

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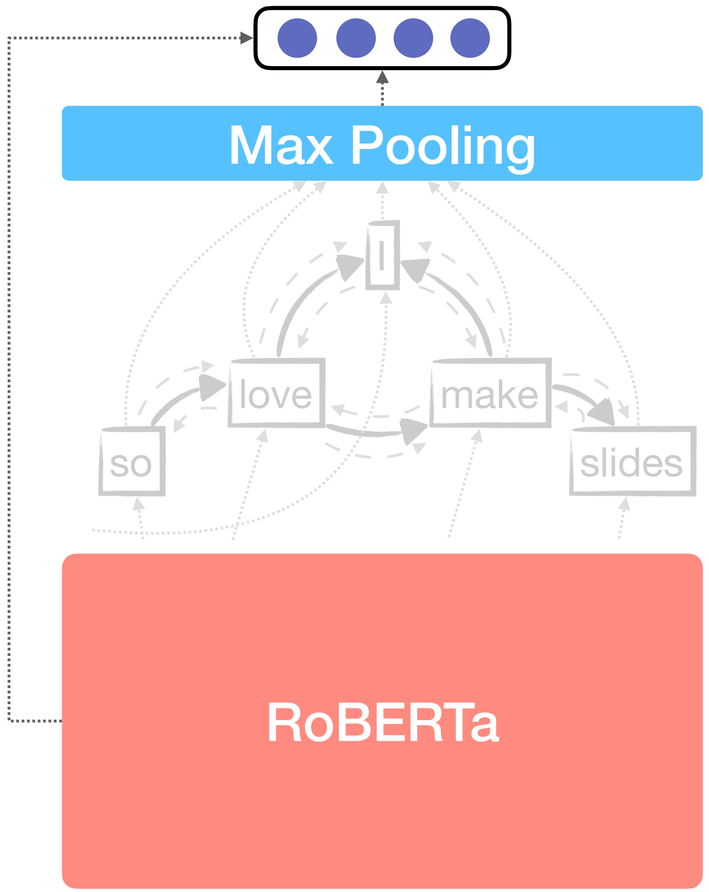

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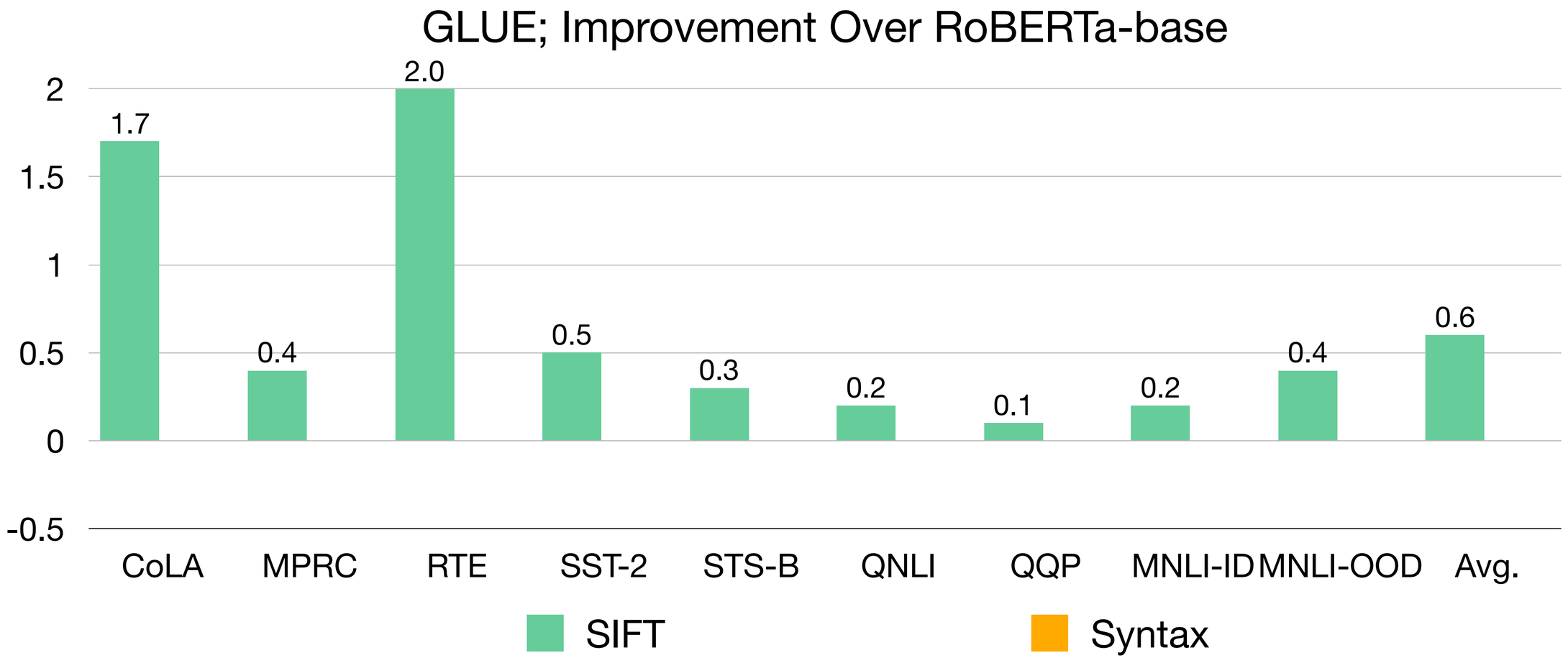
Experiments

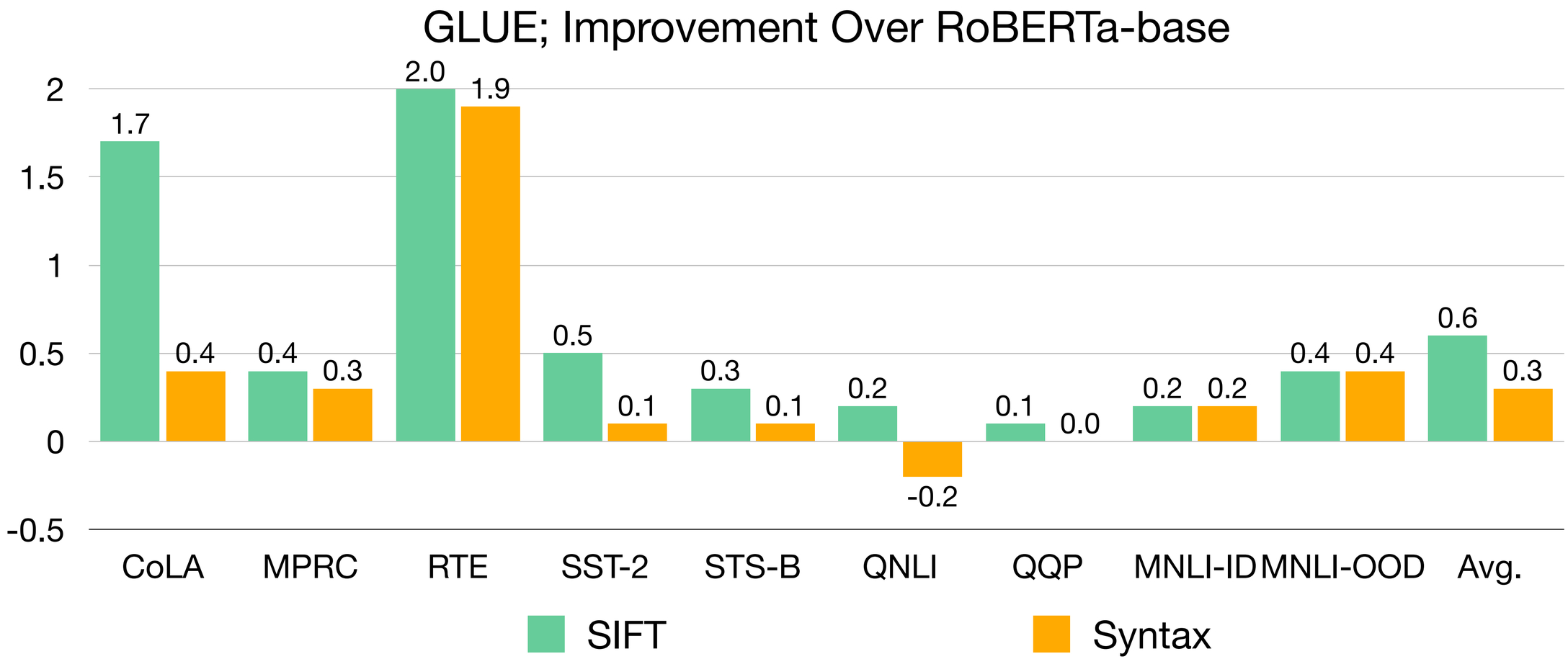
- Dataset: GLUE (Wang et al., 2018)
- Backbone: RoBERTa (Liu et al., 2019b)
- Parser: SOTA DM parser with 92.5 labeled F1 (Che et al., 2019)
- Graph Encoder: RGCN (Schlichtkrull et al., 2017)
  - 2 layers
  - Hidden dimension $\in \{256, 512, 768\}$
- Epochs $\in \{3, 10, 20\}$, learning rate $\in \{1 \times 10^{-4}, 2 \times 10^{-5}\}$

Results

Results


GLUE; Improvement Over RoBERTa-base
2
1.5
1
0.5
0
-0.5
1.7
0.4
2.0
0.5
0.3
0.2
0.1
0.2
0.4
0.6
CoLA
MPRC
RTE
SST-2
STS-B
QNLI
QQP
MNLI-ID
MNLI-OOD
Avg.
SIFT
Syntax

Results


GLUE; Improvement Over RoBERTa-base
2
1.5
1
0.5
0
-0.5
1.7
0.4
0.4
0.3
2.0
1.9
0.5
0.1
0.3
0.1
0.2
-0.2
0.1
0.0
0.2
0.2
0.4
0.4
0.6
0.3
CoLA
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Syntax

Analysis: When Do Semantic Structures Help?

- Two datasets
  - HANS tests if a model uses **invalid reasoning heuristics** (McCoy et al., 2019)
  - GLUE diagnostics tests the model capability in various **linguistic phenomena** (Wang et al., 2018)
- Examine a model trained on existing NLI datasets with synthetic NLI examples

Analysis: HANS Lexical Overlap

The actor stopped the banker. does not entail **The banker stopped the actor.**

RoBERTa	SIFT
68.1	**71.0** (+2.9)

Analysis: HANS Subsequence

The judges heard the actor resigned. does not entail **The judges heard the actor.**

RoBERTa	SIFT
25.8	**29.5** (+3.7)

Analysis: HANS Constituent

If the actor slept, the senator ran. does not entail **The actor slept.**

RoBERTa	SIFT
37.9	37.6 (-0.3)

Analysis: HANS Constituent

If the actor slept, the senator ran. does not entail **The actor slept.**

Before the actor slept, the senator ran. entails

RoBERTa	SIFT
37.9	37.6 (-0.3)

Analysis: GLUE Diagnostics

				RoBERTa	SIFT
Pred-Arg Structure	I opened the door.	entails	The door opened.	43.5	**44.6** (+1.1)
		does not entail	I opened.		
Logic	I have no pet puppy.	entails	I have no corgi pet puppy.	36.2	**38.3** (+2.1)
		does not entail	I have no pet.		

Analysis: GLUE Diagnostics

				RoBERTa	SIFT
Lexical Semantics	**I have a dog.**	entails	**I have an animal.**	**45.6**	44.8 (-0.8)
		does not entail	**I have a cat.**		
Knowledge	**I live in Seattle.**	entails	**I live in the U.S.**	**28.0**	26.3 (-1.7)
		does not entail	**I live in Antarctica.**		

Analysis: Sample Efficiency

- Use the same downsampled MNLI training set to train RoBERTa & SIFT

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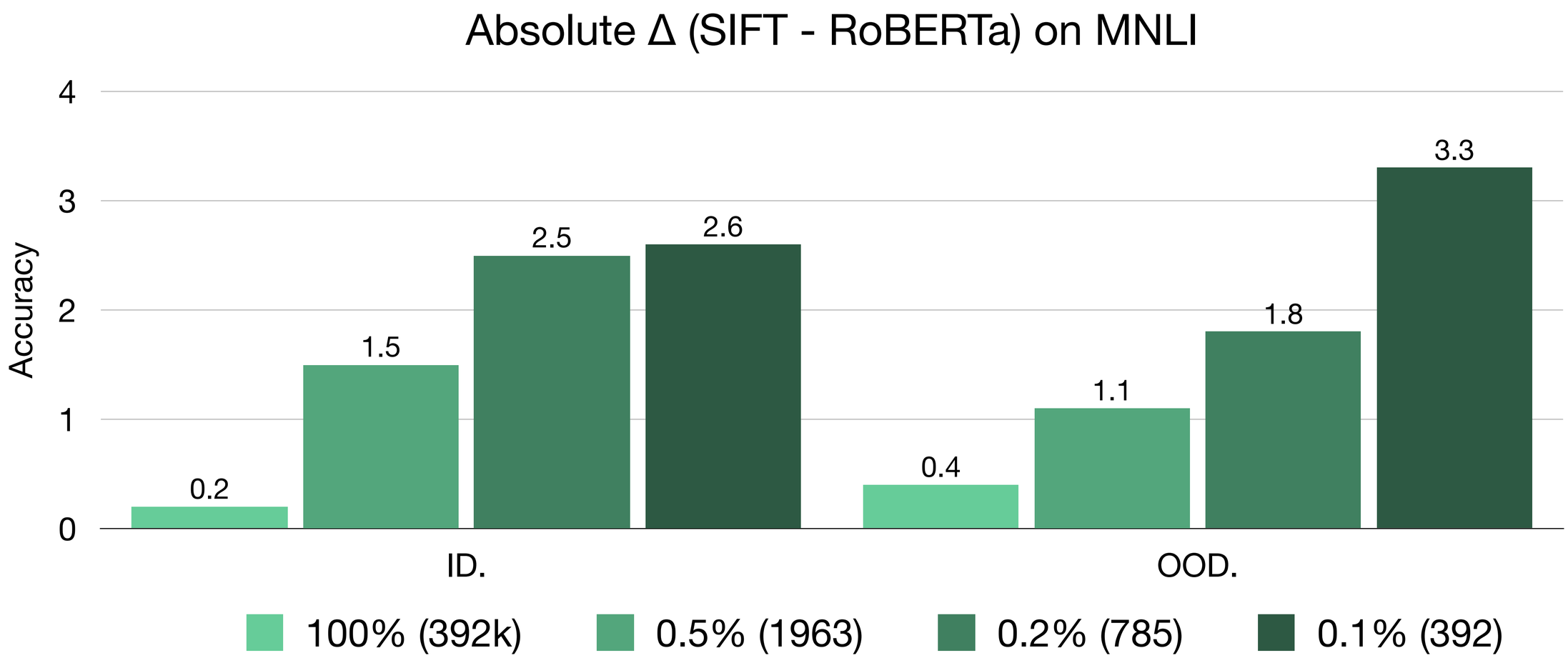
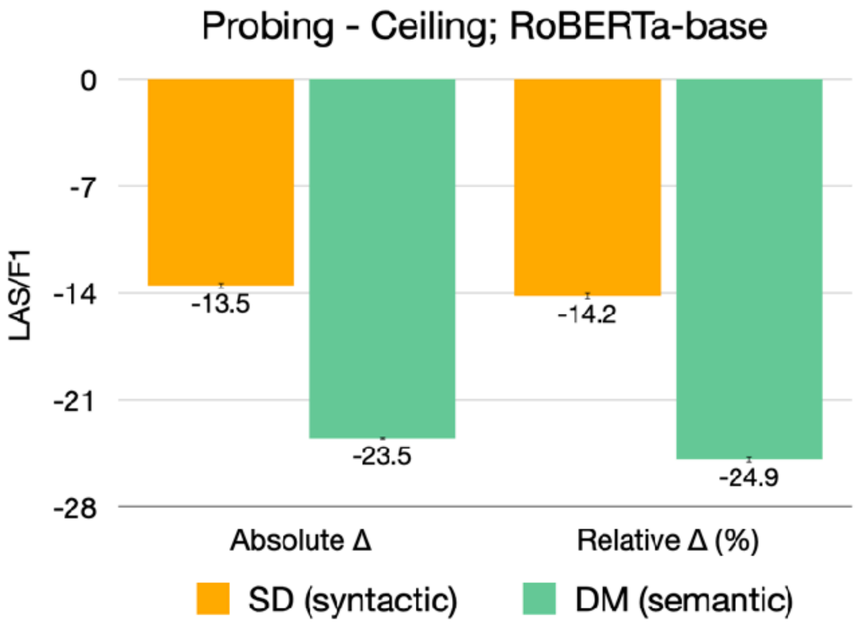
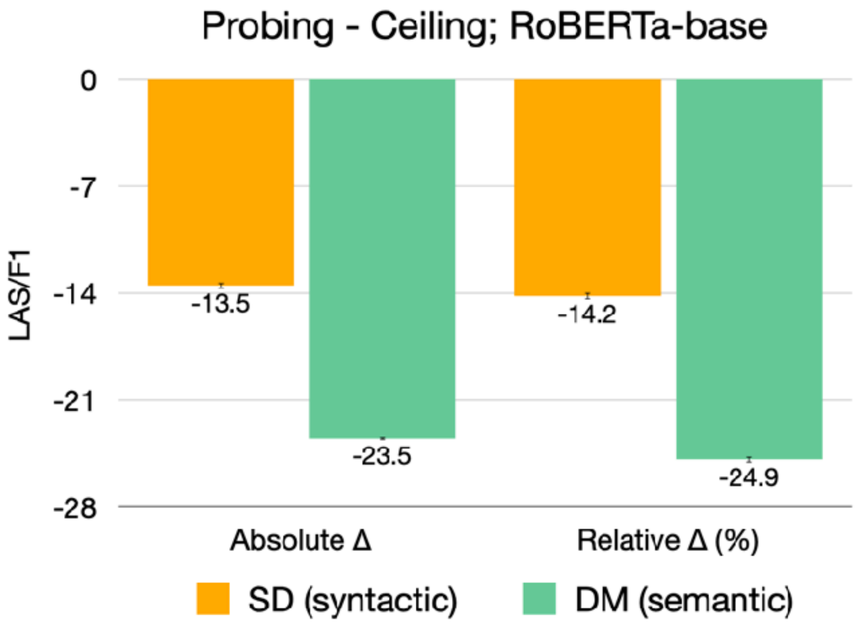
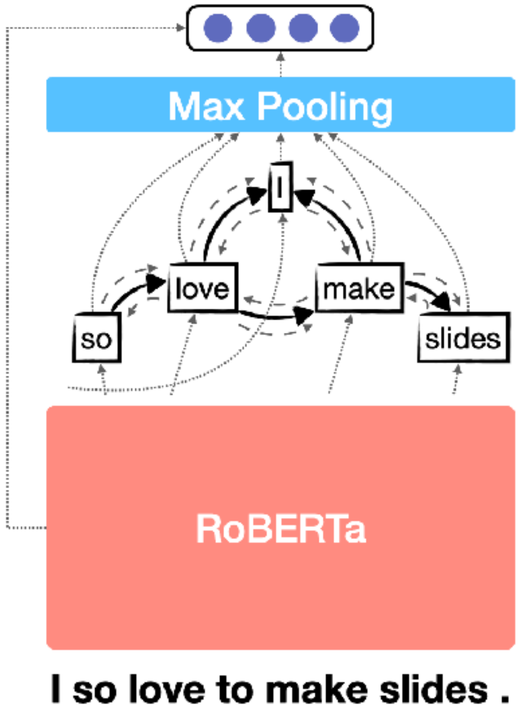


Summary


Probing - Ceiling; RoBERTa-base
0
-7
-14
-21
-28
LAS/F1
-13.5
-23.5
-14.2
-24.9
Absolute Δ
Relative Δ (%)
SD (syntactic)
DM (semantic)

Summary





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Thank you!

arxiv.org/abs/2012.05395

github.com/ZhaofengWu/SIFT