

# Knowledge Sources for Bridging Resolution in Multi-Party Dialog

## *A Preliminary Study*

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# Overview



- What is Bridging?
- State of the Art in Bridging Resolution
- Data and Annotation Experiments
- Knowledge Sources for Bridging Resolution
  - WordNet
  - NEW: Wikipedia
- Automatic Knowledge Extraction
- Summary and Conclusion

# Bridging vs. Coreference



**MN059:** OK, so, um, what I started looking at, uh, to begin with is just uh, [content management systems]<sub>i</sub> uh, i- i- in general.

(Some intervening utterances by the same speaker)

**MN059:** Now, if you sort of put on your semantic glasses, uh you say, well that's not all that easy, because there's an implicit um, uh, assumption behind that is that uh, all the users of this system share the same interpretation of the keyword and the same interpretation of uh, whichever taxonomy is used, and uh, I think that's a - that's a very - that's a key point of [these systems]<sub>i</sub> and they sort of always brush over this real quickly without really elaborating much of that and uh - (Bed017)

# Bridging vs. Coreference



**MN015:** Um, *outbreath* uh in a - in a smaller group we had uh, talked and decided about continuation of [the data collection].

**FN050:** *mike noise*

**MN015:** So Fey 's time with us is almost officially over, and she brought us some thirty subjects and, t- collected [the data], and ten dialogues have been transcribed and can be looked at.  
(Bed017)

# State of the Art in Bridging Resolution



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- Hahn et al. (1996)
  - Computer domain
    - *"The accumulator ... The charge time ..."*
  - Domain-dependent knowledge base
    - CHARGE-TIME - *charge-time-of* - ACCUMULATOR

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    - CHARGE-TIME - *charge-time-of* - ACCUMULATOR
- Poesio et al. (1997)
  - Wall Street Journal (no domain restriction)
    - *"The house ... The chimney ..."*
  - WordNet
    - Direct or indirect meronymy (also: Syn. and Hyp.)

# Data and Annotation: Setup



- Two project-external annotators
- Ten ICSI Meeting Corpus dialogs
- Simple instructions:
  1. Classify NPs as `old`, `mediated`, or `new`
  - 2a. For `old`: Identify *coreferent* antecedent
  - 2b. For `mediated`: Identify *bridging* antecedent
- MMAX2 annotation tool



# Data and Annotation: Setup



```
MMAX2 1.12 /home/chmark/Data/is_data/Bed017.mmax [modified]
File Settings Display Tools Plugins Info  Show ML Panel
MN015 mouth
ME010 O_ K. So, here we are.
FE004 laugh
ME003 Once again.
FN050 laugh
ME010 Once again, right, together.
MN015 laugh
ME010 Um, so we haven't had a meeting for a while, and - and
ME010 probably won't have one next week, I think a number of people are gone.
ME010 Um, so Robert, why don't you bring us up to date on
ME010 where we are with E_D_U?
MN015 Um, outbreath
MN015 mouth uh in a - in a smaller group we had uh, talked and decided about continuation of the data collection.
FN050 mike noise
MN015 So Fey's time with us is almost officially over,
MN015 and she brought us some thirty subjects and, t- collected the data, and
FN050 mike noise
MN015 ten dialogues have been transcribed and can be looked at. If you're interested in
MN015 that, talk to me.
MN015 Um, and we found another uh, cogsci student who's interested in playing wizard for us.
MN015 Here we're gonna make it a little bit more
MN015 complicated for the subjects, uh this round.
ME003 mike noise
MN015 She's actually suggested to
MN015 look um, at the psychology department students, because they have to partake in two experiments in order
to
MN015 fulfill some requirements.
MN015 So they have to be subjected, breath-laugh humor, subjects are subjected to things before they can actually
```

# Data and Annotation: Kappa



	old	mediated	new	all
<b>Bed016</b>	.78	.71	-.02	.71
<b>Bed017</b>	.77	.59	.51	.66
<b>Bmr001</b>	.80	.59	.16	.63
<b>Bmr002</b>	.78	.69	.40	.71
<b>Bns003</b>	.73	.55	.16	.59
<b>Bro003</b>	.68	.57	.08	.60
<b>Bro004</b>	.77	.54	.19	.60
<b>Bro005</b>	.79	.69	.29	.71
<b>Bsr001</b>	.76	.69	.49	.71
<b>Btr001</b>	.79	.73	.14	.74

# Data and Annotation: Confusion Matrix



	old	mediated	new	Anno 1
old	<b>2552</b> (86.71%)	221	10	2783
mediated	137	<b>743</b> (58.12%)	13	893
new	23	163	<b>44</b> (17.39%)	230
Anno 2	2712	1127	67	3906

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- Basis for bridging resolution data set

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Evaluation of knowledge sources for bridging resolution
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Data set of correct / undisputed cases
- -> Just select those where annotators agree
- Restriction: *Definite* NP anaphors only

# Data and Annotation: Data Set Creation



	All anaphors	Definite anaphors only
<b>Same antecedent</b>	86	70
<b>Same head</b>	22	14
<b>Different antecedents</b>	31	27
<b>One antecedent missing</b>	129	72
<b>Two antecedents missing</b>	475	141
$\Sigma$	743	324

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- 84 pairs covering *diverse* (semantic) relations
- Selection of sub-set of 16 pairs on the basis of plausibility

# Data Set



<b>Antecedent</b>	<b>Bridging Anaphor</b>
microphone	batteries, switch
university	address
cafe	floor
data collection	data
Bayes-net	input nodes
field trip	logistics
neural net	training
experiment	result
table	column, line
problem	answer
(two) people	(the) weaker voice
France	villages
utterance	beginning
question	answer

# Evaluation: Antecedent Coverage

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- Manual lookup of antecedent entries

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(<http://wordnet.princeton.edu/perl/webwn>)
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- Missing in Wikipedia  
(<http://en.wikipedia.org>)
  - none

# Evaluation: Antecedent Entries

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- Manual search for anaphor string in antecedent entries

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- Rationale: Presence of anaphor signals relatedness

# Evaluation: Coverage



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# Evaluation: Wikipedia Coverage



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- For automatic processing, manual lookup insufficient
- -> Automatic procedure based on Wikipedia Java API (Zesch et al. 2008)
- Restricted to Wikipedia due to better coverage
- Wikipedia API uses *local* Wikipedia database!

# Evaluation: Automatic Extraction



- Lookup *full* (lemmatized) antecedent string in Wikipedia.

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- Else, search for lemmatized bridging anaphor head in
  - full antecedent page text, or
  - antecedent page *outlink* text only.

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  - full antecedent page text, or
  - antecedent page *outlink* text only.
- Outlink text = text under a hyperlink
- Rationale: Outlink text is important for the source page.



# Evaluation: Automatic Extraction




Microphone - Wikipedia, the free encyclopedia - Mozilla Firefox

File Bearbeiten Ansicht Chronik Lesezeichen Extras Hilfe

W http://en.wikipedia.org/wiki/Microphone

Usage [\[edit\]](#)

Condenser microphones span the range from cheap throw-aways to high-fidelity quality instruments. They generally produce a high-quality audio signal and are now the popular choice in laboratory and studio recording applications. They require a power source, provided either from microphone inputs as [phantom power](#) or from a small [battery](#). Power is necessary for establishing the capacitor plate voltage, and is also needed for internal amplification of the signal to a useful output level. Condenser microphones are also available with two diaphragms, the signals from which can be electrically connected such as to provide a range of polar patterns (see below), such as cardioid, omnidirectional and figure-eight. It is also possible to vary the pattern smoothly with some microphones, for example the [Røde NT2000](#) or [CAD M179](#).



[Patti Smith](#) singing into a [Shure SM58](#) microphone

# Evaluation: Automatic Extraction

A screenshot of a Mozilla Firefox browser window displaying the Wikipedia article for "Question". The browser's address bar shows the URL "http://en.wikipedia.org/wiki/Question". The page features the Wikipedia logo on the left, a navigation menu with links like "Main Page" and "Contents", and the main article text. The article text includes a disambiguation note, a definition of a question, and a quote. The word "answer" in the definition is circled in red. The quote on the right discusses four ways of answering questions.

Question - Wikipedia, the free encyclopedia - Mozilla Firefox

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## Question

From Wikipedia, the free encyclopedia

*For other uses, see [Question \(disambiguation\)](#).*

A **question** may be either a linguistic expression used to make a request for [information](#), or else the request itself made by such an expression. This information is provided with an [answer](#).

Questions are normally *put* or *asked* using interrogative [sentences](#). But they can also be put by [imperative](#) sentences, which normally express commands: "Tell me what 2 + 2 is"; conversely, some expressions, such as "Would you pass the

“ There are these four ways of answering questions. Which four? There are questions that should be answered categorically [straightforwardly yes, no, this,

# Evaluation: Automatic Extraction



Bridging Antecedent	Bridging Anaphor	Antecedent Entry Found?	Bridging Anaphor Found	
			In Page Text	In Outlink
microphone	batteries	yes	yes	no
data collection	data	no	-	-
neural net	training	yes	yes	no
experiment	result	yes	yes	no
table	column	no	-	-
easy problem	answer	yes	yes	no
question	answer	yes	yes	yes

# Evaluation: Automatic Extraction



- Automatic procedure failed to detect two entries:
  - *Data collection* entry missing in local Wikipedia version
  - *Table* entry is a disambiguation page

# Evaluation: Automatic Extraction



- Automatic procedure failed to detect two entries:
  - *Data collection* entry missing in local Wikipedia version
  - *Table* entry is a disambiguation page
- Outlink text only relevant in one out of five cases.

# Summary and Conclusion



- Evaluated applicability of WordNet and Wikipedia as knowledge sources for bridging resolution.

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- WordNet has limited coverage, but contains fundamental relations not found in Wikipedia.
- Wikipedia has better coverage, in particular due to much longer entries.
- Automatic access to required knowledge can be provided by an API.
- Automatic treatment of disambiguation pages needs to be improved (e.g. Ponzetto & Strube 2007)

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- The MMAX2 annotation tool is available at  
`mmax2.sourceforge.net`
- The Wikipedia API is available at  
`www.ukp.tu-darmstadt.de/software/jwpl/`