Bachelor thesis, Institute of Computer Science, Freie Universität Berlin

Human-Centered Computing (HCC), AG NBI

Comparing Interpretability Techniques for Unsupervised Topic Modeling

– Exposé –

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1 Motivation of the thesis

Research on Explainable Artificial Intelligence, often called XAI, is currently wildly distributed and characterized by several competing ideas and approaches from a vast number of fields including computer science, mathematics, social sciences and philosophy. Research is mostly focused on explainability in computer vision since the inner workings of a model can directly be translated into a graphic representation. In contrast to that development stands the fact that most of humanity's knowledge is encoded in text and XAI algorithms and methods from computer vision most often cannot be directly applied to results of NLP algorithms. Therefore there is an urgent need to research these methods in the context of NLP.

Project IKON, which aims to develop a data-driven application for the discovery of knowledge transfer potentials between research projects and society at a major natural history research institution, serves as an optimal use case to analyze and apply this development. The core of this application is a cluster visualization which links research projects by their semantic similarity and is supplemented by links to infrastructures (e.g., collections or labs) and knowledge transfer activities (e.g., collections or labs). This cluster view is driven by a Topic Modelling Pipeline with a Singular Value Decomposition at its heart. It is thought that this method shares a limited amount of expressiveness with different other linear methods due to its purely linear nature [AHM+17]. Furthermore building the pipeline brought up serious concerns and uncertainty concerning the meaningfulness of approaches such as parameter manipulation or choosing between algorithms for dimensionality reduction [BMG18] in our use case.

Therefore the integral problem in Project IKON is: Which parts of the project need explainability, what kind of models can be used for these parts and how precisely can what aspect be made interpretable for humans in order to support the context of identifying potentials for knowledge transfer at the research institution? Especially the last question seems to be unanswered in scientific literature as contextuality, which includes the way in which the output of a machine learning algorithm is used in an algorithmic system as well as the situated context of use, is a sorely neglected aspect of interpretability [Mil17]

2 Related work

With the surge of the application of machine learning (ML) systems in our daily life there is an increasing demand to make operation and results of these systems interpretable for people with different backgrounds (ML experts, non-technical experts etc.). Contrary to these efforts, interpretability as term has become an ill-defined objective [Lip16] for research and development in ML algorithms since there is no widely agreed upon definition of it.

Miller et al. [MHS17] supports this point by conducting a literature study and uncovering that interpretability research is rarely influenced by insights from the humanities, especially connected fields as explainability or causality research.

This thesis builds upon these concepts and tries to transfer their critical insights into

the sub field of natural language processing - an often overlooked discipline in the context of interpretability research.

3 Goal setting and procedure

As formulated in the introduction, the main problem for project IKON is uncertainty about the interpretability of the existing model. This thesis should therefore examine existing interpretability techniques, their applicability to the existing model or a contending one and subsequently a decision for one of them by systematically and iteratively sourcing feedback from the principal researchers of project IKON. The chosen model will be implemented and augmented by a number of interpretability techniques. The results will be assessed with the help of an exemplary, qualitative user test with an expert user from the natural history museum. This goal setting directly leads to the following list of steps:

1. Since we as developers are not sure what kind of techniques to enhance explainability for unsupervised NLP models exist, a thorough and reproducible literature analysis on the status of XAI research in the field of NLP a literature mapping study according to Petersen et al. [PFMM08] is going to be conducted. This should result in a number of papers which are, according to the process, good representatives of the literature base and therefore also of current research efforts.

   A quantitative analysis of these papers should summarize occurring XAI methods and categorize them according to the proposed categories of Hohman et. al. [HHC+19].

2. The currently existing topic extraction pipeline can be clustered into the following four components: document embedding, dimensionality reduction into a topic space, clustering and another dimensionality reduction into 2D. Based on the results of the literature analysis an alternative pipeline is constructed. Based on the results of the previous step for each component either a directly applicable method (e.g. a clustering algorithm) from a paper or a model which supports most collected methods (e.g. a neural network for document embedding) is chosen and implemented. Since the new pipeline should perform at least as good as the old one, each component will be quantitatively accessed according to applicable measures e.g. ([RBH15]).

3.

4. In order to access how the implemented methods may support a non-technical expert in interpreting the results of the pipeline, a cognitive walkthrough from the point of view of a researcher from the national natural history museum will be conducted.

4 Procedure and methods

One of the most crucial parts of the existing topic modelling pipeline is the document embedding. Currently a simple information retrieval method - Tf-Idf - is used, but the main drawback of the technique is that it, as all Bag-of-Words method, completely disregards word order and semantic dependencies in texts. Since that may be a integral part especially in scientific literature a more complex model is needed which is able to capture this dependencies. In order to do this a short summary of the state of research of document embeddings is presented and an contender to the existing NLP pipeline will be chosen.

In this analysis a model is more interpretable if it supports more interpretability techniques that were sourced from the literature analysis. Therefore the next step involves checking which techniques are applicable to the two contending models. Based on the absolute counts the more interpretable model is chosen. Following a number of supported techniques are selected and going to be applied to the chosen model.
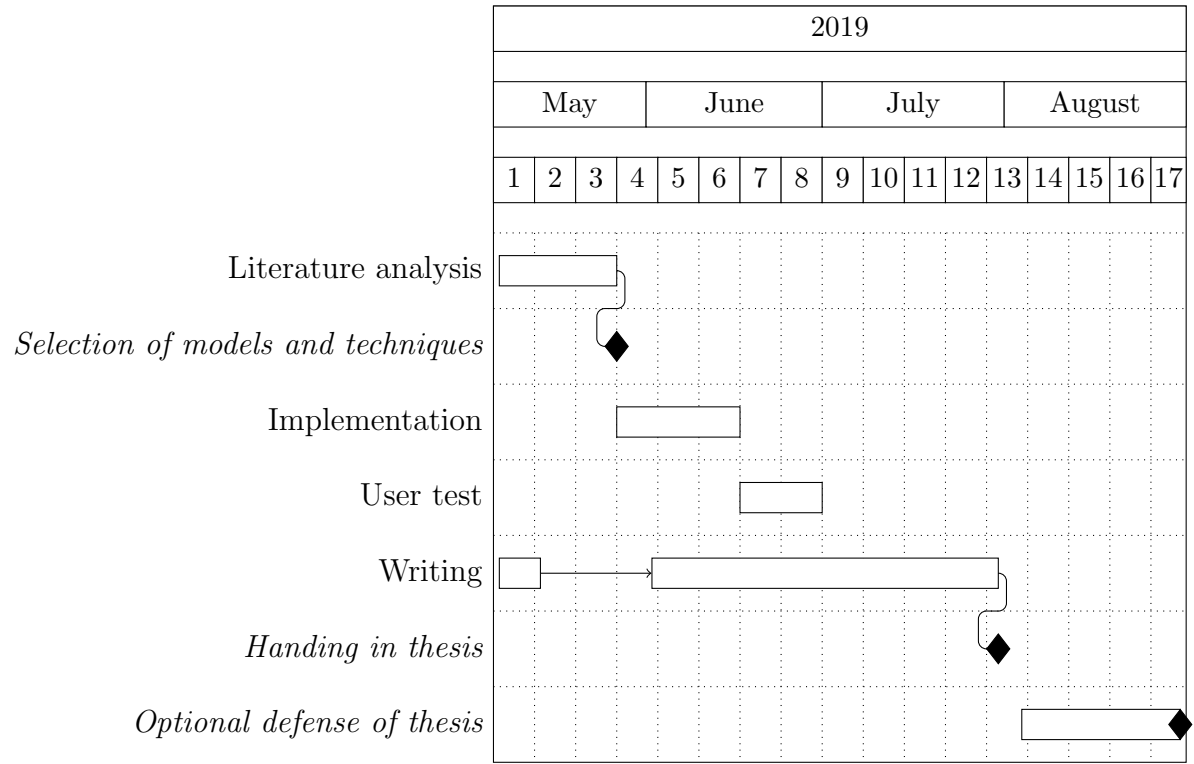
As an exemplary analysis of the impact of these techniques on the human understanding a qualitative test with domain experts from the natural history museum will be conducted. The test, which is inspired by the often used method of Think Aloud Tests, should generate insightful information and pointers for further research.

5 Implementation

One of the main technical challenges and parts of the implementational work will be the augmentation of the current topic modelling pipeline by a document embedding technique. Since the performance of the model greatly depends on this step, it is crucial to have well learned vector representations of the document base. Currently there is a corpus of circa 114000 scientific documents available in order to train the model. If that is not enough to gain expressive document embeddings, one may include pretrained word embeddings via e.g. BERT [DCLT18] to introduce external information into the model and enhance the semantic coherence of the learned embeddings. This path should be taken with caution since it is connected to an hardly determinable amount of complexity. Research in the field of transfer learning for document embeddings is still in its infancy.

In order to adhere to the current research and industry standards, the implementation of this thesis is going to be done in Python. Based on the chosen model which is going to be augmented with explainability mechanisms further packages and technologies are going to be selected.

6 Time calculation

	2019			
	May	June	July	August
	1 | 2 | 3 | 4	5 | 6 | 7 | 8	9 | 10 | 11 | 12 | 13	14 | 15 | 16 | 17

Literature analysis

Selection of models and techniques

Implementation

User test

Writing

Handing in thesis

Optional defense of thesis

4

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