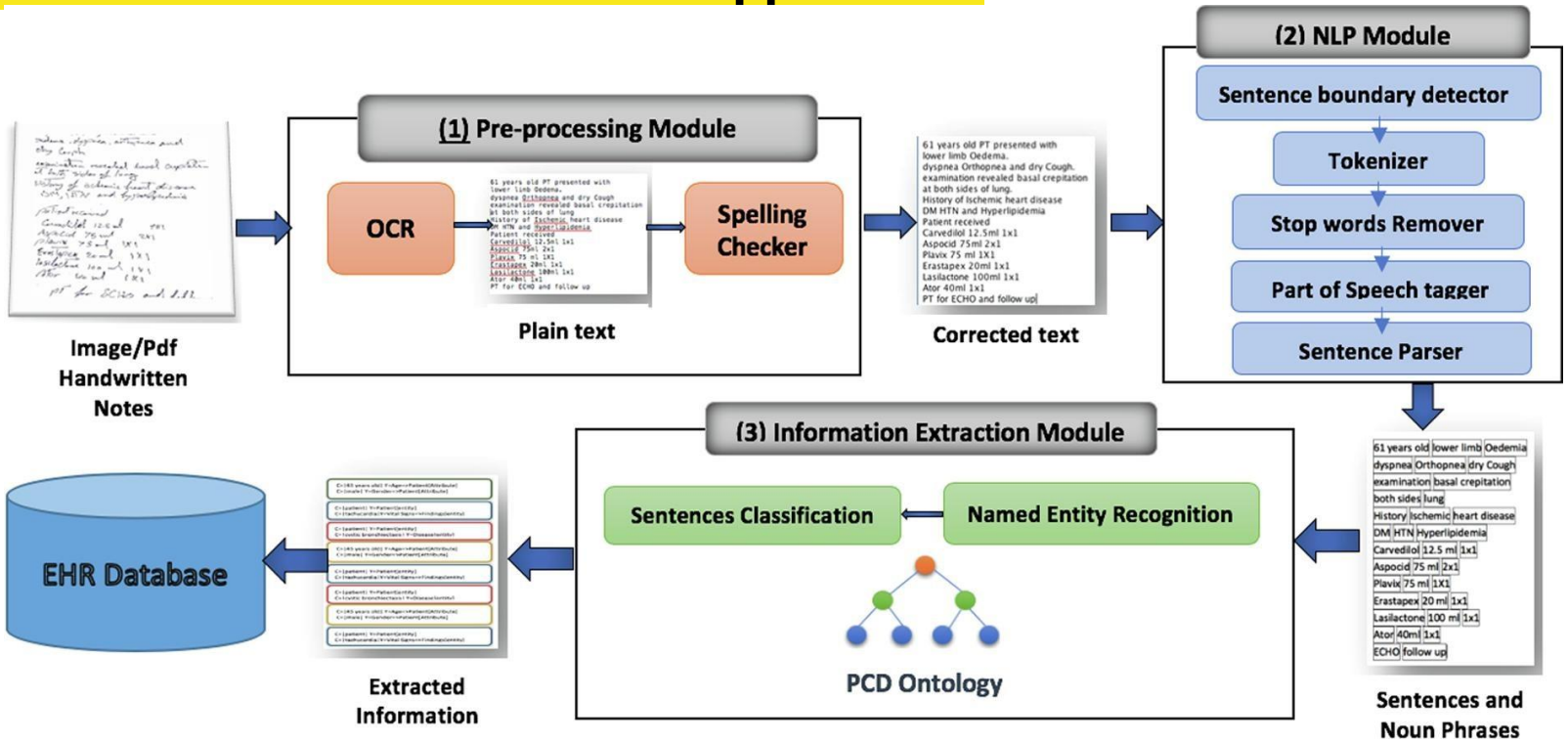
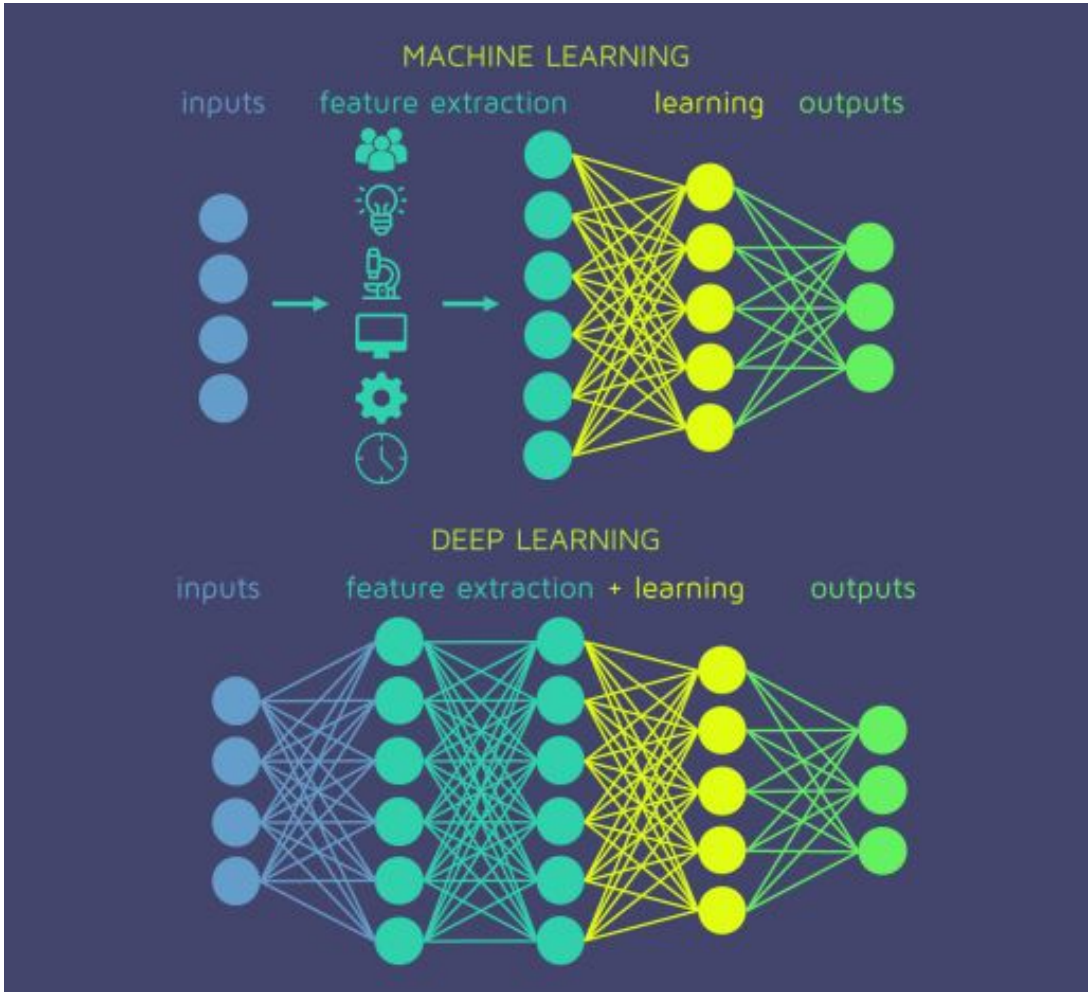
Advanced topics in NLP

A real-world / research NLP application



Ontology-based clinical information extraction from physician's free-text notes

Deep learning for NLP



Deep learning for NLP Neural networks

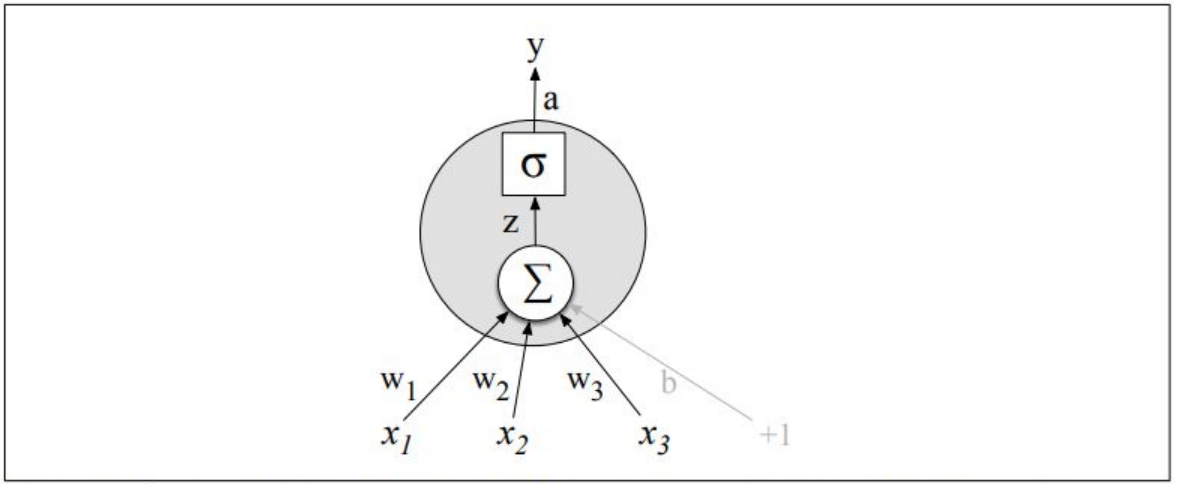


Figure 7.2 A neural unit, taking 3 inputs x_1, x_2, and x_3 (and a bias b that we represent as a weight for an input clamped at +1) and producing an output y. We include some convenient intermediate variables: the output of the summation, z, and the output of the sigmoid, a. In this case the output of the unit y is the same as a, but in deeper networks we'll reserve y to mean the final output of the entire network, leaving a as the activation of an individual node.

Speech and Language Processing (3rd ed. draft)
Dan Jurafsky and James H. Martin

Deep learning for NLP Neural networks

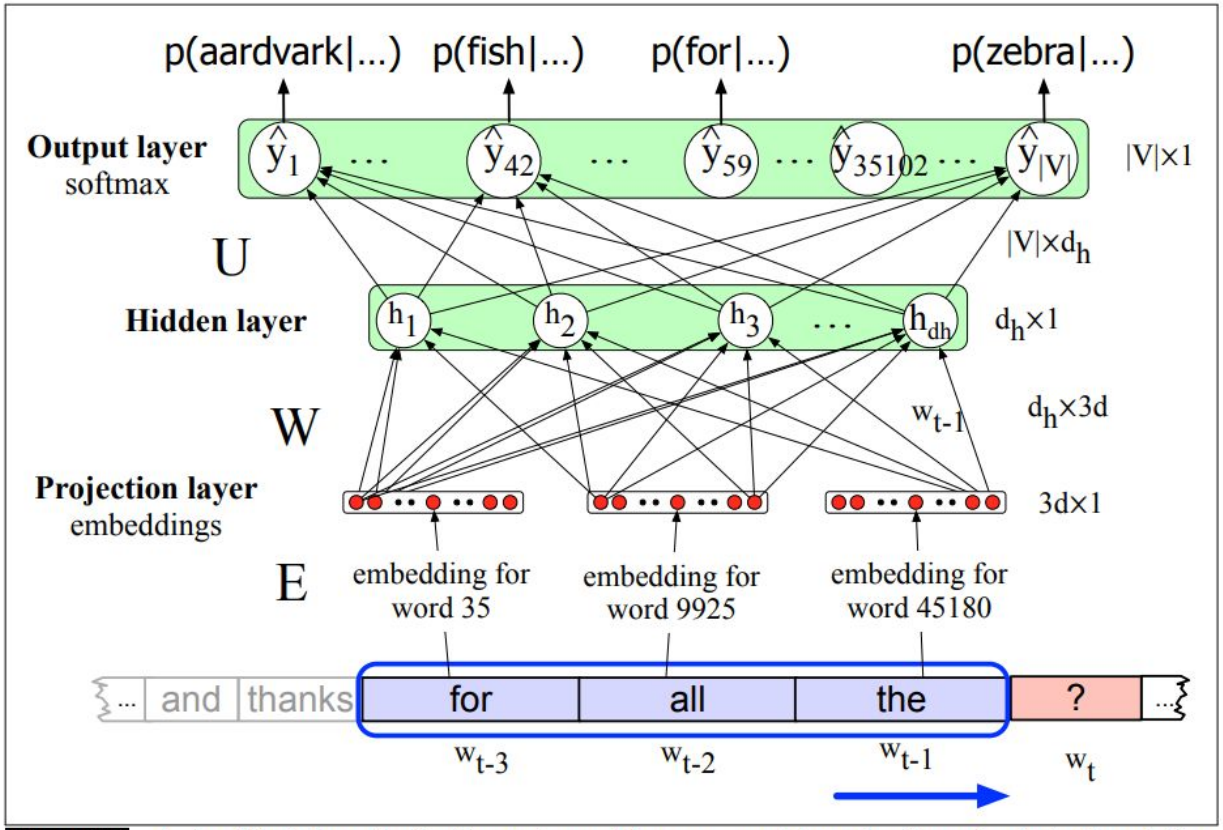


Figure 9.1 A simplified view of a feedforward neural language model moving through a text. At each time step t the network takes the 3 context words, converts each to a d-dimensional embedding, and concatenates the 3 embeddings together to get the $1 \times Nd$ unit input layer x for the network. The output of the network is a probability distribution over the vocabulary representing the models belief with respect to each word being the next possible word.

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Deep learning for NLP RNN

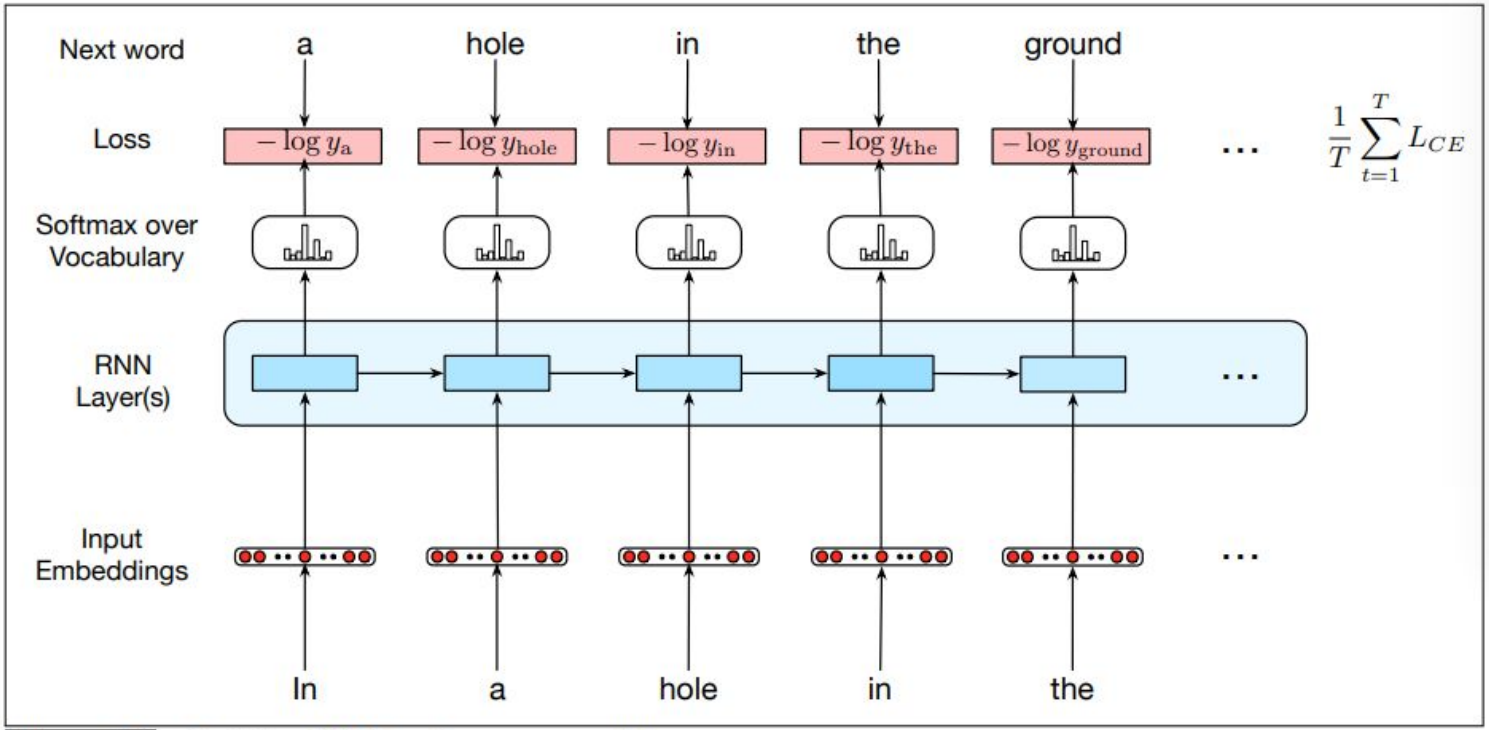


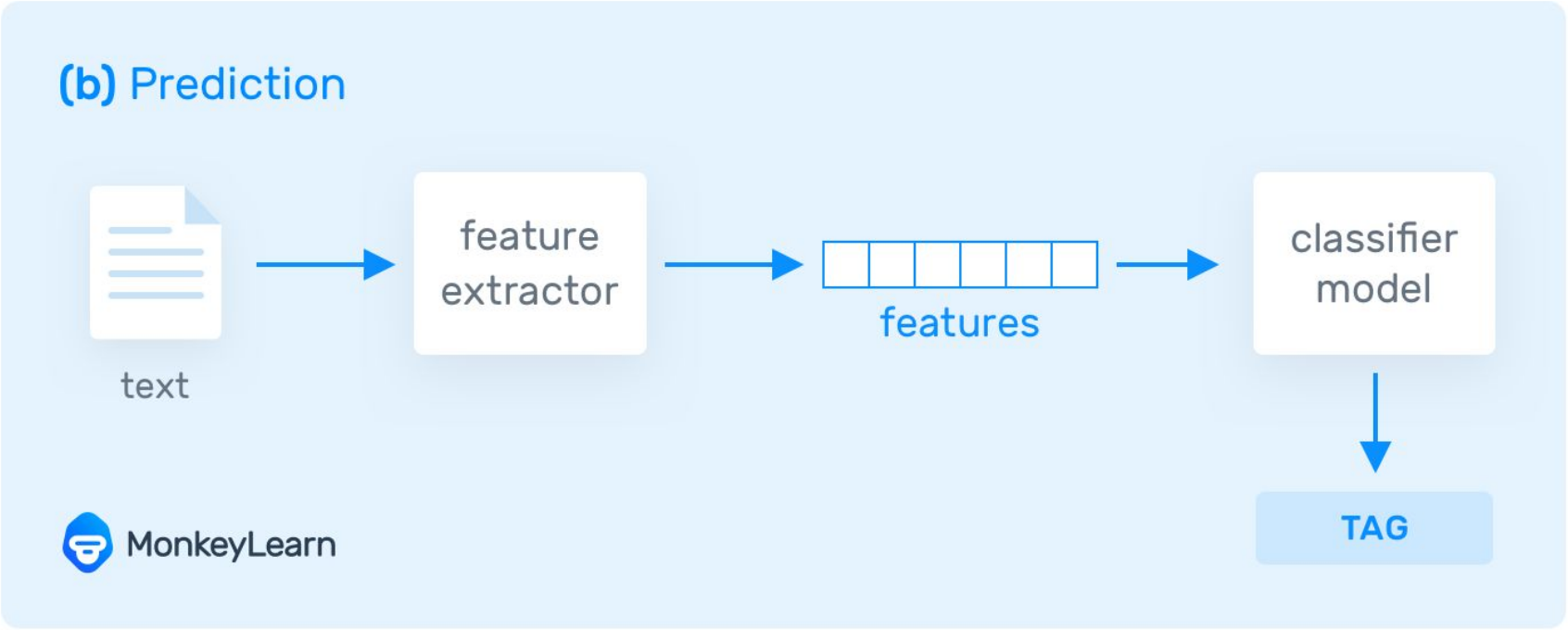
Figure 9.6 Training RNNs as language models.

Speech and Language Processing (3rd ed. draft)
Dan Jurafsky and James H. Martin

Deep learning for NLP

https://github.com/roemmele/keras-rnn-notebooks/blob/master/sentiment_rating/sentiment_rating.ipynb

More text classification tasks...



Fake news detection

If you see a story, check who is reporting it. If it's a mainstream source, chances are, it's true. If it's a site you've never heard of, be skeptical.

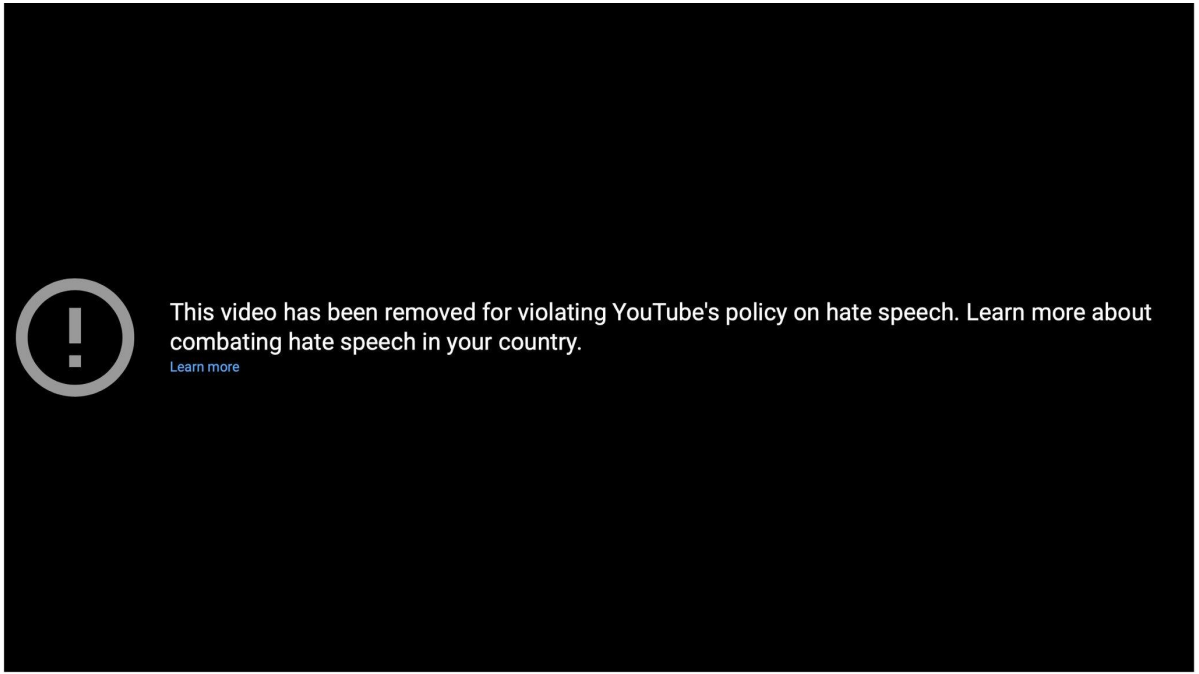
HOW TO RECOGNIZE A FAKE NEWS STORY

1. READ PAST THE HEADLINE
2. CHECK WHAT NEWS OUTLET PUBLISHED IT
3. CHECK THE PUBLISH DATE AND TIME
4. WHO IS THE AUTHOR?
5. LOOK AT WHAT LINKS AND SOURCES ARE USED
6. LOOK OUT FOR QUESTIONABLE QUOTES AND PHOTOS
7. BEWARE CONFIRMATION BIAS
8. SEARCH IF OTHER NEWS OUTLETS ARE REPORTING IT
9. THINK BEFORE YOU SHARE

- Watch for headline and content typos.
- Watch for excessive punctuation!!!!!!
- Watch for biased vocabulary.
- Example: "Immigrants" vs. "Illegals"

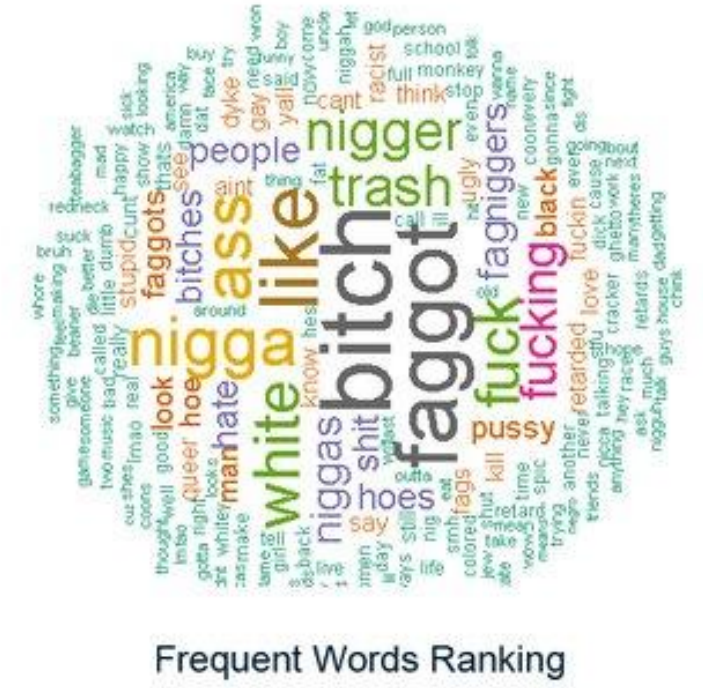
Hate speech detection

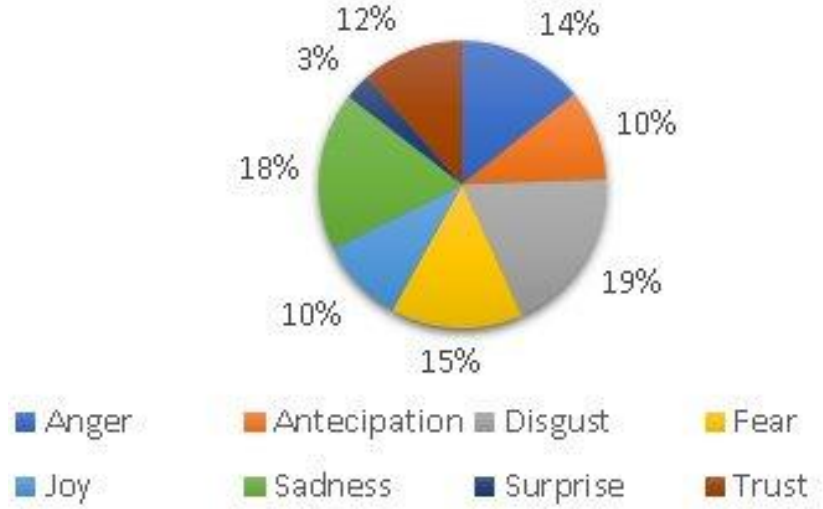
Racism, sexism, trolling, cyberbullying...



Hate speech detection

Hate speech detection

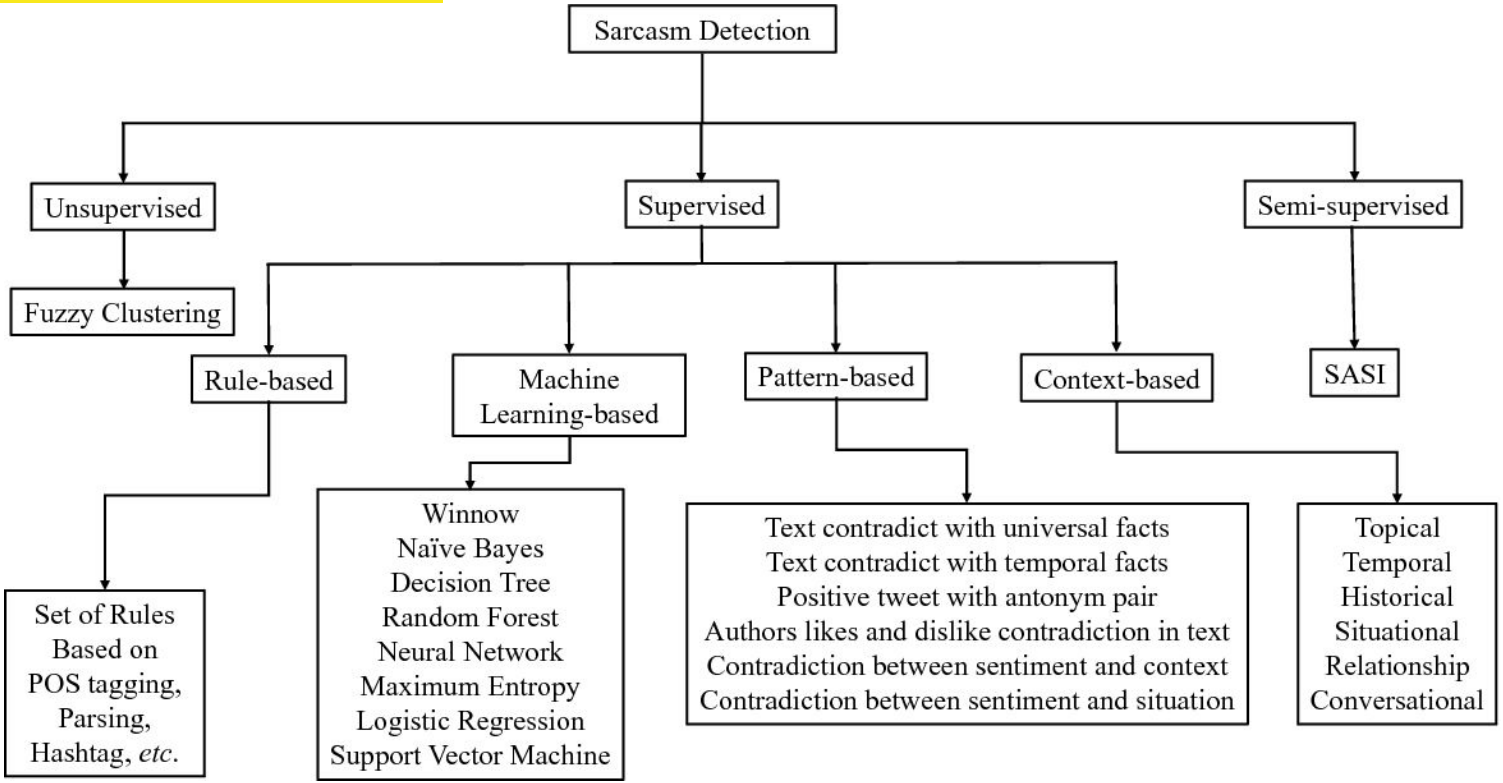




[Hate Speech Classification in Social Media Using Emotional Analysis]

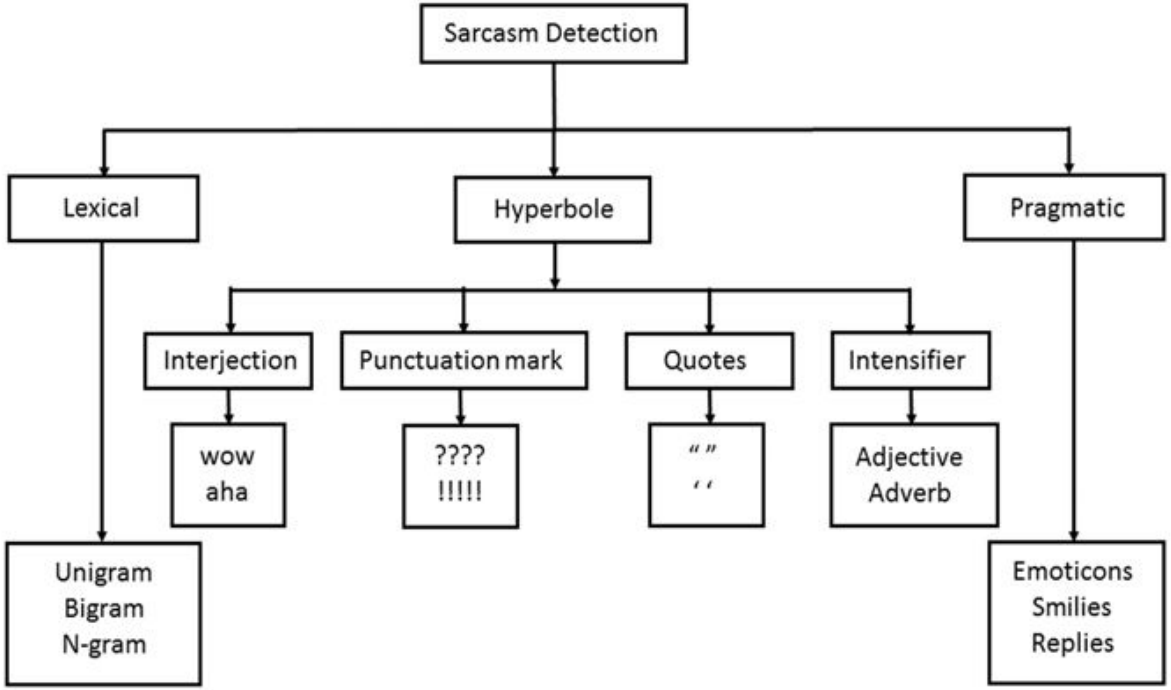
Irony/sarcasm detection

Irony/sarcasm detection



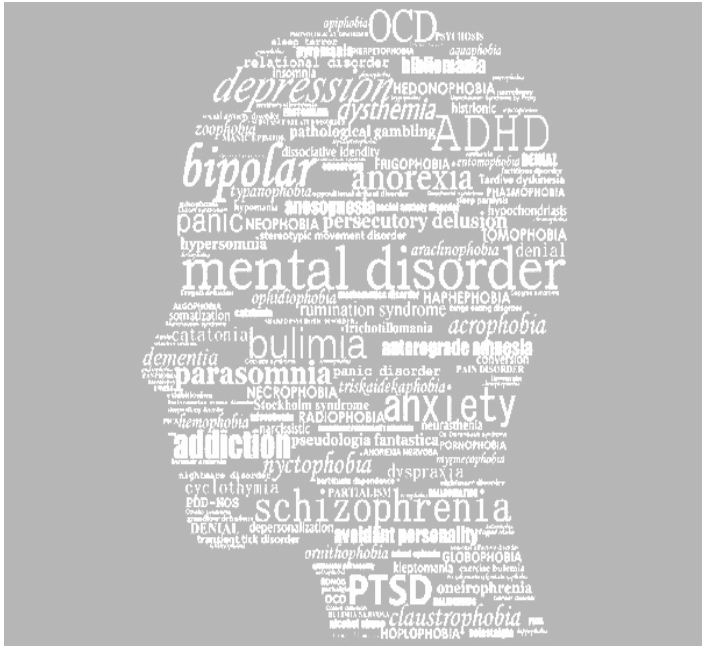
An Improved Approach for Sarcasm Detection Avoiding Null Tweets

Irony/sarcasm detection



Sarcastic Sentiment Detection in Tweets Streamed in Real time: A Big Data Approach

Mental health disorder detection



Motivation

- Affects quality of life (emotions, thoughts, activities, social)
- Affects physical health (sleep, eating, energy)
- Can lead to suicide
- COVID-19 pandemic affected mental health from multiple directions (health, social, economical, ...)
- Social media engagement can further affect mental health
- Underdiagnosed, undertreated
  - Depression 50% diagnosed, 13–49% properly treated

Mental health disorder detection

Applications

- **Alerting** users who show symptoms (recommend professional **help**)
- **Suicide watch**, online counselling (chatbots) ...
- Preventing development of disorders (**early** detection)
- **Assisting clinicians** with new insights and building **diagnosis tools** (patterns of depressive symptoms, causes of depression,...)

Data for mental disorders

- Medical records
- Questionnaires
- Therapy sessions
- Essays, letters etc
- Social media

MHs (Mental Health subreddits)
I have been considering going for some formal therapy. Any suggestions?
Everyday I feel sad and lonely
Since past sometime I think I am having panic attacks. I really need help from you guys.
It has been so many years, I feel I still can't move on. I am noticing behavior what could be considered "triggers" now.
SW (SuicideWatch)
I know I was never meant to lead this life.
Don't want to hurt the people I care but I can't take this anymore.
Today I felt I have nothing left, why am I even living... I don't see a point.
I'd kill myself, but the other part of me tells me not to waste all the money my parents invested on me..

Table 1: Example titles of posts in the MHs and SW datasets; content has been carefully paraphrased to protect the privacy of the individuals.

Mental disorder detection: Existing approaches

How difficult is mental disorder detection?

"Social media-based screening may reach prediction performance somewhere between unaided clinician assessment and screening surveys." (Detecting depression and mental illness on social media: an integrative review)

AUC moderate to high (0.6-0.9 AUC)

Early detection: more challenging (0.62-0.70 F1)

- Harder to detect before the onset of the mental illness

Mental disorder detection
Existing approaches

Features:

- Lexicons: LIWC (self-references, social words, emotion words, cognitive words.)
- Character n-grams, bag-of-words
- Topic modelling (sentiment-bearing topics, topic model with depression seed words, ...)
- Meta: user activity (social engagement, login times), demographic attributes (gender, age)
- Multimodal (rare): video interviews, profile picture
- Recently: language models (contextual embeddings, neural language models)

Models:

- SVM, random forest, neural network...

Features correlated with depression

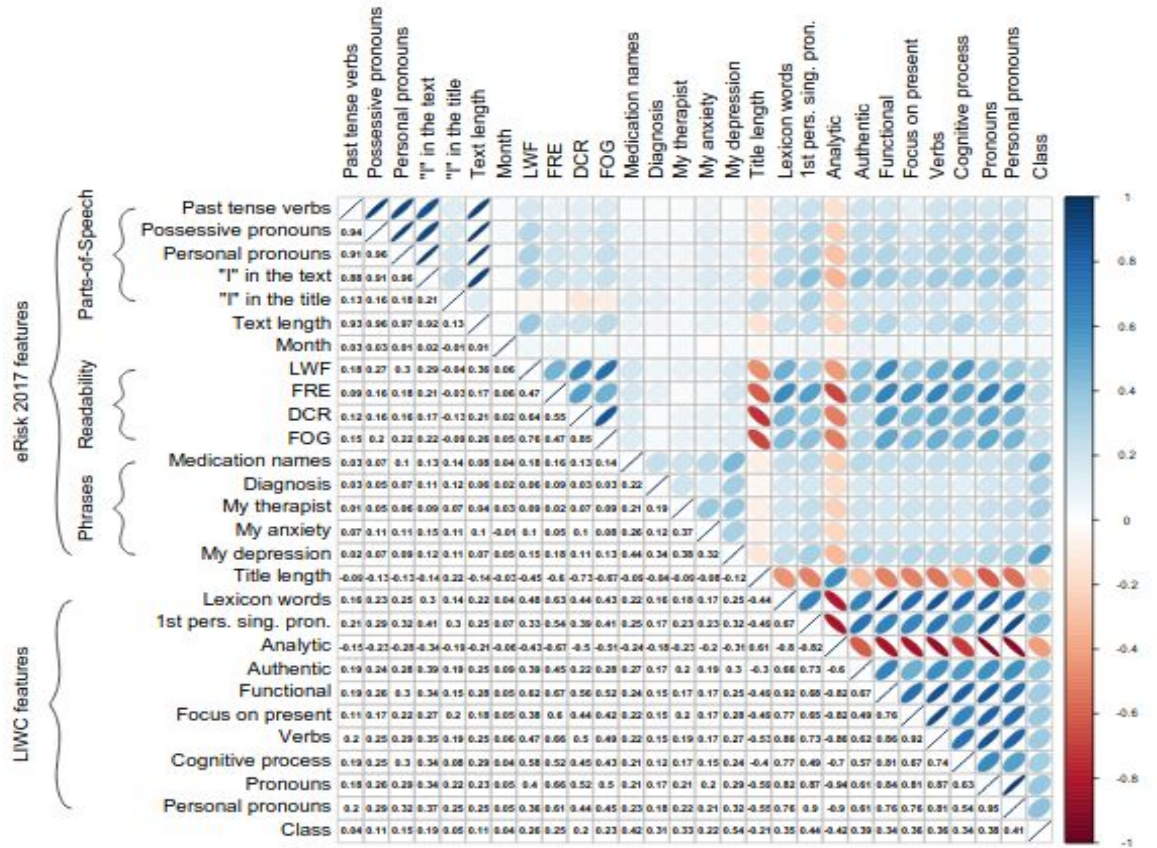
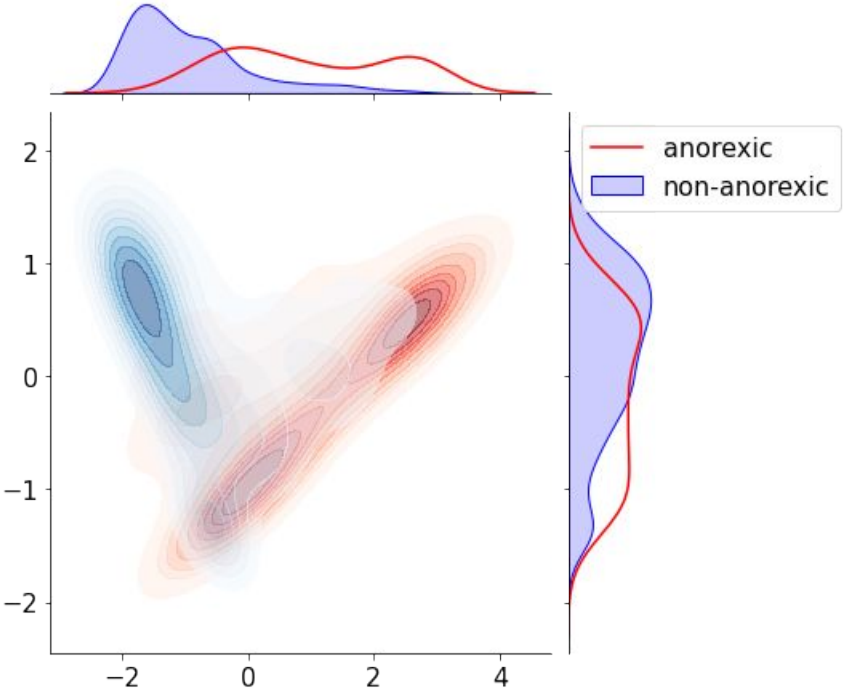


Fig. 1. Correlation matrix of all user features including the class information (non-depressed/depressed) based on the depression subtask training data. This plot is best viewed in electronic form.

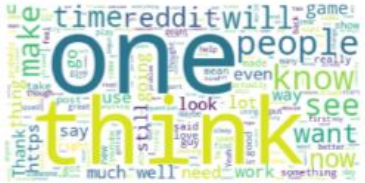
Word Embeddings and Linguistic Metadata atthe CLEF 2018 Tasks for Early Detection ofDepression and Anorexia

Discovering symptoms clusters for anorexia



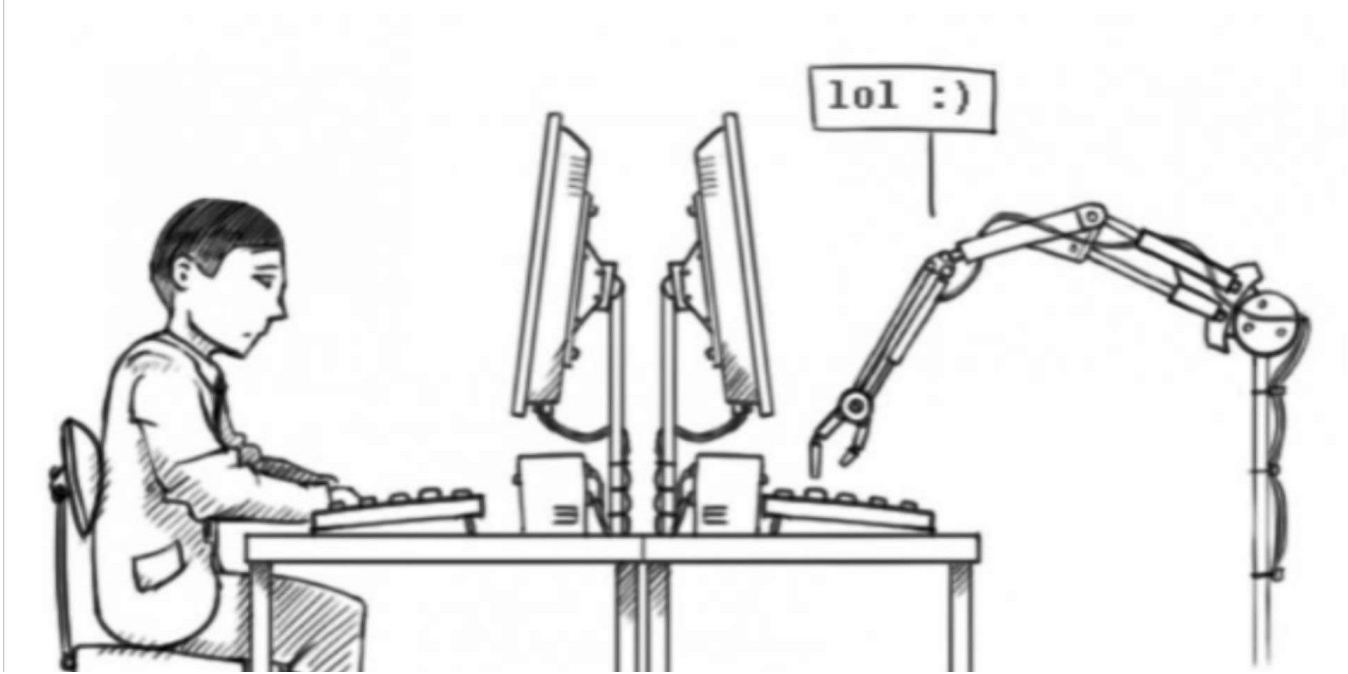
(a) Cluster of anorexic users **ANO1**.

(b) Cluster of anorexic users **ANO2**.



(c) Cluster of healthy users.

Natural language generation



The Imitation Game

I believe that in about fifty years' time it will be possible, to programme computers,..., to make them play the imitation game so well that an average interrogator will not have more than 70 percent chance of making the right identification **after five minutes of questioning**. The original question, 'Can machines think?' I believe to be too meaningless to deserve discussion. Nevertheless I believe that at the end of the century the use of words and general educated opinion will have altered so much that one will be able to speak of machines thinking without expecting to be contradicted. (Turing, 1950)

The Turing test

Natural language generation

- **Language Modeling**: the task of predicting the next word, given the words so far

$$P(y_t \mid y_1, y_2, \ldots, y_{t-1})$$

- A system that produces this probability distribution is called a Language Model
- If that system is an RNN, it's called a RNN-LM

Natural language generation

Conditional Language Modeling: the task of predicting the next word, given the words so far, and also some other input

$$P(y_t \mid y_1, y_2, \ldots, y_{t-1}, x)$$

Examples of conditional language modeling tasks:

- Machine Translation (x=source sentence, y=target sentence)
- Summarization (x=input text, y=summarized text)
- Dialogue (x=dialogue history, y=next utterance)

Natural language generation

- Machine translation

Word Confidence Estimation and Its Applications in Statistical Machine Translation

Natural language generation

- (Abstractive) Summarization

Source Text: Peter and Elizabeth took a taxi to attend the night party in the city.

While in the party, Elizabeth collapsed and was rushed to the hospital.

Summary: Elizabeth was hospitalized after attending a party with Peter. 

Natural language generation

- Text simplification

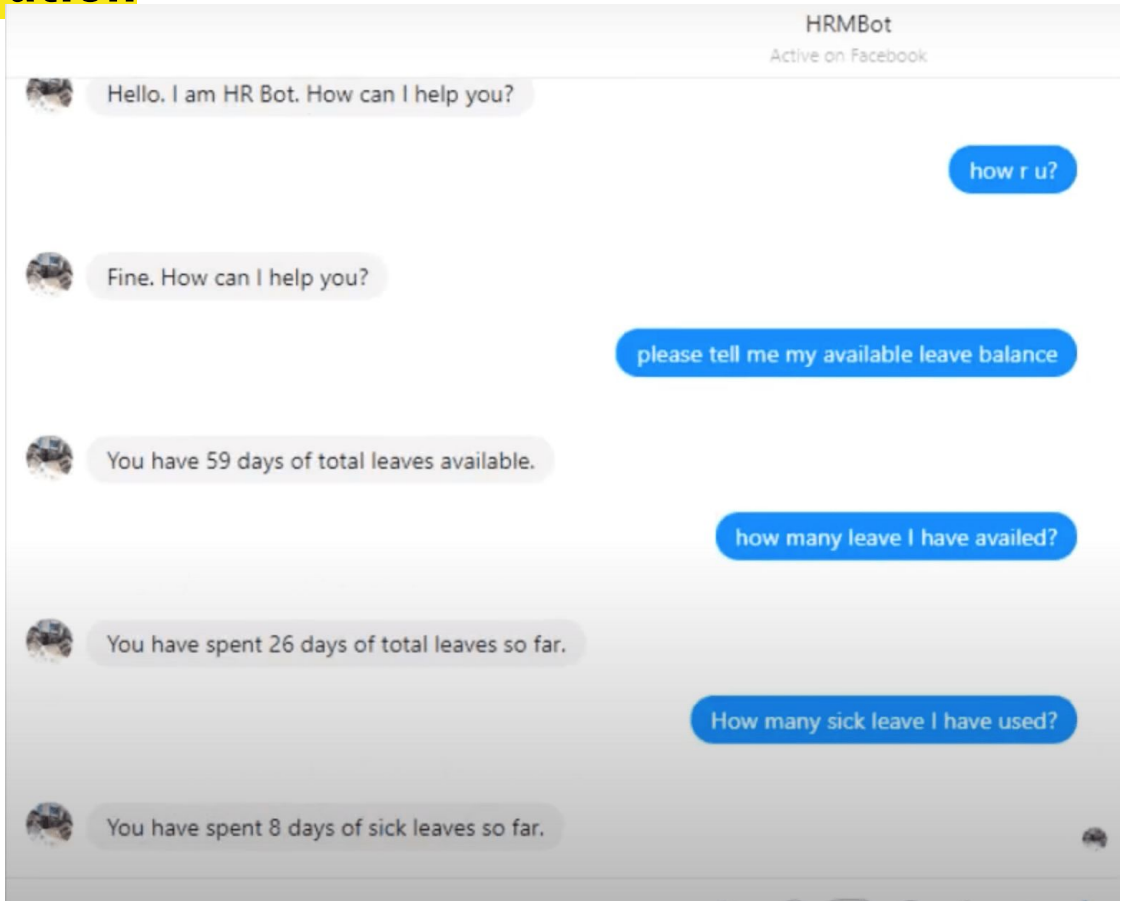
Wikipedia	Simple Wikipedia	BLEU
Spinal tumors are neoplasms located in the spinal cord.	Spinal tumors is a form of tumor that grows in the spinal cord.	0.39
Aspirin is an appropriate immediate treatment for a suspected MI.	Aspirin is an early and important treatment for a heart attack.	0.33

Table 3: Example alignments using BLEU alignment

Simplification in the Medical Domain

Natural language generation

- Dialogue (chit-chat and task-based)



Natural language generation

- Image captioning

"man in black shirt is playing guitar."

"construction worker in orange safety vest is working on road."

"two young girls are playing with lego toy."

Natural language generation

- Creative writing: storytelling, poetry-generation

https://app.inferkit.com/demo

https://lingojam.com/EnglishtoShakespearean

Thank you

http://nlp.unibuc.ro/master_en.html