GNTeam at n2c2 2018 track 2: An end-to-end system to identify ADE, Medications and related entities in discharge summaries

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Motivation

- Adverse events to the administered drugs are the major cause of death in the US and can account for more than 100,000 deaths each year.
- It is an important task to monitor the administration of drugs in electronic health records (EHR) and identify associated adverse drug events (ADEs).
- This work presents the output of the National NLP Clinical Challenge 2018 (n2c2 2018) Track 2, which aimed to extract ADEs, medications (i.e. drugs) and associated attributes, such as form, dosage, route, strength, frequency, duration and reason from discharge summaries.
- The data consists of 505 discharge summaries (303 train and 202 test documents) drawn from the MIMIC-III (Medical Information Mart for Intensive Care III) clinical care database.

Entity	#Mentions	Avg. mention/document	Avg. token/mention
Drug	16,225	53.55	1.22
Strength	6,691	22.08	1.87
Form	6,651	21.95	1.67
Frequency	6,281	20.73	3.03
Route	5,467	18.07	1.07
Dosage	4,221	13.93	2.98
Reason	3,855	12.72	1.80
ADE	959	3.17	1.80
Duration	592	1.95	2.66

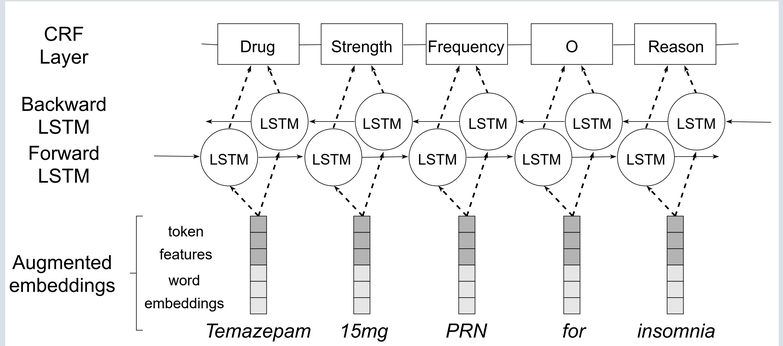
Statistics of entity classes presented in the training dataset

Relation	#Relations	Avg. relations/document	Avg. token level distance(max)
Strength->Drug	6,702	22.12	2.03(84)
Form->Drug	6,654	21.96	7.15(96)
Frequency->Drug	6,310	20.83	9.23(97)
Route->Drug	5,538	18.28	8.28(72)
Dosage->Drug	4,225	13.94	6.76(95)
Reason->Drug	5,169	17.06	14.93(332)
ADE->Drug	1,107	3.65	10.93(156)
Duration->Drug	643	2.12	11.21(98)

Statistics of relation types presented in the training dataset

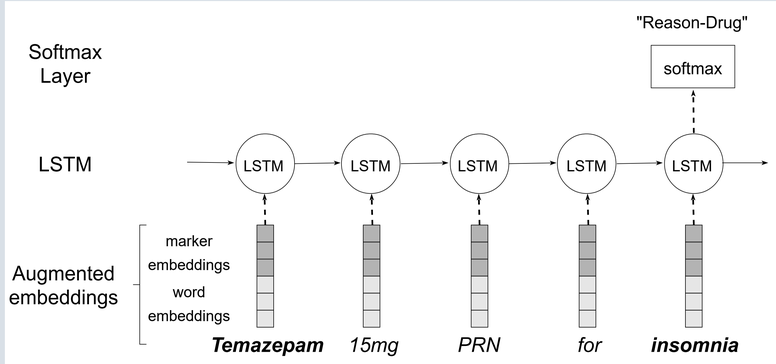
Methods

- The end-to-end system consists of feature-augmented bidirectional long short-term memory (LSTM) neural networks for NER and position-aware LSTM for relation extraction.
- For both tasks, we utilized word embeddings pretrained on all (~2 million) summaries from MIMIC-III dataset.
- For NER, token-level semantic features were extracted using CLAMP and cTakes clinical pipelines.



Architeture of feature-augmented LSTM for NER

- For relation extraction, positions of involved entities were encoded using marker embeddings.



Architeture of position-aware LSTM for relation extraction

Evaluation and results

Entity	Precision	Recall	F1-score
Strength	97.87	97.75	97.81
Frequency	96.66	96.06	96.36
Form	97.02	93.99	95.48
Route	96.47	94.22	95.33
Drug	96.26	94.28	95.26
Dosage	93.22	93.36	93.29
Duration	86.03	81.48	83.70
Reason	73.88	59.02	65.62
ADE	69.30	36.48	47.80
Overall (micro)	**94.56**	**90.85**	**92.67**

Evaluation results of feature-augmented LSTM for NER

Entity	Precision	Recall	F1-score
Strength->Drug	97.28	96.09	96.68
Dosage->Drug	96.34	95.84	96.09
Form->Drug	98.19	91.75	94.86
Route->Drug	95.81	93.40	94.59
Frequency->Drug	96.18	90.43	93.22
Duration->Drug	90.91	89.20	90.05
Reason->Drug	74.09	83.02	78.30
ADE->Drug	73.17	79.26	76.10
Overall (micro)	**92.18**	**91.32**	**91.74**

Evaluation results of position-aware LSTM for relation extraction

Entity	Precision	Recall	F1-score
Strength->Drug	96.41	93.73	95.05
Form->Drug	96.64	86.67	91.38
Dosage->Drug	92.25	89.24	90.72
Route->Drug	94.99	86.58	90.59
Frequency->Drug	95.51	83.84	89.29
Duration->Drug	80.51	66.90	73.08
Reason->Drug	62.00	46.36	53.05
ADE->Drug	56.20	27.83	37.23
Overall (micro)	**90.34**	**79.69**	**84.68**

Performance of the end-to-end system

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