A Dataset Design for Question Generation Based on Human Cognition

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***Abstract*— Asking questions is essential for humans and artificial intelligence (AI) agents in learning and interaction. To enable asking insightful questions, we first describe the cognitive process behind the inquisitive nature of humans and then propose a dataset, CAUS (Curious About Uncertain Scene), consisting of textual scene descriptions and questions. We employ a generative AI model to produce textual scene descriptions with factual inconsistencies to incur cognitive uncertainties in understanding the situation. Our study highlights the significance of considering humans' inquiry process under uncertainty. We also claim that the proposed dataset can be utilized to improve interactive agents and their ability to come up with human-like and insightful questions.**

***Index Terms* – Uncertainty resolution, Question generation, Inquisitive agent, Curiosity, Information gap theory**

I. Introduction

Asking questions for humans significantly mitigates uncertainty from their surroundings [1] and enhances the validity of interactions [2]. Specifically, the ability to ask questions facilitates active learning in cognitive development [3], [4] in line with learning from interaction with others [5]. In line with this, artificial intelligence (AI) that utilizes natural language also requires the ability to ask questions. Despite its importance and prominence, there is a lack of research on questioning in AI [6], [7] and even in humans [8].

However, asking insightful questions is difficult even for humans [9] because question generation is highly context-dependent and has a wide range of variability [10]. Implementing this ability is also more difficult for robots and other AI agents.

Accordingly, we argue that exploring the principle of humans' questioning under uncertainty is necessary to develop AI agents' questioning strategies that resemble humans.

II. Psychology of Uncertainty and Related Work

From an evolutionary perspective, clarifying the uncertainty has been crucial for the survival of animals, including humans [5]. As a result, we feel compelled to mitigate uncertainty when we encounter it. Fig. 1 depicts the flow of uncertainty resolving process of humans. In short, when cognitive incongruities (e.g., information gap, ambiguity, novelty, etc.) cause uncertainty, humans might exploit various cognitive strategies to solve it if they feel they can deal with it [12]. Epistemic curiosity, the motivation for inquisitive (i.e., information-seeking) behavior, plays the most crucial role in the cognitive process for uncertainty resolution [11].

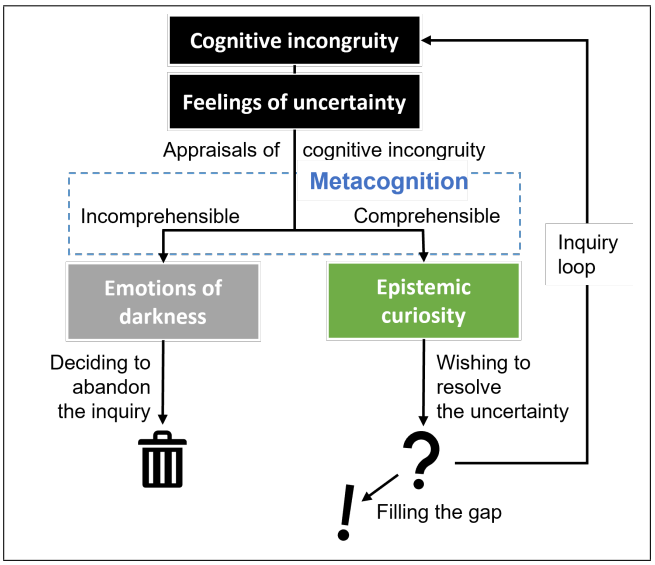

Fig. 1. Flow of uncertainty resolution process in humans. Schematic reconstruction from [11], [12]

The most plausible explanation related to epistemic curiosity is *information gap theory* [13]; people become intrigued when they are aware of missing information [14]. In fact, information gaps are pervasive in our environment and serve as a driving force of interactions between agents, including natural language conversations [7].

However, until now, AI models designed to comprehend given data and engage in question-generation tasks have primarily focused on handling simple and straightforward tasks [15]. Recently, only a few attempts to create datasets aimed at training models to infer unexpected situations, i.e., offering information gap-rich context in image [16] and video [17] domains. However, these attempts primarily focus on prompting the model to deduce the information gaps rather than generating questions. On the other hand, there was an effort aimed at a question-generation model for targeting information gaps in the educational setting, but they employed oversimplified text pair [7]. We claim targeting the information gap also has significant implications for

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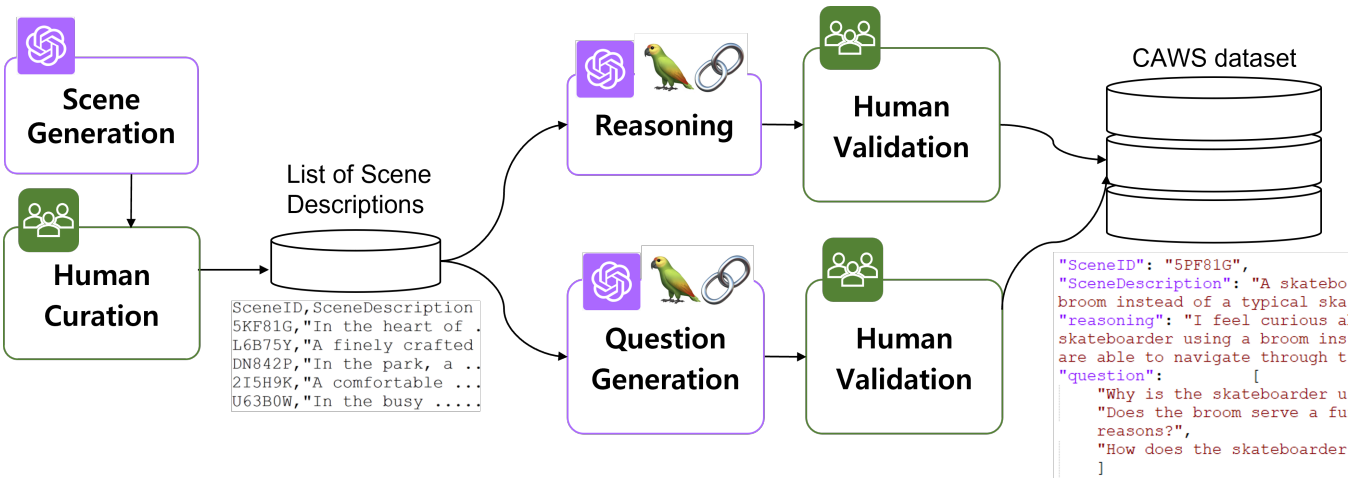

Fig. 2. Workflow for creating a CAUS dataset. Initially, the scenes created by the generative AI are carefully curated by humans to compile a list of scene descriptions. Then, the LangChain framework is employed to gather sentences that infer weird aspects of each scene description and potential queries that may arise from the scene. A human score for the validity of each inference and the usefulness of the question is recorded in the dataset.

designing interactive AIs to encourage successive learning and intellectual growth.

III. Proposal for Dataset Design

Based on the flow of the uncertainty resolution process in humans, as presented in Fig. 1, we suggest a dataset that aims to stimulate a kind of *artificial* epistemic curiosity. The dataset, which we call CAUS (Curious About Uncertain Scene), consists of *scene description*, *reasoning*, and *inquisitive questions*. For eliciting epistemic curiosity, the scene descriptions intentionally contain inconsistencies or uncertainties, along with questions that can be answered to satisfy curiosity and encourage deeper exploration rather than just relying on what is immediately apparent in the scene. And This dataset can be used to train the question generation model to generate *inquisitive questions* when given *textual scene description*.

The whole workflow of building the dataset is shown in Fig. 2. ChatGPT [18] is utilized to generate descriptive sentences with some weird aspects that may seem strange but are still possible in real life yet may be confusing or unclear. After that, two researchers prudently inspected and selected proper scenarios to compile a list of scene descriptions. The curation process aimed to remove sentences that showed bias towards gender, occupation, or age and those that contained unrealistic descriptions.

The LangChain framework, a sophisticated tool designed to exploit Large Language Models (LLM), is employed for the next step. Throughout the framework, we collect chatGPT's inference about the strange or vague features present within the scenario (i.e., Reasoning) and potential questions that may arise within the scene (i.e., Question Generation). To ensure quality and relevance, we carefully assess all inferences and potential questions with human annotators. These judges assign a score for each, quantifying the validity of the inferences and the utility of the questions, and these scores are subsequently incorporated into the dataset. This process ensures a rigorous and comprehensive approach to building a rich, useful dataset.

IV. Conclusion

Asking good questions is essential for AI to be employed in the real world, significantly mitigating uncertainty through actively seeking out information. Therefore, learning by asking is a great tactic. Considering the inquisitive nature of humans, our study highlights the significance of reflecting on their inquiry strategy under uncertainty.

Hence we propose a design for a novel dataset providing partially incongruent or uncertain situations and drawing out open-ended questions pursuing ungiven information; This study can offer a practical guideline to improve the interactive agent's ability to come up with human-like and insightful questions. Furthermore, by utilizing an outstanding LLM (i.e., chatGPT) and establishing a method for evaluating its outputs, we can contribute to enhancing the efficiency of this highly effective tool.

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