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LIHLITH: Learning to Interact with Humans by Lifelong Interaction with Humans

LIHLITH: Aprendiendo a interactuar con las personas mediante la interacción continuada con personas

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Abstract: The LIHLITH project will research, innovate and validate a new lifelong learning framework for the interaction of humans and machines on specific domains with the aim of improving the quality of existing dialogue systems and lowering the cost of deployment in new domains. LILITH will develop dialogue systems that learn autonomously from their interactions with the users, and retain this new knowledge in order to answer more accurately in future interactions. The key insight is that the dialogue systems will be designed to get feedback from the user. Based on this feedback, the system will keep improving after deployment all modules down in the pipeline. LIHLITH project will also develop and deliver evaluation protocols and benchmarks to allow public comparison and reproducibility.
Keywords: Dialogue systems, lifelong learning, question answering, knowledge induction

Resumen: El proyecto LIHLITH investigará, innovará y validará un nuevo marco de aprendizaje permanente aprendizaje continuo para la interacción entre humanos y máquinas en dominios específicos con el objetivo de mejorar la calidad de los sistemas de diálogo existentes y reducir el coste de implementación en nuevos dominios. LILITH desarrollará sistemas de diálogo que aprenden de forma autónoma de sus interacciones con los usuarios, y retendrá este nuevo conocimiento para responder de manera más precisa en futuras interacciones. La idea clave es que los sistemas de diálogo se diseñarán para obtener *feedback* del usuario. Basándose en esta información, el sistema seguirá mejorando después del despliegue todos los módulos del sistema. El proyecto LIHLITH también desarrollará protocolos de evaluación y *benchmarcks* para permitir la comparación y reproducibilidad en el futuro.
Palabras clave: Sistemas de diálogo, aprendizaje continuo, búsqueda de respuestas, inducción del conocimiento

1 Introduction

A dialogue system makes it possible the human-machine interaction more natural, as the goal of such systems is to converse with humans using ordinary natural language. Traditional dialogue systems are built with hand-crafted rules or they use machine learning techniques trained on a large number of manually annotated sample dialogues. These makes the transferring of the dialogue system to a new target domain exceptionally costly in terms of money and time. Moreover, as the background domain knowledge is fixed and does not expand after deployment, the scope of their applications is limited and is not expanded over time.

Humans use dialogue to learn a great deal of knowledge about the world around us. That is, people have interactive conversations with other people in order to confirm or retract our understanding. Mimicking this behaviour, dialogue systems should also need to learn new knowledge continuously, and this requirement can be fulfilled by means of lifelong learning.

The idea of continuous learning or lifelong learning in machine learning systems has recently gained popularity and is based on the

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fact that the implemented system, once it has been deployed, continues to improve through interaction with its environment (Chen and Liu, 2016). The application of lifelong learning in the dialogue systems will make the system adapt its strategy to generate the utterances based on the previous interactions that it has with the user, and this will make its results more satisfactory.

Based on the lifelong learning framework, LILITH will develop dialogue systems that learn autonomously from their interactions with the users, and retain this new knowledge in order to answer more accurately in future interactions. This project focuses the research in the scope of question-answering dialogue, that is, dialogues that have the goal to fulfill the information need of the user. The key insight is that the dialogue systems will be designed to get feedback from the user, if necessary, asking explicitly for it to the user ("Are you asking for a specific recipe?" or "I don't know. Can you give me an example of accurate answer?"). Based on this continuous feedback, the system will keep improving after deployment all modules down in the pipeline (dialogue management, knowledge induction, domain knowledge...).

As the evaluation of a dialogue system is challenging and not very well established, LIHLITH project will also develop and deliver evaluation protocols and benchmarks to allow public comparison and reproducibility.

LIHLITH project[1] is a CHIST-ERA project[2] selected for the call 2016 "Lifelong Learning for Intelligent Systems (LLIS)". It started in January 2018 and it will run until December 2020. The project is coordinated by Ixa Group from the University of the Basque Country (UPV/EHU) and these are the other groups of the consortium: Computer Science Laboratory for Mechanics and Engineering Sciences (LIMSI) in France, Universidad Nacional de Educación a Distancia (UNED) in Spain, Zurich University of Applied Sciences (ZHAW), and Synapse Développement in France.

2 Objectives

LIHLITH has two general objectives: (i) How to improve the state-the-art in lifelong learning using feedback from users, and (ii) how to apply the previous improvements to dialogue systems, leveraging the interaction with humans to improve the overall quality and the ability to cope with new domains. These main objectives will be achieved through the following more specific objectives:

Objective 1: Define a reproducible evaluation protocol for lifelong learning of dialogue systems. Generate resources for lifelong learning evaluation through benchmarking, in the context of dialogue systems and community question answering (CQA).

Objective 2: Improve dialogue systems using lifelong learning through interaction. The improvements will be sought on better domain models, inference models, and the dialogue management module. Special attention will be put on robustness and resilience in the lifelong learning process. The dialogue system will be improved through the reward provided by the interactions, and will include pro-active behaviour, as well as self-assessment capabilities.

Objective 3: Improve knowledge induction through interaction. The necessary domain knowledge is induced using domain texts, existing knowledge bases, and past interactions. The domain knowledge will be used by the inference and dialogue management modules. The induction process will be improved through the reward provided by the interactions.

Objective 4: Build and evaluate a dialogue system for CQA. The dialogue will involve questions on specific question-answering domains.

Objective 5: Build a real industrial use case for chatbot technology and develop the corresponding chatbot system.

3 First year significant results

The following are the results achieved so far during the first year of the project, organized according to the final objectives in section 2:

- Objective 1: We have produced a survey paper on evaluation of dialogue systems (submitted to a journal). In addition, we have implemented an interface to crowdsource train and evaluation dialogues based on community-based question answering forums, and we have collected a set of dialogues using it.

[1] http://ixa2.si.ehu.eus/lihlith

[2] http://www.chistera.eu/

- Objectives 2 and 3: We have produced the baseline knowledge induction, question answering and dialogue systems, which will be improved during the second year using lifelong learning.

- Objective 3: We have produced the baseline technologies, which will be improved using lifelong learning.

3.1 Survey on evaluation methods for dialogue systems

The survey analyses the methods and concepts developed for the evaluation of dialogue systems. Evaluation is a crucial part during the development process. Dialogue systems are often evaluated by means of human assessment and questionnaires, which tend to be costly and time intensive. As an alternative, techniques to reduce the involvement of human labour have been proposed. The survey differentiates various classes of dialogue systems, such as task-oriented dialogue systems, conversational dialogue systems, and question-answering dialogue systems. This survey is key to set a common understanding on evaluation of dialogue systems, which will be the base for the design of reproducible lifelong learning dialogue benchmarks, to be produced in the second year.

3.2 Collection of dialogues

We have implemented an Amazon Mechanical Turk (AMT) interface to collect dialogues. This interface allows to collect dialogues by an interactive task between two workers on AMT. Each of the workers have a different role: (1) one worker asks questions about a cooking topic (the topic is the title of a thread in the forum), and (2) the other worker has to answer these questions selecting a span of text presented to them (the text is the most voted answer in the thread). The collected dialogues are based on the Stack-Exchange CQA forum, more specifically the forum about cooking[3]. We have already collected around 1700 dialogues, consisting on 8195 questions and 7744 answers. Figure 1 shows one of the collected dialogues. The resulting dataset will be used to train and test the neural dialogue system for CQA that we are going to implement in the second year.

Q: How long can you keep chocolate, and what is the best way to store it?
A: Regardless of type, all chocolate should be stored in a cool and low humidity (dry) place away from direct sunlight.
Q: How long does chocolate last before losing flavor?
A: Dark chocolate will last for years. Milk and white chocolate will last for a much shorter time (a few months), because of their milk content.
Q: Once it gets that white stuff on the outside, is it done?
A: No, This kind of chocolate is still suitable for any application where the chocolate will be fully melted (most baking)

Figure 1: Example of a dialogue collected via AMT

3.3 Demo for generating triples of knowledge from a text

We have made a demo available online to generate triples of knowledge from a text[4]. This system, first, processes the input text with a natural language processing pipeline (coreNLP): sentence splitting, tokenization, part-of-speech tagging, Named Entities recognition, coreference resolution and dependency analysis. Then, departing from this information, it generates sets of triples expressing concepts and relations contained in each of the sentences. Figure 2b shows an example of the output produced by this tool given the input text in 2a.

3.4 Demo of a question answering system

We have a demo for a baseline question answering system, which is a subset of an industrial chatbot system. This system generates all the questions and answers that can be asked about the product or service from client documentation. Questions are generated on the basis of manually defined rules. For example, after analyzing the sentence *"You can reset your password by sending an email to admin@example.com"*, the question *"How can I reset my password?"* is generated. Similarly, if an enumerating structure is found in a document, a question of the type *"What are the steps for [subject of the primer]"* is generated. The answers to these questions are always excerpts of the text.

[3]https://cooking.stackexchange.com/

[4]http://nlp.uned.es/lihlith-project/ki/

John W. Carr (...) was a North Dakota Republican Party politician who served as the 15th Lieutenant Governor of North Dakota under Governor George F. Shafer.

(a) Input text

John W. Carr a **politician**
John W. Carr a **person**
north Dakota Republican Party a **organization**
John W. Carr a **lieutenant governor**
North Dakota a **location**
George F. Shafer a **person**
north Dakota Republican Party organization:has:lieutenant governor **John W. Carr**
15th ordinal:has:lieutenant governor **John W. Carr**
North Dakota location:has:lieutenant governor **John W. Carr**
John W. Carr lieutenant governor:serve under:person **George F. Shafer**

(b) Set of triples for each sentence.

Figure 2: Example of the generated triples of knowledge from a text

3.5 Demo of a task-oriented dialogue system

We have made available online a demo of a baseline task-oriented dialogue system working on the cooking domain[5]. It handles two different types of scenarios: (1) the user wants to find a recipe meeting his criteria, and (2) the user asks a question relative to the cooking domain. For the first scenario, the system carries out an interactive search in a database which contains 1,064 recipes extracted from the Wikipedia textbook "Cookbook". The database contains information about the name, the details, the ingredients, the variations, the procedure and the categories for each recipe. For the second scenario, the system accesses, based on semantic textual similarity methods, the unstructured data consisting in sentences from 784 non-recipe documents that can be found on "Cookbook". An example of a dialogue can be seen in Figure 3.

3.6 "Dialogue systems and lifelong learning" special session at IWSDS 2019

LIHLITH project organized the "Dialogue systems and lifelong learning" special session[6] at the Tenth International Workshop on Spoken Dialogue Systems Technology (IWSDS 2019), which was held in Sicily on April 24-26, 2019 (Agirre, Jonsson, and Larcher, 2019). The main objective of this special session was to gather researchers interested in dialogue systems that interact with the users in order to learn about new domains or acquire new knowledge. Thus, continuous learning for question answering and dialogue systems and learning inferences and understanding strategies from the interactive structure of a corpus where some of the topics discussed in the session. The workshop gathered feedback from the community on the ideas and techniques being explored in LIHLITH.

SYSTEM: Hello, Are you hungry?
USER: I want to cook a chocolate mousse
SYSTEM: 3 recipes correspond to your search, including : atkins-friendly chocolate mousse, chocolate mousse cake (vegan) and chocolate mousse . Which one do you want?

Figure 3: Example of a dialogue with the baseline task-oriented dialogue system

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[5]https://lihlith.limsi.fr/dialog.php (user/pass: lihlith/recipe?)

[6]https://iwsds2019.unikore.it/dialogue-systems-and-lifelong-learning/