Contextual phenomena and thematic relations in database QA dialogues: data from a Wizard-of-Oz experiment

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Introduction

- In QA interactions we can expect that the individual user questions will be thematically connected, giving the users the possibility of reusing part of the context when formulating new questions.

- That users make use of discourse phenomena has been replicated in several Wizard-of-Oz experiments (Carbonell, 1983), (Dahlbäck and Jönsson, 1989).

- Thematic relations between the individual questions and the preceding context have been previously studied, however not with genuine interactive data (Chai and Ron, 2004), (Kato et al., 2004).

Introduction

- In order to resolve discourse phenomena a model of discourse structure is needed.
    - What is the nature of discourse structure in QA interactions?
    - How are questions thematically related to the preceding discourse?
    - Does thematic structure play a role in determining discourse structure?

Outline

- Corpus: experimental set-up and annotation scheme.
- Thematic relations between questions and the preceding discourse.
- Distance and thematic relations between utterances containing contextual phenomena and those containing their antecedents.
- Conclusions.

Wizard-of-Oz experiment

- Tasks requiring some thematic overlap.
- 3 tasks and 10 subjects per task (+ 3 pilots).
  - Find 3 traineeships at 3 different projects at 3 different institutions dealing with different subjects.
  - Find 3 conferences in the winter-term and 3 in the summer-term taking place in different countries and dealing with different topics.
  - Obtain some information for a report about language technology in the last 10 years in Europe.
- Querying LT-WORLD in English.
- Interaction modality: typing.

Wizard-of-Oz experiment

- Wizard's actions:
  - answer questions,
  - ask for clarification,
  - make statements about the database contents when no answer was found or when the user was confused about the structure of the domain,
  - return requests to wait and information about the process.

Corpus

- 33 logs.
- 125.534 alphanumerical strings.
- 2.534 turns.
- 1.174 user turns.

Annotation scheme

- Annotation levels:
  - **turns** → speaker and time.
  - **pos**

  - questions
  - utterances
  - entities

automatically annotated

Questions

- User questions corresponding to database queries.
- *question-to-question-relation:*
  - refinement, theme-entity, theme-property, paraphrase, overlap.
- *question-to-answer-relation:*
  - refinement, theme.

Refinement

- **Refinement from question:** a question which asks for the same type of entity as some previous question, but where the restricting conditions are different, asking, thus, for a subset, superset, overlapping set or disjoint set of the same class.

- **Refinement from answer:** a question which asks for a subset of the entities given in the previous answer.

(14:16:22) **USER:** How many institutions concerning language technologies are there?
(14:16:52) **LT-WORLD:** 3810.
(14:17:36) **USER:** and how many in Europe?

(14:18:34) **LT-WORLD:** 1130.
(14:19:16) **USER:** How many of them came to exist during the last 10 years?
(14:20:13) **LT-WORLD:** The database does not contain information about founding dates.
(14:20:56) **USER:** How many financing institutions, companies are there?

Theme

- **Theme-entity from question:** a question is about the same entity as some previous question.

  (15:28:01) **USER:** What kind of topics will be discussed at AAAI Spring Symposium on Semantic Web meets eGovernement?
  (15:28:57) **LT-WORLD:** Semantic Web. Semantic Knowledge Mangament. Ontology. Mapping. Knowledge Retrieval.
  (15:29:24) **USER:** What is the dead-line for applicants?
  (15:30:06) **LT-WORLD:** 2005-10-21.

- **Theme-property from question:** a question asks for the same property as the previous question but for another entity.

- **Theme from answer:** a question asks about an entity first introduced in some previous answer.

  (16:59:14) **USER:** I need projects at the University of Athens in Signal Processing.
  (16:59:55) **LT-WORLD:** RainbowII. MEMPHIS. MKBEEM. CATCH-2004. PHYSTA. MANDES. VISION.
  (17:00:27) **USER:** Description of MANDES, please.
  (17:01:16) **LT-WORLD:** The database does not contain information about MANDES.
  (17:01:28) **USER:** What about VISION?

Discourse structure

- In QA interactions the discourse structure is given by the discourse goals, rather than the overall goals of the user, like in task-oriented dialogues (Ahrenberg et al., 1995).
- The QA discourse is structured in segments composed by a pair of initiative-response units, like question-answer, or question-assertion, in the absence of an answer.
- A segment can be embedded in another segment if it is composed by a clarification request and its corresponding answer.

Speech acts and subordination relations

- speech-act: question, answer, assertion, request.
- Discourse subordination relations are annotated between question-answer pairs, dependent questions and the question they are dependent on, and requests and assertions and the questions they are related to.

(14:42:56) **USER:** how many inventions linked with language technology were there over the last ten years?
(14:44:14) **LT-WORLD:** 749.
(14:44:29) **USER:** Can you give me examples?
(14:44:48) **LT-WORLD:** How many patents would you like to see?
(14:45:30) **USER:** the 10 most recent ones?
(14:46:46) **LT-WORLD:** Annotation of an image based on associated data. Speech synthesis apparatus and method. Machine translation apparatus and method. System of Finite State Machines. …

(14:46:51) **USER:** where were they announced?
(14:47:24) **LT-WORLD:** Please wait...
(14:49:00) **LT-WORLD:** Annotation of an image based on associated data, in United_Kingdom. Speech synthesis apparatus and method, in United_States. Machine translation apparatus and method, in United_States.

Fragments

- **An utterance incomplete at its outward form, but whose meaning can be recovered from the context:**

(18:27:03) USER: where is European Joint Conferences on Theory and Practice of Software?

(18:27:42) LT-WORLD: Vienna, Austria.

(18:27:49) USER: and AAAI Spring Symposium on Semantic Web meets eGovernment?

Reference

- 3 types of reference:
  - Identity (or co-reference):
    - if a linguistic expressions denotes the same entity as some previous linguistic expression.
  - Superset/subset:
    - if a linguistic expression denotes a subset or superset of the set of entities denoted by some previous linguistic expression.
  - Bridging:
    - A definite NP denoting an entity which hasn't been introduced in the discourse, but which stands in some kind of relation to an entity currently being spoken about.

Reference

Identity:

(11:38:33) **USER:** the Speech TEK West 2006, when does it take place?
(11:39:36) **LT-WORLD:** 2006-03-30 - 2006-04-01.
(11:40:28) **USER:** Until when can I hand in a paper [ ]
(11:40:51) **LT-WORLD:** 2006-01-21.

Superset / subset:

(12:55:22) USER: please give me a list of technologies, that are uses in europe
(12:55:42) LT-WORLD: Acoustic Modelling in Speech Recognition. Answer Extraction. Authoring Tools. …

(12:56:30) USER: which are the most important

Bridging:

(18:10:08) **USER:** tell me the dates of these conferences.
(18:10:55) **LT-WORLD:** 2006-03-27. 2006-01-20. 2005-12-20.
(18:12:22) **USER:** what are the homepages

Thematic follow-up

- 1047 queries to the database:
  - 948 (90.54%) follow-up on some previous question or answer, or both.
  - 99 questions (9.46%) open a new topic.
- 725 are related to some question.
- 333 are related to some answer.
- 109 are related to both some question and some answer.
- 74.58% of the connected questions immediately follow the question or answer they are related to.

Thematic follow-up

	REF. Q	THEME E. Q	THEME P. Q	PARA. Q	OVERL. Q	REF. A	THEME A
TOTAL	**74 (7.80%)**	**338 (35.65%)**	**107 (11.29%)**	**174 (18.35%)**	**29 (3.06%)**	**29 (3.06%)**	**303 (31.96%)**
DISTANCE 1 (segment)	88.73%	81.65%	100%	60.92%	78.57%	83.34%	46.39%
DISTANCE 2 (segment)	5.63%	1.86%	0%	8.09%	21.43%	13.33%	10.20%

- Differences across tasks: information gathering task elicits more refinement, information browsing tasks more *theme* relations.
- Different strategies: 1) to ask everything about an entity before turning to the next one (most common), 2) to ask about the value of a property for all the entities under discussion before turning to the next property (less common).

References and their antecedents

REL./PHEN.	THEME-ENTITY	THEME-PROPERTY	THEME	REF. Q.	REF. A.	TOTAL OF CONNECTED OCCS.
FRAGMENT (114)	53 (54.08%)	17 (16.32%)	3 (3.06%)	21 (21.42%)	0	97 (85.08%)
DEFINITE NP (50)	26 (78.78%)	0	4 (12.21%)	2 (6.10%)	0	33 (66%)
DEICTIC NP (47)	19 (51.35%)	0	13 (35.13%)	2 (5.40%)	1 (2.70%)	37 (78.72%)
ANAPHOR (83)	13 (39.39%)	2 (6.06%)	10 (30.30%)	0	5 (15.15%)	33 (39.75%)
DEICTIC PRONOUN (12)	2 (75%)	0	1 (25%)	0	0	3 (25%)
ELIDED NP (21)	9 (69.23%)	0	2 (15.38%)	0	0	13 (61.90%)
BRIDGING (92)	40 (74.07%)	0	3 (5.55%)	1 (1.85%)	0	54 (58.69%)
NOMINAL ELLIPSIS (16)	0	1 (7.69%)	6 (46.15%)	1 (7.69%)	5 (38.46%)	13 (81.25%)

Fragments and their antecedents

- There are distances between fragments and antecedents up to 6 utterances, but in most cases they are 2 utterances and 2 turns from each other.

- Antecedents are in 98 cases (85.96%) in the preceding segment and thematically related to fragments.

- In the rest of the cases antecedents are mostly in the same segment as fragments.

  (12:23:45) **USER:** Which institutions organize projects which have themes on grammar? In Germany.

References and their antecedents

- The antecedents of more implicit referring expressions (pronouns) are very often in the same segment as the expressions (same utterance, 1 utterance away).

- The antecedents of less explicit referring expressions (NPs) are mostly in the immediately preceding segment, but also often in the same segment. About 50% are 2 utterances away, 20% between 3 and 5.

- In few cases (11) antecedents of NPs are across the boundaries of the immediately preceding segment.

Thematic and discourse structure

(16:48:25) **USER:** what is the name of the coordinate **[ ]**
(16:48:54) **LT-WORLD:** Christoph Bussler.
(16:48:56) **USER:** what is his email address
(16:49:19) **LT-WORLD:** Please specify your question.
(16:49:31) **USER:** what is the homepage of **the project**
(16:49:42) **LT-WORLD:** http://dip.semanticweb.org
(16:49:57) **USER:** what is the email address of Christoph Bussler.
(16:50:13) **LT-WORLD:** The database does not contain this information.
(16:50:45) **USER:** where does **the project** take place

- There is an intervening segment between the last reference to the project and the current reference.

- However, the focus of the intervening segment is an entity introduced to the discourse in relation to the focus of the previous segment (the project).

- Thematic nesting: the embedded segment shifts the focus of attention to an entity related to the one in focus in the embedding segments.

- In the embedded segment the focused entity from the embedding segment, although not being the main focus, keeps still being in focus, that's why it can be referred later with an implicit device.

Thematic and discourse structure

- Thematic relations provide a structure which, together with the one provided by the discourse goals, limits the search space for antecedents.
- Thematic structure is in information-browsing dialogues analogous to the intentional structure in task-oriented dialogues.
- 3 degrees of context locality:
  - the same discourse segment,
  - the immediately preceding discourse segment.
  - the immediately preceding discourse segment at the same level of thematic nesting.

Does thematic structure have anything to contribute to the resolution of contextual phenomena?

- The possibility of using contextual phenomena across segments is given by certain types of thematic relatedness and contiguity of questions.
- In most cases antecedents are in the immediately preceding segment or in the same segment as the reference → local context determined by the discourse goals.
- But in some cases:
    - antecedents are across the boundaries of the immediately preceding segment → less local context determined by thematic structure.
    - a less local context may encompass several segments sharing the same theme in a more or less direct way.

Towards modelling less local context

- For QA systems querying structured data:
  - Frames: when an entity is introduced, its properties and the entities related to it through these properties are activated. Reference is resolved within the activation scope.
  - But in some cases plan recognition may be needed to decide at which level of thematic embedding a reference must be resolved.
- For open domain systems querying unstructured data and other kind of interaction of a less structured nature than our tasks, it may be more difficult to keep track of the less local context.