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PhD Program: Computational and Data Science and Engineering

Title of Thesis: Efficient Active Learning and Fact-Checking via Predictive Uncertainty Quantification for Natural Language Processing

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The topic and material of the thesis covers the development and analysis of efficient uncertainty quantification methods for applied natural language processing tasks. The methods used in this thesis represent new approaches to uncertainty quantification that take into account the specifics of the applied problems, namely active learning and fact-checking.

The main contributions of this thesis can be summarized as follows:
- a new method for batch active learning for a classification task based on an approximation of one of the current state-of-the-art methods
- a new approach for fact-checking via uncertainty estimation and corresponding validation methodology for white-box language models
- a new fact-checking dataset collection and annotation according to the provided detailed methodology.

The structure of the thesis meets the standard requirements, and represents 6 main chapters: introduction, related work, 3 chapters related to new methods and results, and conclusion. The text is written in detail with a coherent presentation of the material.

The proposed uncertainty estimation methods demonstrate superiority in terms of efficiency compared to state-of-the-art alternatives. In terms of active learning, it is the computation time for taking a large set of samples for labeling. From the fact-checking point of view, it is to consider only the relevant uncertainty of the generating model.

The results of the thesis research were published in proceedings of high-level conferences, including EMNLP 2022 (CORE A*), SIAM SDM 2023 (CORE A), ACL 2024 (CORE A*) and EMNLP 2024 (CORE A*). In the two publications, Aleksandr is the main/shared first author.

Overall, the thesis presents high-quality research, which makes a notable contribution to the field of uncertainty quantification. The methods and results obtained are sharpened for real-world applications, as demonstrated by the experimental studies.

Alexey Zaytsev