Question Answering

- Overview and task definition
- History
- Open-domain question answering
- Basic system architecture
  - Watson’s architecture
- Techniques
  - Predictive indexing methods
  - Pattern-matching methods
  - Advanced techniques

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Watson’s architecture

From AI Magazine

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Question Analysis

- Identify question type
- Determine if decomposition is needed
- Determine the “lexical answer type”
- Determine “focus” of question
  - “When hit by electrons, a phosphor gives off electromagnetic energy in this form”
  - “Secretary Chase just submitted this to me for the third time; guess what, pal. This time I'm accepting it.”
- Relation detection
  - “They're the two states you could be reentering if you're crossing Florida’s northern border”
    - borders(Florida,?x,north)
Decomposition

Category: Diplomatic Relations
Clue: Of the four countries in the world that the United States does not have diplomatic relations with, the one that’s farthest north.

Inner subclue: The four countries in the world that the United States does not have diplomatic relations with (Bhutan, Cuba, Iran, North Korea).

Outer subclue: Of Bhutan, Cuba, Iran, and North Korea, the one that’s farthest north. Answer: North Korea

Decomposition

Category: “Rap” Sheet
Clue: This archaic term for a mischievous or annoying child can also mean a rogue or scamp.

Subclue 1: This archaic term for a mischievous or annoying child.

Subclue 2: This term can also mean a rogue or scamp. Answer: Rapscallion

Content acquisition

- Depends on answer types
  - LATs
- Wide range of
  - encyclopedias
  - Dictionaries
  - Thesauri
  - Newswire articles
  - Literary works
  - Taxonomies, ontologies, WordNet
- Automatic corpus expansion
Watson’s architecture

- Primary search
  - Top 250 candidates
- Candidate answer generation
  - Extracts the answer from the text/passage/db entry
- Soft filtering
  - A bit mysterious…whittle down to top 100
- Hypothesis and evidence scoring
  - “rigorous evaluation process”
- Final merging and ranking
  - Uses many scoring models
  - Many are question-type-specific

The Rest

- The Research Team
- The Algorithms Team
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Indexing with predictive annotation

- Some answers belong to well-defined semantic classes
  - People, places, monetary amounts, telephone numbers, addresses, organizations
- Predictive annotation: index a document with “concepts” or “features” that are expected to be useful in (many) queries
  - E.g. people names, location names, addresses, etc.

Predictive annotation

In the early part of this century, the only means of transportation for travelers and mail between \(<\text{LOCATION}>\) Europe \(</\text{LOCATION}>\) and \(<\text{LOCATION}>\) North America \(</\text{LOCATION}>\) was by passenger steamship. By \(<\text{DATE}>1907</\text{DATE}>\), the \(<\text{COMPANY}>\) Cunard Steamship Company \(</\text{COMPANY}>\) introduced the largest and fastest steamers in the \(<\text{LOCATION}>\) North Atlantic \(</\text{LOCATION}>\) service: the \(<\text{NAME}>\) Lusitania \(</\text{NAME}>\) and the \(<\text{NAME}>\) Mauritania \(</\text{NAME}>\). Each had a gross tonnage of \(<\text{WEIGHT}>31,000</\text{WEIGHT}>\) tons \(</\text{WEIGHT}>\) and a maximum speed of \(<\text{SPEED}>26</\text{SPEED}>\) knots \(</\text{SPEED}>\).


Advantages and disadvantages

+ Most of the computational cost occurs during indexing
  - Allows use of more sophisticated methods
+ Annotator has access to complete text of document
  - Important for recognizing some types of features
  - Must know ahead of time which types of concepts are likely to be important
  - Increases size of index considerably
    - E.g. by an order of magnitude if many features

Used (in varying amounts) by almost all open-domain Q/A systems.
Simple pattern-based QA

- Observation: there are many questions... but fewer types of questions
- Each type of question can be associated with
  - Expectations about answer string characteristics
  - Strategies for retrieving documents that might have answers
  - Rules for identifying answer strings in documents

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Example

- Who is the President of Cornell?
  - Expectation: answer string contains a person name
    - Named entity identification
    - Search query: “president Cornell *PersonName”
  - Rule: “*PersonName, President of Cornell”
    - Matches “…David Skorton, President of Cornell”
    - Answer = “David Skorton”

Question analysis

- Input: the question
- Output
  - Search query
  - Answer expectations
  - Extraction strategy
- Requires
  - Identifying named entities
  - Categorizing the question
  - Matching question parts to templates
- Method: pattern-matching
  - Analysis patterns initially created manually...
Question analysis example

• “Who is Elvis?”
  – Question type: “who”
  – Named-entity tagging: “Who is <person-name>Elvis</person-name>”
  – Analysis pattern: if question type = “who” and question contains <person-name> then
    • Search query doesn’t need to contain a *PersonName operator
    • Desired answer probably is a description
    • Likely answer extraction patterns
      – “Elvis, the X”
        » “…Elvis, the king of rock and roll…”
      – “the X Elvis”
        » “the legendary entertainer Elvis”

Simple pattern-based Q/A: assessment

• Extremely effective when
  – Question patterns are predictable
    • Fairly “few” patterns cover the most likely questions
      – Could be several hundred
    • Not much variation in vocabulary
      – Simple word matching works
    • The corpus is huge (e.g., Web)
      – Odds of finding an answer document that matches the vocabulary and answer extraction rule improves

• Somewhat labor intensive
  – Patterns are created and tested manually

Common problem: improving answer extraction patterns

• Word sequence patterns have limited power
• Solution: create patterns that use syntactic information
  – Partial syntactic parsing of documents
    • Is this noun the subject or the object of the sentence?
  – Allows more complex patterns
    • Question: “Who shot Kennedy?”
      “Who” implies a person that should be subject of answer sentence/clause
    • “Kennedy” should be direct object of answer
    • Pattern: <subject> shot Kennedy
    • Matching text: "Oswald shot Kennedy”

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Question analysis

- Parsing and named entity recognition
- Expected answer type determined by parsing

Exceptions for “special cases”

(Q-PL): What is the definition of <phrase to define>?  
(Q-PL2): What is the definition of <phrase to define>?  
(Q-PL3): Who is (what are) <person name(s)>?

Feedback loops

Answer verification

- Parse passages to create a dependency tree among words
- Attempt to unify logical forms of question and answer text