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Identifying Implicit Relationships

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Outline

- Introduction
- Spreading Activation for Concept Expansion
- Knowledge Resources Used
- Application to Common Bond Questions
- Application to Missing Link Questions
- Experimental Results
- Conclusion

Introduction

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- What Teddy Roosevelt and Barack Obama have in common?
- How old was the youngest U.S. president when he took office?

Introduction Contd…

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- IBM Watson uses recursive spreading-activation algorithm, which identifies related concepts based on a collection of heterogeneous underlying data resources

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- This process allows us to identify concepts closely related to a given concept and to score the relatedness between two concepts

Spreading Activation for Concept Expansion

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- The spreading-activation interface allows for the specification of fan size f and depth d, which causes the process to identify the f most related concepts to the current active concept and to recursively invoke the activation process on these f new concepts another d-1 times

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- The spreading-activation interface allows for the specification of fan size f and depth d, which causes the process to identify the f most related concepts to the current active concept and to recursively invoke the activation process on these f new concepts another d-1 times
- Watson uses three different underlying resources to measure relatedness: an n-gram corpus, the PRISMATIC knowledge base, and Wikipedia

Using an N-gram Corpus

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- JFK is semantically strongly related to ‘airport’ and ‘assassination’, and these relationships are represented in the n-gram corpus by the high collocation frequency between the terms ‘JFK’ and ‘airport’

Using an N-gram Corpus

- Watson uses a 5-gram corpus with frequency counts from Watson's primary unstructured sources
- The n-gram based spreading activation implementation uses Lucene
- Given term t the f most frequent 5-grams that include t are retrieved from the corpus
- Given two terms, the NGD semantic similarity metric was used to compute the semantic distance between two given terms based on the underlying n-gram corpus

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- Provides quick access to statistics over tuples
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- In cases where they differ, we attempt to capture semantic relatedness using the target document titles for two reasons
  - Anchor texts frequently co-occur with the source document title
  - the target document title represents the canonical form

Using Wikipedia Links

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- Given term t, we identify the Wikipedia document whose title best matches t and return all target document titles from links in that document

Application to Common-Bond Questions

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- Common-Bond questions generally refer to questions that seek the hidden relationship among multiple entities

Application to Common-Bond Questions

(1) COMMON BONDS: Bobby, bowling, rolling. (Answer: “pins”)

(2) COMMON BONDS: Your legs, your T’s, the Rubicon. (Answer: “things you cross”)

(3) CULINARY COMMON BONDS: Grinder, hero, submarine. (Answer: “sandwiches”)

(4) COMMON BONDS: Shirts, TV remote controls, telephones (Answer: “things with buttons”)

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- This observation of semantic relatedness enables us to adopt the spreading-activation mechanism previously outlined as a principal method for answering common-bond questions

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  - Identify concepts that are closely related to each given entity
  - Score each concept on the basis of their degrees of relatedness to all given entities

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Common-Bond Candidate Generation

- Analysis of common-bond questions in Jeopardy! indicates that the answer is typically directly related to the given entities
- So depth d=1 and f is empirically evaluated to be 50
- The spreading-activation process is invoked on each entity given in the question
- For most questions, the common bond can be found in lexical proximity to the given entities so only n-gram corpus was used for common bond questions

Common-Bond Answer Scorer

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- The scores representing the candidate's semantic relatedness to the given entities are multiplied together to represent the overall goodness of the candidate as a common-bond answer

Application to Missing-Link Questions

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- Questions in which a missing entity is either explicitly or implicitly referred to and the identification of this missing entity facilitates answering the question

Application to Missing-Link Questions

(5) THE 17th CENTURY: The 1648 Peace of Westphalia ended a war that began on May 23 of this year. (Answer: “1618”)

(6) EXPLORERS: On hearing of the discovery of George Mallory’s body, this explorer told reporters he still thinks he was first. (Answer: “Edmund Hillary”)

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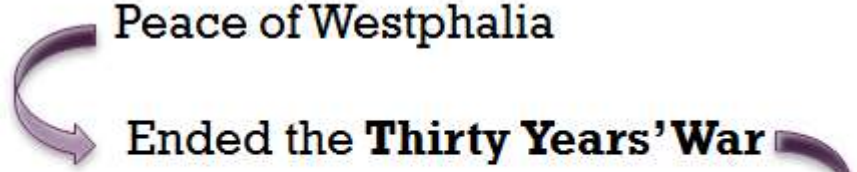

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- Our approach to answering these missing-link questions is to
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  - Invoke the system again by including these missing links in the search process, with the hope that the new search results will include some correct answers that we previously failed to generate as candidate answers

Missing-Link Identification

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- The existing WATSON's components are used to find highly associated answers
- Then the missing links are the ones which are of the wrong type
- 'thirty year war', highly associated with the question but its type is not year

Candidate Generation using Missing Links

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- If one or more missing links exist for the question, we invoke part of the question-answering process again, taking the missing link(s) into consideration

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- If one or more missing links exist for the question, we invoke part of the question-answering process again, taking the missing link(s) into consideration
- The scoring of the candidate answers is done based on its relatedness to the missing link

Experimental Evaluation

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- Common Bond Questions

	Binary recall	*Accuracy*	*Precision@70*
Baseline	69%	48%	62%
+Common bond	73%	58%	73%
Percentage change	4%	10%	11%

Experimental Evaluation

Experimental Evaluation

- Missing Link Questions

	All questions (1,112)		*Missing-link subset (259)*	
	Binary recall	*Accuracy*	*Binary recall*	*Accuracy*
Baseline	74.82%	51.08%	74.1%	45.6%
+Missing link	75.63%	51.53%	76.5%	47.1%
Percentage change	0.81%	0.45%	2.4%	1.5%

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- We have described a spreading-activation approach for concept expansion and for measuring semantic relatedness
- We have shown how this technique can be adopted in an end-to-end question-answering system to more effectively address two types of Jeopardy! questions, i.e., common-bond and missing link questions