The Informative Role of WordNet in Open-Domain Question Answering

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Introduction

- Information Extraction: not just for keywords anymore!
  - Massive document collections (databases, webpages) require more sophisticated search techniques than keyword matching
  - Need way to focus and narrow search → improve precision
- One solution: Open-Domain Q/A
  - Find answers to natural language questions from large document collections
  - Examples:
    - *"What city is the capital of the United Kingdom?"*
    - *"Who is the first private citizen to fly in space?"*
  - Text Retrieval Conferences (TREC) evaluate entered systems; show that this sort of task can be performed with "satisfactory accuracy" (Voorhees, 2000)

Q/A: Previous Approach

- Captures the *semantics* of the question by recognizing
  - expected answer type (i.e., its semantic category)
  - relationship between the answer type and the question concepts/keywords
- The Q/A process:
  - Question processing – Extract concepts/keywords from question
  - Passage retrieval – Identify passages of text relevant to query
  - Answer extraction – Extract answer words from passage
- Relies on standard IR and IE Techniques
  - Proximity-based features
    - Answer often occurs in text near to question keywords
  - Named-entity Recognizers
    - Categorize proper names into semantic types (persons, locations, organizations, etc)
    - Map semantic types to question types (“How long”, “Who”, “What company”)

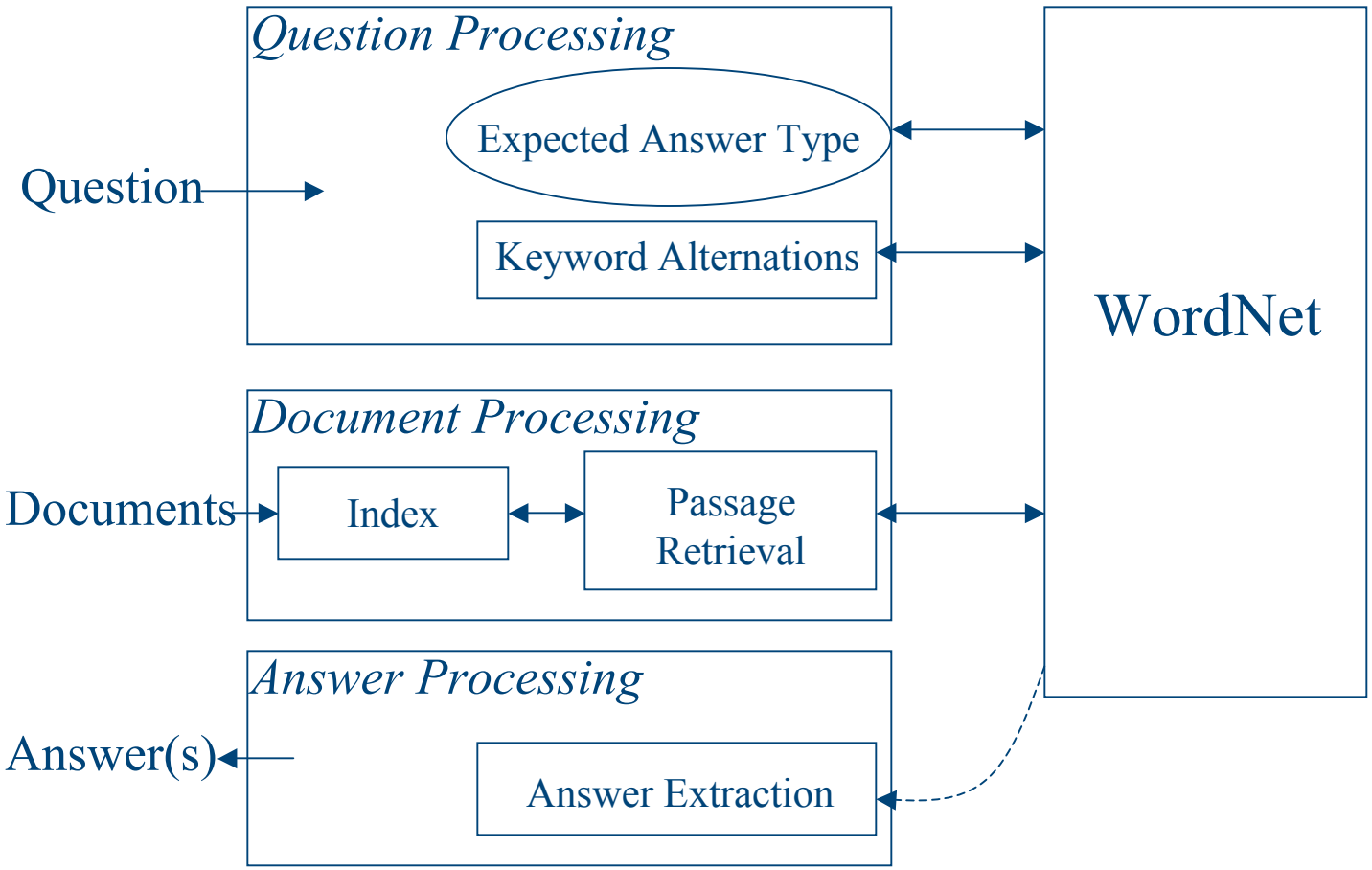
Problems

- NE assumes all answers are named entities
  - Oversimplifies the generative power of language!
  - What about: *"What kind of flowers did Van Gogh paint?"*
- Does not account well for morphological, lexical, and semantic alternations
  - Question terms may not exactly match answer terms; connections between alternations of Q and A terms often not documented in flat dictionary
  - Example: "*When was Berlin's Brandenburger Tor erected?*" → no guarantee to match *built*
  - Recall suffers

WordNet to the rescue!

- WordNet can be used to inform all three steps of the Q/A process
  1. Answer-type recognition (*Answer Type Taxonomy*)
  2. Passage Retrieval ("specificity" constraints)
  3. Answer extraction (recognition of keyword alternations)
- Using WN's lexico-semantic info: Examples
  - *"What kind of flowers did Van Gogh paint?"*
    - Answer-type recognition: need to know (a) answer is a kind of flower, and (b) sense of the word flower
    - WordNet encodes 470 hyponyms of flower sense #1, flowers as plants
    - Nouns from retrieved passages can be searched against these hyponyms
  - *"When was Berlin's Brandenburger Tor erected?"*
    - Semantic alternation: *erect* is a hyponym of sense #1 of *build*

Interactions between WN and Q/A



WN in Answer-type Recognition

- *Answer Type Taxonomy*
  - a taxonomy of answer types that incorporates WN information
  - Acts as an "ontological resource" that can be searched to identify a semantic category (representing answer type)
  - Used to associate found semantic categories with a named entity extractor
  - So, still using an NE, but not bound to proper nouns; have found a way to map NEs to more general semantic categories
- Developed on principles conceived for Q/A environment (rather than as general onto principles)

  Principle 1: Different parts of speech specialize the same answer type

  Principle 2: Selected word senses are considered

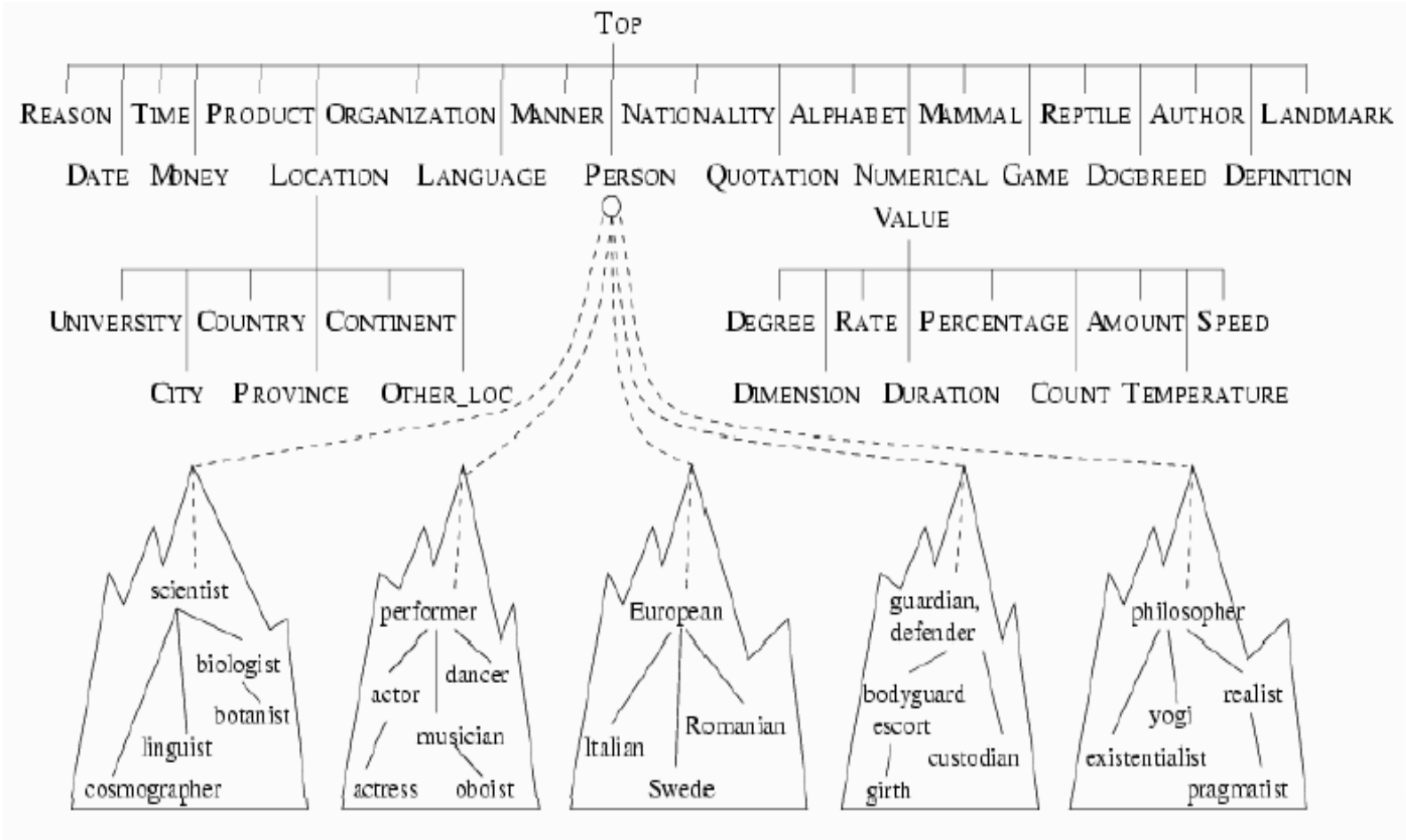
  Principle 3: Completeness of the top hierarchy

  Principle 4: Conceptual average of answer types

  Principle 5: Correlating the Answer Type Taxonomy with NEs

  Principle 6: Mining WordNet for additional knowledge

Answer Type Taxonomy (example)



WN in Passage Retrieval

- Identify relevant passages from text
  - Extract keywords from the question, and
  - Pass them to the retrieval module
- "Specificity" – filtering question concepts/keywords
  - Focuses search, improves performance and precision
  - Question keywords can be omitted from the search if they are too general
  - Specificity calculated by counting the hyponyms of a given keyword in WordNet
    - Count ignores proper names and same-headed concepts
    - Keyword is thrown out if count is above a given threshold (currently 10)

WN in Answer Extraction

- If keywords alone cannot find an acceptable answer, look for alternations in WordNet!

Q196: Who wrote “Hamlet”?
Morphological Alternation: wrote → written
Answer: before the young playwright has written Hamlet – and *Shakespeare* seizes the opportunity

Q136: Who is the queen of Holland?
Lexical Alternation: Holland → Netherlands
Answer: Pricess Margrit, sister of Queen *Beatrix* of the Netherlands, was also present

Q196: What is the highest mountain in the world?
Semantic Alternation: mountain → peak
Answer: first African country to send an expedition to *Mount Everest*, the world’s highest peak

Evaluation

- Pa_ca/Harabagiu approach measured against TREC-8 and TREC-9 test collections
- WN contributions to Answer Type Recognition
  - Count number of questions for which acceptable answers were found; 3GB text collection, 893 questions

Method	# questions with correct answer type	
	All	*What* only
Flat dictionary (baseline)	227 (32%)	48 (13%)
A-type taxonomy (static)	445 (64%)	179 (50%)
A-type taxonomy (dynamic)	463 (67%)	196 (56%)
A-type taxonomy (dynamic + answer patterns)	533 (76%)	232 (65%)

Evaluation (2)

- WN contributions to Passage Retrieval

Impact of keyword alternations

No alternations enabled	55.3% precision
Lexical alternations enabled	67.6%
Lexical + semantic alternations enabled	73.7%
Morphological expansions enabled	76.5%

Impact of specificity knowledge

Specificity knowledge	# questions with correct answer in first 5 documents returned	
	TREC-8	TREC-9
Not included	133 (65%)	463 (67%)
Included	151 (76%)	515 (74%)

Conclusions

- Massive lexico-semantic information must be incorporated into the Q/A process
  - Using such information encoded in WN improved system precision by 147% (qualitative analysis)
- Visions for future:
  - Extend WN so that online resources like encyclopedias can link to WN concepts
    - Answer questions like: *"Which classic rock group first performed live in Alburquerque?"*
  - Further improve Q/A precision with WN extension projects
    - Eg, "finding keyword morphological alternations could benefit from derivational morphology, a project extension of WordNet" (Harabagiu et al., 1999)