BRNO UNIVERSITY OF TECHNOLOGY
VYSOKÉ UČENÍ TECHNICKÉ V BRNĚ

FACULTY OF INFORMATION TECHNOLOGY
FAKULTA INFORMAČNÍCH TECHNOLOGIÍ

DEPARTMENT OF COMPUTER GRAPHICS AND MULTIMEDIA
ÚSTAV POČÍTAČOVÉ GRAFIKY A MULTIMÉDIÍ

STYLIZED NATURAL LANGUAGE GENERATION IN DIALOGUE SYSTEMS

GENEROVÁNÍ STYLIZOVANÉHO LIDSKÉHO JAZYKA V DIALOGOVÝCH SYSTÉMECH

BACHELOR'S THESIS
BAKALÁŘSKÁ PRÁCE

AUTHOR **KSENIA BOLSHAKOVA**
AUTOR PRÁCE

SUPERVISOR **Ing. MARTIN FAJČÍK**
VEDOUCÍ PRÁCE

BRNO 2020

Abstract

Do tohoto odstavce bude zapsán výtah (abstrakt) práce v anglickém jazyce.

Abstrakt

Do tohoto odstavce bude zapsán výtah (abstrakt) práce v českém (slovenském) jazyce.

Keywords

Sem budou zapsána jednotlivá klíčová slova v anglickém jazyce, oddělená čárkami.

Klíčová slova

Sem budou zapsána jednotlivá klíčová slova v českém (slovenském) jazyce, oddělená čárkami.

Reference

BOLSHAKOVA, Ksenia. *Stylized Natural Language Generation in Dialogue Systems.* Brno, 2020. Bachelor's thesis. Brno University of Technology, Faculty of Information Technology. Supervisor Ing. Martin Fajčík

Stylized Natural Language Generation in Dialogue Systems

Declaration

I hereby declare that this Bachelor's thesis was prepared as an original work by the author under the supervision of Mr. X The supplementary information was provided by Mr. Y I have listed all the literary sources, publications and other sources, which were used during the preparation of this thesis.

.....
Ksenia Bolshakova
November 17, 2019

Acknowledgements

Here it is possible to express thanks to the supervisor and to the people which provided professional help (external submitter, consultant, etc.).

Contents

Chapter 1

Introduction

//TODO Write what is NLP

Chapter 2

Dialogue systems

Dialogue system is a computer system to communicate with a human. Nowadays you meet dialog systems everywhere. A lot of devices have incorporated goal-oriented spoken dialogue systems, such as Yandex's Alisa, Apple's Siri, Microsoft's Cortana, Amazon Alexa, and Google Assistant. Dialogue systems are also used in cars (hands-free car-specific functions, Android Auto, Apple CarPlay, vendor-specific solutions), web (search assistants (IKEA), Facebook Messenger and Telegram chatbots), robots, computer games, research systems (skylar.speech.cs.cmu.edu) etc, because a conversation is a natural way for people to get information.

Basic Dialogue System Types:

- Task-oriented
  - focused on completing a certain task(s)
- Non-task-oriented
  - chitchat
  - gaming the Turing test

Communication Domains:
„**Domain**“ is a conversation topic or an area of interest

- Single/Closed-domain is one well-defined area
- Multi-domain is joining several single-domain systems
- Open-domain "responds to anything"

Exists several **modes of communication**:

- Text
- Voice
- Multimodal
  - voice/text + graphics
  - additional modalities: video - gestures, mimics; touch

Dialogue initiative:

- system-initiative
  - system asks questions, user must reply in oreder to progress
  - least natural
  - „form-filling“ („Hello, please enter your e-mail“)
- user-initiative
  - user asks, machine responds („Siri, set the timer for 5 minutes“)
- mixed-initiative
  - system and user both can ask and react to queries
  - most natural

Dialogue system architecture is illustrated in Figure 2.1. This architecture consists from Natural Language Understanding (NLU), dialogue management (DM), and Natural Language Generation (NLG).

NLU extracts the meaning from the user utterance and converts into a structured semantic representation. Natural Language Understanding traditionally consists of domain identification and intent prediction, which are framed as utterance classification problems, and slot filling, framed as a sequence tagging task.

DM plays two roles,tracking the dialogue state and performing the dialogue policy (i.e., telling the agent how to act given the dialogue state.)

NLG transforms structured data into natural language.[2]

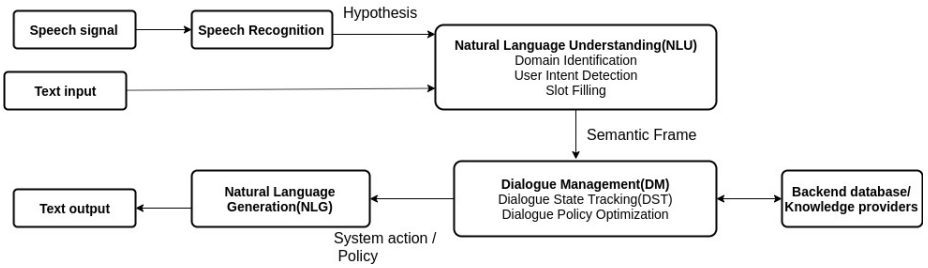

Figure 2.1: Dialogue system architecture.

Chapter 3

Natural Language Generation

Natural Language Generation is a subsection of Natural Language Processing (NLP). NLG approaches can be grouped into two categories, one focuses on generating text using templates or rules (linguistic) methods, the other uses corpus-based statistical methods, where **corpus** is a collection of texts.

Categories of Natural Language Generation approaches

Template-based systems map their non-linguistic input directly to the linguistic surface structure. This linguistic structure may contain gaps. Well-formed outputs does not cointain gaps. The template-based system selects a proper response for the current conversation from a repository with response selection algorithms.

Advantages:

- Robust and reliable
- The output produced by this modules is likely to be grammatically correct and not contain unexpected generation errors
- Generation process is fully controlles

Disadvantages:

- Number of templates grows quickly (different templates for singular and plural versions)
- Expensive and time-consuming to deploy a real dialogue system
- Limits its usage to other domains
- Not much variation in output (no planning of text; simple concatenation of strings)
- Not able to handle unknown inputs
- Templates often sound unnatural due to their generic structures
- Not able to learn and not able to adapt to the user

Example: „The 306 train leaves Aberdeen at 11:20 am“

Semantic representation:

$$Departure(train_{306}, location_{abdn}, time_{1120})$$

Template:
[train] *is leaving* [town] *now*

The gaps represented by **[train]** and **[town]** are filled by looking up the relevant information in a table. More information you can find in [4].

Corpus-based models dominate the NLG community, special in the case of open-domain tasks, where it is almost impossible to hand-craft the templates for all possible combinations of semantic units and their respective surface realization. In corpus-based systems include statistical and machine learning approaches.

Advantages:

- Possibility to mimick the language of a real domain expert
- Ability to generate more proper responses that could have never appeared in the coprus
- Possibility to use for open-domain dialogue systems
- A lot of possible variations of output
- Ability to learn
- Ability to handle unknown inputs

Disadvantages:

- It is necessary to have a good corpus
- Generation process is not fully controlled
- The output can be grammatically incorrect

[3] [1]

NLG problems

The NLG component converts an abstract dialogue action into natural language surface utterances. In NLG it is necessary to control not only correctness of output but also if output is appropriate or felicitous in a given context. As noticed in [5], a good generator usually relies on several factors: adequacy (similarity in meaning), fluency (syntactic correctness), readability (efficacy in context), and variation.

Chapter 4

Other

Oh and Rudnicky showed that stochastic generation benefits from two factors:

- it takes advantage of the practical language of a domain expert instead of the developer
- it restates the problem in terms of classification and labeling, where expertise is not required for developing a rule-based generation system

Non-task-oriented dialogue system

The aim of task-oriented dialogue systems is to complete specific tasks fo user, non-task-oriented dialogue systems focus on conversing with human on open domains.

//TODO: more information in article [] //TODO: Info about datasets //TODO: NLP vs Computation linguistic

//TODO: In non task oriented dialogue systems it is very difficult to use template-based generation [3]

Bibliography

[1] Chen, H., Liu, X., Yin, D. and Tang, J. *A Survey on Dialogue Systems: Recent Advances and New Frontiers.* [Online; visited 17.11.2019]. Available at: https://arxiv.org/pdf/1711.01731.pdf.

[2] Chen, Y.-N. and Gao, J. *Open-Domain Neural Dialogue Systems.* [Online; visited 10.11.2019]. Available at: https://www.aclweb.org/anthology/I17-5003.pdf.

[3] Oh, A. H. and Rudnicky, A. I. *Dialog Annotation for Stochastic Generation.* [Online; visited 10.11.2019]. Available at: https://acl-arc.comp.nus.edu.sg//~antho/W/W00/W00-0306.pdf.

[4] Reiter, E. and Dale, R. *Building Applied Natural Language Generation.* [Online; visited 17.11.2019]. Available at: https://pdfs.semanticscholar.org/728e/18fbf00f5a80e9a070db4f4416d66c7b28f4.pdf.

[5] Stent, A., Marge, M. and Singhai, M. *Evaluating Evaluation Methods for Generation in the Presence of Variation.* [Online; visited 17.11.2019]. Available at: http://www.cs.cmu.edu/~mrmarge/cicling04eval.pdf.