

## Master's Thesis of Science in Engineering at HES-SO

# GraphQA, a Deep Retrieval Chatbot

A Multi-hop Conversational Question-Answering Chatbot using Sub-Knowledge Graphs

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## DESCRIPTION

New technologies are revolutionizing the way humans access knowledge as a service from multiple platforms and providers. Thanks to the emergence of increasingly powerful Artificial Intelligence algorithms, particularly in the field of Natural Language Processing (NLP), conversational agents, commonly named chatbots, have come a long way and have become popular among information consumers. Even though the *chatbots* are continually improving at providing the best outputs for specific tasks as well as providing meaningful human-like sentences, they still cannot generalize the tasks toward human-like conversations. The task of conversation, as humans are applying it, a complex integration of tasks including understanding, reasoning, context linking, context tracking, curiosity, initiatives, Few-Shots Learning or Zero-Shot Learning and on the fly learning, has yet to be accomplished. Nonetheless, as research progresses, chatbots are improving with new technics and tools that make them step by step closer to complete human-like discussions, slowly progressing toward Artificial General Intelligence chatbots. As for the scope of the thesis, we humbly focus on the combination of few NLP tasks with a zero-shot approach to help Machine Learning and NLP research getting closer to General Question-Answering Conversational Chatbots.

The initial goal of the thesis was to explore and combine State-of-the-art Question-answering Systems and Language Models into an experimental Proof-of-Concept of a Multi-Turns Conversational Question-Answering Chatbots.

## OBJECTIVES

In the scope of this research, we realize the proof-of-concept of an open-domain and closed-ended question-answering chatbot able to output comprehensive natural language generated sentences using the Wikidata knowledge base.

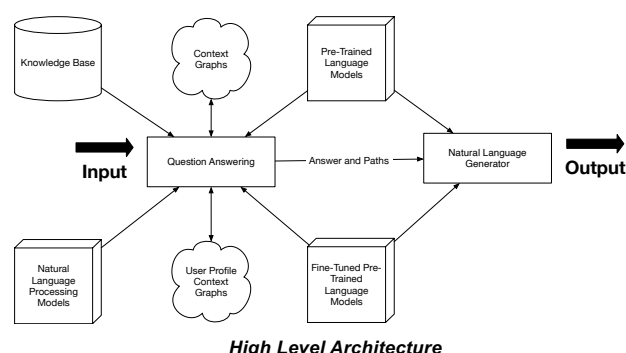
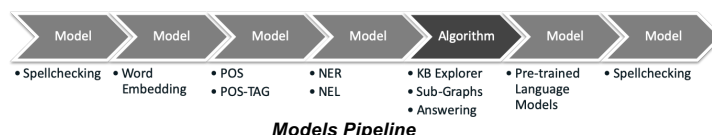
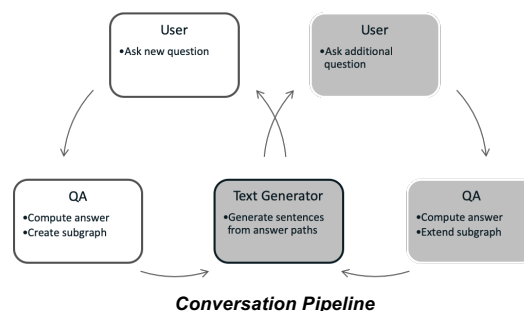
To achieve the concept, we explore the extraction, and the use of sub-knowledge graphs from the Wikidata knowledge base to answer questions conversationally and to use the sub-graphs as context holder. Additionally, we are extracting subject-predicate-object tuples from the graph and using language models to join the Subject-Predicate-Object Tuples (SPOs) and extend the answers as natural language sentences.

Finally, we evaluate the answers and compare the results with state-of-the-art single-hop and multi-hop question-answering systems on question-answering datasets. We find out that, aside from the computation time and the computational resources needed, our proof-of-concept performs similarly at question-answering compared to its competitors.

## RESULTS

### Natural Language Question-Answering Chatbot

The proof-of-concept architecture uses a combination of state-of-the-art and industry-used models with a fine-tuning strategy. As a motivational target, we use a zero-shot learning approach, by combining various models with an algorithmic orchestrator and using pure algorithmic for the graph manipulation and answer extraction.



## CONCLUSION

We propose an innovative approach for question-answering chatbots to handle conversational contexts and generate natural language sentences as answers. In addition to the ability to answer open-domain questions, our zero-shot learning approach, which uses a pure algorithmic orchestration in a grounded learning manner, provides a modular architecture to swap statically or dynamically task-oriented models while preserving its independence to training. As next steps, we suggest to explore further the context graph by pre-generating contexts based on Articles.