“Divide and Conquer”
Presentation 2
John Grosh & Chris Valant
Agenda

Topic Overview

Paper 1: Towards a method for evaluating naturalness in conversational dialog systems

Paper 2: Making a clever intelligent agent: The theory behind the implementation

Paper 3: Fuzzy logic in natural language processing

Questions
Project Topic: Conversational “Chatbot”

Our Goal

Generate “intelligent” conversational responses to user input without relying on selecting random numbers, and instead exhaustively or heuristically search the trained vocabulary for the best response.

Parallel Programming

Write the portion of the program that deals with finding a response in parallel to increase response time (strong scaling) or increase the search space (weak scaling)
The Sentence Generation Tree

Sequential Program
Depth-first sequentially

Parallel Program
Breadth-First sequentially

Depth-First in parallel
Towards a method for evaluating naturalness in conversational dialog systems

Author: Victor Hung, Miguel Elvir, Avelino Gonzalez, Ronald DeMara


Date: 11-14 Oct. 2009

Pages: pp111

URL: http://ieeexplore.ieee.org/document/5345904/
Problem addressed by this paper

- Focus is determining naturalness
  - How well a chatbot can maintain a natural conversation flow
- Quantitative methods can not be the only metric in assessing performance
- There is a great deal of subjectivity in assessing the performance of conversation bots
- There is no general method for judging how well it performs
Applications

Functional

- Customer Service
- Tool for automating part of a business
- Weather, News, and Daily Event reminders
- Grocery bot
- Scheduling bots
- Clevertweet

Fun

- Have a conversation
  - Some applications are of specific people, like the William Shakespeare bot.
- Advice, fortunes, fun facts
Contributions of this paper

• Surveyed the current practices in evaluating conversation bot responses
• Discussed the duality of quantitative and qualitative aspects of evaluation
• Provided methodology to determine the effectiveness and naturalness of a dialog system
• Performance function to evaluate the total effectiveness of a dialog system in relation to its task
  • The dialog performance (the means)
  • The task success (the ends)
How we plan to use this in our investigation

• To validate the performance of our chat bot
  • Using the proposed method to compare results from multiple chatbots
  • We will compare our chat bot with another like CleverBot.
  • Testers will have pre-specified goals to achieve during dialog interaction
  • A log will be kept for quantitative analysis and user will fill out quality questionnaire
• Sentence tree search speed will a focus
• Using some or all of the chatbot metrics described next
PARAdigm for Dialogue System Evaluation (PARADISE)

Performance Function

\[ \text{Performance} = (\alpha \cdot N(\kappa)) - \sum_{i=1}^{n} w_i \cdot N(c_i) \]

Attribute Value Confusion Matrix

<table>
<thead>
<tr>
<th>DATA</th>
<th>Departure City</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ATL</td>
</tr>
<tr>
<td>ATL</td>
<td>16</td>
</tr>
<tr>
<td>BOS</td>
<td>1</td>
</tr>
<tr>
<td>CLT</td>
<td>5</td>
</tr>
<tr>
<td>DEN</td>
<td>1</td>
</tr>
<tr>
<td>SUM</td>
<td>23</td>
</tr>
</tbody>
</table>

Chatbot Cost Metrics

<table>
<thead>
<tr>
<th>Metric</th>
<th>Type</th>
<th>Data Collection Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total elapsed time</td>
<td>Efficiency</td>
<td>Quantitative Analysis</td>
</tr>
<tr>
<td>Total number of user/system turns</td>
<td>Efficiency</td>
<td>Quantitative Analysis</td>
</tr>
<tr>
<td>Total number of system turns</td>
<td>Efficiency</td>
<td>Quantitative Analysis</td>
</tr>
<tr>
<td>Total number of turns per task</td>
<td>Efficiency</td>
<td>Quantitative Analysis</td>
</tr>
<tr>
<td>Total elapsed time per turn</td>
<td>Efficiency</td>
<td>Quantitative Analysis</td>
</tr>
<tr>
<td>Number of re-prompts</td>
<td>Qualitative</td>
<td>Quantitative Analysis</td>
</tr>
<tr>
<td>Number of user barge-ins</td>
<td>Qualitative</td>
<td>Quantitative Analysis</td>
</tr>
<tr>
<td>Number of inappropriate system responses</td>
<td>Qualitative</td>
<td>Quantitative Analysis</td>
</tr>
<tr>
<td>Concept Accuracy</td>
<td>Qualitative</td>
<td>Quantitative Analysis</td>
</tr>
<tr>
<td>Turn correction ratio</td>
<td>Qualitative</td>
<td>Quantitative Analysis</td>
</tr>
<tr>
<td>Ease of usage</td>
<td>Qualitative</td>
<td>Questionnaire</td>
</tr>
<tr>
<td>Clarity</td>
<td>Qualitative</td>
<td>Questionnaire</td>
</tr>
<tr>
<td>Naturalness</td>
<td>Qualitative</td>
<td>Questionnaire</td>
</tr>
<tr>
<td>Friendliness</td>
<td>Qualitative</td>
<td>Questionnaire</td>
</tr>
<tr>
<td>Robustness regarding misunderstandings</td>
<td>Qualitative</td>
<td>Questionnaire</td>
</tr>
<tr>
<td>Willingness to use system again</td>
<td>Qualitative</td>
<td>Questionnaire</td>
</tr>
</tbody>
</table>

Task success is recall
Problem Addressed

- Collaborative communication
  - Each participant wants mutual understanding of the topic
- Availability, anchoring and adjustment
  - Availability: People usually believe things to be more similar to their own understanding than they might actually be
  - Anchoring and Adjustment: Making a model of the current topic and slightly modifying it based on the conversation
- Maxim of Relation
  - A statement doesn’t need to fully reflect all possible information because both participants can infer from context what the statement means
Contribution towards a Solution

Suggestions for creating clever agents

• Don’t imitate these patterns, but rather take advantage of them
• Psycholinguistic theory
How We Will Use This

Knowledge, Topics, and Response Heuristic

• Utilize anchoring to establish a knowledge base for a particular conversation
• Rely on the Maxim of Relation to react positively unless there is significant evidence of a needed negative reaction
Paper 3

Fuzzy logic in natural language processing

Author: Vilém Novák


Date: 9-12 July 2017

Pages: 1-6

URL: http://ieeexplore.ieee.org/document/8015405/
Problem Addressed

- Linguistics are often vague and have multiple ‘solutions’
- Modeling language can be difficult
- Fuzzy set theory has been mostly unused in linguistics (at the time of writing)

![Diagram showing fuzzy sets to characterize the temperature of a room.](image)
Fuzzy Sets

• Pair \((U, m)\) where \(U\) is a set and \(m: U \rightarrow [0, 1]\)
• \(m(x)\) is a grade of membership
• \(x\) not included when \(m(x) = 0\)
• \(x\) fully included when \(m(x) = 1\)

Fig. 2 - Fuzzy Sets to characterize the Temp. of a room.
Contribution towards a Solution

Fuzzy Type Theory applied to Natural Language Processing

- More in-depth classification of words (ex: countable vs mass-nouns)
  - nouns, adjectives, hedging, evaluative expressions, quantifiers, determiners, noun phrases, and verbs
- Fuzzy Natural Logic in the field of language processing
How We Will Use This

• Utilize some elements of FTT for classifying words
• While we might not separate nouns and adjectives, we might use other characteristics such as usage percentage, word structure, or location within sentences
Questions?