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Aspect-Based Sentiment Analysis

NLP Homework 2

July 2021

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Overview

- Given: **Aspect-Based Sentiment Analysis task**
  - **Aspect Extraction**
  - **Aspect Sentiment**
  - **Aspect Extraction + Aspect Sentiment**
  - **Category Extraction**
  - **Category Evaluation**
  - **Category Extraction + Category Sentiment**
- Goal: **Obtain the best-performing model (in terms of macro-F1)**

Models (denoted with just letters are transformer-based):

- **Naive**
- **a**
- **b**
- **c**
- **d**
- **a -> b**
- **a + b**
- **c -> d**
- **c + d**

Naive (just word embeddings)

Pre-processing

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Pre-processing

1. First input sentence is tokenized and each token maps to ground truth labels as follows:

1 if token ∈ gt term
0 otherwise

2. Then **indexed vocabulary** (with <UNK> and <PAD> tokens indexed as 1 and 0) and **indexed label vocabulary** (with 3 elements: 2 labels and <PAD> token indexed as 2) are created:

```
Vocab: ['A:2', 'hearty:1', 'two:3',...,
'subwoofer:3553', 'scary:3552']

Label vocab: ['<pad>:2', '0:0', '1:1']
```

Before:

```
'The selection changes frequently but
the basic dishes are always
available.'
```

After 1:

```
['The: 0', 'selection: 1', 'changes:
0', 'frequently: 0', 'but: 0', 'the:
0', 'basic: 1', 'dishes: 1', 'are:
0', 'always: 0', 'available: 0']
```

After 2:

```
[('The', 36), ('selection', 76), ('changes',
1), ('frequently', 77), ('but', 78), ('the',
9), ('basic', 79), ('dishes', 80), ('are',
81), ('always', 82), ('available', 83),
('None', 0), ('None', 0),...,('None', 0)]


[0, 1, 0, 0, 0, 0, 1, 1, 0, 0, 0, 2, 2, …, 2]
```

Embeddings

Two ways of creating indexed vocabulary are applied:

- Based on the dataset;
- Downloading **GloVe 100d** embeddings, so they could be further applied as pre-trained in the network layer.

Naive

Model

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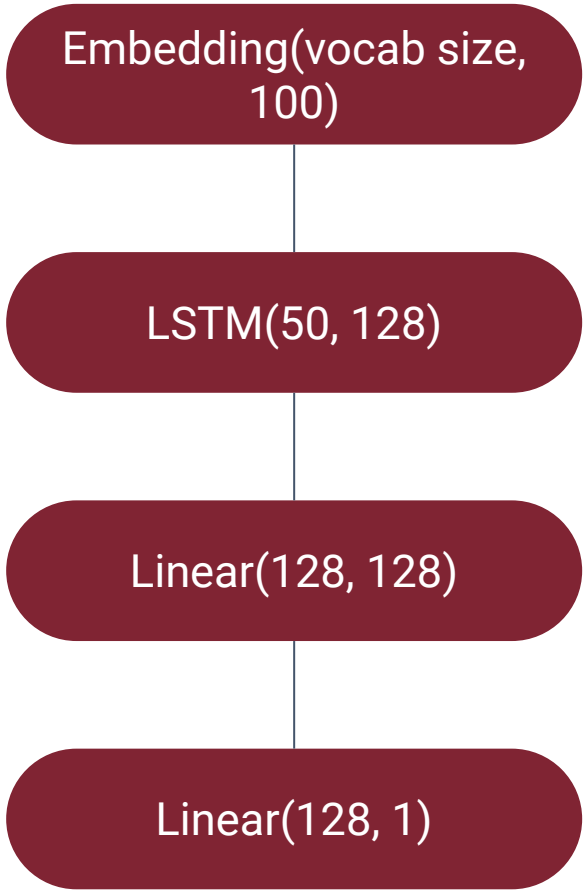
Model

Architecture



Hyper-parameters

Epochs	100
Batch size	128
Embedding dim	100
Window Size	100
Window Shift	50
N hidden units	128
N LSTM cells	1
Optimizer	Adam
Learning Rate	0.0001
Dropout Rate	0.0

Naive

Post-processing and Performance

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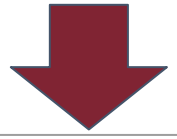
Post-processing: collect predicted tokens to the multi-token terms


```
{'targets': [[[11, 29], 'wines by the glass', 'negative']],
 'text': 'Not enough wines by the glass either.'}
```



Ground truth tokens	Input tokens	Gold labels	Predicted labels	Predicted tokens
	Not	0	0	
	enough	0	0	
wines	wines	1	1	wines
by	by	1	1	by
the	the	1	0	
glass	glass	1	1	glass
	either	0	0	

```
{'wines by', 'glass'}
```

- Best F1: **0.67**

BERT-models

Pre-processing

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Pre-processing

- Interpret as a **sentence-pair classification** task:

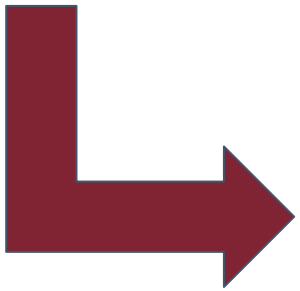
<CLS> Sentence 1 **<SEP>** Sentence 2 **<SEP>** Label

- Apply BERT tokenizer form pre-trained for the corresponding BERT model:

[**ind(<CLS>)**,
indices(tokenized(sentence 1)), **ind(<SEP>)**,
indices(tokenized(sentence 2)), **ind(<SEP>)**,
indices(padding)]

\+ **attention mask**

[**1**,
1,…,1, **1**,
1,…,1, **1**,
0, …,0]



to Embedding layers

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Given

```
{'categories': [['food', 'neutral']],
 'targets': [[[4, 13], 'selection', 'neutral'],
  [[41, 53], 'basic dishes', 'neutral']],
 'text': 'The selection changes frequently but the basic dishes are always
available.'}
```

Aspect Extraction

Pre-processing

Binary classification

Sentence (Sentence 1)	Aspect (Sentence 2)	Label
The selection changes frequently but the basic...	The	unrelated
The selection changes frequently but the basic...	selection	**related**
The selection changes frequently but the basic...	changes	unrelated
The selection changes frequently but the basic...	frequently	unrelated
The selection changes frequently but the basic...	but	unrelated
The selection changes frequently but the basic...	the	unrelated
The selection changes frequently but the basic...	basic	**related**
The selection changes frequently but the basic...	dishes	**related**
The selection changes frequently but the basic...	are	unrelated
The selection changes frequently but the basic...	always	unrelated
The selection changes frequently but the basic...	available	unrelated
The selection changes frequently but the basic...	.	unrelated

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Given

```
{'categories': [['food', 'neutral']],
 'targets': [[[4, 13], 'selection', 'neutral'],
  [[41, 53], 'basic dishes', 'neutral']],
 'text': 'The selection changes frequently but the basic dishes are always
available.'}
```

4-class classification
{positive, negative, neutral, conflict}

Aspect Sentiment

Sentence (Sentence 1)	Aspect (Sentence 2)	Label
The selection changes frequently but the basic...	selection	**neutral**
The selection changes frequently but the basic...	basic dishes	**neutral**

ground truth terms

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Given

```
{'categories': [['food', 'neutral']],
 'targets': [[[4, 13], 'selection', 'neutral'],
  [[41, 53], 'basic dishes', 'neutral']],
 'text': 'The selection changes frequently but the basic dishes are always
available.'}
```

Binary classification

Category Extraction

Sentence (Sentence 1)	Category (Sentence 2)	Label
The selection changes frequently but the basic...	food	**related**
The selection changes frequently but the basic...	service	unrelated
The selection changes frequently but the basic...	price	unrelated
The selection changes frequently but the basic...	ambience	unrelated
The selection changes frequently but the basic...	anecdotes/miscellaneous	unrelated

fixed 5 for each Sentence 1

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Given

```
{'categories': [['food', 'neutral']],
 'targets': [[[4, 13], 'selection', 'neutral'],
  [[41, 53], 'basic dishes', 'neutral']],
 'text': 'The selection changes frequently but the basic dishes are always
available.'}
```

4-class classification
{positive, negative, neutral, conflict}

Category Sentiment

Sentence (Sentence 1)	Category (Sentence 2)	Label
The selection changes frequently but the basic...	food	**neutral**

ground truth categories

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Given

```
{'categories': [['food', 'neutral']],
 'targets': [[[4, 13], 'selection', 'neutral'],
  [[41, 53], 'basic dishes', 'neutral']],
 'text': 'The selection changes frequently but the basic dishes are always
available.'}
```

Aspect Extraction + Aspect Sentiment

Pre-processing

5-class classification
{none, positive, negative, neutral, conflict}

Sentence (Sentence 1)	Aspect (Sentence 2)	Label
The selection changes frequently but the basic...	The	none
The selection changes frequently but the basic...	selection	**neutral**
The selection changes frequently but the basic...	changes	none
The selection changes frequently but the basic...	frequently	none
The selection changes frequently but the basic...	but	none
The selection changes frequently but the basic...	the	none
The selection changes frequently but the basic...	basic	**neutral**
The selection changes frequently but the basic...	dishes	**neutral**
The selection changes frequently but the basic...	are	none
...	...	...

Aspect Extraction -> Aspect Sentiment

Pre-processing

Binary classification

Sentence (Sentence 1)	Aspect (Sentence 2)	Label
The selection changes frequently but the basic...	The	unrelated
The selection changes frequently but the basic...	selection	**related**
...	...	...

predictions

4-class classification
{positive, negative, neutral, conflict}

Sentence (Sentence 1)	Aspect (Sentence 2)	Label
The selection changes frequently but the basic...	predicted terms	neutral
...	...	...

Given

```
{'categories': [['food', 'neutral']],
 'targets': [[[4, 13], 'selection', 'neutral'],
  [[41, 53], 'basic dishes', 'neutral']],
 'text': 'The selection changes frequently but the basic dishes are always
available.'}
```

Pre-processing

Category Extraction +
Category Sentiment

5-class classification
{none, positive, negative, neutral, conflict}

Sentence (Sentence 1)	Category (Sentence 2)	Label
The selection changes frequently but the basic...	food	**neutral**
The selection changes frequently but the basic...	service	none
The selection changes frequently but the basic...	price	none
The selection changes frequently but the basic...	ambience	none
The selection changes frequently but the basic...	anecdotes/miscellaneous	none

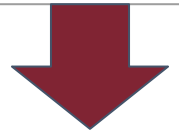
fixed 5 for each Sentence 1

Category Extraction -> Category Sentiment

Pre-processing

Binary classification

Sentence (Sentence 1)	Aspect (Sentence 2)	Label
The selection changes frequently but the basic...	food	unrelated
The selection changes frequently but the basic...	service	**related**
...	...	...



predictions

4-class classification
{positive, negative, neutral, conflict}

Sentence (Sentence 1)	Aspect (Sentence 2)	Label
The selection changes frequently but the basic...	predicted categories	neutral
...	...	...

BERT-models

Models

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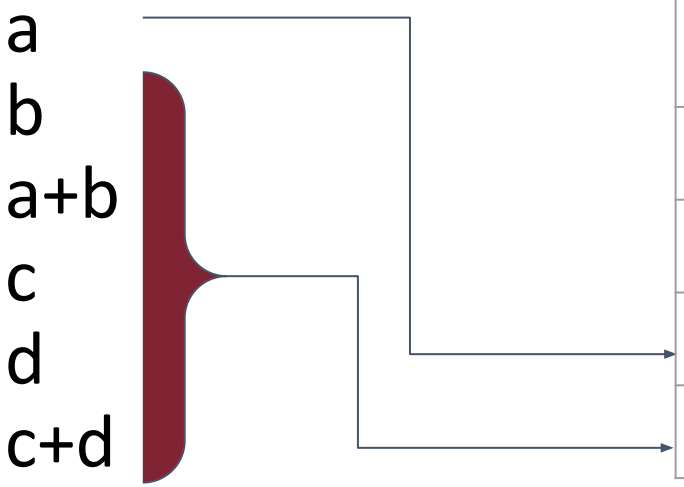
Models



Model	Epochs	Batch Size	Learning Rate
Small BERT	10	24	0.00002
BERT	4	16	0.00002
Distil BERT	4	24	0.00002
Large BERT	4	24	0.00002

BERT-models

Performances

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Performances: Naive vs BERT for Aspect Extraction and Choose the best BERT

- Task: **Aspect Extraction**
- Dataset: **Restaurants**

Model	Best F1
Naive	67
Distil BERT	**83**

Transformer based architecture is preferable

- Task: **Aspect Extraction**
- Dataset: **Restaurants**

Model	Best F1
Small BERT	79
BERT	81
Distil BERT	**83**
Large BERT	**83**

Distil BERT is preferable

- Dataset: **Restaurants**

Task	Distil BERT	Large BERT
b	55	**60**
a + b	44	**48**
c + d	48	**56**

Large BERT is preferable

Performances: Choose best model for joined and separate tasks, merge datasets

- Dataset: **Restaurants**

Task	->	+
ab	**48**	40
cd	50	**56**

For Aspect Extraction + Aspect Sentiment a -> b performs better than a + b

For Category Extraction + Category Sentiment c + d performs better than c -> d

- Dataset: **Restaurants**

Task	As is	From Combined
a	**83**	82
b	**60**	50
c	**82**	82
d	**64**	55

Separately implemented models perform better than their estimations from a + b and c + d

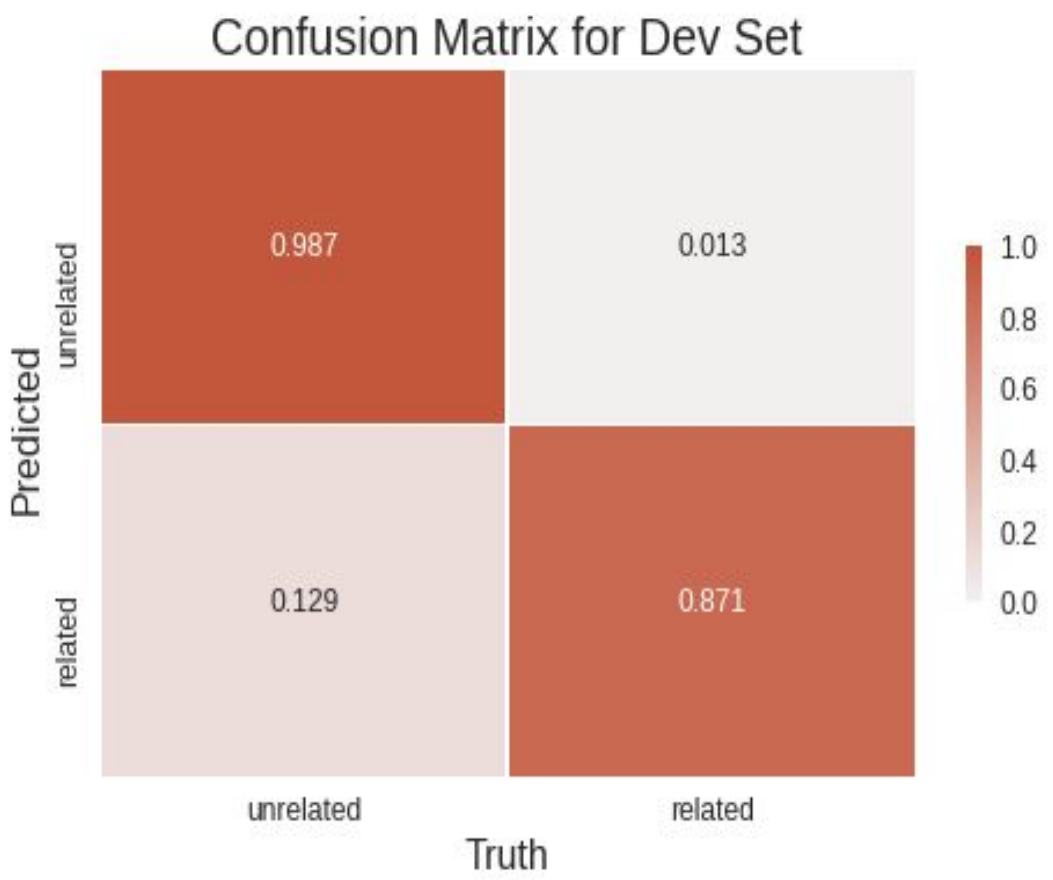
- Task: **Aspect Sentiment**

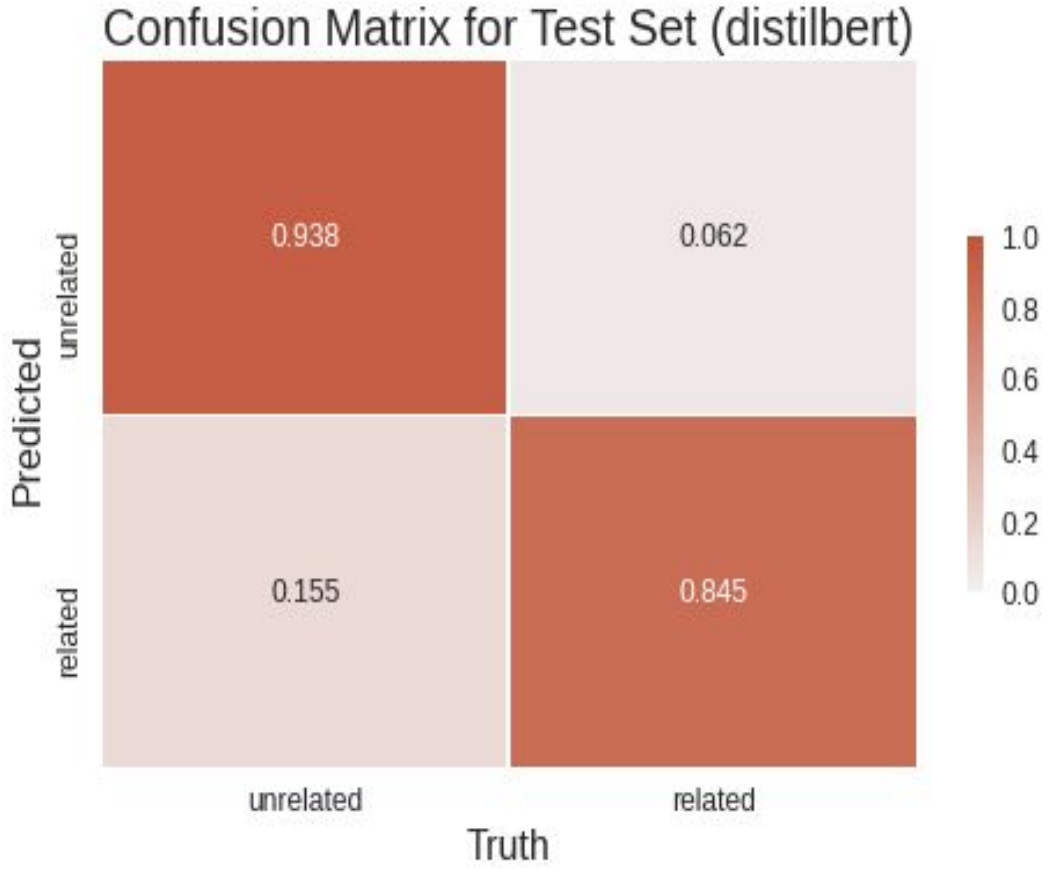
Dataset	Best F1
Restaurant	60
Laptops	54
Mixed	59

Mixed dataset can be approximated by Restaurants
Laptops are a bit harder than Restaurants

Performances: Confusion matrices for Extractions

For tokens!

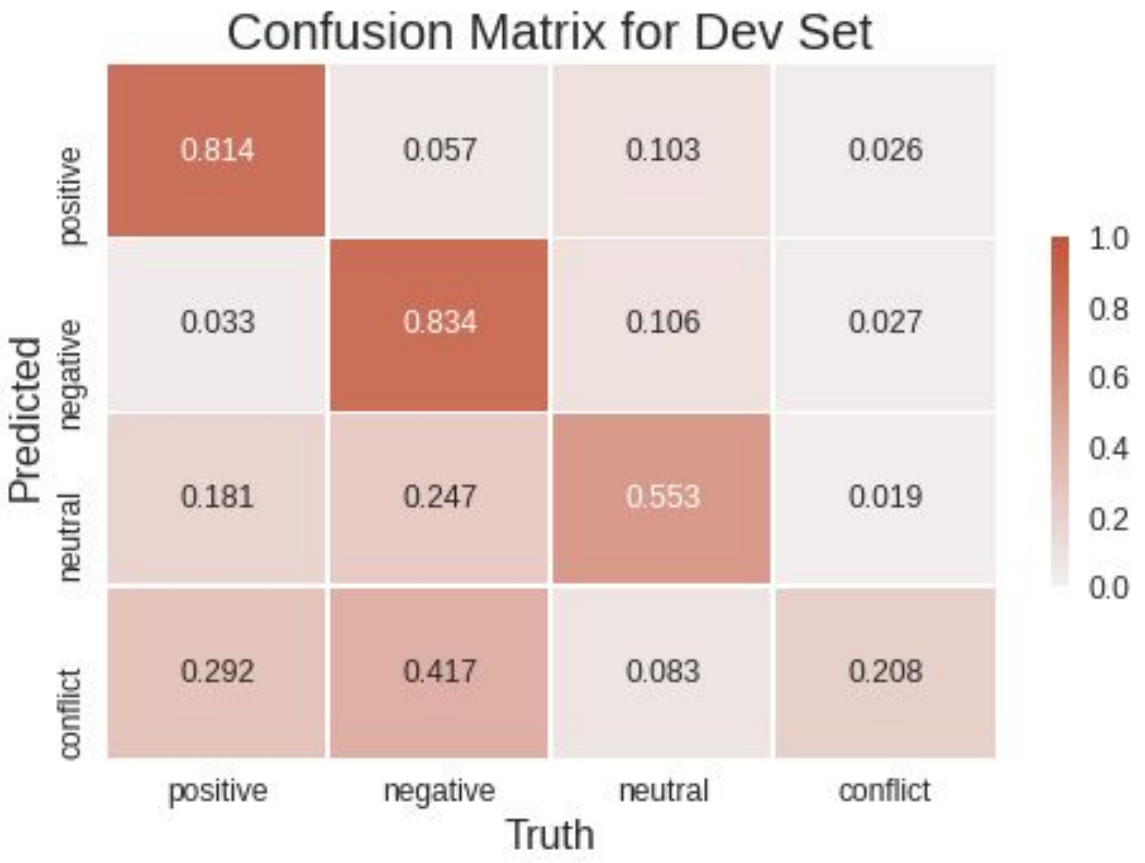




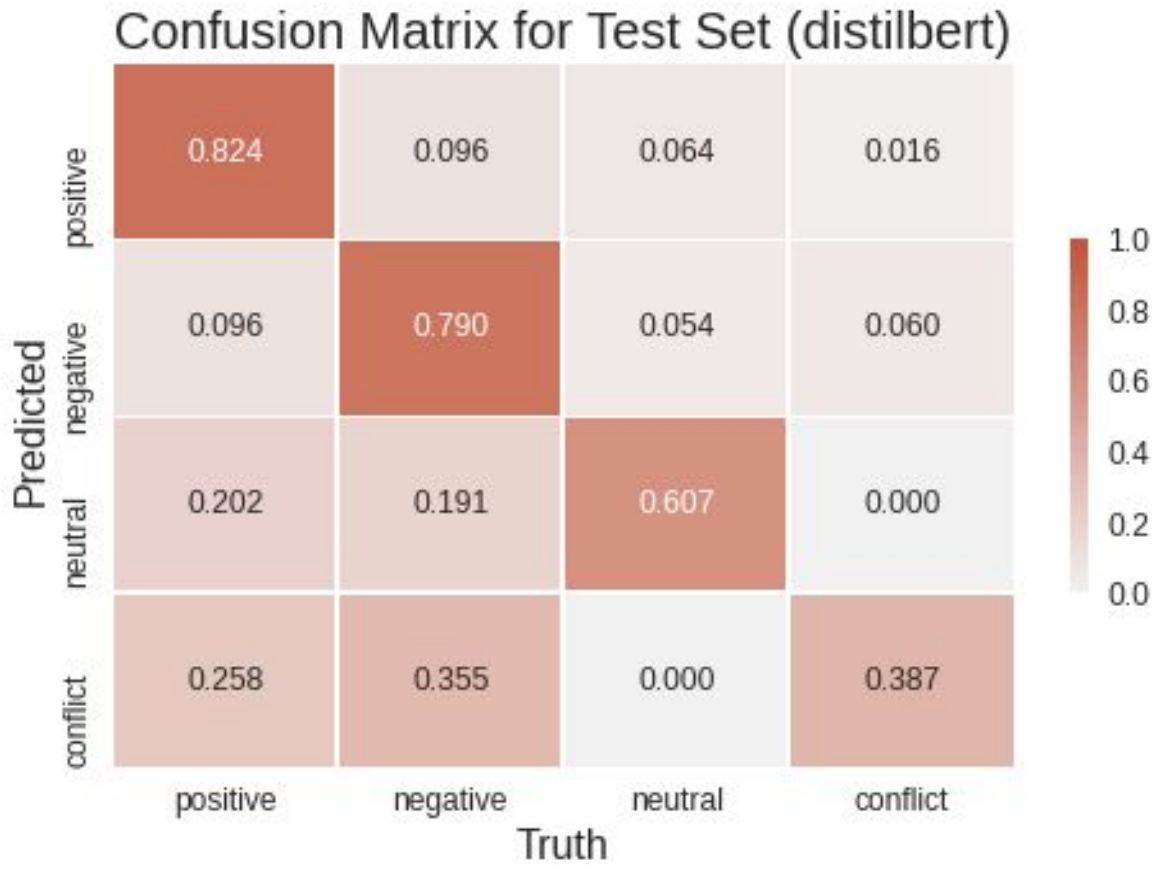
- Task: **Aspect Extraction**
- Dataset: **Mixed**

- Task: **Category Extraction**
- Dataset: **Restaurants**

Performances: Confusion matrices for Sentiments



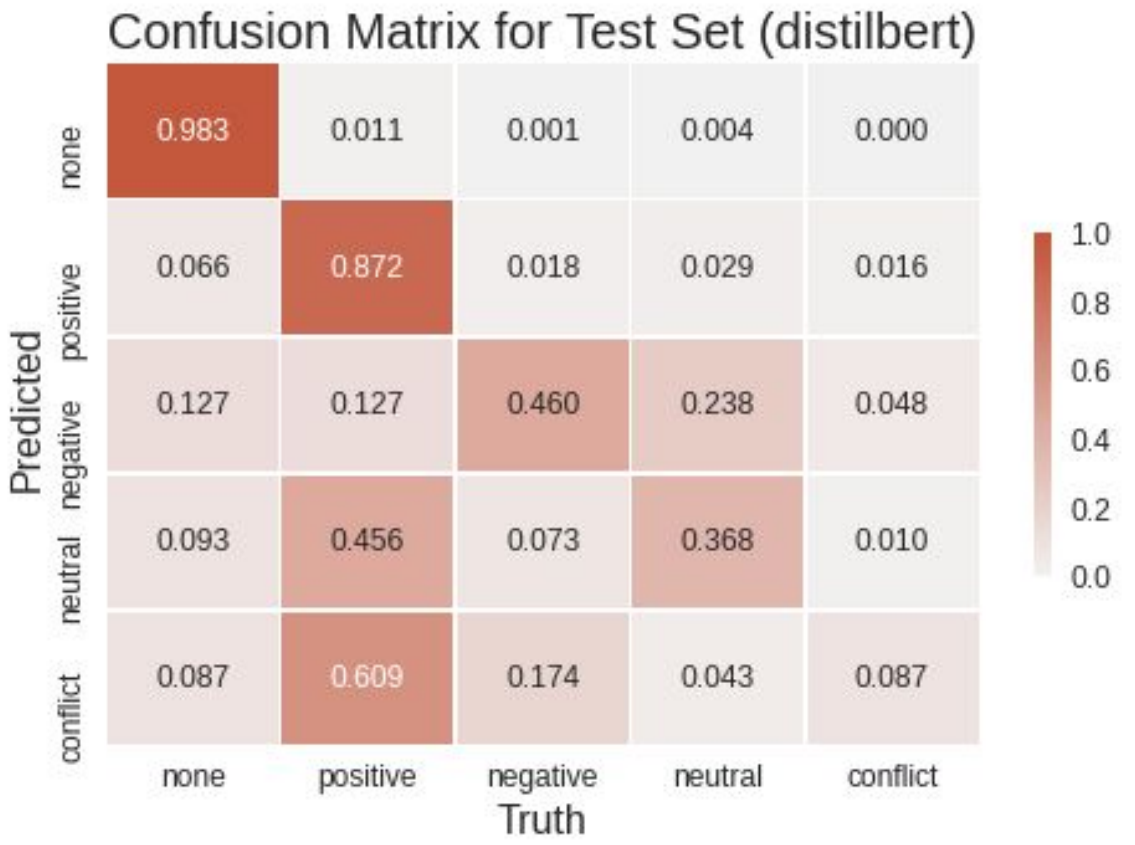
- Task: **Aspect Sentiment**
- Dataset: **Mixed**

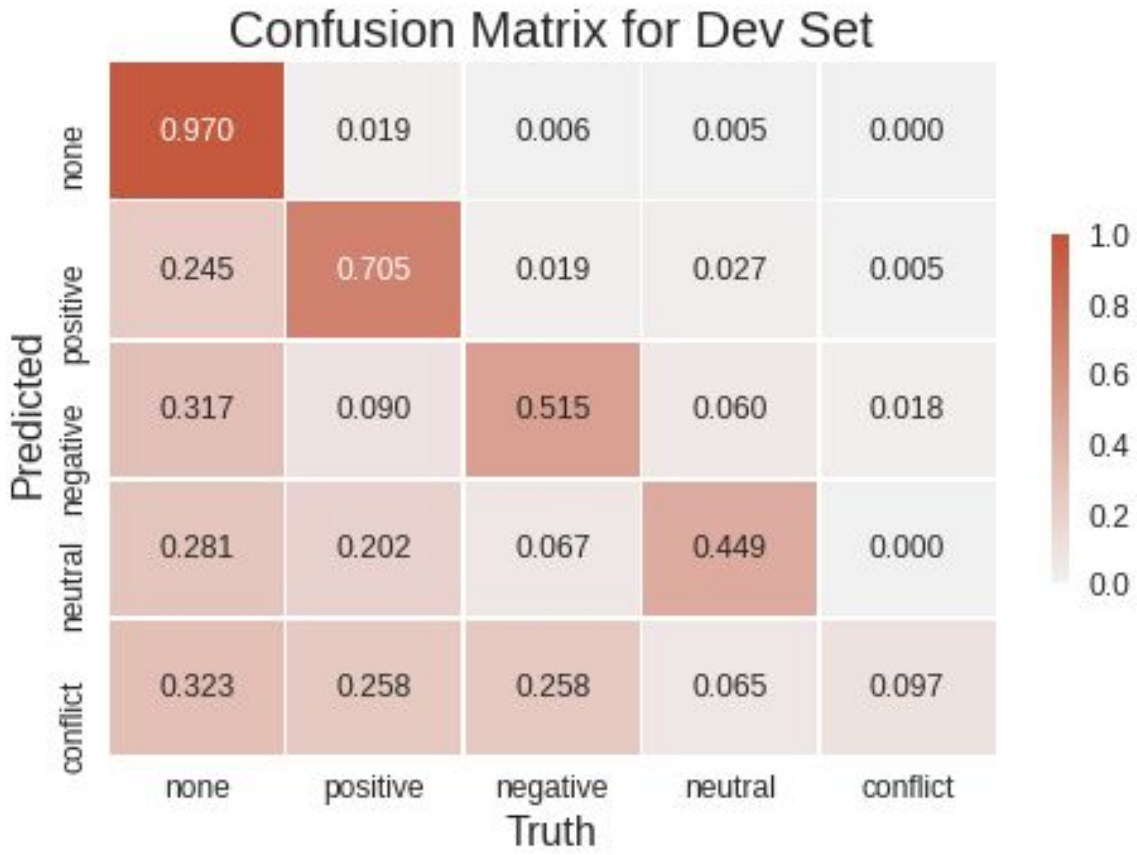


- Task: **Category Sentiment**
- Dataset: **Restaurants**

Performances: Confusion matrices for Combinations

For tokens!





- Task: **a + b**
- Dataset: **Mixed**

- Task: **c + d**
- Dataset: **Restaurants**

Conclusion

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- **Transformers** are powerful instrument in approaching Aspect-Based Sentiment Analysis;
- **Sentence-pair classification** interpretation of a task is appropriate for use of pre-trained BERT models;
- Work on aspects could be improved through the modification of the **decoding** approach;
- Work on categories could be improved through the **conceptual** modifications;
- Precise **fine-tuning** should be under focus;
- For sentiment analysis part **conflict** class is the hardest for recognition.