

Question-Answering for Biomedicine

Methods and State of the Art

Pierre Zweigenbaum

MIE 2005 Workshop

“Terminologies and Ontologies in Biomedicine: can text mining help?”

Question Answering

The future of Information Retrieval

Information Retrieval

- Given a search topic (a *query*) and a collection of documents, find *documents* relevant to topic

Question Answering

- Given a *question* (in Natural Language) and a collection of documents, find *answer(s)* to question
- “*What is the height of the Eiffel Tower?*”
- 315 m

QA = IR + NLP (IE)

Question answering in the biomedical domain

1 Question Answering Methods

- Architecture
- Components

2 Specificities of Biomedical Question Answering

- Biomedical QA for whom?
- Document sources
- Types of questions
- Knowledge sources

3 Current Work

- The EQueR Evaluation Forum
- Recent workshops and conferences

Outline

1 Question Answering Methods

- Architecture
- Components

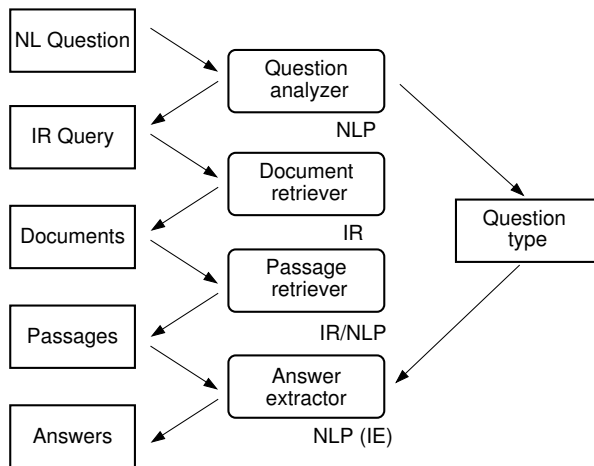
2 Specificities of Biomedical Question Answering

- Biomedical QA for whom?
- Document sources
- Types of questions
- Knowledge sources

3 Current Work

- The EQueR Evaluation Forum
- Recent workshops and conferences

Generic Architecture of a QA System



after (Lin & Katz, 2003)

Question Analyzer

- Determine question type and focus
 - ▶ to help spot answers in final passages (*expected answer type*)
 - ▶ *age of person; who is person; where is location. . .*
- Select “keywords” to build IR query
 - ▶ to retrieve potentially relevant documents
- Methods
 - ▶ recognize predefined question patterns
 - ★ associate them with expected answer types
 - ▶ recognize “named entities”
 - ▶ possibly involves some level of parsing

Document Retriever

- Standard Information Retrieval system
- Useful if document collection is huge (processing time too long)
- or is more easily accessed through existing search engines (e.g., the Web)

Passage Retriever

- Segment retrieved documents into passages (paragraphs, sentences)
- Score these passages *wrt* question (common words, named entities, expected answer type. . .)
- In some systems, IR system directly works on passages instead of documents

Answer Extractor

- Select short answer text in selected passage
- Find phrase with expected answer type
- May involve deeper parsing, reasoning. . .

Outline

1 Question Answering Methods

- Architecture
- Components

2 Specificities of Biomedical Question Answering

- Biomedical QA for whom?
- Document sources
- Types of questions
- Knowledge sources

3 Current Work

- The EQueR Evaluation Forum
- Recent workshops and conferences

Biomedical QA For Whom?

(Zweigenbaum, 2003)

- Medical (clinical) questions
 - ▶ Patients (the general public)
 - ▶ Medical students
 - ▶ Health care professionals
 - ★ General practitioners
 - ★ Specialists
- Biomedical (genomics) questions
 - ▶ Researchers

Document sources

- Closed collections

- ▶ Drug compendium
- ▶ Encyclopedia
- ▶ Medline abstracts

- The Web

- ▶ Issue of reliability
- ▶ Documents to answer clinical questions
 - ★ General public: validated, endorsed data
 - ★ Health care professionals: + level of evidence
- ▶ Selected Web collections: quality controlled health gateways
 - ★ CISMef, HON. . .

Types of questions

- Questions by family doctors
(Ely *et al.*, 1999; Ely *et al.*, 2000)
- Questions by medical students
(Jacquemart & Zweigenbaum, 2003)
- Clinical questions and Evidence-based medicine
(Ely *et al.*, 2002; Yu *et al.*, 2005)
- Definitional questions
(Malaisé *et al.*, 2005)

Evidence Taxonomy

used to classify 200 family doctors' questions (Ely et al., 2002)

Clinical (n=193)

- General (n=141)

- ▶ Evidence (n = 106)

- ★ Intervention (n = 71)

- What is the drug of choice for epididymitis?*

- ★ No intervention (n = 35)

- How common is depression after infectious mononucleosis?*

- ▶ No evidence (n = 35)

- What is the name of that rash that diabetics get on their legs?*

- Specific (n=52)

- What is causing her anaemia?*

Nonclinical (n=7)

How do you stop somebody with five problems, when their appointment is only long enough for one?

Knowledge Sources: Vocabulary

Ability to recognize and correctly process domain words and terms

Domain entities (diagnoses, body parts, gene names, etc.) are an extension of the traditional “named entities”.

- Lexicon
 - ▶ UMLS Specialist Lexicon
 - ▶ European Network of Excellence “Semantic mining in biomedicine” WP20 “Multilingual medical dictionary” [Baud et al., AMIA 2005]
- Terms
 - ▶ UMLS Metathesaurus etc.; see [Bodenreider 2005]
 - ▶ Where relevant and available, national terminologies

Knowledge Sources: Semantics, Knowledge Bases

Ability to reason over generic/specific entities, semantic types

For instance, for clinical questions, in UMLS Metathesaurus:

- Is-a relation: terminologies, classifications. . . (see above)
- Part-of relation: some terminologies
 - ▶ FMA, SNOMED, MeSH. . .
- Location of: SNOMED
- May treat

Outline

1 Question Answering Methods

- Architecture
- Components

2 Specificities of Biomedical Question Answering

- Biomedical QA for whom?
- Document sources
- Types of questions
- Knowledge sources

3 Current Work

- The EQueR Evaluation Forum
- Recent workshops and conferences

The EQueR Evaluation Forum

- Project EVALDA (Technolangue call for projects), 2003-2005 (Ayache, 2005)
- EQueR Question-Answering evaluation: French, 2 tracks
- System runs July 2004, evaluation Aug-Sep 2004, final workshop Nov 2004
- General track
 - ▶ newspaper articles, French Senate reports (1.5 Gb),
 - ▶ 500 questions
- *First QA evaluation forum to provide a medical track (../..)*

EQueR Medical Track

- Documents: selected pages from medical Web sites indexed by CISMeF (140 Mb)
 - ▶ guidelines, information to patients, official reports. . .
- 200 questions
 - ▶ 81 factual, 25 list, 70 definition, 24 boolean
- Best results: Synapse Développement's QRISTAL system
 - ▶ AP-HP/LIPN's system 2nd/3rd for short answers/passages
- Questions more difficult than general track
 - ▶ best MRR 0.49 vs 0.7

EQueR Medical Track: Example Questions

- MF1: Pour quelles raisons une consultation diététique est-elle préconisée ?
For which motives is a dietetics consultation advised?
- MD91: Qu'est-ce que la thérapie génique ?
What is genic therapy?
- MB111: Les antiseptiques sont-ils capables d'inhiber la croissance des micro-organismes ?
Can antiseptics inhibit the growth of micro-organisms?
- ML131: Quels sont les 4 stades du cancer de l'ovaire ?
What are the 4 stages of ovary cancer?

ACL 2004, AAI 2005 Workshops

“QA in specific domains”

- ACL 2004 Workshop
 - ▶ Genomics: (Rinaldi *et al.*, 2004)
 - ▶ Clinical: (Niu & Hirst, 2004)
- AAI 2005 Workshop
 - ▶ Clinical: (Demner-Fushman & Lin, 2005)
 - ▶ Clinical: (Yu *et al.*, 2005)

MIE 2005, AMIA 2005

- MIE 2005
 - ▶ (EQueR) (Delbecque *et al.*, 2005)
- AMIA 2005
 - ▶ ...

Conclusion

- Question Answering is an emerging field in Biomedicine, with a potentially high impact
- Work has begun in several research groups which span Computational Linguistics and Biomedical Informatics
- While results can be obtained with current technology for some types of questions, technical research is still needed in several areas
- The precise shape of applications and usage remains to be designed

References I



AAAI2005 QA Workshop (2005).

Proceedings AAAI 2005 Workshop on Question Answering in Restricted Domains. AAAI.



ACL2004 QA Workshop (2004).

Proceedings ACL 2004 Workshop on Question Answering in Restricted Domains. ACL.



AYACHE C. (2005).

Campagne EVALDA/EQueR – Évaluation en Question-Réponse, rapport final. Rapport interne, ELDA, Paris.

Available at

http://www.technolangua.net/IMG/pdf/rapport_EQUER_1.2.pdf.



DELBECQUE T., JACQUEMART P. & ZWEIGENBAUM P. (2005).

Indexing UMLS semantic types for medical question-answering.
In Proceedings Medical Informatics Europe, Genève.



DEMNER-FUSHMAN D. & LIN J. (2005).

Knowledge extraction for clinical question answering: Preliminary results.
In (AAAI2005 QA Workshop, 2005).

References II



ELY J. W., OSHEROFF J. A., EBELL M. H. *et al.* (1999).
Analysis of questions asked by family doctors regarding patient care.
BMJ, **319**, 358–361.



ELY J. W., OSHEROFF J. A., EBELL M. H., CHAMBLISS M. L., VINSON D. C.,
STEVERMER J. J. & PIFER E. A. (2002).
Obstacles to answering doctors' questions about patient care with evidence:
qualitative study.
British Medical Journal, **324**, 1–7.



ELY J. W., OSHEROFF J. A., GORMAN P. N., EBELL M. H., CHAMBLISS M. L.,
PIFER E. A. & STAVRI P. Z. (2000).
A taxonomy of generic clinical questions: classification study.
BMJ, **321**, 429–432.
Available at <http://bmj.com/cgi/content/full/321/7258/429>.



JACQUEMART P. & ZWEIGENBAUM P. (2003).
Towards a medical question-answering system: a feasibility study.
In R. BAUD, M. FIESCHI, P. LE BEUX & P. RUCH, Eds., *Proceedings Medical
Informatics Europe*, volume 95 of *Studies in Health Technology and Informatics*,
p. 463–468, Amsterdam: IOS Press.

References III



LIN J. & KATZ B. (2003).

Question answering techniques for the World Wide Web.
In *Tutorial at EACL 2003*, Budapest: ACL.



MALAISÉ V., DELBECQUE T. & ZWEIGENBAUM P. (2005).

Recherche en corpus de réponses à des questions définitives.
In M. JARDINO, Ed., *Proceedings of TALN 2005 (Traitement automatique des langues naturelles)*, Dourdan: ATALA LIMSI.



NIU Y. & HIRST G. (2004).

Analysis of semantic classes in medical text for question answering.
In (ACL2004 QA Workshop, 2004).



RINALDI F., DOWDALL J., SCHNEIDER G. & PERSIDIS A. (2004).

Answering questions in the genomics domain.
In (ACL2004 QA Workshop, 2004).



YU H., SABLE C. & ZHU H. R. (2005).

Classifying medical questions based on an evidence taxonomy.
In (AAAI2005 QA Workshop, 2005).

References IV



ZWEIGENBAUM P. (2003).

Question answering in biomedicine.

In M. DE RIJKE & B. WEBBER, Eds., *Proceedings Workshop on Natural Language Processing for Question Answering, EACL 2003*, p. 1–4, Budapest: ACL.