

Sporcle Goes AI

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Abstract

Intelligent question answering systems provide specific answers to users' questions. This paper describes a unique AI system that uses online knowledge bases and reasoning tools to answers questions posed by the Sporcle quiz site.

Introduction

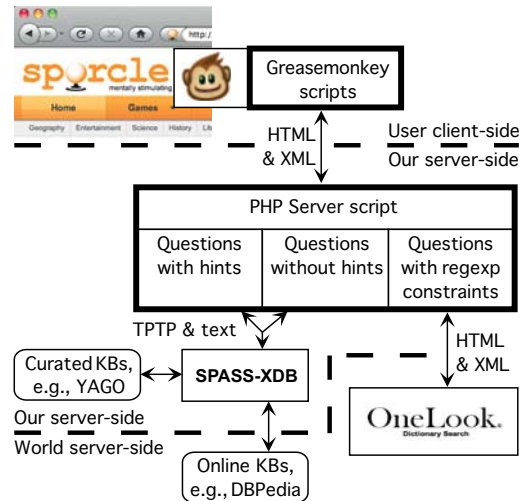
Recently there have been significant advances in question answering systems that take advantage of the huge amount of world knowledge that is now available online (Gunning, Chaudhri, and Welty 2010). Such systems aim to provide more than internet search engines, which find documents that are relevant to search keywords. Rather, these systems aim to provide specific answers to users' questions. Further research and the development of such systems provides the world with more effective knowledge retrieval tools.

Sporcle¹ is an online source of "mentally stimulating diversions" – quizzes that test users' general knowledge in a wide range of domains. The popularity of Sporcle indicates that the questions it poses are of the nature and level that (human) users like to answer. Examples include naming the capitals of specified US states, naming capital cities that might get flooded due to their proximity to water, and providing words that match given hints and end in 'ACE'.

This paper describes a unique AI system, **SporcleAI**, that hooks into Sporcle's web interface to automatically answer quiz questions. **SporcleAI** provides basic natural language understanding of Sporcle questions, uses knowledge from online knowledge bases and ontologies, and answers questions using techniques ranging from simple string processing through to full first-order reasoning.

Architecture

The figure shows the system architecture, including the Sporcle browser interface, the **SporcleAI** scripts (heavily outlined), and the two backend knowledge providers SPASS-XDB (Sutcliffe and others 2010) and OneLook². Two examples are used here to illustrate the processing



in **SporcleAI**. They are presented as English questions in Sporcle, each with a time limit for providing the answers: (1) "Can you name world capitals that can be flooded?" (10 minutes) and (2) "Can you name the following words that end in 'ACE'?" (4 minutes). Some questions provide a hint for each answer, e.g., for (2), hints such as "an enclosed structure in which heat is produced" are provided.

Greasemonkey (GM) is a Firefox extension that uses snippets of JavaScript to refashion users' interactions with specified web pages. **SporcleAI**'s GM script scrapes the question and hints from a Sporcle quiz page, and sends them to the PHP server script. In (1) there are no hints so just the question is sent, and in (2) the question and the hint for each word are sent. The PHP script analyses the question and hints (details below), obtains answers from a backend knowledge provider, and returns batches of answers to the GM script. The GM script enters the answers into the Sporcle page while the user watches. The GM script can optionally mimic the behavior of a human player by introducing typographical errors and a staggered typing style.

SporcleAI's PHP script runs as a web service. When the script receives a question and (possible) hint, it performs some basic natural language processing to transform them into formats usable by the backend knowledge providers. In (1), the statement of the question is scanned for keywords that trigger the use of hand-selected first-order SUMO ax-

ioms (Niles and Pease 2001) and a first-order logic formulation of the question, which are sent to SPASS-XDB (details below) to obtain answers. In (2), the question is converted into Attempto Controlled English (ACE) (Fuchs, Kaljurand, and Kuhn 2008) – “Which words end in ‘ACE’?” – and sent to an ACE parser at the University of Zurich. A Discourse Representation Structure (DRS) is returned, which is scanned for terms such as “begins with”, “ends with” and “contains”. If found, the DRS is used to create a regular expression that can be used by OneLook, e.g., “*ACE:”. The hint and the regular expression are sent to OneLook (details below) to obtain answers. If not found, or OneLook is unable provide answers, the question and hint are analyzed as for (1), to obtain answers from SPASS-XDB.

SPASS-XDB is a first-order logic automated theorem proving system that can retrieve world knowledge from a range of external sources (databases, internet, computations, etc.) asynchronously, on demand, during it’s deduction process. SPASS-XDB accepts a problem containing specifications for the external sources, internal axioms, and a conjecture to be proved. Axioms from the SUMO ontology are examples of internal axioms that are used to provide deep reasoning over the world knowledge.

OneLook is a reverse dictionary service that matches a term or definition against several online dictionaries and encyclopedias, and returns words in decreasing order of fit. OneLook can also accept a regular expression as a constraint on the words that are returned.

Illustrative Results

SporcleAI can answer quiz questions from a variety of Sporcle categories, ranging from wordplay to geography to movies. The level of success depends on a number of factors, some of which are analyzed in this section. A summary of the performance on selected quizzes is provided.³

Knowledge Domain Breadth: SporcleAI’s ability to answer any question depends on the existence of a relevant data source available to the backend providers. For example, geographical data is abundant, so naming the capitals of all 50 US States is highly tractable. Quizzes in other fields, e.g., popular culture, are much less reliably answered. For example, the quiz about words ending in the letters ‘RO’ gets an answer for the hint “A large hat often worn by Speedy Gonzales” (Sombrero), but not for “DC comic book supervillain who is a doppelgänger of Superman” (Bizarro).

Time Limits: There are quizzes for which the backend providers have access to the necessary knowledge, but the answers cannot all be extracted within the quiz time limit. For example, the quiz that asks for actor(resses) who have appeared in three named movies (e.g., Helena Bonham Carter appeared in *Fight Club*, *Big Fish*, and *Corpse Bride*), can be answered by SPASS-XDB, which has access to the LinkedMDB (Movie Database). However, only six of the 30

questions are answered in the six minute time limit. Similarly, for (1) above, only 28 of the 36 expected answers are provided in the allotted time.

Natural Language Processing: While the phrasing of some Sporcle questions is amenable to direct translation into ACE or first-order logic (e.g., “name the capitals of the US States”), most questions are beyond the scope of SporcleAI’s basic natural language processing. For example, the logical statement of (1) above requires 16 axioms and a conjecture, which have had to be hand-written for SporcleAI.

Performance: SporcleAI’s performance on eight Sporcle quizzes is summarized in this table, showing the fractions of answers found and fractions of the time limits taken:

Quiz topic	Solutions	Time
US state capitals	50/50	7:33/10:00
Canadian territory capitals	11/13	1:56/3:00
Countries of the world	149/195	7:45/15:00
Floodable world capitals	36/36	3:34/10:00
Words that start and end with ‘D’	14/16	0:14/4:00
Words ending with ‘ACE’	15/16	0:21/4:00
Greek gods and goddesses	11/12	0:15/5:00
Actor by movie	6/30	6:00/6:00

Conclusion

This paper has described the SporcleAI system, that uses online knowledge bases and reasoning tools to answer quiz questions posed by Sporcle. This work’s contribution is to show how diverse AI techniques and sources of world knowledge can be effectively combined and applied, to provide specific answers to different types of user questions. SporcleAI might be viewed as an example of an intelligent semantic web “mashup”, going beyond most semantic web services by including deep reasoning based on first-order logic.

The main weakness of the current implementation is the limited natural language processing capability. It would be desirable to augment SporcleAI with greater natural language processing capability, e.g., through greater use of the ACE parser.

References

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³Try SporcleAI at sporcleai.cs.miami.edu.