# Explaining Question Answering Systems with Contexts

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**Abstract**

One central issue in the usability of answers is in their understandability. We have focused a line of research on explaining answers from heterogeneous distributed systems with the goal of improving usability and trustability in answers by increasing answer understandability and trustability. We explore ways of providing an interoperable distributed infrastructure that supports explanations containing provenance concerning answers – where information came from, how reliable it is -- along with information about assumptions relied on, information manipulation techniques, etc. The infrastructure utilizes the Proof Markup Language, encoded in the OWL Web Ontology Language so as to be compatible with web standards and also so as to be able to leverage existing web ontologies. In this paper, we expose and explore some issues related to context as it is used in some of our question answering systems.

## Introduction

As question answering systems utilize more varied data sources and reasoning methods, it is becoming increasingly important to provide not only answers, but also information about the answers so users (humans and agents), can evaluate and understand the answers. The information may provide details concerning the raw data sources, how recent they are, who authored them, whether they are considered authoritative, etc. The explanations may further contain information about any manipulations that were done to the raw sources – were text extraction techniques used to generate knowledge bases? How accurate are those extraction routines? What reasoning methods and reasoners were used to deduce conclusions? Were the methods heuristic, sound and complete, etc.? Further, were assumptions relied on in the reasoning process? If so, which ones? When this kind of information is available in a machine operational format, for example by being encoded in the Proof Markup Language, then this information can be made available to agents and end users. When explanations contain this kind of meta information about the answer and the answer process, users become empowered to make informed decisions about when to use the answer. The user can access information that can allow them to check how reliable the sources were, how accurate the information manipulation techniques might have been, if assumptions were used that either they agree with or can tolerate, etc. Our approach enables this information to be packaged together in a structured object, sometimes called a "proof object" or "justification object" that can accompany any statement.



## Explanation in Context

We propose the use of a portable, distributed infrastructure – Inference Web [McGuinness and Pinheiro da Silva, 2004]— that provides:

- support for registering meta information about objects used in justifications;
- a web compatible, interoperable proof markup language for encoding formal and information justifications [Pinheiro da Silva, McGuinness, & Fikes, 2005];
- services for manipulating proof objects to provide capabilities for browsing, abstracting, checking, and interacting with justifications.

We have used Inference Web to explain answers from applications that use standard first order logic reasoning systems such as Stanford's JTP system, used in applications for example in the KSL Wine Agent Demo [Hsu & McGuinness, 2003] and in DARPA programs such as the Personalized Assistant that Learns program's Cognitive Assistant that Organizes project. It has also been used in a number of other settings that include question answerers that may rely on knowledge bases that use text extraction, such as those from IBM's UIMA effort [Ferrucci & Lally, 2004]. Inference Web has been integrated with UIMA to support the ARDA Novel Intelligence for Massive Data program in a system called KANI so that it can explain answers derived using reasoning over knowledge bases partially generated by text extraction [Welty et. al., 2005].

The KANI system does more than typical theorem proving- it also addresses issues related to typicality and temporal reasoning. It makes decisions using typicality assumptions, such as "People who own businesses typically have offices at the businesses" or "People who have access to a particular telephone line at a particular time may make a call on that line". It needs to then provide explanations of its answers that include information such as which typicality assumptions were used in the reasoning path. Further, if there is any information about the trust a user may have in the assumptions (or the raw sources or the question answerers, etc., this should also be exposed).

Our explanation infrastructure provides an extensible format that has been adequate for encoding assumptions required for the contextual reasoning required to date. It has also been adequate for encoding the information manipulation steps required to date. It can be viewed as a prototype implementation of a design that supports explanations of hybrid question answering systems that require some support for context. The implementation today in the KANI system does not integrate the trust component [Zaihrayeu et. al., 2005] however a future implementation will include this so that trust levels can be included with explanations. Our interest in this workshop is to gather input both on the existing explanation support for our initial forms of limited context reasoning and to gather additional requirements for explanation support for future, more expansive applications.

## Conclusion

Our thesis is that question answering systems may have limited value if they can only answer questions but can not provide explanations along with the answers. We have provided an explanation infrastructure that supports explanations in distributed heterogeneous question answering environments, such as the web, where data sources may have a wide diversity of quality, recency, and reliability. Further, it supports explanations of question answering environments that must take context into account and provide forms on reasoning with context. Our Inference Web framework is being used to support question answering systems in a number of research programs funded by DARPA and ARDA and has been integrated with question answering systems that range from theorem provers, to text analysis engines, to expert systems, to special purpose temporal and context reasoners.

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