

1. *Text Representation.* What is the document-term matrix?

- Each term of a language is getting documented by specially trained linguists
  - { just does not make sense }
- The latent representation of attention heads in Transformer blocks
  - { maps a query and a set of key-value pairs to an output }
- Feature space spawned by terms over documents represented as a matrix
- Adjacency matrix of the bipartite graph of documents and the terms contained in each document
  - { why bipartite? Adjacency matrix would be square, document-term matrix #documents × #terms }

2. *Assumptions.* Which are reasonable approaches to capture information in text?

- Words are influenced by their surrounding words in context
- The sentiment influences the word order in conjunctions
  - { I would expect no influence here }
- Average sentence length depends on the author's specific writing style
  - { also does depend on other factors, e.g. what text are we writing }
- Lexems depends on the anaphoric resolution
  - { anaphoric resolution ... the problem of resolving what a pronoun, or a noun phrase refers to lexeme ... root form of a word
  - pronouns are probably invariable in terms of lexemes? }

3. *Learning.* Which of these statements is true?

- Deep learning is always preferred over rule-based approaches
  - { rule-based might be simpler, if it also solves the problem why not use it, also rule-based approaches need far less data than deep learning }
- Rule-based approaches require large amounts of labelled training data
  - { often created manually, no need for large amount of data }
- The industry often prefers rule-based approaches over machine learning
  - { can't really speak for the whole industry, but I guess that both approaches have valid applications }
- Deep learning is considered the state of the art for many NLP tasks

4. *Named Entity Recognition.* There are multiple ways on how to encode the tokens used to train sequence classification systems, like named entity recognition systems.

- (a) Why is a simple binary scheme like EO (entity token, outside token) not a good idea?
- (b) What could be the reason that a BERT-based sequence classifier fail to learn [O B I O ...] and outputs [O I I O ...] instead?
  - (a) can't really tell where one sequence ends and the next one starts
  - (b) (BERT sequence should start with a [CLS] token)  
inside, outside, beginning  
there is a beginning inside of two outsides

5. *Word Embeddings.* Traditional word embedding techniques like word2vec have been popular in past years, but today are less used and contextual embedding techniques are preferred.
- (a) What are the advantages of contextual word embeddings, like BERT, over classical word embeddings?
  - (b) Are there cases, where a traditional word embedding method is preferred? If yes, please provide an example.
  - (a) For classical word embeddings we would use the same embedding for words even if they are used in different contexts. For example “computer mouse” and “mouse rodent”, in this case we would get the same word embedding vector for both ('global' word embedding). Contextual word embedding we would in the best case get two different embeddings depending on the context the word is used in.
  - (b) Can't really think of any. In some cases the contextual word embedding would not provide any advantages, but I see no case were it would actively hurt to use contextual word embeddings.

6. *Deep Learning.* Many attention-based approaches combine as inputs a token embedding and a position embedding.

- (a) Why is there a position embedding, what is its purpose?
- (b) Are there tasks, where the position embedding is not useful? If yes, please provide an example.
- (a) The many attention-based approach does not really process the sequence of input tokens one by one (more of a parallel computation). Therefore the order of tokens gets lost. We believe that language has an order therefore we would like to keep this information intact. Otherwise the sentences “cook kneads dough” and “dough kneads cook” would be the same. This is achieved by additionally adding a position embedding, which could be either learned or fixed. Now the transformer is able to know the relative position of the words.
- (b) speech to text, text generation  
If we would like to generate text the transformer does not really net a position embedding for the input.

7. *Word Senses.* You are asked to develop a method for disambiguation of named entities, e.g., names of celebrities, based on Tweets. For example this tweet refers to Adam Scott, the golfer and not Adam Scott, the actor.

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- (a) Are there any Twitter-specific features, which can be used for this task?
- (b) Would there be other data sources that can be useful for the task?
- (c) Briefly describe how you would solve the task.
  - (a) hashtags, twitter id / @handle
  - (b) crawl or find a dataset that has the name of celebrities and some information about their field of work (sport, movie, politician, ...) e.g. actor/actress imdb
  - (c) We could crawl a dataset from twitter by using the twitter handle of celebrities. Now we know that these tweets correspond to the individual celebrities. We could train a model by masking out the text of the twitter handle of the person and asking the model to predict which celebrity the tweet corresponds to. We know the ground truth and after training we could apply the model on tweets that do not contain the twitter handle.

8. *Plagiarism.* Consider the university asks you to develop a system to test thesis (e.g., Bachelor and Master) for cases of plagiarism. Your system should for each thesis check, if there are plagiarised passages and mark the beginning and the end of a suspicious passage, which is then checked by human experts.
- (a) Which data sources would you consider?
  - (b) What features would you use? (short list with explanation)
  - (c) What method would you choose?
  - (d) How well do you expect your method to work? What are the bottlenecks?
    - (a) Consider larger knowledge bases in the web (wikipedia, ...), other bachelor thesis, master thesis and publications. If we know the field we could maybe narrow down the data needed.  
Previously known cases of plagiarism (probably hand labeled) will also be useful.
    - (b) A simple feature to use would be n-grams and then compare the overlap. Maybe use POS tagging for semantic similarity. Use some vector embedding like GloVe. Compute similarity features and containment. Find subsequences that are the same (long = probably plagiarism). We should also decide if we do this on a word or sentence level. Also stylometry could be considered. If some part of the text has a vastly different style and is not cited it could be an indication for plagiarism.
    - (c) Some deep learning model. There are Deep Structured Semantic Models which might be a good fit for this task. Otherwise maybe a Bi-LSTM or Transformer.
    - (d) Data collection would need large amount of resources. Furthermore training the model on a large amount of data will take quite some time. Would definitely work well on the form of “copy-paste plagiarism”. If somebody translates one language into another and uses this to plagiarize we would not detect that. It would probably be unfeasible to do this for all languages. Since “stealing” ideas is also a form of plagiarism, we could also not detect that. I am not sure how that could even be possible to detect.

9. *Causality.* You are asked to build a system to extract causal statements from text of a manufacturing company with a lot of textual document, including technical reports. For example the sentence  
“Mechanical stress is one of the main causes of yield loss”  
should be automatically annotated as  
“{Mechanical stress}<sub>Cause</sub> is one of the main {causes}<sub>Cue</sub> of {yield loss}<sub>Effect</sub>”.
- (a) What type of approach do you choose?
  - (b) What properties do you expect for your approach? E.g., better recall/precision, better performance on longer sentence?
    - (a) A machine learning approach seems to be the best fit. Probably some kind of deep learning like BERT (maybe we find a pretrained BERT-model that is trained on technical reports or similar).
    - (b) Evaluation often struggles as there is often no ground truth.

10. *Evaluation.* You developed a method for style transfer for German text. Given a sentence written by an arbitrary writing style, your method outputs the “same” text as it were written by a famous author (e.g., Thomas Mann, Wolf Haas). Now you are requested to assess how well your system is working.
- (a) What evaluation methodology do you follow?
  - (b) What evaluation measures do you use?
  - (c) Are there known limitations in your evaluation methodology or evaluation measures?
    - (a) Somehow create some ground truth that we can compare to, otherwise we need to involve humans that rate the output of the model. Might also make sense to use an explainable AI model, if possible. We also need a baseline to compare against (heuristic, human).
    - (b) Compare the stylometry of the output of the model with texts from the author we are trying to mimic. Ensemble some typical stylometric features like average word length, vocabulary richness measure, white space ratio, . . . . Maybe the individual authors have some consistent style that is very recognizable, look at what feature separates that author from the others. Another idea would be to use an already trained model that identifies authors and let that rate the writing style of the created texts.
    - (c) If we use humans to create a ground truth or to rate the output we also need to look at the inter-rater agreement. They might disagree in some aspects.