Call Routing

11-761 Dialog Seminar
Class Presentation
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Call Routing Papers

- How May I Help You?

- Dialogue Management in Vector-Based Call Routing
  Jennifer Chu-Carroll and Bob Carpenter (1998)

- Natural Language Call Routing: A Robust, Self-Organizing Approach
  Bob Carpenter Jennifer Chu-Carrol (1998)
Overview
Three Papers -- Two Bodies of Work

- Gorin’s Paper is earlier and focuses exclusively on routing calls based on user response to the prompt "How may I help you?"

- Carpenter and Chu-Carroll’s Papers are more explicit about including three types of functionality:
  - call routing
  - transfer to a human operator
  - disambiguation questions
Overview
(continued)

- Gorin’s Paper also engages in clarifying dialogs but does not consider that as an endpoint of the dialog, as compared with Chu-Carroll and Carpenter
Confirmations and Clarifications in Gorin

Explicit Confirmation

M: How may I help you?
U: Can you tell me how much it is to Tokyo?
M: You want to know the cost of a call?
U: Yes, that's right.
M: Please hold on for rate information.

M: How may I help you?
U: What's the area code for Chicago?
M: You want an area code.
U: (silence)
M: The area code for Chicago is 312.

Implicit Confirmation

M: How may I help you?
U: Can I charge this call please?
M: You want to charge this to another number?
U: No, to my Universal card.
M: You want to charge this call to a credit card.
U: (silence)
M: Please speak your card number.

Disconfirmation/Clarification + Implicit Confirmation
Call Type Distribution

10,000 Sentences
- 8K Training
- 2K Testing

- yes I need to make a long distance phone call and charge it to my home phone number please
- yes how much is it to call the number I just dialed
- yes where is area code x x x
- yes what time is it in area code x x x right now I'm trying to gauge the time difference
- I just I'm trying to get a number from information

14 Services + OTHER category
Vocabulary Growth
Gorin’s Matching Algorithm

- Statistical bigram grammar automatically created from training data for each category.
- Phrase fragment induction (described in Goring ’96) is used.
- The fragment is then run through a simple pattern-matching classifier.
Three Types of Outcomes

Correct Detections

yes I_JUST_DIALED AN_INCORRECT_NUMBER.
I_WAS_CUT_OFF when trying to call this number.

Missed Detections / Incorrect Rejections

I am trying to call wooster and the number I have rings to a different number.
I’m going to blame this one on my wife I misread her handwriting.

Incorrect Detections

yes I have a number here and I don’t know if it’s a WRONG_NUMBER.
I was trying to get xxx xxx xxxx and it said it WAS_DISCONNECTED.

Figure 4. Detecting Billing Credit Queries from Speech
Carpenter and Chu-Carroll’s Architecture

Figure 1: Call Router Architecture
Carpenter and Chu-Carroll’s Corpus

- 4497 transcribed telephone calls
- Customers interacting with human operators at a large call center
- Financial services domain
- 23 destinations selected
  - each had 10 or more calls in the corpus
Carpenter and Chu-Carroll’s Corpus (ctd.)

Types of Request in Corpus

Frequency that a dialog action should be employed based strictly on ambiguity

<table>
<thead>
<tr>
<th></th>
<th>Name</th>
<th>Activity</th>
<th>Indirect</th>
</tr>
</thead>
<tbody>
<tr>
<td># of calls</td>
<td>949</td>
<td>3271</td>
<td>277</td>
</tr>
<tr>
<td>% of all calls</td>
<td>21.1%</td>
<td>72.7%</td>
<td>6.2%</td>
</tr>
</tbody>
</table>

Table 1: Semantic Types of Caller Requests

<table>
<thead>
<tr>
<th></th>
<th>Notification</th>
<th>Query</th>
</tr>
</thead>
<tbody>
<tr>
<td># of calls</td>
<td>3608</td>
<td>657</td>
</tr>
<tr>
<td>% of all calls</td>
<td>80.2%</td>
<td>14.6%</td>
</tr>
</tbody>
</table>

Table 2: Call Operator Dialogue Actions
Training uses an IR approach

- One document created for each destination.
  - Composed of all the callers’ contributions in conversations leading to that destination.
- These documents are then *stemmed* (stripped of morphological info) by Sproat, resulting in the *root word form*.
- High frequency n-grams are combined into one term.
Training uses an IR approach (ctd.)

- This corpus is then indexed
  - tf idf
  - singular value decomposition to reduce the dimensionality of the feature space
Router

- The router takes a user utterance (query) and extracts n-gram terms (stemmed).
- These are used in pseudo-document generation
- IR queries are then performed with the new pseudo-document as the query
- These results are scored (confidence values slightly better than cosine)
Router (continued)

- After scoring, a decision is made.
  - One destination possible → route to destination
  - Two or more possible → disambiguate
  - No possible destinations → operator
Carpenter and Chu-Carroll’s Threshold

Figure 2: Router Performance vs. Threshold
Carpenter and Chu-Carroll’s Evaluation Scheme

Figure 3: Classification of Router Outcome

Table 3: Calculation of Upperbounds and Lowerbounds
Results: Effect of ASR Noise

<table>
<thead>
<tr>
<th></th>
<th>Unambiguous Requests</th>
<th>Ambiguous Requests</th>
<th>All Requests</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NO NOISE</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LB</td>
<td>80.1%</td>
<td>58.5%</td>
<td>75.6%</td>
</tr>
<tr>
<td>UB</td>
<td>96.7%</td>
<td>98.8%</td>
<td>97.2%</td>
</tr>
</tbody>
</table>

**Table 4:** Transcription Results, no rejection, threshold = 0.2

<table>
<thead>
<tr>
<th></th>
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<th>All Requests</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ASR NOISE</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LB</td>
<td>77.9%</td>
<td>47.6%</td>
<td>71.5%</td>
</tr>
<tr>
<td>UB</td>
<td>90.6%</td>
<td>86.6%</td>
<td>89.7%</td>
</tr>
</tbody>
</table>

**Table 5:** ASR Results, no rejection, threshold = 0.2
Conclusion

- Performance adequate for replacing menus with automated routing on real systems.
- Specialized development required
- Labor intensive
- How can the process be automated?