Predicting laughter relevance spaces

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Why laughter?

- Non-verbal vocalisations, such as laughter, are ubiquitous in our everyday interactions.
- In Switchboard Dialogue Act Corpus (Jurafsky et al., 1997) (SWDA) 1.7% of all dialogue acts are non-verbal, and **laughter tokens** make up 0.5% of all the tokens.

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For SDS we need to make sense of laughter:

- coordination with speech
- social and pragmatic functions
- reasons for laughter

What do we know

1. Laughter has a **social function**: it is associated with senses of closeness and affiliation, establishing social bonding and smoothing away discomfort.
2. Laughter has a **pragmatic function**: e.g. indicate a mismatch in 'just kidding' sense.
3. Laughter is not exclusively associated with positive emotions, but positive emotional state is an intuitive notion of where laughter occurs.

Laughter relevance spaces

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We introduce the term laughter relevance spaces:

a position within the interaction where an interlocutor can appropriately produce a laughter (either during their own or someone else's speech)

- Analogous to backchannel relevance spaces (Heldner et al., 2013) and transition relevance spaces (Sacks et al., 1978).
- Following Heldner et al. (2013) we distinguish **actual laughs** and **potential laughs**.

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The task and the data

Amazon Mechanical Turk

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Conclusions

Data

- Switchboard Dialogue Act Corpus (Jurafsky et al., 1997)
- 1155 dialogues, 221616 utterances
- disfluencies (Meteer et al., 1995)
- laughter – 0.5% of all tokens

```
sp_A {F Oh, } I know. /
sp_A It's really amazing. /
sp_B Yeah. /
sp_A It's, {F uh, } <LAUGHTER> -/
sp_B Beautiful, beautiful machine. /
sp_A Absolutely, /
```

Data preparation

1. We split utterances into tokens using `swda.py` library
2. The laughter tokens are then removed from the text and replaced by laughter annotations, so

```
data: sequence of tuples (tᵢ, lᵢ)
  - tᵢ ∈ N     -- i-th speech or speaker token
  - lᵢ ∈ {0,1} -- laughter marker
```

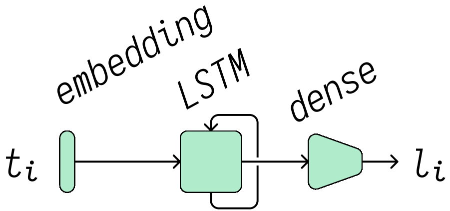
- The goal is to predict laughter token l_i after a given sequence of tokens $(t_0..t_i)$.

Exploratory task

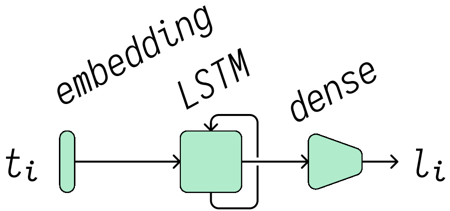
- split the corpus on turn boundaries with no overlap
- predict laughter after every token
- training data (80%) ranges from 17k samples (10-turn span) to 73k (3-turn span)

```
1 sp_A {F Oh, } I know. /
1 sp_A It's really amazing. /
1 sp_B Yeah. /
2 sp_A It's, {F uh, } -/
2 sp_B Beautiful, beautiful machine. /
2 sp_A Absolutely, /
```

Model and results



Model and results



span	th	to predict	precision	recall	F_1
3	0.50	1128	0.733	0.010	0.007
5	0.50	1116	0.786	0.010	0.005
10	0.50	1127	0.630	0.015	0.018
10	0.45	1127	0.407	0.020	0.132
10	0.40	1127	0.400	0.039	0.036
10	0.35	1127	0.255	0.060	0.049

We introduced the balanced set instead

- proportion of laughs is 0.5%
- instead we fix the positions of laughs to predict, such that frequency of laughs will be equal to the frequency of non-laughs
- sliding window (50 or 100 tokens)
- training set (80%) 17k samples, 10% val. and 10% test.

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task

- 400 samples, 2 annotations per sample
- listen to the audio
- a) very unlikely, b) not very likely, c) quite likely, d) very likely

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result

- very low Cohen's kappa (below chance level: $\kappa = -0.125$ for four-class predictions and $\kappa = -0.071$ for binary predictions)
- 66% of excerpts were annotated as "quite likely" or "very likely"
- only 2% were annotated as "very unlikely" or "not very likely" by both annotators

As compared with actual laughs

Annotators might be predicting potential laughter, which is suggested by the predominance of such predictions.

Selection principle	accuracy	precision	recall	F_1
avg. of 4-class annot.	0.51	0.50	0.92	0.65
avg. of binary annot.	0.51	0.49	0.67	0.57
annot. agree on valence	0.51	0.49	0.98	0.66

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Baseline

- We employed sentiment analysis baseline: VADER Gilbert (2014) designed for social media texts (part of NLTK).

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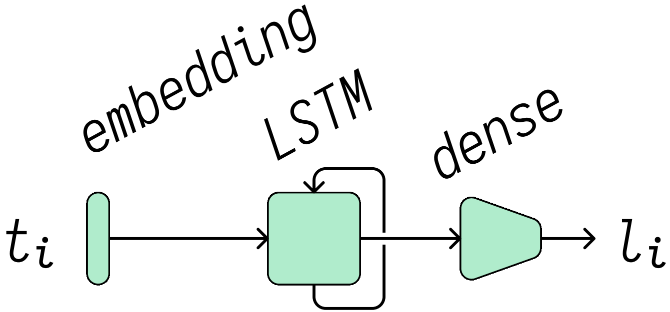
Neural networks

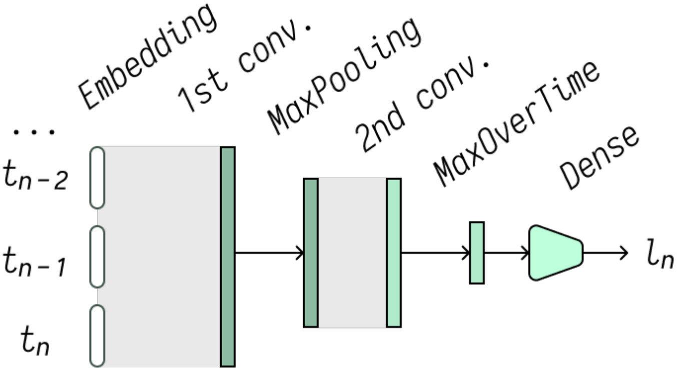
- RNN (LSTM)
- CNN
- two combinations of RNN and CNN

Implemented in TypedFlow:
`https://github.com/GU-CLASP/TypedFlow`

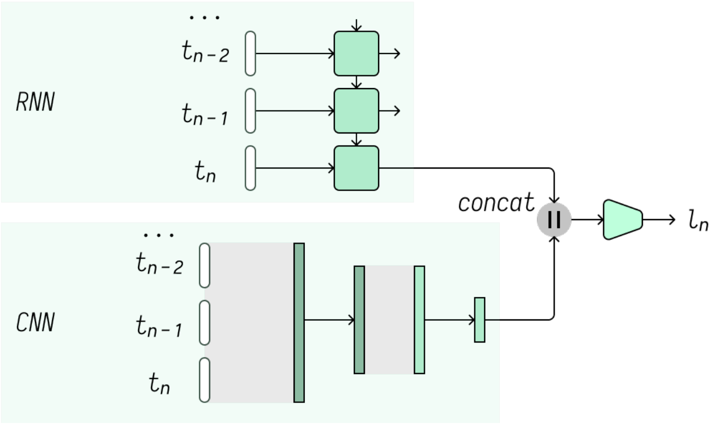
RNN



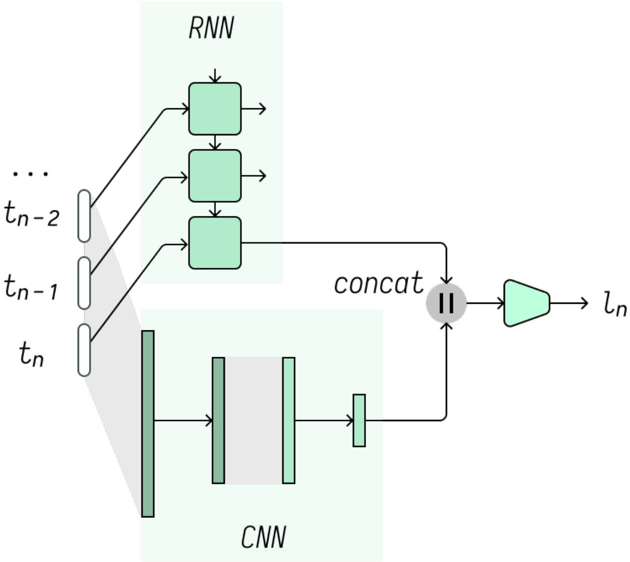
CNN


...
t_{n-2}
t_{n-1}
t_n
Embedding
1st conv.
MaxPooling
2nd conv.
MaxOverTime
Dense
l_n

Fusion



Hybrid



Results

Model	accuracy	precision	recall	F_1
AMT	0.510	0.500	0.920	0.650
VADER	0.518	0.511	0.749	0.607
RNN (span=100)	0.770	0.761	0.777	0.769
CNN (span=100)	0.787	0.777	0.794	0.785
RNN (span=50)	0.743	0.732	0.763	0.747
CNN (span=50)	0.765	0.761	0.771	0.766
fusion (span=50)	0.766	0.760	0.778	0.768
hybrid (span=50)	0.776	0.775	0.774	0.774

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Turn boundaries

Laughters tend to occur at a turn boundary

```
A: let me ask you this.
A: How, how old are you?
B: I’m, uh, thirty-three.
A: Thirty-three?
B: Thirty-two,
B: excuse me.
A: Okay.
B: <LAUGHTER> [correct!]

B: when I was a freshman in college
A: Uh-huh.
B: uh, my degree was in computer, uh, technology originally
B: and it seemed like it would,
B: <LAUGHTER> [wrong!]
```

We removed these samples…

Table: Performance of the models before and after removing the examples where turn change token is the last token. As a result, the dataset is 22% smaller and it is missing 36% of positive examples. All deep learning models use the dataset with the span of 50 tokens.

Model	accuracy	precision	recall	F_1
RNN	0.743	0.732	0.763	0.747
RNN (removed)	0.738	0.673	0.705	0.689
CNN	0.765	0.761	0.771	0.766
CNN (removed)	0.761	0.715	0.694	0.705

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for the given task deep learning approaches perform significantly better than untrained humans

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- step towards inferring **appropriate spaces for laughter** from textual data
- this should enable future dialogue systems to understand when is it appropriate to laugh
- but...

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- step towards inferring **appropriate spaces for laughter** from textual data
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- but…

… we are aware that this requires understanding laughter on a deeper level, including its various semantic roles and pragmatic functions.

Future work

1. Extend our AMT experiments, introduce probabilistic annotations (Passonneau and Carpenter, 2014)
2. Address the task in a more 'dialogical' way:
    - input: two possibly overlapping streams instead of one
    - **coordination between speakers** as a predictor
3. Work in progress: symbolic (Dynamic Syntax) model for laughter relevance spaces

`-- Thank you! <LAUGHTER?> <QUESTIONS?>`

`https://github.com/GU-CLASP/laughter-spaces`

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